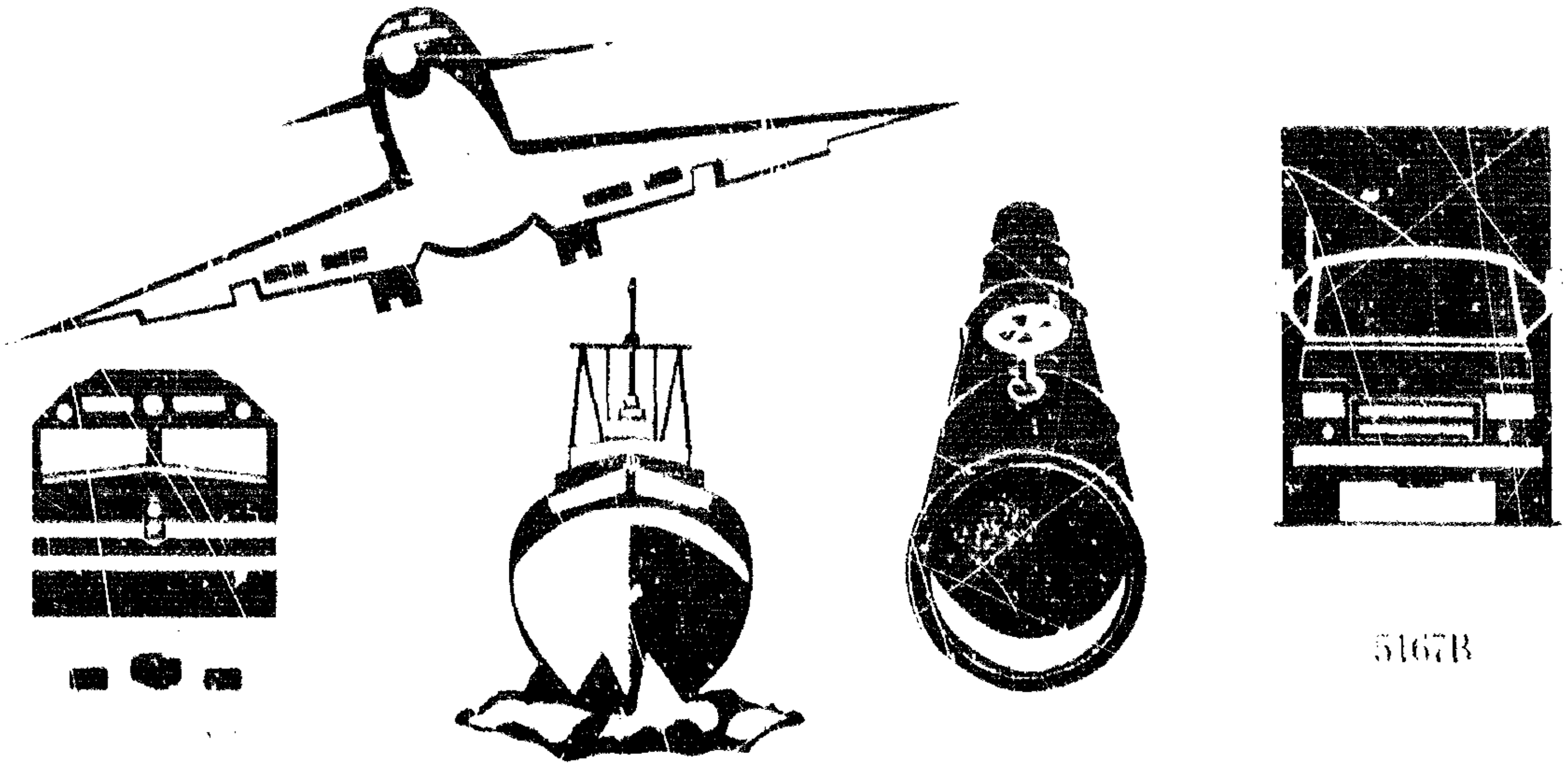
PB91-916304
NTSB/RAR-91/04

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

DERAILMENT OF
CSX TRANSPORTATION INC. FREIGHT TRAIN
AND HAZARDOUS MATERIALS RELEASE
NEAR FREELAND, MICHIGAN
ON JULY 22, 1989



5167B

The National Transportation Safety Board is an independent Federal agency dedicated to promoting aviation, railroad, highway, marine, pipeline, and hazardous materials safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable cause of accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The Safety Board makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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DERAILMENT OF CSX TRANSPORTATION INC. FREIGHT TRAIN AND HAZARDOUS MATERIALS RELEASE NEAR FREELAND, MICHIGAN ON JULY 22, 1989

ADOPTED: JULY 23, 1991

NOTATION 5167B

Abstract: This report explains the derailment of CSX Transportation, Inc., freight train R-33-22 and the subsequent release of hazardous materials near Freeland, Michigan, on July 22, 1989. The safety issues discussed in the report are equipment maintenance and inspection practices for heavy-capacity freight cars; shipper notification of accidents involving excess dimensional loads; the lack of operable multifunction event recorders; tank car performance; emergency response procedures for trimethylchlorosilane; and CSX training and procedures for the collection of toxicological samples, surveillance of safety devices, and crew placement. The National Transportation Safety Board made safety recommendations addressing these issues to the Federal Railroad Administration, the Association of American Railroads, the Silicon Health Council, the Dow Corning Corporation, the CSX Transportation, Inc., and the Atchison, Topeka and Santa Fe Railway Company.

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EXECUTIVE SUMMARY

About 11:20 a.m. central daylight time on July 22, 1989, CSX Transportation, Inc., freight train R-331-22 derailed near Freeland, Michigan. The train consisted of 2 locomotive units, 17 loaded freight cars, 15 empty freight cars, and an unoccupied caboose. Of the 14 freight cars that derailed, 6 were tank cars that sustained damage resulting in either partial or total loss of load. A flatcar (ATSF 90005) carrying a heat recovery steam generator, which was being transported as an excess dimensional load, overturned, and the module was destroyed. One nearby residence was destroyed by the fire that ignited following the release of hazardous materials. About 1,000 residents were evacuated for 7 days after the accident. No one was killed; 11 people were treated for injuries. Estimated damage exceeded $4 million.

The National Transportation Safety Board determines that the probable cause of this accident was inadequate car inspection by CSX and ATSF that, combined with other factors, including track conditions and train handling, resulted in wheel lift and the subsequent derailment of ATSF 90005. Contributing to the severity of the accident were the release of hazardous materials from tank cars that were not equipped with head-shield protection and the lack of effective fire fighting techniques for responding to large trimethylchlorosilane fires.

The major safety issues discussed in this report include:

- Equipment maintenance and inspection practices for heavy-capacity freight cars.
- Shipper notification of accidents involving excess dimensional loads.
- The lack of operable multifunction event recorders.
- Tank car performance.
- Emergency response procedures for trimethylchlorosilane.
- CSX training and procedures for the collection of toxicological samples, surveillance of disabled safety devices, and crew placement.

Safety recommendations concerning these issues were made to the Federal Railroad Administration, the Association of American Railroads, the Silicon Health Council, the Dow Corning Corporation, the CSX Transportation, Inc., and the Atchison, Topeka and Santa Fe Railway Company. The Safety Board also reiterated Safety Recommendation R-89-50 to the Federal Railroad Administration.

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RAILROAD ACCIDENT REPORT

DERAILMENT OF CSX TRANSPORTATION INC. FREIGHT TRAIN AND HAZARDOUS MATERIALS RELEASE NEAR FREELAND, MICHIGAN ON JULY 22, 1989

INVESTIGATION

Accident

General.--The traincrew for CSX Transportation, Inc., (CSX) freight train R-331-22 reported for duty at Port Huron, Michigan, at 5 a.m. central daylight time, July 22, 1989. The crew, which comprised an engineer, a conductor, and a brakeman, received the necessary documents and authority to operate over two CSX subdivisions and the Grand Trunk Western (GTW) railroad. During depositions taken following the accident, the traincrew stated that they reviewed all the operating documents, as well as the train profile, and understood the contents. Following an initial terminal air brake test at Port Huron, the train departed without incident at 5:45 a.m. for Midland, Michigan. (See figure 1.)

Shortly after train R-331-22 entered the GTW main track just west of Port Huron, an emergency brake application occurred. The conductor and brakeman inspected the train and found an air hose separation between the 18th and 19th cars. The conductor replaced the broken air hose and the train proceeded without further incident. The train reentered CSX trackage at North Kearsley and continued to Flint, Michigan.

At Flint the crew set out 14 cars and picked up 23, including cars carrying an excess dimensional load[1] (see figure 2) and 11 loads of hazardous materials. CSX car inspectors had performed a detailed, indepth mechanical inspection of 20 cars of the pickup; they did not examine the car carrying the excess dimensional load and the 2 empty idler cars associated with it, which were placed on the track after the inspection. None of the inspected cars were reported to be mechanically defective.

The traincrew stated that after the cars were switched, crewmembers performed an intermediate terminal air brake inspection of the cars that had been added at Flint. They pressurized the trainline and then set the train brakes. The brakeman walked alongside the 23 cars, observing brake cylinder pistons to make sure they had applied. He testified that he did not notice any piston that had not applied but noted that he could not see the piston on every car and was unable to

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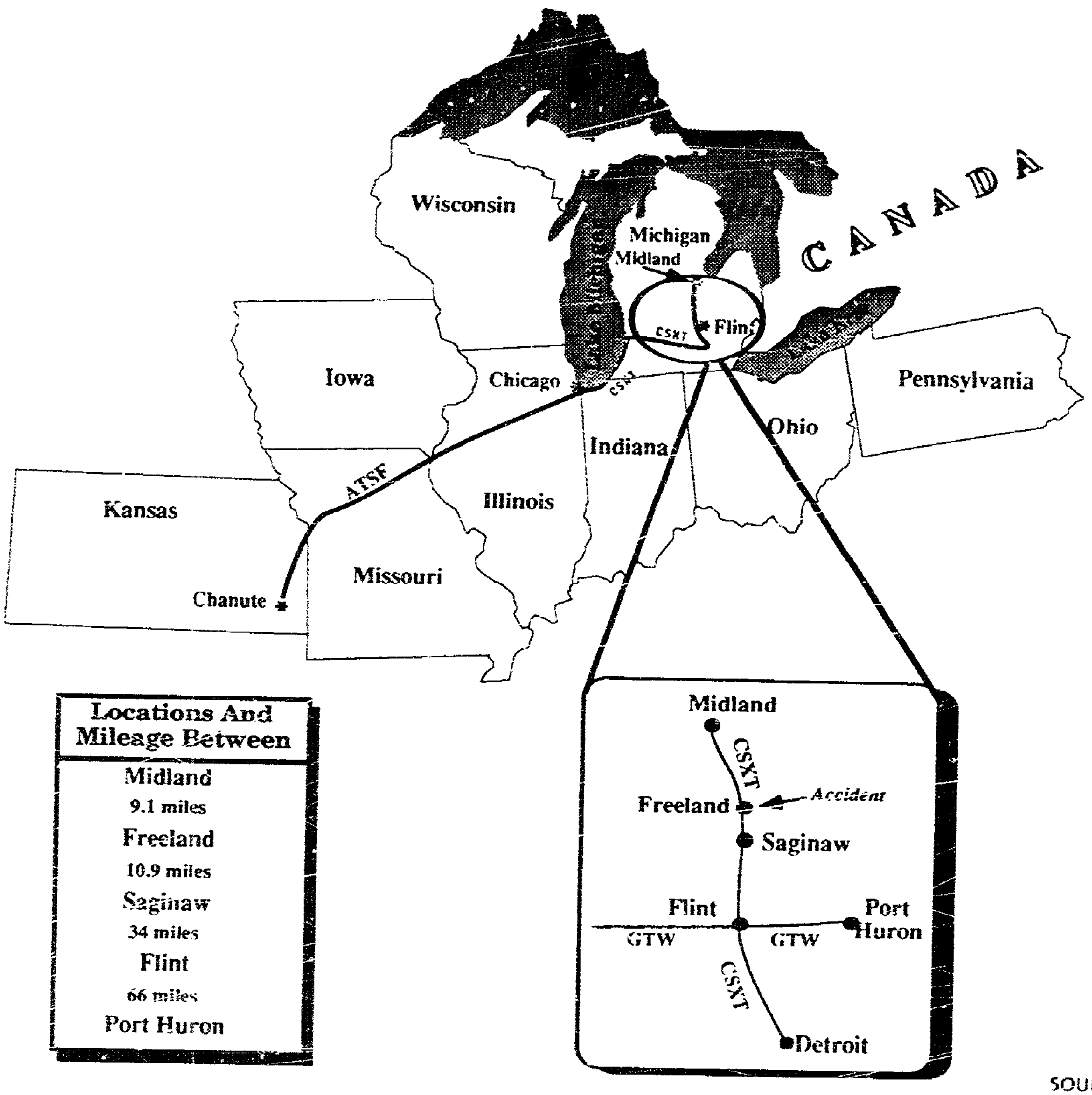
[1]Load that exceeds height standards, width standards, or both, as established by the Association of American Railroads (AAR).

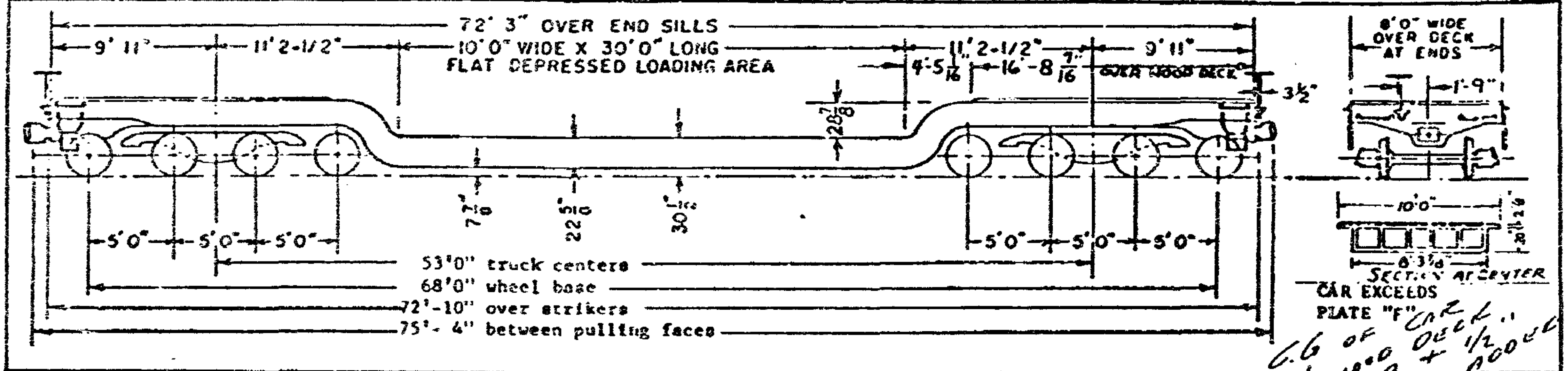


MAP NOT TO SCALE

SOURCE: NTSB

Figure 1.--Route of freight train R-331-22.

FIRST ISSUE DATE 12-18-58	ATSF FT-13 (DEPRESSED CENTER)	SERIES: 90005	NO. OF CARS: 1
DATE OF REVISION	AAR MECHANICAL DESIGNATION FD	BUILT: T.S. 1958	FOLIO 211-4
2-02-73 / 8-08-80			
7-22-76 / OCT. 1 6 1981			PAGE F-35



CAR EXCEEDS PLATE "F"

6.6 of car w/ wood deck Removed + 1/2 Steel Plt added is 25.38" 7/27/89

NOMINAL CAPACITY	340,000 LBS.
LOAD LIMIT	341,600 LBS.
LIGHTWEIGHT OF CAR	184,400 LBS.
LENGTH:	520 000
LOADING PLATFORM	30'0"
OVER END SILLS	72'3"
OVER STRIKERS	72'10"
OVER PULL FACE OF COUPLERS	75'4"
DEPRESSED DECK LENGTH	30'0"
WIDTH:	
OVER LOADING PLATFORM	10'0"
OVER UPPER DECK	8'0"
EXTREME	10'0"
HEIGHT:	
RAIL TO TOP OF LOADING PLATFORM	2'6½"
RAIL TO BOTTOM OF FRAME	7-7/8"
EXTREME @ HAND BRAKE (DROP SHAFT)	6'8"
RAIL TO TOP OF UPPER DECK	4'11-3/8"
BODY CENTER PLATE HEIGHT	2'10-7/8"
RAIL TO EXTREME WIDTH	2'5"

GEN. ARRGT. DWG.	2-26-A-6324
BRK. ARRGT. DWG.	2-26-A-6375, 2-26-A-6376
TYPE VALVES	AB (10 x 12)
BRK. REGULATOR	NONE
HAND BRAKE NATIONAL, DROP SHAFT, NO. 1180-2-NS	
BELL CRANK	N.A.
TIE DOWN EQUIPMENT	HOLES THROUGH DECK
DECK: LOADING PLATFORM	½" STEEL PLT.
ENDS	3" WOOD
COUPLERS	TYPE E, NAT. CAST. NO. 02E7327
YOKE	LOCO. TYPE, EMD PART NO. 8209976
DRAFT GEAR	NATIONAL MF-400
UNCOUPLING LEVER	STANRAY, DWG 1U-14086-A

LENGTH OF DIST. LOAD FT.	PERMISSIBLE LOAD LBS.	LENGTH OF DIST. LOAD FT.	PERMISSIBLE LOAD LBS.
0	294,000	14	303,000
2	294,600	16	305,800
4	295,500	18	309,400
6	296,500	20	314,000
8	297,700	22	320,000
10	299,100	24	328,000
12	300,800	26	338,000

TRUCK WHEEL BASE	15'0"
TRUCK CENTERS	53'0"
WHEEL BASE OF CAR	68'0"
CURVE: COUPLED TO A.A.R. BASE CAR	251-FT.
COUPLED TO LIKE CAR	251-FT.
CENTER PLATE CAST INTEGRAL	20" DIA.
WHEELS	MW-G-33, CLASS BR
AXLES	6½"x12" ROLLER BEARING
JOURNAL BRGS. TIMKEN AP, WITH K-85531 ADAPTERS	
TRUCK SIDE BEARINGS	½"x4"x11" BAR
BRAKE BEAMS	#28 HANGER TYPE
BRAKE SHOES	1½" CAST IRON
TRUCK MFR.	BUCKEYE
TRUCK GEN. ARRGT.	2-20-A-2885
BOLSTER	CS-2982
SIDE FRAME	CS-2981
TRUCK SPRINGS	6 -0C-D-2, 6 -1C-D-2
FRICTION SNUBBER TYPE	N.A.
SNUBBER SPRING	N.A.
SUPPLEMENTAL SNUBBING	SPRING NO. 743
CENTER OF GRAVITY LOADED	EMPTY 25.25"
METALLIC WT.	181,000 LBS

Figure 2.--Schematic drawing of ATSF 90005.

see the piston on the car with the excess dimensional load.[2] The brakeman then radioed the engineer to release the brakes. After the engineer had done so, he pulled the 23-car pickup past the brakeman so that the brakeman could check whether the brakes had released.

Following this inspection, the 23-car pickup was coupled to the remainder of the train, resulting in placement of a tank car loaded with hazardous materials next to the caboose. Because of the proximity of the hazardous materials car to the caboose, the conductor did not ride in the latter; instead, he rode from Flint westward in the second locomotive unit, which was less crowded and where he thought he could get some paperwork done. The brakeman and engineer occupied the lead locomotive unit.

The train departed Flint at 9:45 a.m. and proceeded without incident until just after it passed through Freeland, Michigan, about 11:20 a.m. At that time, the traincrew members stated, they felt a "slight lurch or a tug" on the train followed almost immediately by an emergency application of the air brakes. When they looked back at the train, they saw cars derailing (see figures 3 and 4) amid a large fireball and a dense cloud of black smoke starting to rise. (See figure 5.)

The engineer provided the following account of events just prior to and during the derailment. As he approached Freeland, the throttle was positioned in run 8 (maximum throttle advancement) and the automatic and independent air brakes were fully released. The train was traveling about 37 mph, and as it crested a slight grade (0.14 percent) about 3 miles before the point of derailment (POD), its speed increased slightly. When the locomotive reached the bottom of the grade, he initiated a first service reduction[3] of the automatic train brakes, thereby slowing the rate of acceleration and maintaining train speed at 37 mph. About 20 seconds later, he released the train brakes and reduced the throttle setting from position 8 to position 6, which is the setting the controls were in when an emergency air brake application occurred during the general derailment. The engineer estimated that the brakes had been fully released and the trainline air pressure fully restored for about 1/2 to 3/4 mile before the emergency application.

The conductor sent an emergency radio message to the CSX dispatcher while the locomotive was coming to a stop during the accident sequence. The three crewmembers left the locomotives at once after they stopped. The conductor went from house to house north of the accident site, advising residents to leave immediately; the brakeman did the same south of the site. The engineer went to nearby highway 47 to alert motorists. (See figure 6.)

Emergency response personnel arrived at the scene about 11:30 a.m. About 1,000 residents within a 1/2-mile radius of the accident site were evacuated. A command post was established from which emergency response personnel, CSX officers, and hazardous-materials teams planned the attack on the chemical fire. Hazardous materials from derailed tank cars burned for 6 days. The evacuation order was lifted at 8:56 p.m. on July 29, 1989.

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[2]The brakeman, who was performing a cursory visual inspection, was not responsible for checking the piston on every car.

[3]About 6 pounds per square inch (psi).

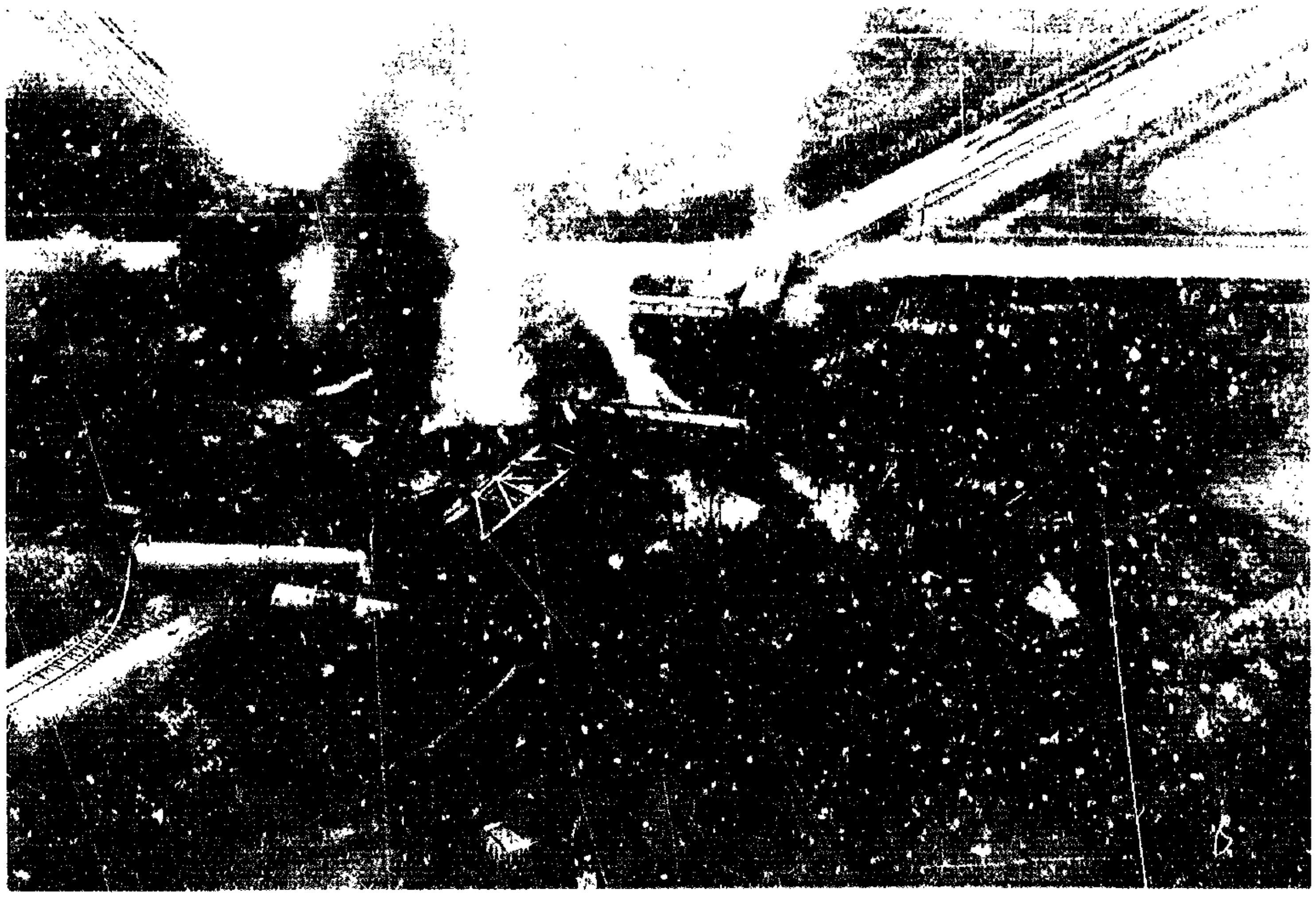

Figure 3.--Derailed cars, freight train R-331-22.

Injuries

	Railroad Personnel	Emergency Personnel	Residents/ Passersby	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	7	4	11
None	3	0	0	3
Total	3	7	4	14

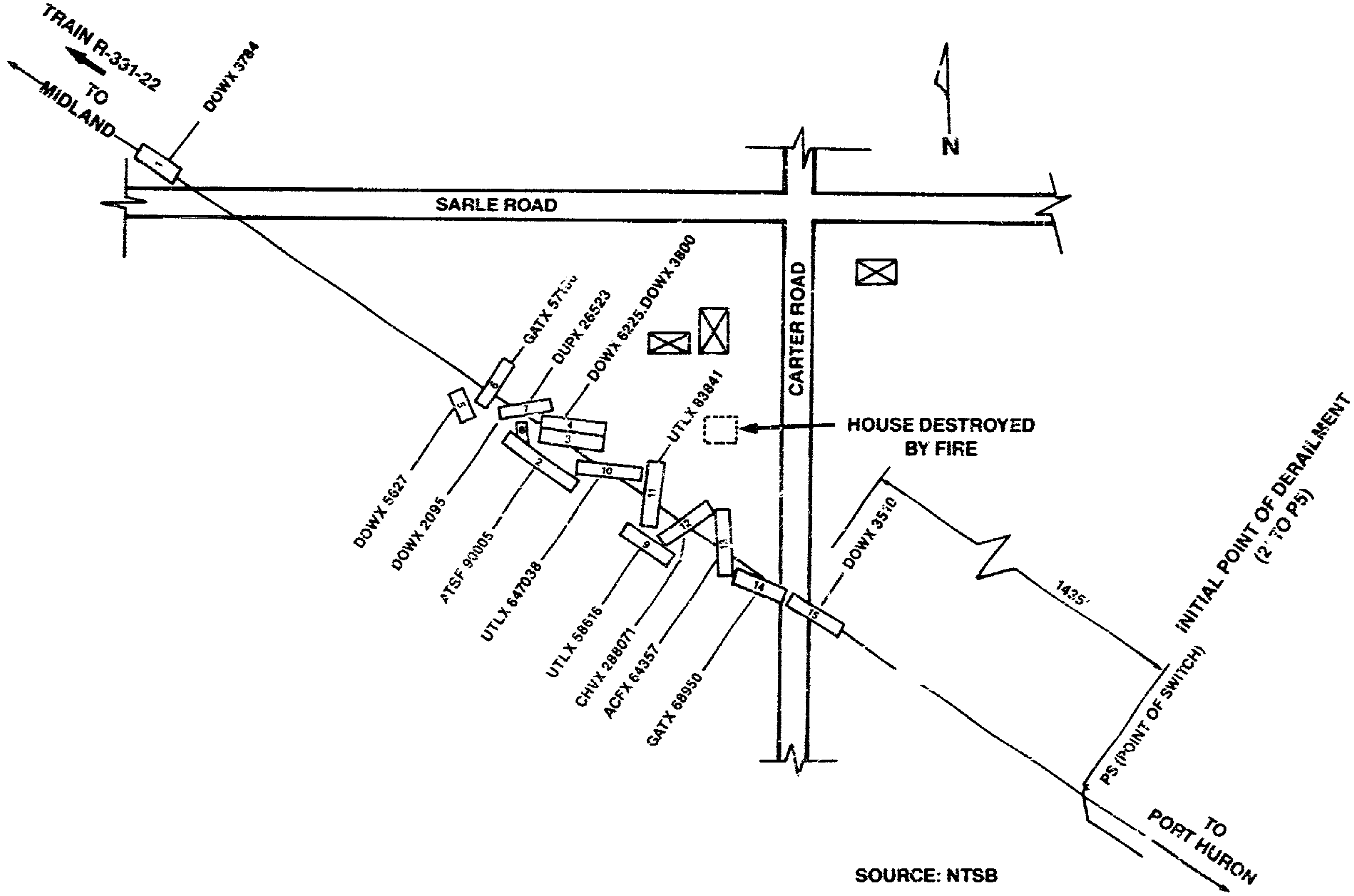

Figure 4.--Identification of derailed cars, freight train R-331-22.

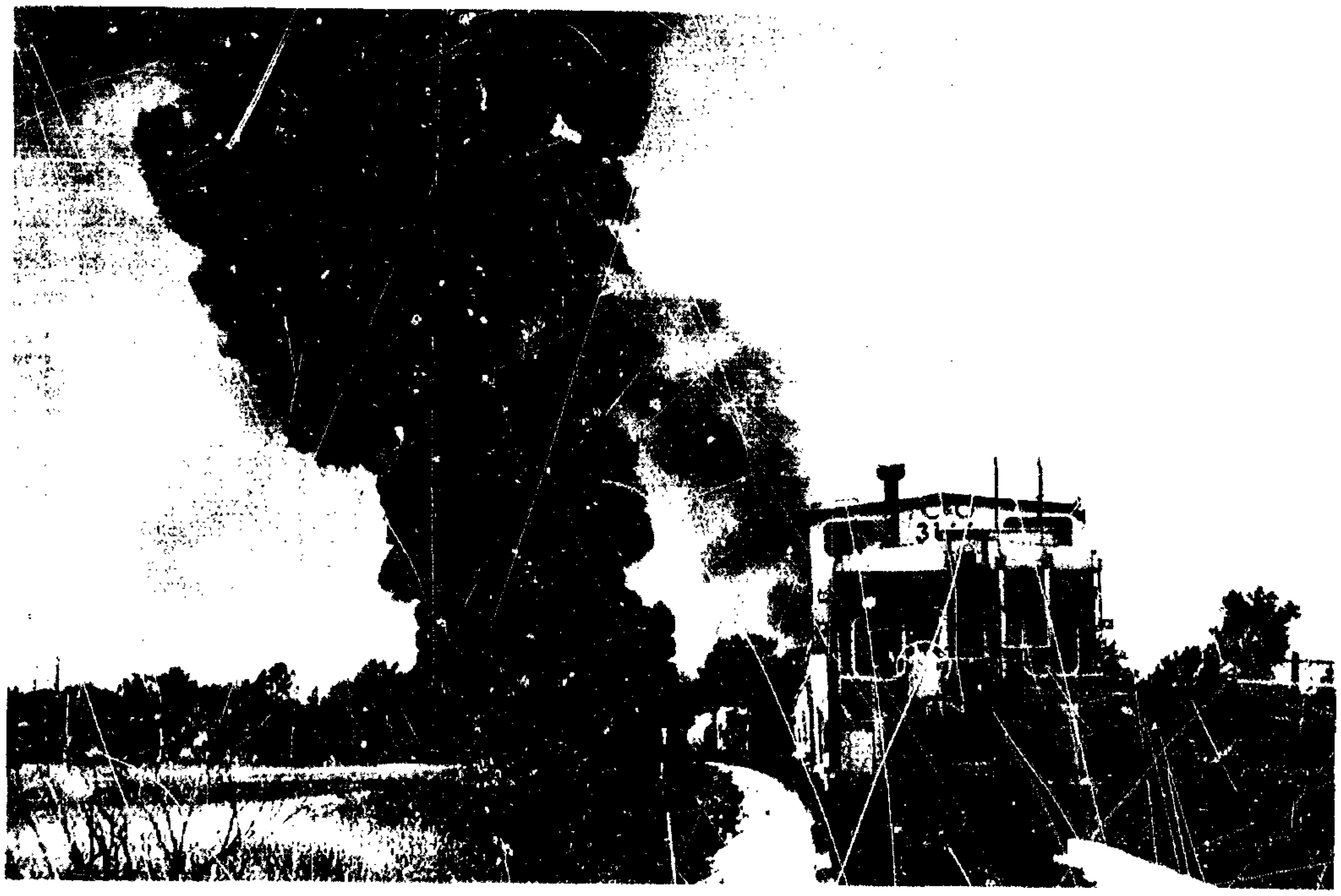

Figure 5.--Fireball and smoke cloud following derailment.

Damage

Of the 14 freight cars that derailed, 6 were tank cars that sustained damage resulting in either partial or total loss of load. A flatcar loaded with a heat recovery steam generator (HRSG) module overturned, and the module was destroyed. One nearby residence was destroyed by the fire that ignited following the release of hazardous materials.

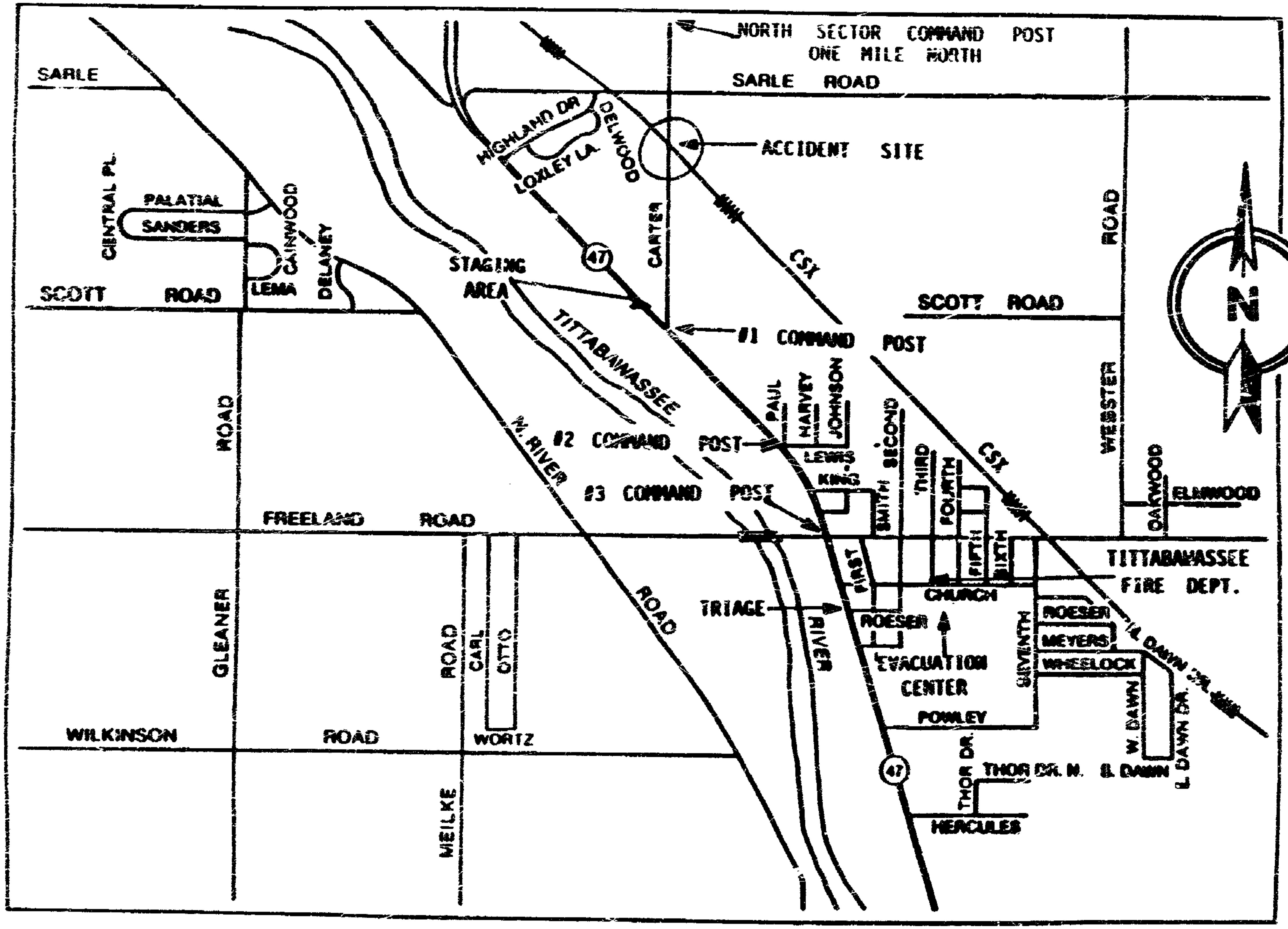

Figure 6.--Accident site and surrounding area, Freeland, Michigan.

Estimated damage was:[4]

Lading	$1,300,000
Wreck Clearing	1,200,000
Nonrailroad	810,000
Environmental Cleanup	1,000,000
Equipment	390,000
Track	19,000
	$4,719,000

Personnel Information

The three crewmembers of train R-331-22 had been off duty for 19 hours 45 minutes before reporting for duty at 5 a.m., July 22, 1989, as scheduled. The crewmembers stated that before they went off duty they knew when they would be called the next morning. Port Huron was an "away from home" terminal for this crew; CSX provided lodging at a local hotel, the Downtown Motor Lodge. Crewmembers were notified in their rooms by telephone 1 hour before they were required to report for duty. The crew had been on duty for 6 hours 20 minutes at the time of the accident. (See appendix B.)

The engineer reported that he had spent his off-duty time sleeping, watching television, and relaxing. He stated that he had not consumed any alcohol during that time, that he was not a user of illicit substances, and that he had received his usual amount of sleep (8 hours) and was fully rested when he reported for duty. The engineer also said that he had been on a medically supervised diet for the past year; as a result of the diet, he had to urinate more frequently than usual.

The brakeman reported that during his off-duty time he watched television and "dozed" for 4 or 5 hours in the afternoon. He left the hotel about 6:30 p.m. and went to the waterfront section of Port Huron to see the sailboats that were gathered there for the beginning of the annual Port Huron-Mackinaw race. He stated that he consumed two gin and tonics at a bar between 7 p.m. and 7:30 p.m., July 21, 1989. A short while later, he was invited aboard a 50-foot sailboat, where he estimated he ingested about 1 gram of powder cocaine through his nose between 8 p.m. and 9:30 p.m. After leaving the sailboat, he stopped at a bar and consumed more gin and tonics. He said that he arrived at his hotel room about midnight, watched television for a while, and then got about 2 or 3 hours sleep before answering his duty call at 4 a.m. He remembered feeling "a little kind of hung over" on the morning of the accident.

The conductor stated that he had spent his off-duty time sleeping, eating, watching television, and relaxing. He said that he did not use alcohol or illicit substances. He had received his usual amount of sleep (about 8 hours) and was fully rested when he reported for duty.

4Except for the HRSG module replacement cost, which was provided by the manufacturer, estimates were provided by CSX. Wreckage clearing cost estimates were adjusted by Safety Board staff. CSX reported that equipment cost was based on "depreciated value" as established by the AAR.

Train Information

General.--Train R-331-22 comprised 2 locomotive units, 17 loaded freight cars, 15 empty freight cars, and a caboose. It was 1,979 feet long, and its gross weight was 3,123 tons (276 tons engine weight and 2,847 trailing tons).

The lead locomotive unit was equipped with a speed-distance recorder. The second locomotive unit had an electronic event recorder capable of recording time, speed, application of brakes, and other information; however, this locomotive unit had been shut down for a mechanical problem, and the event recorder was not functioning at the time of the accident.

The lead locomotive unit was also equipped with a "deadman" pedal. This safety control device is designed to apply the train brakes in the event an engineer becomes incapacitated and does not keep a floor-mounted pedal depressed.

ATSF 90005.--ATSF 90005, a heavy-capacity, depressed-center flatcar, was the second car in train R-331-22; empty idler cars (DOWX 3784 and DOWX 6225) were positioned ahead and behind it. The eight-axle car had a light weight of 184,400 pounds and a load limit of 341,000 pounds; total allowable weight-on-rail was 526,000 pounds. The CSX clearance instructions for ATSF 90005 showed a gross weight of 487,760 pounds. Atchison, Topeka and Santa Fe Railway Company (ATSF) reported that the car had been built in 1958 and that ATSF had rebuilt it in February 1989.

According to ATSF records, the shipment on ATSF 90005 (see figure 2) originated on the ATSF in Chanute, Kansas, and after being transported 830 miles to Chicago, Illinois, was interchanged there with the CSX at the Belt Railway Yard. ATSF reported that following the interchange, the CSX detained ATSF 90005 to repair the braking system . CSX replaced five brake shoes before moving the car about 230 miles to Flint, Michigan, where CSX freight train R-331-22 picked it up to take it to its final destination in Midland.

A postaccident inspection of ATSF 90005 revealed that the number 2 axle had been in contact with the B-end[5] span bolster at least twice, once on the right and once on the left side of the span bolster directly above the number 2 axle. The metal transfers on the left side were unoxidized; the contact on that side centered on the span bolster about 13 inches in from the L2 (second wheel, left side) wheel flange. An 8-inch cone-shaped wear pattern was evident on the left side contact point of the span bolster; metal had extruded onto the leading[6] edge. The right side of the span bolster evinced a similar 6-inch conical pattern, and metal transfers were present on the number 2 axle beneath the contact point. The span bolster abrasion surface on the right side and the metal transfers on the axle beneath that abrasion were oxidized.

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[5]The B-end of a car is the end on which the hand brake is located. If a car has two hand brakes, the B-end is either the end toward which the body-mounted brake cylinder piston moves in the application of the brakes or the end on which the retaining valve is located when such a valve is used. If none of the preceding definitions apply, the car owner arbitrarily designates the B-end.

[6]In the direction of axle rotation relative to the direction of train movement at the time of derailment.

The inboard face of the R1 wheel rim and the outboard face of the L1 wheel rim displayed continuous curved abrasion marks around the periphery of the wheel faces at sporadic intervals. The abrasions varied in width from 1/4 to 7/8 inch. Part of the wheel set had been buried in debris, and part had been exposed to smoke from the chemical fire; the abrasion surfaces were not oxidized.

The car had hanger-type brake beams. The brake shoes on both B-end trucks had been overriding.[7] The R1, L2, R3, and L4 had been overriding the wheel flanges; the L1, R2, L3, and R4 had been overriding the outside edge of the wheel rims. The overriding brake shoes were at diagonally opposite locations on each truck. The shoes contacting the wheel flanges had contoured to the flange profile, and some were worn about 50 percent cross-sectionally through the brake shoe.

Part of the R2 wheel flange had worn away continuously around the circumference at the point of wheel-rail interface. The wear angle formed at the juncture of the tread and flange was sharply defined, and no metal extruded onto the flange. Wear began near the apex of the wheel flange, extended inward toward the hub, and ended about 3/8 inch above the tread surface at the throat of the flange. The wear surface face was smooth, and the fracture surface of the interior wear surface edge was irregular. The interior edge was about 1/16 inch from a perpendicular at the base of the wheel flange.

The car was configured with block-type side bearings and equipped at each end with two standard 100-ton, three-piece trucks. (See figure 7.) Load was transmitted from the primary center plates at each end and distributed through a span bolster to the truck center plates. This arrangement produced 12 side bearing clearance locations.[8] The car was reassembled after the accident and side bearing clearance dimensions were reconstructed. All parties to the Safety Board's investigation at the time were invited to participate in the reconstruction; the Federal Railroad Administration (FRA), CSX, and ATSF elected to participate. Of the 12 locations, 11 had insufficient side bearing clearance. (See table 1.) Rule 47, section E, part 2 of the Association of American Railroads (AAR) field manual of interchange rules states that "side bearings must have 3/16 minimum to 5/16 inch maximum clearance."

When ATSF 90005 was rebuilt in February 1989, according to information provided by ATSF, "it was necessary to place three-sixteenths (3/16) inch to one-quarter (1/4) inch shims in the center bowl of the span bolster on the end of the car that had no side bearing clearance." ATSF stated that "this was done after the original record of repairs was completed and, through inadvertence, no supplemental or amended record was made." No shims were found during the investigation and reassembly of the trucks following the accident.

[7]An overriding condition exists when the brake shoe applies against the wheel flange or the outside edge of the wheel rim rather than to the running surface of the wheel rim.

[8]Six locations on each truck. Side bearings are load-bearing components, located either on the truck or body bolster, and are arranged to absorb vertical loads created by the car's rocking motion. Side bearing clearance refers to the space between mating body and truck side bearings on cars that have conventional side bearing arrangements.

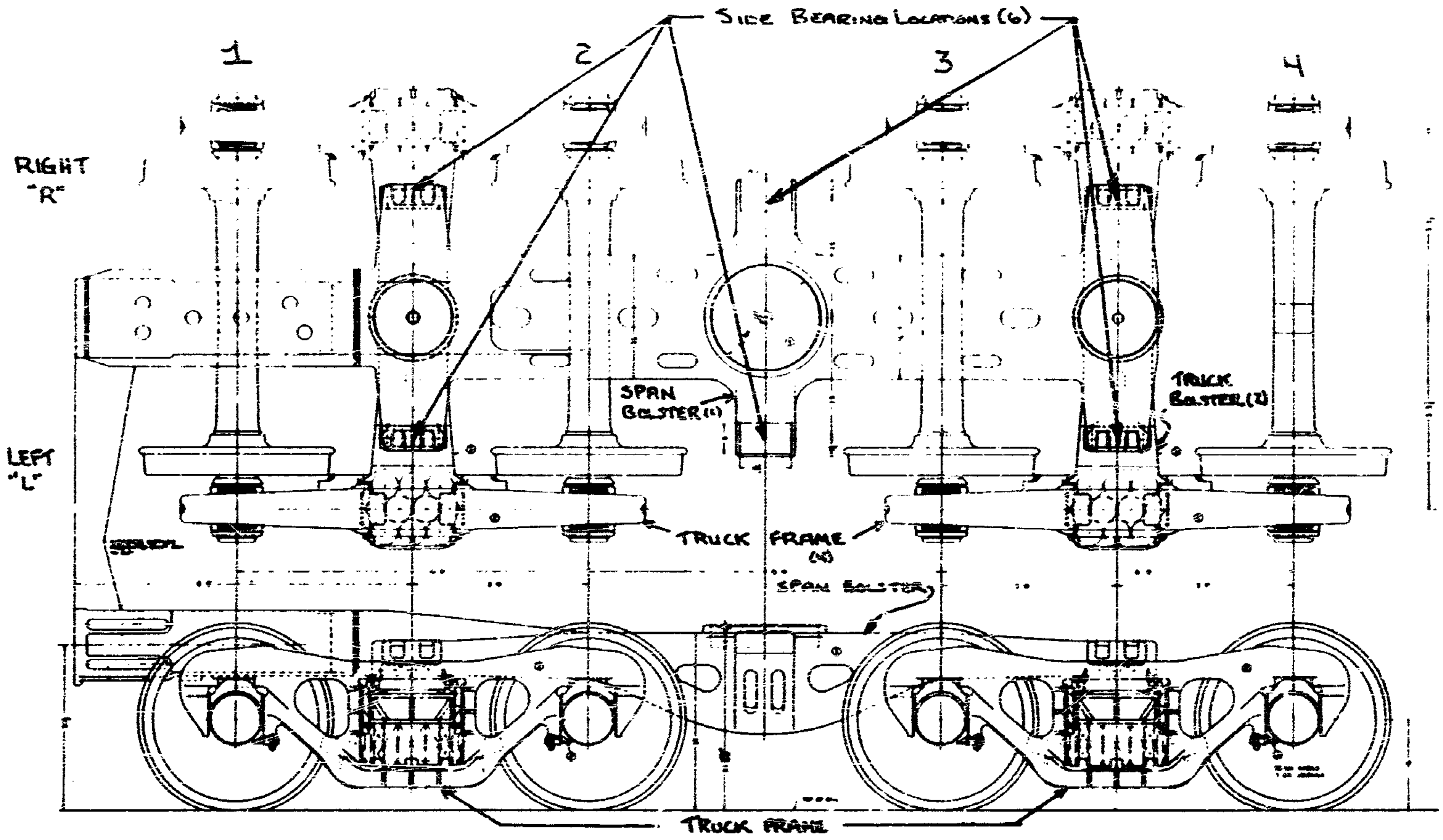

Figure 7.--Railcar truck assembly configuration.

Table 1

ATSF 90005 reconstructed side bearing clearances

Location	Left 1	Left 2	Left 3	Left 4	Left 5	Left 6
Measurement[9]	5/32	1/4	0	5/32	0	5/32
Location	Right 1	Right 2	Right 3	Right 4	Right 5	Right 6
Measurement	0	0	0	1/16	1/8	0

Following reassembly of ATSF 90005, the wheel sets from the car's four-axle lead truck were placed in the derailment marks at the Carter Road crossing. The spacing of the axles matched exactly the spacing of the wheel marks cut into the timber crossing surface.

Derailed Tank Cars.--All hazardous materials tank cars that derailed, including the five that were loaded and the one that was not, were damaged, and all were equipped with top and bottom shelf-type couplers. The tank car types involved were Department of Transportation (DOT) 105, DOT 111, and DOT 112. Damage was as follows:

> GATX 57100, DOT 111A100W (6th car), was not equipped with a head shield (a supplemental heavy steel plate on the end(s) of a car) or a jacket (a thin outer shell used to contain insulating material wrapped around the tank); the underframe and the left side at the B-end were severely dented and scraped, the outer leg for the bottom outlet was missing (the leg failed at the shear bolts that attached it to the tank), the A-end head was dented above the center line of the car and the B-end was dented below the centerline of the car, the A-end sill was broken, one coupler was disengaged, and one coupler was broken. The trucks were destroyed.
>
> DUPX 26523, DOT 112A200W (7th car), was not equipped with head shields or a jacket; both ends and the tank shell were dented and scraped (the dent in the A-end head was 14 inches deep and 5 feet in diameter), the A-end sill was bent and buckled, the A-end coupler was disengaged, the B-end knuckle was broken, and the B-end body bolster was bent. Both trucks were derailed.
>
> UTLX 647038, DOT 111A100W6 (10th car), was not equipped with head shields and had a jacket and thermal insulation; the right side of the tank had a 3-inch by 6-inch hole near the B-end (about 2 inches from the seam), the A-end stub sill was bent downward and spread open, the jacket had deep dents in both ends, the jacket was torn near the B-end saddle bracket and at the middle of the car, burn damage to the jacket was extensive,

[9] In fractions of an inch.

the A-end saddle bracket was bent, one coupler was disengaged, the other coupler was damaged, and both tank heads were severely dented. The trucks were destroyed.

UTLX 83841, DOT 105A300W (11th car), was not equipped with a head shield but did have a jacket. Both stub sills were damaged, the B-end sill was broken off and missing beyond the end of the car, and the A-end sill was bent downward at approximately a 20-degree angle. Almost all of the B-end head above the centerline of the car was punctured, and the head was severely dented below the centerline. Fire damage to the jacket was extensive. Both couplers were broken, and both trucks were destroyed.

CHVX 288071, DOT 111A100W1 (12th car), was not equipped with head shields but did have a jacket and thermal insulation; the B-end tank head had a 10-inch by 14-inch puncture below the centerline of the car and was dented above and below the centerline, the A-end tank head was dented above and below the centerline of the car, the jacket was dented and scraped near the sill on the B-end, and the jacket was extensively burned on the B-end and partially burned on the A-end. Both couplers were disengaged. The trucks were destroyed.

GATX 68950, DOT 105A500W (14th car), was not equipped with a head shield but did have a jacket; the A-end safety railing was bent and the A-end crossover platform was crushed. The A-end truck was derailed. One coupler was disengaged; the other remained coupled to the adjacent car.

Hazardous Materials.--Of the 15 cars in the train that contained hazardous materials (see appendix C), 7 derailed. They included tank cars loaded with styrene monomer, acrylonitrile, acrylic acid, petroleum naphtha, and a mixture of chlorosilanes, including trimethylchlorosilane, which was shipped as a flammable liquid-corrosive not otherwise specified (NOS);[10] a covered hopper car loaded with paraformaldehyde; and an empty tank car[11] that had last contained a flammable liquid-corrosive NOS.

Three tank cars carrying hazardous materials sustained major structural damage in the derailment and lost the bulk of their products, which ignited. The cars were UTLX 647038, the 10th car, which contained acrylic acid; UTLX 83841, the 11th car, which contained trimethylchlorosilane; and CHVX 288071, the 12th car, which contained petroleum naphtha.

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[10]As defined in 49 CFR 171.8.

[11]An empty tank car may contain residual amounts of the last product it transported. An empty tank car that last carried a hazardous material is treated in rail transportation as one that has some residual product; it requires appropriate placarding and handling.

Styrene and acrylic acid, in addition to their respective hazard classifications as a flammable liquid and a corrosive material, can polymerize.[12] Acrylonitrile, which has a primary hazard classification as a flammable liquid, is also toxic by inhalation and a carcinogen. Trimethylchlorosilane is designated a flammable liquid, is a corrosive, and is difficult to extinguish once ignited.

The material safety data sheet (MSDS) for the trimethylchlorosilane mixture states that fires involving this mixture are difficult to extinguish. It lists water fog, foam, and carbon dioxide as extinguishing agents and notes that flooding with water may be necessary. The MSDS warns that the mixture forms hydrochloric acid in the presence of water and states that contact with water should be avoided.

The 6th (GATX 57100) and 7th (DUPX 26523) cars were tank cars that contained styrene monomer and acrylonitrile, respectively. Although both sustained major structural damage, neither lost significant amounts of product. CSX estimated that 1 gallon of styrene monomer and 1 pint of acrylonitrile were lost.

The 13th car (ACFX 64357) was a covered hopper that contained paraformaldehyde. The 14th (GATX 68950) was the empty tank car that had last contained a flammable liquid-corrosive NOS. Neither car sustained significant superstructure damage or lost any product.

Track Information

General Description.--The derailment occurred near mile post (MP) 11.9 on the Coleman subdivision of the Detroit division. The Coleman subdivision extends north-south about 20 miles between Saginaw, Michigan, and Midland, Michigan. The track structure in the accident area comprised a single main track and a single passing track. The topography of the subdivision was slightly undulating with nominal grades.

The main track near the initial POD was constructed of 115-pound jointed, staggered rail connected with 36-inch, 6-hole joint bars that were fully bolted. The rail was laid new in 1954. The rails rested on 7 3/4- by 13-inch double-shouldered tie plates and were secured by cut spikes to 8 1/2-foot treated timber cross ties. One spike each on the field and gauge sides held the rail. Ties numbered 24 per 39-foot rail section. Longitudinal rail movement was restrained by base-applied rail anchors; 8 to 16 anchors per section were applied in a box pattern midway between staggered rail joints. No evidence indicated appreciable rail movement. The track was surfaced on crushed rock ballast. Each side of the main track had a 50-foot right-of-way. A 10-inch gas pipeline was near the north side of the property line and a fiber-optic cable was near the south side.

Postaccident Inspection.--The first indication that the first wheel had derailed was a faint wheel flange mark on the running surface of the rail. The mark, which began 3/4 inch from the gauge side of the south rail and 21 inches west of the trailing point switch, extended west 16 feet 6 inches before dropping off the field side of the rail. At the point where the wheel dropped off the running surface of the

[12]A chemical reaction in which a large number of relatively simple molecules combine to form a chain-like macromolecule. These reactions typically release heat that can lead to self-propagation of the reaction.

south rail, a parallel set of wheel marks began on the tie plates at the gauge side of the north rail. Wheel marks on the base of the rail, tie plates, and cross ties indicated that only one wheel set was derailed at that point.

After derailing, as evidenced by abrasion marks, the wheel set moved abruptly about 11 inches south from the base of the rails, at which point the marks of the derailed wheel set began to travel parallel with the rails. The east end of the joint bars bore recent strike marks beginning at this point and extending 1,435 feet until the derailed wheel set struck the wooden road crossing panels at Carter Road. The abrasion marks on the cross ties were alternately heavy and light between the wheel that was derailed to the field side and the wheel that was derailed within the gauge. Metal fragments were found within the gauge of the rails about 13 inches in from the northward abrasion marks. These fragments were apparently in a molten state when they dropped onto the cross ties and ballast.

<u>Postaccident Survey</u>.--To determine surface conditions after the accident, track geometry was measured at 15.5-foot intervals 465 feet before and 124 feet after the POD; base-of-rail levels and track gauge were measured under load;[13] and track alignment was measured under static conditions. (See appendix D.)

CSX maintained track in the Coleman subdivision to comply with class 3 standards. Postaccident inspection of the track geometry in the derailment area disclosed that maximum deviation from zero cross level was 11/16 inch, maximum track warp was 1 1/16 inches, and maximum deviation in rail profile was 3/4 inch. Minimum track gauge was 56 3/8 inches; maximum was 57 1/8 inches.

Approaching the POD, the north rail was uniformly out of cross level by 1/4 to 3/8 inch low. This uniformity in cross level was interrupted by a 1 1/16-inch warp at the heel of the frog (a track structure at the intersection of two running rails) and by a 13/16-inch warp immediately east of the POD, which was at the point of minimum track gauge.

The FRA prescribes minimum track safety standards and corresponding authorized train speeds that vary depending on the class of track. For class 3 track, the FRA allows[14] 1 3/4-inch deviation from zero cross level, 1 3/4-inch difference in cross level between two points within 62 feet (warp), and 2 1/4-inch deviation in rail profile when measured at the midordinate of a 62-foot chord. Cross level is the distance one rail is above or below another. Minimum allowable track gauge is 56 inches; maximum is 57 3/4 inches.

As noted in 49 CFR 213.1 (Track Safety Standards), "a combination of track conditions, none of which individually amounts to a deviation from the requirements. . .may require remedial action to provide for safe operations over that track." And the AAR Steering Committee has stated:[15]

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[13]Load was applied to the track structure using a four-axle hopper car filled with ballast. The combined weight of the car and ballast was 131 tons.

[14]Title 49 CFR 213.

[15]AAR publication R-185, "Track Train Dynamics To Improve Freight Train Performance," 2d edition, p. 4-15.

Vertical irregularities in track surface allow vertical displacements of the truck suspension. This can result in variations of up to 300 percent in the forces imparted to the rail from a single wheel within a distance of one rail length. As speeds increase, the maximum wheel load can reach levels in excess of twice that of the static wheel load.

Maintenance and Inspection.--CSX authorizes freight trains to operate at 40 mph over track in the Coleman subdivision. To authorize that speed, CSX must maintain the track to meet the safety standards in 49 CFR Part 213 for class 3 track. Part 213.233 states:

Class 3 track, main track and sidings [must be inspected]:

Weekly, with at least 3 calendar days interval between inspections; or before use, if the track is used less than once a week; or twice weekly with at least 1 calendar day interval between inspections if the track carries passenger trains or more than 10 million gross tons of traffic during the preceding calendar year.

Typically, 14 freight trains a week operate over this track. CSX hauled 2.63 million gross tons over it in 1988 and routinely inspected the track once a week. In the 7 weeks before the derailment, the CSX track inspector made seven routine and three unscheduled inspections. He performed the latter to look for track irregularities that might have been brought about by high temperatures. He did not note any defects on the main track near the derailment during these inspections, and no temporary slow orders were in effect on the main track at the time of the derailment.

An FRA track inspector checked the Coleman subdivision from MP 0.0 to MP 17.5 on July 18, 1989. He found one track defect--missing joint bar bolts--on the main track at MP 3.2, nine defects--missing joint bar bolts, defective ties, and improper track gauge--on siding tracks, and four defects--defective ties and missing joint bar bolts--in turnouts. Nine of the defects were within 1 mile of the POD; however, none were on the main track.

A Michigan Department of Transportation (MDOT) track inspector had checked the Coleman subdivision from MP 0.1 to MP 17.8 on March 13, 1989, and from MP 0.0 to MP 0.6 on July 14, 1989.[16] During the March inspection, he found defects in turnouts that included defective ties and improper track gauge at MP 0.1, a loose switch point stop at MP 2.1, and a loose switch point stop and less than two bolts per rail in the heel of the switch point at MP 10.9. One defect--10 consecutive defective ties at MP 0.3--was reported following the July inspection.

Although Federal regulations do not require that rails be tested for internal defects on class 3 track, CSX did so annually on the Coleman subdivision, most recently (before the derailment) on April 14, 1989. During that inspection, Dapco Industries[17] found two defective rails on the main track at MPs 0.5 and 10.9. Both defects were bolt hole breaks at joint locations, and both defective rails were replaced.

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[16] MDOT performs such inspections under a program for the FRA.

[17] A private rail testing company.

CSX had last operated a track geometry car over this subdivision on June 22, 1989. During that evaluation, a 1 5/8-inch cross level deviation on the north rail was detected at MP 11.9, which was the POD. CSX records indicate that this irregularity in track surface was repaired on June 26; they do not show that any previous accidents had occurred at this location. (Title 49 CFR 213.63 allows a 1 3/4-inch tolerance for class 3 track.)

Method of Operation

General Information.--Train movements in the Coleman subdivision are governed by CSX operating rules, timetable instructions, train orders, bulletin orders, and the wayside signals of a centralized traffic control (CTC) system. Maximum authorized train speed over the subdivision is 40 mph.

Before leaving Port Huron, CSX traincrews are required to contact the GTW dispatcher to obtain the necessary train orders, bulletins, and a clearance form. They must also contact the CSX dispatcher in Jacksonville, Florida, to obtain those documents for movement over the CSX Saginaw subdivision between Flint and Saginaw, Michigan, and they have to contact the CSX dispatcher in Saginaw for the same documents to move over the CSX Coleman subdivision between Saginaw and Midland, Michigan.

As noted earlier, the crew of train R-331-22 testified that they had complied with these requirements. CSX and, later, the Safety Board examined the speed tape from the lead locomotive; the tape indicated that at the time of derailment the train was traveling 37 mph and that it did not exceed any speed restrictions during the trip.

The engineer stated that his method of train handling while approaching Freeland was "power braking," which is permissible under CSX rules.[18] He said the locomotive was equipped with dynamic brakes but that according to a work report left on the engine by a previous engineer, they were inoperative. A completed work report found on the locomotive after the accident listed the dynamic brakes as inoperative.

According to the engineer, he released the train brakes directly from a first service reduction (6 psi) as he approached Freeland. CSX service braking guidelines, which are in the CSXT Train Handling Rule Book, state:

> When operating conditions permit, before making a running release, the brake pipe reduction should not be less than 10 pounds and brake pipe exhaust stopped. Then place automatic brake valve in Release (Running on 24RL) position.

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[18]A train handling method that involves application of the train's air brakes concurrently with a locomotive power application.

The AAR's guidelines are similar:[19]

> A final running release of train brakes should not be made unless a total reduction of not less than 10 pounds has been made. This procedure will generally avoid stuck brakes.

Regarding the use of locomotive power concurrently with a service air brake application, the AAR Steering Committee recommends:

> When approaching hump, knoll, or hogback terrain with the throttle in a power mode, a slack-stretched slowdown should be made employing the automatic brake and throttle.
>
> b. Employing automatic brake
>
> (1) Avoid applying the automatic brake, if possible, while the locomotive is ascending the knoll. A minimum brake pipe reduction of five to eight psi is made, preferably when the head end has reached the summit of the knoll. Keep the locomotive brakes released. The throttle is used to maintain a constant speed as the automatic brake application is becoming effective throughout the train.
>
> (2) As the train speed decreases the throttle is reduced one notch at a time. Additional light brake pipe reductions of two or three psi are normally made as needed to assure that the total brake pipe reduction reaches a minimum of 10 psi before releasing the automatic brake.
>
> (3) When the desired speed is reached the automatic brake is released. As the brakes are releasing, reduce the throttle in order to avoid excessive draft forces.

The engineer testified that he blocked the deadman pedal twice, leaving the control stand unattended, while train R-331-22 was en route: "I have been on a medically supervised diet where I have to urinate a lot and there is no other way [to operate] unless you stop the train every time. Instead of stopping the train I block the pedal and urinate."

Excess Dimensional Load Movements.--The HRSG on the flatcar that overturned was en route to an electrical powerplant in Midland, Michigan. Chanute Manufacturing Company in Chanute, Kansas, and Kentobe Manufacturing Company in Tulsa, Oklahoma, were supplying several types of HRSG modules for a project to convert the plant from a proposed nuclear facility to a gas-fired, steam-driven operation. The Midland plant was scheduled to receive 96 modules.

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[19] AAR publication R-185, p. 2-12.

Because of the size of the modules, representatives of the designer (Combustion Engineering, Inc.), the manufacturer (Chanute Manufacturing Company), a shipping company (Fluor Daniel, Inc.) acting on behalf of the manufacturer, and ATSF had arranged for a pool of railcars to be made available for use in shipping the 96 modules. The schedule called for shipments from Chanute to begin in September 1988 and to continue in November 1988, January 1989, March 1989, and July 1989.

The HRSG module was shipped on ATSF 90005 as an excess dimensional load. For movement of such loads, the AAR states, in part:[20]

> Shippers must observe . . . all applicable rules regulating the safe loading of freight as published herein; and must inspect shipments to see that they are properly and safely secured and that all applicable details in Rules 1 to 21 inclusive . . . have been complied with in all cases, before shipments are tendered to carrier. . . .
>
> When lading requires flat cars longer than 60 ft. [as it did in the case of ATSF 90005], the shipper and the originating carrier are to confer as to additional securement required.
>
> Loads of dimensions and weight which make it necessary to handle them under restricted speeds must be reported by the originating carrier to the carriers over whose lines they are to be transported.

The shipper, the manufacturer, and the ATSF discussed the method of loading and securement of the modules. ATSF also conferred with the AAR Operations and Maintenance Department concerning the shipment.

The HRSG designer provided detailed engineering drawings to the manufacturer. They contained information on the overall dimensions of the module, the location of the center of gravity (cg) of the module, the cg of the railcar, the cg of the module and railcar when the module is loaded on the car (referred to as the combined cg), the weight of the module, placement measurements for loading the module on the railcar, and the calculated weights of the shipping braces.

The transverse cg did not correspond with the geometric centerline of the module. The maximum width the railroads involved would allow was 12 feet 10 inches.[21] To adjust the transverse cg to fit within the allowable shipping envelope, a steel plate ballast counterweight was attached by external truss arrangement to the lighter side of the module. The HRSG designer had previously determined that 26,700 pounds of ballast was needed to position the combined transverse cg of the railcar and module over the geometric centerline of the module;

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[20] AAR Operations and Maintenance Department, Mechanical Division, "General Rules Governing the Loading of Commodities on Open Top Cars," 1989.

[21] Railroads determine clearance width by measuring from the centerline of the car to the widest point on the load and multiplying that dimension by two. This measurement is based at the top of the rail (ATR) and is calculated wherever significant changes in width occur.

this point was approximately 4 1/2 inches from the geometric centerline of the railcar.

According to the manufacturer's loading supervisor, the module was positioned exactly as specified on the designer's drawing when it was loaded onto a railcar at Chanute in September 1988. The loading supervisor testified, "When I first start loading the cars, I always measure from the rails to the top of the car, all four corners, and then place the load on it; and if it lays one way or the other, I know I got to move the load, and then after I get it loaded I will measure the corners again." He further stated that after the first load had been positioned, "it [the module] didn't set right, it laid over to one side." He thought but was not certain that the load leaned toward its ballasted side. The loading supervisor recalled repositioning it about 2 inches so that the load and car were level with the track. He said that as a result of the repositioning, the module itself, excluding the truss and ballast, was geometrically centered on the railcar.

The manufacturer's vice president stated on August 2, 1989, that his company:

> [D]id not load module 1A per drawing 36587-8C-0075 Rev 6 [which called for changing the position of the module when loaded on the railcar to ensure maximum clearance] because on the first shipment (Aug '88) when loaded per the drawing caused the car to list toward the ballasted side and the projection of the ballast retaining bolts caused an over width condition. All units shipped were loaded with the (centerline between the 24" beams at the centerline of the railcar). Calculations from the drawings would indicate a 12' 5" $\pm$ 1" width at the widest point.

After the module was repositioned in September 1988, according to the loading supervisor, metal "I-beam" blocking was welded to the deck of the railcar and the module was bolted to the blocking to prevent it from shifting longitudinally during transit. The module bolt holes were predrilled during fabrication and were reportedly in identical locations on similar modules. The blocking, which remained welded to the car after the module was removed at Midland, was used to position subsequent modules on that car. The B-end blocking was still attached to the deck of ATSF 90005 after the accident. Postaccident measurements indicated that the BR and BL bolt hole centers were, respectively, 55 9/16 inches and 55 3/4 inches from the centerline of ATSF 90005. Bolt hole tolerance was about 1/16 inch.

The vertical cg of each module and the vertical cg of individual railcars were calculated to determine combined vertical cgs. ATSF clearance file HL-25182 listed the combined vertical cg of a module loaded on CR 766088 (an eight-axle, 70-foot, depressed-center flatcar that has 47-foot, 10-inch truck centers) as 100.363 inches above top of rail (ATR).[22] The combined vertical cg of a module loaded on CNW 48003 (an eight-axle, 70-foot, depressed-center flatcar that has 47-foot, 10-inch truck centers) was 101.5 inches ATR. ATSF attached the following notices to the clearance file:

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[22]The railroad industry calculates height using the running surface of the rail as a base line.

> CR 766088--If 15,000 lbs additional ballast is added at 29.5-inches ATR then gross weight would be 481,799 and [vertical] center of gravity reduced to 98.0-inches ATR or less.
>
> CNW 48003--If 20,000 lbs additional ballast is added at 29.5-inches ATR then gross weight would be 494,994 lbs and [vertical] center of gravity reduced to 98.0-inches ATR or less.

The manufacturer's records indicate that the firm held discussions with Fluor in August 1988 to determine whether deck ballast (weight applied to the deck of a railcar) should be added to ATSF 90005. According to the manufacturer, Fluor was concerned that the car's load limit would be exceeded if deck ballast were applied. The manufacturer's records show that Fluor advised the firm not to apply deck ballast, and none was applied.

The combined vertical cg, as reported by ATSF, was 97.9 inches ATR, without deck ballast, for the module that derailed in Freeland. AAR interchange rule 89, "Conditions Governing Delivery and Acceptance," states that loaded cars are acceptable in interchange only if the combined vertical cg of car and load does not exceed 98 inches ATR.

AAR interchange agreements allow railroads to interchange loaded cars that have a vertical cg of 98 inches or more, but individual arrangements must be made for each such load. CSX policy requires "special train service" for loads accepted on the Detroit division that have a vertical cg of 98 inches or more. Other CSX divisions not involved in this accident allow a vertical cg of 104 inches before special train service is required. According to CSX, that service can include up to 10 "special cars" in a train that does not move at more that 40 mph, and speeds must be reduced 10 mph below the maximum on curves. While on ATSF track, ATSF 90005 was restricted to 45 mph.

<u>Inspection and Repair Procedures</u>.--Title 49 CFR Part 215, which prescribes minimum Federal safety standards for railroad freight cars, states, "Each railroad that operates railroad freight cars to which this part applies shall designate persons qualified to inspect railroad freight cars for compliance with this part. . . ."[23] When a designated person is not on duty to inspect freight cars, the same statute specifies minimum conditions that the cars must be inspected for. (See appendix E.) Both ATSF and CSX were members of the AAR at the time of the Freeland accident, and under AAR rules, "Each railroad is responsible for the condition of all cars on its line."[24]

ATSF personnel did a mechanical inspection of the railcars and measured the loads before accepting them. The same ATSF personnel were responsible for inspecting excess dimensional loads originating in both Chanute and Tulsa. The ATSF equipment supervisor testified that he and an ATSF carman typically went to the loading site, where they recorded the height and width measurements of the excess dimensional loads and inspected the railcars after they had been loaded. According to the supervisor, he and the carman independently measured load

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[23]Title 49 CFR 215.11.

[24]AAR, "Field Manual of the AAR Interchange Rules," Rule 1, 1989.

height and width and then compared these measurements on site. Any discrepancies between the dimensions recorded and those on the drawings were resolved before the supervisor gave final clearance to accept the load for shipment.

The equipment supervisor was not aware of any pretrip mechanical inspection that railcars received before being placed for loading. He said that mechanical defects discovered during the inspection after cars are loaded are repaired on site.

Three modules had been shipped from Chanute on ATSF 90005 before the Freeland accident. ATSF records indicate the equipment supervisor and the same carman inspected and measured those loads on March 20, May 15, and July 13, 1989. The extreme width measurements reported for them were 11 feet 6 inches, 12 feet 0 inches, and 11 feet 11 inches, respectively. Modules loaded on other cars were measured at 12 feet 2 inches (CR 766011, September 16, 1988), 12 feet 3 inches (PC 766071, January 18, 1989), and 11 feet 11 inches (PC 766071, November 3, 1988).

According to both the equipment supervisor, who testified that he was familiar with the module's loading dimensions, and the manufacturer, the actual width of a ballasted module was 11 feet 11 inches. The supervisor said that he could not explain how the module could have been measured at 11 feet 6 inches on March 20, 1989.

<u>Derailment History</u>.--ATSF 90005 had derailed three times in less than a year before the July 22 derailment. The car, which had been loaded with an HRSG module at Chanute on November 4, 1988, derailed and came to rest on its side on November 22, 1988, on CSX's Mobile division. The combined weight of the load and car was reportedly 518,332 pounds; extreme width was 12 feet 3 inches. Extensive search by the Safety Board and by CSX revealed no information concerning any reports, repairs, or inspections that may have been made after this derailment. ATSF records indicate that the car was not used to transport modules until after ATSF had completed extensive underframe repairs, including truck reconditioning, in February 1989.

The AAR does not require that shippers of excess dimensional loads be notified of derailments involving their shipments. Car owners are made aware of a derailment involving their car when they receive a repair bill from the handling railroad. Neither Chanute nor Fluor-Daniels received notification of any derailment involving cars loaded with the modules.

On March 31, 1989, ATSF 90005, which had been loaded with a module at Chanute on March 23, 1989, derailed a second time, about 5:45 p.m. in Flint, Michigan, on CSX's Saginaw subdivision. CSX records state:

> Train R32830, with 2 engines, 15 loaded and 20 empty cars derailed 1 car (ATSF 90005) on main track 1. 6th head car, weight 237 tons. Car remained standing [upright] after derailment. Car damage $700. Track damage $500. . . .Cause: 799 [FRA code for "other miscellaneous causes"] . . .Cars had speed restriction of 45 mph per special instruction. Train engr. said train was traveling about 35 miles per hour at time of derailment. . . .Car wheel L-4 climbed left/west rail on a right hand 2 degree curve. Car had a high center of gravity, assumed to be 98. No apparent car defects. Track notes taken with no defects. . . . ATSF wheels derailed L-3, L-4, R-3, R-4. Car is equipped with two set of trucks

> on each end of car, lead wheels of 1st trailing trucks derailed. Engr had used dynamic braking between GR. Blanc and ATW. JCT. . . .[Special instruction] called for car to be within 5 of [head end]. Remarks--used [train] D78531 from GR. Blanc to double rear end over to # 2 main for R32830 to [pick up] with their head 5 cars. Left ATSF90005 and 1 idler on #1 main. This put train back together with proper spacing of H/W loads. . . .Car to be placed on RIP wheel dock in a.m. for inspection and repairs.

In the Flint accident, ATSF 90005 traveled about 1,200 feet after derailing. CSX records indicate that the roller bearings were subsequently inspected under provisions of AAR rule 36, section A.1.b. That section applies to minor derailments, defined as "derailed trucks on empty or loaded cars involved in a derailment at a speed of not over 10 miles per hour or which have not moved on the ground more that 200 feet." Section A.1.a. of rule 36 covers major derailments; it specifies that "wheel sets must be removed and handled in accordance with the Wheel and Axle Manual and roller bearings must be removed and disassembled for inspection and necessary repairs."

After the Freeland accident, CSX stated that the wheel sets that derailed on March 31, 1989, should have been removed from ATSF 90005 and the roller bearings disassembled under provisions of section A.1.a. before the car was returned to service. CSX issued instructions to all its mechanical inspection forces and mechanical supervisors on August 4, 1989, reemphasizing AAR and CSX policy for the inspection of roller bearings involved in derailments. (See appendix F.)

About 10 p.m., April 7, 1989, ATSF 90005 derailed a third time, but did not overturn, in CSX's Saginaw, Michigan, yard while moving empty at 1 mph. According to CSX records:

> When pulling five cars out of #8 track, Dean Yard the ATSF 90005 derailed #L1 & R1 wheels. Car was placed on the RIP track at Dean Yard. This car was derailed 03/31/89 at Maple Road, Flint, Mich when enroute to Midland, Mich. Cause for change. Estimated damage $150.

The records further indicate that one pair of roller bearings on ATSF 90005 was inspected at Saginaw on April 10, 1989, under provisions of AAR rule 36, section A.1.b.

On August 14, 1989, after the Freeland accident, CSX rejected PC 766071, along with three other loaded depressed-center flatcars, when ATSF offered the four cars in interchange at Chicago. ATSF mechanical personnel subsequently removed parts from PC 766071 to repair the other three cars, which departed Chicago for Midland on August 23, 1989, after an inspection by CSX mechanical personnel. They arrived without incident. On September 7, 1989, span bolsters and trucks were removed from one of those three cars (CR 766073) and placed under PC 766071. On the same day, CSX mechanical personnel inspected and approved PC 766071 for interchange. It departed Chicago for Midland on September 10, 1989.

About 10:12 p.m., September 11, 1989, three cars from CSX train R33610 derailed on the main track in Lansing, Michigan. The traincrew observed that PC 766071 was the first car to derail, overturning and derailing the empty idler cars entrained before and after it. PC 766071 was an eight-axle, heavy-capacity, depressed-center flatcar that was carrying an HRSG module to Midland. CSX records state:

> PC 766071 gross weight - 504,000 lbs; [vertical] cg 81.24-inches ATR; extreme width 12 ft 10-inches; Train speed 22 mph (authorized 25 mph); Derailed #8 wheel [first]; 1,978 ft from point of derailment to point of rest; FRA class 2 track; Toxicological testing performed.

According to CSX, PC 766071 was blocked with empty idler cars at the rear of the train involved in the Lansing accident. The conductor was riding in the caboose when he observed PC 766071 derail. He immediately notified the engineer, who initiated a full service brake application in an effort to stop the train without generating additional forces within it. According to the traincrew, the train's speed was less than 5 mph when PC 766071 struck a grade crossing and overturned.

The module remained secured to the car during the accident and subsequent rerailing. Nothing indicated the load had shifted. Deck ballast[25] had been applied in the depressed center of the car. On the left side, the frame of the module was exactly over the edge of the car deck at the car's center. On the right side, the frame was 6 inches outboard from the edge of the deck at the car's center. The extreme width of the load was 12 feet 6 inches.

PC 766071 was not equipped with constant contact side bearings. The AAR rule 47 requirement of 3/16-inch minimum to 5/16-inch maximum applied to each of the car's 12 locations for measuring side bearing clearance. Measurements taken after the accident showed that 10 locations had improper side bearing clearance. (See table 2.)

Table 2

PC 766071 reconstructed side bearing clearances

Location	Left 1	Left 2	Left 3	Left 4	Left 5	Left 6
Measurement	7/16	0	0	3/16	5/16	0
Location	Right 1	Right 2	Right 3	Right 4	Right 5	Right 6
Measurement	0	1/64	0	0	1/64	5/32

ATSF, which had also transported HRSG modules over class 3 track, reported no derailments of flatcars loaded with the HRSGs. Train makeup differed between it and CSX. The latter required that ATSF 90005, when loaded with the modules, "precede and follow multi-axle cars . . .with one loaded or empty spacer car not to exceed 263,000 lbs. gross weight on rail for weight displacement."

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[25]Two stacks of plate steel, six sheets in each stack. One stack measured 1/2 inch by 60 3/4 inches by 96 inches, and the other stack measured 1/2 inch by 60 1/2 inches by 96 inches.

Medical and Pathological Information

General.--The emergency medical service's triage center treated 24 people for minor inhalation and exposure injuries as a result of the Freeland accident. No one was admitted to a hospital. At 3:55 p.m. on July 22, a local resident drove an automobile through the police barricade that had been set up near the accident site. Sheriff's deputies stopped the vehicle after it had traveled 3/4 mile into the smoke from the burning tank cars. Seven law enforcement officers and the driver were taken to area hospitals and treated for minor eye irritations and inhalation injuries.

On July 24, three residents who had previously refused to evacuate reported to the command post, complaining of inhalation injuries. They were taken to an area hospital, treated for minor inhalation injuries, and released.

Toxicological Information.--CSX's vice president of train management, the Detroit division manager, and the superintendent of operations determined within 1 hour after the accident that Federal regulations[26] required that the traincrew be toxicologically tested. CSX directed a trainmaster at the accident site to arrange to have the traincrew taken to a medical facility for sample collection under FRA guidelines.

The two trainmasters and an assistant trainmaster at the accident site said some confusion existed concerning which program required the sample collection. In addition to the Federal requirement, which is commonly called "FRA" or "mandatory" testing, CSX has a program referred to as "agreement" testing, which provides for the collection of toxicological samples in circumstances that do not require Federal testing. Both blood and urine must be tested under the FRA program; only urine has to be tested under the agreement program, although the individual providing the urine sample may volunteer to have a blood sample drawn for testing. The collection containers, container seals, written procedures, and mailing instructions are assembled into kits for both types of testing. FRA test kits were to be sent to the Center for Human Toxicology (CHT) in Salt Lake City, Utah. Agreement test kits were to be sent to CompuChem Laboratories in Chapel Hill, North Carolina. The two kits differ substantially in size and contents.

The assistant trainmaster took the traincrew by automobile to CSX's Midland yard office, where they arrived about 1:30 p.m. He procured agreement test kits and the paperwork for toxicological sample collection. The assistant trainmaster initially stated that he did "paperwork in regards to the crew that was on duty at Midland Yard doing work at the plant" and also "went up to the front where my office is located to see how my other job was doing." However, he later testified that he only inquired about the yard job and did not perform any duties that were not directly related to the accident. According to the traincrew, the engineer and conductor were instructed to fill out accident reports at this time and all three traincrew members were allowed to make telephone calls to their families and union representatives. The traincrew was neither sequestered nor kept under constant observation during the approximately 45 minutes they were at the yard office.

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[26]Title 49 CFR Part 219, Subpart C (Post-Accident Toxicological Testing); administered by the FRA.

The assistant trainmaster next drove the traincrew to the Mid Michigan Regional Medical Center in Midland for the collection of toxicological samples. They arrived about 2:35 p.m., and a physician in the emergency room examined the traincrew members. The assistant trainmaster gave agreement test kits to medical personnel, and two urine samples and a blood sample were collected from each traincrew member. The assistant trainmaster (who later stated that he did not know whether blood samples had been drawn) instructed a nurse at the medical center to forward the samples to the address given in the kit. He then drove the traincrew back to the Midland yard office, where a trainmaster was to interview them.

The instructions in the agreement test kit specified that the toxicological samples were to be forwarded by Airborne Express, and the kit included a preaddressed, prepaid shipping label. When the nurse at the medical center contacted Airborne Express to arrange for transportation of the samples, she testified that she was informed that Airborne Express "did not do this service on weekends, that it required special arrangements to have them pick up the samples and that they would need directives from the CSX railroad to do this and that they would not just go ahead and set that up without some further direction." She then contacted CSX to determine what to do with the samples.

In conversations with CSX officials during the next hour, the nurse determined that the wrong test kit had been used in the sample collection. She testified that when she asked one CSX official what he wanted done with the samples, "he initially said to go ahead and destroy them. I questioned him as to if that is what he really wanted me to do and he said that he would check other sources and he would get back or somebody would get back with me, somebody from CSX, would get back with me as to what I was to do with the original samples."

CSX officials from Jacksonville, Florida, and Detroit, Michigan, contacted the assistant trainmaster at the Midland yard office. After confirming that the wrong kit had been used in the sample collection, they instructed him to return the traincrew to the medical center and have a second set of toxicological samples taken. The trainmaster, who was at the yard office to interview the traincrew, accompanied the four men on the return trip. They arrived at the medical center about 6:30 p.m., as did a labor union representative for the conductor and brakeman. Medical personnel, using an FRA test kit, collected a second set of samples (blood and urine) from each traincrew member about 7 p.m., 14 hours after the crew went on duty and 7 1/2 hours after the accident. The labor union representative and the assistant trainmaster witnessed the collection.

The Jacksonville CSX official, who was responsible for toxicological sample collection, told the assistant trainmaster to ask the medical center to destroy the first set of samples after a second set had been collected. The assistant trainmaster made the request, and the nurse at the medical center testified that she had the original samples incinerated that evening.

The medical center prepared the second set of samples for shipment and delivered them to the assistant trainmaster. He was unable to find an air carrier that would transport the samples from Saginaw that evening but did find a flight scheduled to depart at 6:30 the next morning. When he relayed this information to CSX officials, they told him that such a delay was unacceptable. The labor union representative, who had accompanied the assistant trainmaster from the medical center, located a flight departing Detroit at 12:30 a.m., July 23, that would accept the toxicological samples. The assistant trainmaster discussed that flight with CSX officials, who instructed him to deliver the samples to Detroit. Accompanied by the labor union representative, he drove to Detroit and did so.

The trainmaster interviewed the traincrew after they provided the second set of toxicological samples. During this interview, the brakeman requested that he be enrolled in CSX's employee assistance program (EAP). He stated that he had used cocaine while off duty the previous evening. CSX admitted him to an EAP for substance abuse on July 22.

CHT tested the second set of samples and detected no alcohol in any specimens, no drugs in the specimens from the engineer and the conductor, 845 ng/ml cocaine and more than 4,000 ng/ml benzoylecgonine[27] in the brakeman's urine specimen, and 203 ng/ml benzoylecgonine (but no cocaine) in the brakeman's blood specimen.

A review of the training provided to CSX officers from the Detroit division showed that the program included instruction in the proper procedures for toxicological sample collection. The assistant trainmaster and one other officer who had not received this training at the time of the accident were provided with it in the week following the accident; previously trained officers received refresher training.

The FRA stated that destruction of the first set of toxicological samples was "unnecessary and unfortunate." CSX said it was the "right thing to do" and that future toxicological samples will be destroyed if collected under similar circumstances.

Emergency Response

Notification.--As the locomotive was coming to a stop after the accident, the conductor broadcast an emergency radio message to the CSX dispatcher. He repeated the word "emergency" three times, identified the train, and said that the train was "on the ground" (derailed) and on fire.

The CSX dispatcher recorded the time of the emergency radio broadcast as 11:20 a.m. and about 1 minute later notified local emergency services. At 11:25 a.m. the CSX dispatcher alerted the local CSX trainmaster and assistant trainmaster that train R-331-22 had declared an emergency. After gathering information on the train consist, both CSX officers immediately responded to the accident site.

At 11:25 a.m. the Saginaw County Fire Emergency Department received a call from an unidentified individual who reported an accident involving a chemical train at Carter Road. The department activated the siren at the Tittabawassee Fire Department (TFD) in Freeland and notified the TFD volunteer fire fighters by radio and pagers at 11:26 a.m. At the same time, a Saginaw County sheriff's unit was dispatched to the scene. Mutual aid was requested and received from Thomas Township Fire Department, Kochville Fire Department, and Tri County Airport Fire Department. The train engineer reported that emergency personnel were already responding to the accident scene by the time he got to the highway.

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[27]Benzoylecgonine is a principal metabolite of cocaine. The laboratory's upper limit for benzoylecgonine was 4,000 ng/ml.

Evacuation.--Although the traincrew had started the evacuation immediately, the TFD captain-in-command requested more personnel from Saginaw County Central Dispatch at 11:42 a.m. to help evacuate residents within a 1/2-mile radius of the accident site. Emergency response personnel had the train consist by then and knew which chemicals were being transported. However, they could not determine which chemicals were involved in the intense fire that had ignited after the railcars overturned. They based the initial evacuation area on the DOT Emergency Response Guide, which recommends a 1/2-mile evacuation for the chemicals that were reportedly involved. Estimates of the number of evacuees varied but were generally about 1,000. The Red Cross provided shelter. (See figure 8.)

The Saginaw County Sheriff's Department and the Michigan State Police quickly secured the evacuated area, and only minor inhalation injuries were reported. Several residents became disgruntled when they could not return to their homes after the fire and danger of toxic fumes had apparently subsided. Fire officials allayed much anxiety by announcing that they would not allow residents to return home until emergency personnel had thoroughly inspected the evacuated area for toxic substances. Saginaw County officials and the CSX public relations department informed the public about significant developments following the accident.

Command Post Activities.--At 12:15 p.m. CSX operating officers arrived at the initial command post, which had been established at the intersection of Carter Road and highway 47, where the engineer from train R-331-22 was assisting emergency personnel. The officers had copies of the train consist and distributed them at the command post. They also advised the captain-in-command that they would arrange to have the railroad cars that had not derailed pulled away from fire. Those cars were pulled back about 1:15 p.m.

The command post was moved three times during the first 7 hours after the accident. The size of the evacuation area was changed five times in Saginaw County and three times in Midland County because of weather, wind direction, and the possibility of a boiling liquid expanding vapor explosion (BLEVE)[28] at the accident site. At 6:25 p.m. the command post was relocated to the Tittabawassee Fire Station, where it remained until the end of the emergency.

The Midland County command post was unable to communicate directly with Saginaw County. A Midland Township fire unit dispatched to the TFD command post relayed messages via the fire unit's radio to the Midland County command post. After the accident, officials of both counties met to discuss plans for a communications link between the counties during emergencies.

Fire Fighting Response.--Hazardous materials teams from Dow Chemical, shipper of the styrene and the petroleum naphtha; Dow Corning Corporation, shipper of the trimethylchlorosilane; Rohm and Haas, shipper of the acrylic acid; and CSX were at the accident scene, en route, or on standby within 2 hours after the derailment. After consulting with the chemical manufacturer's representatives at the accident site, the TFD chief decided during the first hour of the emergency not to

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[28]The term BLEVE refers to the violent thermal rupture of a pressurized vessel that results in the instantaneous and violent release of burning gases.

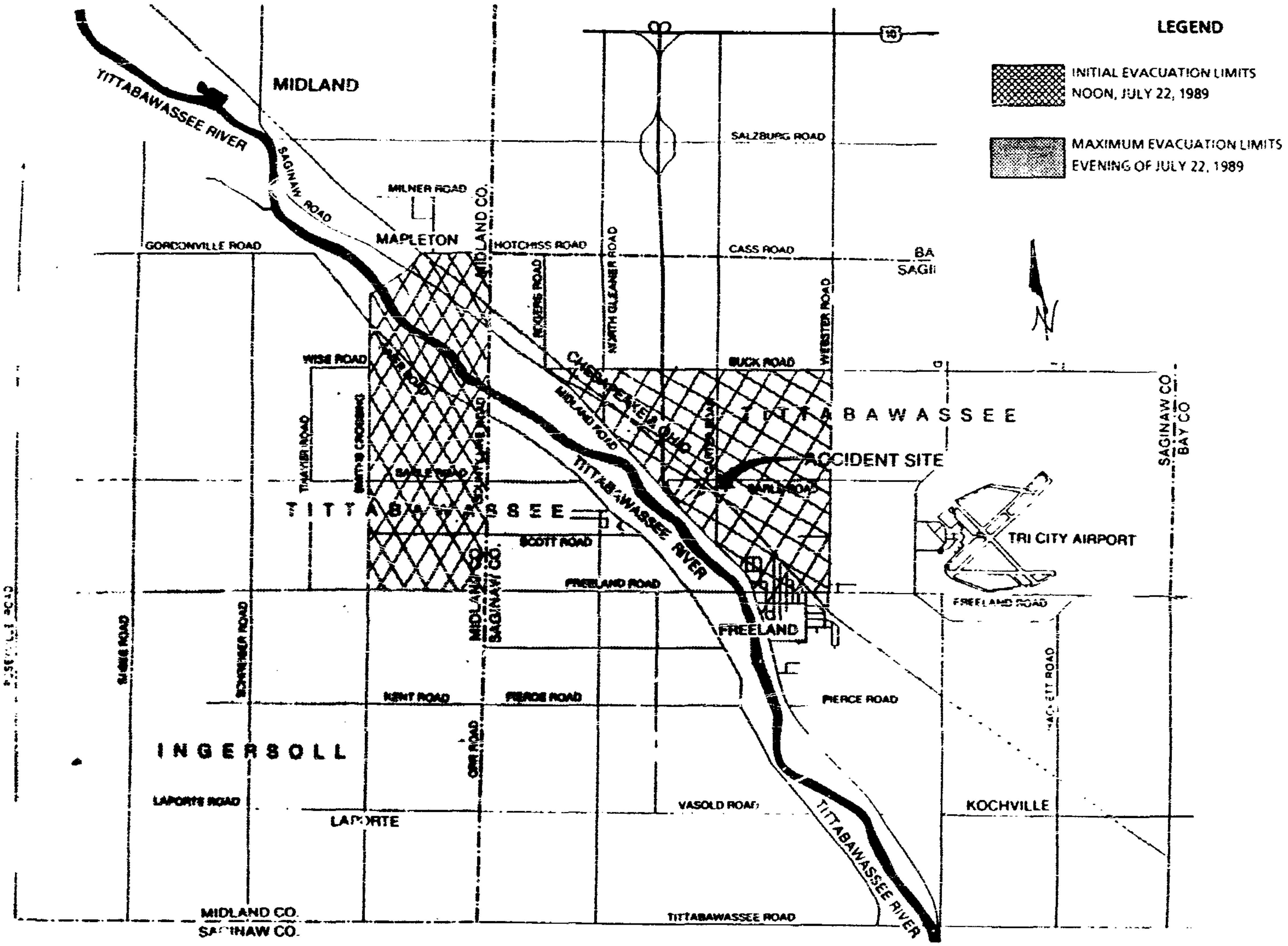


Figure 8.--Evacuation areas.

use extinguishing agents on the fire immediately. All apparatus was then staged, used to barricade roads, or positioned as sector commands.

On July 23, following an evaluation and on-site inspection, CSX, the chemical companies, the TFD chief, and other agencies determined that the trimethylchlorosilane and acrylic acid were still burning. Since a short burn life was anticipated, the TFD chief decided to allow the burning to continue.

Hazardous materials teams made an early morning evaluation of the fire scene on July 25 and determined that the trimethylchlorosilane continued to burn. The TFD chief decided to try to extinguish the fire. When sodium bicarbonate was applied, a reaction occurred that created hydrogen gas, which accumulated underneath the tank car and suddenly ignited.

Emergency response personnel then abandoned attempts to put out the fire and decided to try to accelerate the burning of the trimethylchlorosilane. Acceleration efforts began about 3 p.m., July 25. Debris around the car was removed, and the burn rate appeared to increase. When air was pumped between the jacket and the inner tank shell of the car, the burn rate seemed to further increase. The accelerated burning was allowed to continue through the night.

On the morning of July 26 the trimethylchlorosilane was still burning at the accelerated rate without apparent abatement. Options for extinguishing the burn discussed at that time included removing part of the tank car jacket, dragging the car away from the other cars to allow more air to circulate around it, and burying the burning car. The TFD chief was concerned that any action taken not endanger those persons who had just been allowed to reenter their homes. He decided not to move the car since that action would necessitate increasing the evacuation area. Part of the jacket was removed and the burn rate increased but not significantly. At day's end the trimethylchlorosilane continued to burn at about the same rate as it had in the morning.

The car was still burning on the morning of July 27. Following extensive discussion of possible methods to end the emergency, response personnel decided to continue acceleration efforts. They injected nitrogen into the car to increase internal pressure and to bring more product to the fire. To estimate how much longer the trimethylchlorosilane would burn, Dow Corning used nondestructive testing methods--neutron backscatter technology and thermal imaging--to check the liquid level in the car. Neither process yielded a definitive answer.

Burning continued on July 28. After emergency response personnel removed the jacket on the A-end of the car and pumped out about 2,000 gallons of product, the fire burned out about 1 p.m. Workers then removed the empty trimethylchlorosilane and acrylic acid cars from the track.

On July 29 CSX began moving the loaded styrene car (GATX 57100) during the wreck clearing operations. Earlier, a patch had been applied to the bottom outlet, where a leg had broken off during the derailment; the outlet valve was internal and had not been damaged. As the car was being lifted on the 29th, the tank flexed and released styrene from the bottom outlet. The car was returned to the ground and the release stopped. CSX and Dow Chemical decided that the safest option was to transload the car before removing it from the accident scene.

The empty tank car for the styrene arrived about 11:45 a.m., and the transloading operation was completed at 4:45 p.m. In the meantime, CSX had loaded the acrylonitrile car (DUPX 26523) onto a flatcar and secured it for transport. The loaded tank car and the loaded flatcar were transported to Midland about 5:25 p.m. The evacuation was lifted at 8:56 p.m. on July 29.

Environmental Monitoring.--CSX monitored for hydrogen chloride (HCL) vapors and for organic vapors (OV) to determine whether any hazardous materials had migrated from the accident site and where the public could go without risk of exposure. The monitoring equipment, which had detection limits of 0.5 part per million (ppm) for HCL and 1.0 ppm for OV, did not detect any HCL or OV at the perimeter of the evacuation area while the tank cars were burning. HCL vapors were detected at the accident site and in the downwind plume. Maximum detection distance from the site at ground level was less than 1/4 mile. Monitoring for OV ceased when the fire from the acrylic acid car had burned out.

Other Information

Condition of Heavy-Capacity and Special Flatcars.--A July 26, 1989, Safety Board inspection at Midland of four cars that had carried or were involved in moving HRSG modules revealed that all four were defective:

CR 766087 (eight-axle, heavy-capacity, depressed-center flatcar):

--Side bearing clearance less than required, 9 of 12 locations.
--Side bearing plate weld broken AL.
--Excessive bolster gib clearance, 10 of 16 locations.
--No hand brake on B-end.
--B-end coupler horn hitting striker.
--B-end coupler shank worn.
--Car ends stenciled incorrectly.

ATSF 90032 (four-axle, 89-foot, FMS, 190,000-pound capacity flatcar):

--Coupler height B-end not within AAR dimensional standards.
--Train line support missing A-end.
--Train line dragging A-end.

ATSF 94688 (four-axle, 68-foot, FMS, 230,000-pound capacity flatcar):

--Coupler height A-end not within AAR dimensional standards.

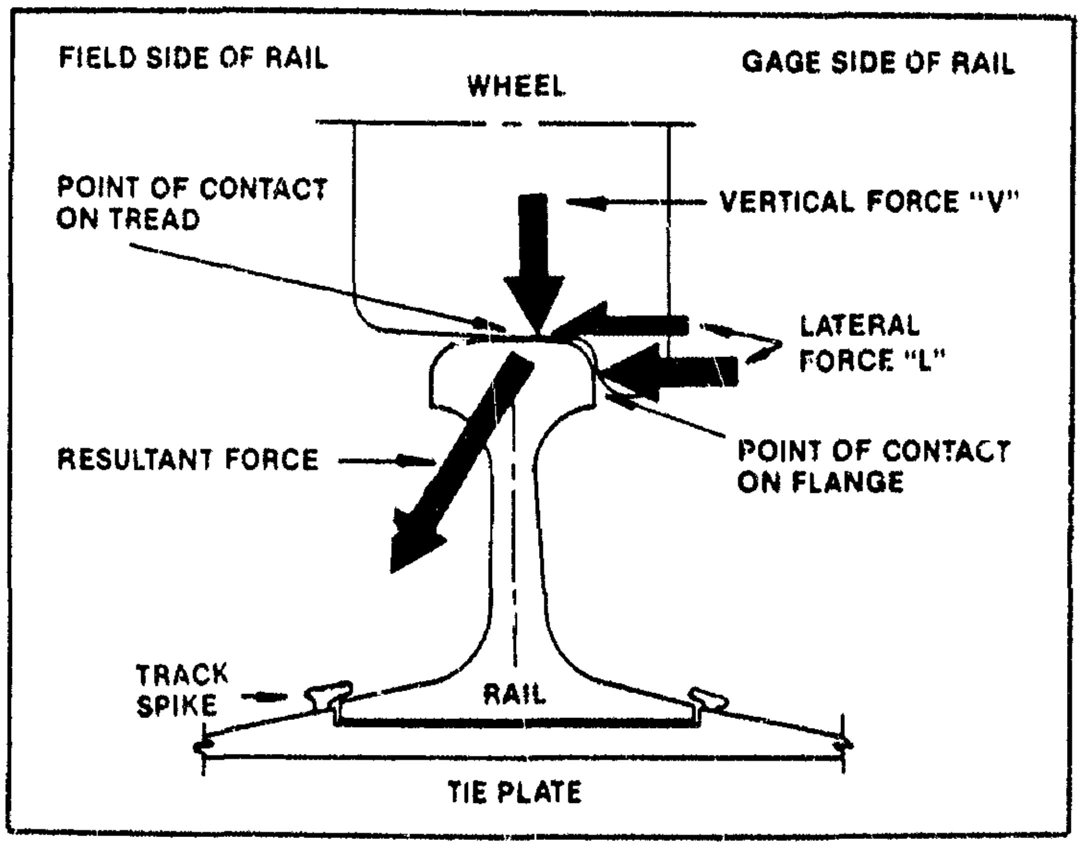
ATSF 94622 (four-axle, 68-foot, FMS, 232,000-pound capacity flatcar):

--A-end hand brake stirrup not locked under shaft.
--No coupler anticreep, A-end.

Track-Train Dynamics.--The AAR defines track-train dynamics[29] as the motion and forces resulting from the interaction of vehicles coupled into a train with the track, under given climatic conditions, train handling, train makeup, grades, curvature and operating policies.

According to the AAR Steering Committee for the Track Train Dynamics Program,[30] wheel lift derailments, which are related to the forces present at the wheel-rail interface, may be associated with track-train dynamics (see figure 9):

> The reaction of forces at the wheel-rail interface will determine the tendency for a wheel to derail. The term commonly used to identify this reaction is L/V (L over V) [lateral to vertical force] ratio as shown in [figure 9]. The greater this ratio becomes, the greater the likelihood of derailment.



SOURCE: AAR

Figure 9.--Lateral to vertical force relationship between rail and wheel.

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[29]AAR R-185, p. 1-33.

[30]An international government-industry research program on track-train dynamics; Train Derailment Cause Finding, R-522, April 1982.

> Lateral forces are influenced by: centrifugal force, coupler forces, wheel creep forces and track geometry input. Vertical forces are influenced by: vehicle weight, unbalanced elevation in curves, coupler forces, and track geometry input.

The AAR describes the dynamic forces involved in wheel-rail stability as follows:[31]

> Longitudinal train forces are transmitted serially through the train between the coupler pivot points. . . .Because the gauge face on both the rail and wheel is sloped, this lateral pressure produces a tendency for the wheel to lift off of the rail or to climb the rail. That tendency is usually greatest in the case of the outer wheel on the leading axle of a truck. . . .Despite the tendency of the wheel to lift or to climb the rail in these circumstances it is normally prevented from doing so by the vertical loading on the wheel. However, wheel lift or wheel climb will occur if the L/V ratio (the ratio of the lateral load (L) at the point of contact divided by the vertical load (V) at the point of contact) becomes sufficiently great.

Coupler forces, as the Steering Committee[32] has noted, "are a significant factor influencing the lateral and vertical force reactions that characterize [track-train dynamics]-related derailments and L/V ratios." Generally, vertical coupler forces increase proportionately with weight.

Harmonic roll, as defined in the AAR's publication on track train dynamics, "is the side-to-side rocking motion that shifts car weight alternately from one rail to the other. It can cause. . .derailment due to wheel climb or lift." In the case of conventional equipment, as the AAR states, harmonic roll usually occurs at speeds of 12 to 18 mph for loaded cars.[33]

ANALYSIS

General

The evidence indicates that the initial derailment resulted from track-train dynamics that caused a wheel on ATSF 90005 to lift. ATSF 90005 was a flatcar carrying an excess dimensional load. Key issues raised by the accident include maintenance and inspection practices for heavy-capacity freight cars, shipper notification of accidents involving excess dimensional loads, the lack of operable multifunction event recorders, the lack of head shields on some railcars transporting hazardous materials, and the lack of well-defined emergency response procedures for trimethylchlorosilane fires.

The crewmembers of train R-331-22 had been qualified by CSX for their positions, and crewmember qualifications were not considered a factor in the accident. However, CSX training and procedures for collection of toxicological

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[31]AAR R-185, p. 3-10.

[32]AAR R-522, pp. VI-6 and VI-7.

[33]AAR R-185, pp. 4-15 and 4-16.

samples, surveillance of disabled safety devices, and crew placement are issues of concern.

Accident

First Car To Derail.--The curved abrasions around the inboard face of the R1 wheel rim and the outboard face of the L1 wheel rim on ATSF 90005 matched the abrasion marks on the rail joint bars and joint bar bolts, which had been struck only from the direction ATSF 90005 was moving. No other wheels from R-331-22 displayed similar marks. The condition of the tread surface on ATSF 90005's R1 and L1 wheels indicated longer contact with the crushed rock track ballast than did any other wheel set from the train. As signified by the spacing of the marks, a four-axle truck had made the wheel marks in the wooden planks at Carter Road crossing; ATSF 90005 had the only four-axle trucks in R-331-22. Therefore, the Safety Board concludes that the number 1 wheel set from ATSF 90005 was the first to derail.

The Safety Board believes the metal fragments found between the rails from the initial POD to the road crossing were produced when the B-end span bolster came in contact with the number 2 axle on ATSF 90005 as the axle was rotating. The frictional heat generated during this contact was sufficient to melt part of the span bolster, and the resulting molten metal dropped between the rails. The abrasion locations on both the axle and the bolster, as well as the discovery of the metal fragments directly beneath what would have been the point of contact, support this conclusion.

Wheel Lift.--The derailment marks, which began on the running surface of the rail, clearly indicated wheel lift. The first mark was distinct and was not at the normal wheel-rail interface position. In order for a wheel to lift, the vertical forces holding it down had to be unloaded and lateral forces had to be simultaneously imposed, causing the axle to move laterally across the rail.

Harmonic Roll.--The Safety Board believes that as ATSF 90005 passed through the main track turnout and approached the POD, irregularities in track geometry, such as the track warp at the heel of the frog, combined with the jointed rail, initiated lateral and vertical forces that caused excessive harmonic roll movement on the car.[34] Harmonic roll transferred the weight of the load from one side of the car to the other, unloading vertical forces on diagonally opposite wheels of the same truck and at diagonally opposite corners of the car. While the vertical forces were unloaded, the lateral dynamic forces caused ATSF 90005's lead wheel set to move from the normal wheel interface position and to lose flange contact with the gauge side of the rail head. An indication of harmonic roll movement was the alternately heavy and light marks on the cross ties and in the ballast that the number 1 wheel set made after ATSF 90005 initially derailed and before it reached the Carter Road crossing.

The traincrew had not focused their attention on ATSF 90005 just before the derailment; consequently, the Safety Board cannot conclusively determine how long or how severely ATSF 90005 rocked before it derailed. ATSF 90005 was an atypical

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[34]Excessive lateral rocking of cars, usually at low speeds and associated with jointed rail. The speed range over which this cyclic phenomenon occurs is determined by factors such as the wheel base, height of each car's cg, and the spring dampening associated with each vehicle's suspension system.

car, and the harmonic roll was a cyclic phenomenon affected by the wheel base, the high cg, and the dampening effect of insufficient side bearing clearance on the car's suspension system.

The Board believes, based on several factors, that harmonic roll did not have to be sustained or severe to cause an accident with this type of car carrying this type of load. One such factor is the short distance between the track warp at the heel of the frog and the initial POD at Freeland; another is the statements by the traincrew who observed a similarly loaded car (PC 766071) derail and overturn in Lansing. Although the irregular track conditions near the derailment were within allowable tolerances for FRA class 3 track and did not greatly affect standard cars with typical ride characteristics, the combination of conditions may have been sufficient to induce rocking that lifted and moved the wheels on ATSF 90005 at this location.

All elements in the track structure help absorb the forces transmitted by the car wheels, and vertical forces are directly proportional to the load under ideal track conditions on well-lined and -surfaced track. When track geometry is irregular, the lead axle of a truck is most severely affected; it absorbs the initial impact caused by track warp and depresses the track structure for the axles that follow. Where track irregularities exist, heavy loads may produce excessive bearing, which must be absorbed by a car's wheels, axles, and suspension systems; by its ability to torque around its longitudinal and rotational axes; and by the track structure. In this accident, ATSF 90005's ability to twist was probably diminished by the truss work that had been fabricated to the car to accommodate the excess dimensional load. As the Steering Committee has stated,[35] "A car body that is stiff in torsion. . .is more prone to wheel lift than one that is flexible."

The Safety Board concludes that atypical freight cars, such as ATSF 90005 and similarly loaded and maintained cars, are more susceptible to harmonic roll and wheel lift because of their high combined cg, which amplifies lateral motion. This susceptibility is exacerbated by improper side bearing clearance, inadequate suspension, and inability to absorb torque. Insufficient side bearing clearance impaired ATSF 90005's ability to dampen lateral motion. In addition, ATSF 90005 was vertically rigid; free travel in its truck spring system was restricted because of a load weight approaching the car's limit and less than optimum spring capacity, as evidenced by the full compression of the truck springs.

Train Braking.--The engineer's train handling method differed from that recommended by the Steering Committee and in CSX guidelines, both of which prescribe a minimum 10-psi brake pipe reduction to avoid sticking brakes. The engineer did not make the minimum reduction; therefore, the brakes may not have been completely released throughout the train at the time of the derailment and may have contributed to truck slewing problems, which occur when contact between the wheel flange and rail head is improper for operating conditions. ATSF 90005's unusual wear on the R2 wheel flange and its overriding brake shoes on diagonally opposite corners indicate a truck that is improperly slewing. Improper truck slewing induces an angle between the wheel flange and the rail head comparable to that on curved track while a car is traversing tangent track, effectively creating curved rail conditions on tangent track and introducing lateral forces. Had

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[35]AAR R-185, p. 4-16.

the engineer made a minimum 10-psi brake reduction, the derailment might not have occurred.

Freight Car Inspection

ATSF 90005 had previously derailed three times on the CSX (twice while loaded with an HRSG module and once while empty). CSX officials should have been concerned about the repeated derailment of a car, especially one that was loaded with a high dollar value shipment. The Safety Board believes that CSX should have considered the derailment record of this car before placing it in a train consist in which hazardous materials were to be carried.

The Safety Board also believes that all carriers should have access to the complete derailment history of special-use, heavy-capacity flatcars. The Board therefore urges the FRA to require that carriers report all derailments involving such flatcars to the AAR and recommends that the AAR implement and maintain a reporting system that makes that information available.

In addition to the inspections at Chanute and Chicago, the train's brakeman inspected ATSF 90005 before it departed Flint on the day of the accident. However, a CSX carman was on duty at the time, and he, not the brakeman, was designated under 49 CFR 215.11 to inspect the flatcar for compliance with Federal safety standards. Only when a designated person is not on duty does 49 CFR 215, Appendix D, authorize a train crewmember to perform the predeparture inspection. Thus, the inspection at Flint was illegal, and since a designated individual had, in fact, inspected the bulk of the freight car pickup involved in the Freeland accident, the Safety Board believes that CSX allowed an improper inspection procedure to be performed.

The Safety Board is concerned that 49 CFR 215, Appendix D, only requires inspection for certain "imminently hazardous conditions," which do not include inadequate side bearing clearance. (See appendix E.) However, the provisions of Appendix D did not apply when ATSF 90005 was in Flint because the CSX carman was by law the designated inspector there. The Safety Board believes that if he had inspected the flatcar at that time, the carman, given his experience, might have observed that the side bearing clearance was inadequate and held the car at Flint until appropriate repairs could be made.

During this investigation, four heavy-capacity flatcars associated with the series of derailments involving HRSG modules were inspected and major safety deficiencies were found. The deficiencies included improper side bearing clearance on heavily loaded cars, improper coupler heights, improper bolster gib clearances, loose and missing safety appliances, train lines dragging below top of rail, and numerous minor safety deficiencies. Given the condition of the cars, the Safety Board concludes that they were allowed to continue in service despite repeated, albeit inadequate, inspections by ATSF and CSX and that they were interchanged for some time in spite of the safety deficiencies.

The Safety Board's postaccident inspection of ATSF 90005 indicated insufficient side bearing clearance at 11 of 12 locations on the car. The condition of the components used to establish side bearing clearance suggests that inadequate clearance had been a pre-accident and ongoing condition of ATSF 90005. Neither ATSF's nor CSX's inspections had resulted in the identification and correction of the defective condition before the accident, and the Safety Board is, therefore, concerned about the adequacy of the inspections being performed.

The Safety Board also found discrepancies in the calculations of the shipping dimensions. The Safety Board believes that ATSF incorrectly described the shipping dimensions for HRSG modules that were loaded on ATSF 90005 during inspections at Chanute, Kansas, on March 20 and May 15, 1989. Moreover, on March 31, 1989, after one of the incorrectly measured shipments derailed, CSX performed an improper roller bearing inspection and allowed the car to continue in revenue service.

In sum, the inadequacy of car inspection at almost every point of car movement during the shipment of HRSG modules concerns the Safety Board. Heightening that concern are the reservations recently expressed about the adequacy of freight car inspections following the investigation of a CSX freight train derailment at Akron, Ohio, on February 26, 1989. In its report on that accident,[36] which resulted in the release of hazardous materials and subsequent fire, the Safety Board recommended that the AAR emphasize the need for car inspectors to check side bearing and gib clearance during inspections.

Inspection and Oversight of Heavy-Capacity and Special Flatcars

Identification of an equipment defect is the first step in correcting a problem. The next step is to evaluate the severity of the problem and to determine whether the equipment can be operated safely until maintenance can be scheduled or whether it must be immediately withheld from service pending repairs. Whether a car is empty or loaded, the apparent value of a load, any special arrangements or authorizations associated with a movement, and the availability of replacement equipment are all factors in making such a decision. The Safety Board believes these factors entered into the decisions of railroad personnel who allowed these heavy-capacity cars to continue in service while in disrepair. The Board urges the AAR to establish a procedure among member roads for a complete annual inspection of heavy-capacity and special flatcars.

Tank Car Performance

Of the six tank cars that derailed, five sustained impact damage to the tank heads and two of those five had head-end punctures. In the case of the DOT specification 105A300W tank containing trimethylchlorosilane, almost all of the head above the top half of the tank head was punctured. The DOT specification 111A100W1 tank containing petroleum naphtha had a 10-inch by 14-inch puncture in the head below the top half of the tank head. Both tank heads of the DOT specification 111A100W6 tank containing acrylic acid were severely dented. The A-end of the DOT specification 112A200W tank car, which contained acrylonitrile, also had a 5-foot diameter, 14-inch deep dent in the tank head. The severity and extent of the damage to the derailed tank cars shows the vulnerability of the tank heads to impact damage despite the requirement for top and bottom shelf couplers on all tank cars transporting hazardous materials.

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[36]Hazardous Materials Accident Report--"Derailment of a CSX Transportation Freight Train and Fire Involving Butane, Akron, Ohio, February 26, 1989" (NTSB/HZM-90/02).

Because the Safety Board does not have the information necessary to determine the impact forces that these tank cars sustained during the accident, it cannot conclude with certainty that head shields would have prevented the tank heads from being punctured. Nonetheless, the performance of these cars can be contrasted with that of tank cars that did have head shields and were involved in a comparable derailment. On February 26, 1989, a CSX freight train derailed in Akron, Ohio, at a speed of almost 44 mph. The accident in Akron resulted in the derailment of seven DOT specification 112 and two DOT specification 105 tank cars that contained butane, all of which were equipped with head shields.

The Safety Board determined, based on its investigation of the Akron accident, that four of the nine tank cars sustained strikes to the head shields, including hard strikes to the top half of the head shields on two tank cars. However, none of these tanks was breached. A comparison of the damage to the tank heads in the Freeland and Akron accidents strongly suggests that full head shields would have reduced the likelihood of tank head punctures in the Freeland accident.

Current regulations in 49 CFR Part 173 do not require that any of the five products carried in the six derailed tank cars involved in this accident be transported in DOT specification tank cars equipped with head shields. Nonetheless, except for petroleum naphtha, all these products pose multiple hazards or have unique properties that can endanger the public if released as a result of a transportation accident.

Despite these hazards, DOT regulations currently require only that flammable gases, anhydrous ammonia, and ethylene oxide be transported in tank cars with head-puncture protection. Shippers and industry associations, however, recognize that certain products require more protection during rail transportation than existing regulations require. The Chlorine Institute, in its 1988 annual report, endorsed the addition of half-head shields to "enhance the safety of new and existing chlorine tank cars."[37]

The Safety Board has consistently maintained that head shields significantly improve protection against punctures of the tank head and has recommended that they be required on tank cars carrying a wider range of hazardous materials. In its report on the Akron accident, the Board stated that the safety benefits of full tank car head shield protection were demonstrated even when cars are equipped with vertical restraint couplers. The Board most recently addressed the need to improve protection for such cars in a safety study adopted on May 14, 1991.[38] As noted in that study, the DOT is completing a safety analysis to identify hazardous materials that pose an unacceptable level of risk when released during transportation, and DOT plans to modify existing regulations to achieve an acceptable level of safety for each product.

In the meantime, the Safety Board recommended that the Research and Special Programs Administration, the FRA, the AAR, the Chemical Manufacturers Association, and the American Petroleum Institute establish a working group to address immediately the issue of better packaging of products. The Safety Board

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[37]The Chlorine Institute is a trade association of chlorine manufacturers, packagers, distributors, and related companies that promote safety in the manufacture, transport, and use of chlorine.

[38]Safety Study--"Transporting Hazardous Materials by Railroad" (NTSB/SS-91/01).

proposed that the group develop a preliminary list of hazardous materials that should be transported only in tank cars with head-shield protection, thermal protection, or both; such materials would include those that are highly flammable or toxic, as well as those that pose a long-term health hazard through contamination of the environment. The Board also asked that the working group agree to ship the listed hazardous materials in tank cars that provide adequate protection. The Board continues to support the use of head shields on tanks to prevent the puncture of heads and the release of the most dangerous hazardous materials.

Operating Procedures

Train Handling.--Since the train did not have an operating dynamic brake, the engineer's train handling options were limited. The fact that he artificially blocked the deadman pedal would have affected neither the standard service nor emergency functions of the automatic air brake system, but it did eliminate the protection afforded by this safety device. The Safety Board has serious concern about a train operating while no one is at the controls, particularly a train carrying hazardous materials, even if the period of operation is brief. According to the traincrew's testimony, the engineer involved in this accident, as well as other engineers, routinely left the locomotive controls to urinate while trains were moving, and these engineers, with the tacit approval of the rest of the traincrew, continued to do so even though they knew the practice violated CSX operating rules.

After the Freeland accident, CSX's Detroit division implemented an extensive train operations review that focused on traincrew disablement of safety devices. The division superintendent testified that during the first month of this review CSX discovered six instances of safety device disablement, two of which involved the same engineer. According to CSX, the engineers involved were disciplined and reinstructed concerning pertinent CSX operating rules, and no further instances were discovered in the following 6 months. The Safety Board has long advocated vigorous operational efficiency testing programs as a means of promoting safe train operations. The information derived from them is critical for monitoring rules compliance and routine performance related to safety enhancement.

Crew Placement.--The General Code of Operating Rules, which has been adopted by some 38 railroads, requires that, subject to available seating, crewmembers ride in the control compartment of the locomotive and that the conductor ride in the control compartment when he is on the head end of a train. CSX operating rules do not require that conductors ride in any particular location on a train. Nonetheless, the conductor is in charge of the train under CSX rules and is generally responsible for train operations and for other train crewmembers.

In the Freeland accident, the conductor was riding on the head end because switching performed en route had resulted in placement of a hazardous materials car next to the caboose. FRA regulations preclude anyone from riding in the caboose in that situation. When the conductor moved to the head end, he positioned himself in the second locomotive unit. While the conductor was in that unit, the engineer repeatedly blocked the deadman pedal and abandoned the locomotive controls in the lead unit. Had the conductor been riding in the control compartment of the lead locomotive unit, he would have been better positioned to determine whether the engineer was adhering to the operating rules and to advise the engineer if he was not.

The Safety Board has previously addressed the issue of the need for providing qualified relief personnel for locomotive operators. On May 16, 1985, the Board issued a letter of recommendation to the FRA, the AAR, the United Transportation Union, and the Brotherhood of Locomotive Engineers (BLE) that stated:

> When the accident data is analyzed purely from a safety standpoint, without regard to union work rules or State laws, the need for more than one qualified train operator in the locomotive is obvious. Even on short routes, the locomotive operator needs relief occasionally. Therefore, the Safety Board concludes that safe freight train operations under most conditions require that at least two persons should be on the locomotive. . .and that both persons should be qualified to operate the locomotive.

The BLE supported the concept, but both the FRA and the AAR were firmly opposed to it. The events in this accident again call attention to the ramifications of not providing for the relief of a locomotive engineer.

Emergency Response

General.--The Safety Board believes the emergency response of the TFD, a volunteer group, was timely and well organized. The department implemented its incident command system according to established procedures. Since the accident occurred on a Saturday, many TFD members were available to respond to fire calls. The number of units and personnel that responded from mutual aid fire departments was adequate. The response by such departments, which volunteered time and equipment, was not delayed.

The traincrew's performance during the initial stage of the emergency response was commendable. The crew immediately notified the CSX dispatcher about the accident and had the presence of mind to alert residents to the imminent danger, help evacuate the area, and promptly provide emergency responders with the train profile.

Evacuation.--The assistant fire chief made the appropriate decision early that an evacuation was necessary. Assisting him at the command post were a train crewmember and a Dow Corning employee, who was able to identify the chemicals in the train consist and who gave advice on evacuation distances. The Red Cross provided adequate shelter.

Although communications between Saginaw and Midland Counties were inadequate, the Safety Board believes that officials on-scene initiated a timely evacuation, which they carried out in an organized and efficient manner, and that the evacuation was appropriate and necessary to protect public safety.

Response to Hazardous Materials Release and Fire.--CSX and the hazardous materials shippers promptly responded to the accident. Nonetheless, response teams encountered problems with UTLX 83841, the tank car containing trimethylchlorosilane, which burned for 6 days before the fire could be extinguished. The incident commander and hazardous materials experts tried several methods to minimize the danger from the burning trimethylchlorosilane. They initially allowed the fire to burn. After 3 days, they tried to put it out by applying sodium bicarbonate, which failed to extinguish the fire and created a potentially more hazardous situation by generating and igniting hydrogen gas. Discussions over the next 2 days about accelerating the burn rate, moving and burying the tank car, and injecting nitrogen into the car suggest that the response teams and product experts did not have a reliable method for responding to the burning trimethylchlorosilane and were unsure of what could or should be done.

Fire fighters extinguished the blaze on July 28 after pumping 2,000 gallons of trimethylchlorosilane from the burning tank car, effectively removing the "fuel" for the fire. Although Dow Corning's MSDS identified water fog and foam as fire extinguishing media, it also warned that the trimethylchlorosilane mixture reacts with water to generate hydrochloric acid vapors. Thus, the application of certain recommended extinguishing media appeared to contradict the warning about the mixture's reactivity with water. Water fog and foam were not used, presumably to avoid generating hydrochloric acid vapors.

At the time of the accident, chlorosilane manufacturers had not conducted large-scale spill tests to determine effective fire extinguishing or spill containment techniques. The lack of information about such techniques for a large release of a chlorosilane product quite likely contributed to the difficulty in extinguishing the fire.

Dow Corning reported that on May 7-14, 1990, chlorosilane manufacturers and users tested the effectiveness of foams on spills and fires involving two chlorosilanes, trichlorosilane and silicon tetrachloride. A principal conclusion, according to Dow Corning, "was that medium expansion type foams are in general the most effective in suppressing fires and vapors involving these chlorosilanes. It should be borne in mind, however, that all of these tests involved rectangular, flat pools of liquid and were conducted under relatively favorable conditions. Other configurations could present unique and/or additional challenges."

Although chlorosilane manufacturers have tested the effectiveness of extinguishing agents under "favorable conditions," the Safety Board remains concerned that effective response procedures for emergencies have not yet been proven and that recommendations in the MSDS for fire extinguishing media conflict with warnings about the material's reactivity with water. The Board believes that the Silicon Health Council, because of its role within the chemical industry, can best coordinate the efforts of chlorosilane manufacturers to develop effective emergency response procedures.

The Safety Board, therefore, urges the Council, with the assistance of Dow Corning and other chlorosilane manufacturers, to develop such procedures, including fire fighting procedures, for handling releases of chlorosilanes in transportation accidents and to provide this information to the National Fire Protection Association and the DOT. In addition, the Board encourages Dow Corning to modify its MSDSs for chlorosilanes to include those emergency response procedures found most effective. Dow should also clarify or correct apparently conflicting information in the MSDSs on the use of water to extinguish fires, as well as warnings to avoid contact between the product and water.

Toxicological Testing

In the Freeland accident, the traincrew arrived at the hospital to have toxicological samples collected about 3 hours after the derailment despite the crew's participation in emergency response activities and a delay by the conductor and engineer, who prepared accident reports while the assistant trainmaster inquired about routine duties. Nonetheless, the samples actually analyzed were not obtained until about 7 1/2 hours after the accident. The Safety Board believes the assistant trainmaster inadvertently provided "agreement" rather than "FRA" test kits for sample collection because he did not understand FRA and CSX requirements for postaccident toxicological testing. In the Board's opinion, documentation of this and other delays would help individuals involved in the toxicological sample collection process understand and comply with FRA requirements.

The Safety Board believes that CSX decided to collect a second set of toxicological samples and have the first set destroyed in an effort to comply with the strictest possible interpretation of FRA requirements. However, CSX officials did not first seek advice from the FRA about what that interpretation should be. As was apparent from testimony by the FRA's special counsel for the alcohol and drug program, the FRA considers toxicological testing a sensitive area that requires everyone involved in sample collection to act responsibly in order to avoid violating the Fourth Amendment rights of individuals being tested. The FRA conducted a comprehensive education program for carriers before the alcohol and drug rules went into effect. It held regional seminars throughout the country, distributed instruction manuals, and responded to extensive questioning. As in the case of other regulatory requirements, the FRA wants the carriers to administer this program based on the published regulations. Nonetheless, in a situation such as the one following the Freeland accident, in which officials were confused about collection requirements, the FRA stated that it would have welcomed a request for guidance and would have provided timely advice.

The first set of samples had not been compromised for purposes of toxicological analysis. CSX could either have forwarded the sealed samples in an appropriate shipping container to the FRA-approved laboratory or sent them to a laboratory to be "portioned out" (split) and then forwarded a sample portion to the FRA-approved laboratory for analysis. If CSX had sought advice from the FRA, the two parties may have been able to identify other options. The Safety Board agrees with the FRA that destruction of the first set of toxicological samples was "unnecessary and unfortunate." The Board does not support CSX's position that destruction of that set of samples was appropriate or its position that future toxicological samples should be destroyed if collected under similar circumstances. The Safety Board urges CSX to reconsider these positions and to seek advice from the FRA before any toxicological samples are destroyed in the future.

The brakeman admitted that he had consumed several gin and tonics and had used about 1 gram of cocaine the night before the accident; he also stated that he felt "kind of hung over" the next day. Blood and urine specimens taken 7 1/2 hours after the accident contained cocaine and cocaine metabolite levels sufficient to support the brakeman's admission. Since the stimulant action of cocaine can lead to insomnia and since alcohol adversely affects sleep, it is unlikely that the brakeman slept much the night before the accident and may have been fatigued the following morning.

The Safety Board believes the brakeman was not fit for duty on the day of the accident as a result of cocaine and alcohol usage the night before. Although the brakeman's performance was not a factor in the accident, his apparent use of cocaine is troubling, since someone in his position must be alert, have good judgment, and be prepared to respond quickly to various situations in order to carry out his duties. Moreover, studies have shown that drug users have an increased accident rate and thus may not only be susceptible to accidents but may also represent a threat to their fellow workers.

The Safety Board expressed concern about timely collection of toxicological samples in its 1988 study of the impact of alcohol-drug use on railroad safety.[39] Collection times in a sample from 46 railroad accidents in 1987 ranged from 1 1/2 to 14 hours; the average was 5 1/2 hours. As a result of its study, the Safety Board recommended on August 9, 1988, that the FRA:

> R-88-31
>
> Amend 49 CFR Part 219 to require railroads to collect all appropriate toxicological samples as soon as practicable and not more than 4 hours after the triggering event. Written explanation of the reason(s) for failure to collect samples within 4 hours or not at all must be submitted to the Federal Railroad Administration.

On March 10, 1989, the FRA responded to Safety Recommendation R-88-31, stating that it disagreed with the need to set a time limit for collection of toxicological samples. The Safety Board has placed Safety Recommendation R-88-31 in an "Open--Unacceptable Action" status. The Board believes that the FRA's willingness to tolerate delays of many hours in sample collection weakens the effectiveness of the alcohol and drug testing rules and that it undermines efforts to determine whether alcohol and drug use by railroad employees in safety-sensitive positions is a human performance factor in accidents.

Delays in sample collection seriously limit the ability to identify and quantify drugs that are rapidly metabolized. These drugs include, depending on the extent of the delay, cocaine, the psychoactive component of marihuana, and alcohol. Delays in sample collection also increase the difficulty and uncertainty in determining whether an individual was impaired at the time of the accident. Thus, blood and urine samples should be obtained from surviving crewmembers as quickly as possible. If collection cannot be carried out within 4 hours, samples should still be obtained, but the analytical measurements and interpretation of positive results become more difficult.

The Independent Safety Board Act Amendments of 1990 (Public Law 101-641) recognize the importance of timely collection of samples for toxicological testing. Section 5 of the law states in part:

> When the Department of Transportation, including any of its agencies, conducts postaccident or postincident testing of an employee of the Department, specimen collection shall be accomplished as soon as practicable after the accident or incident, and the Department shall endeavor when feasible to complete such collection within four hours after the accident or incident.

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[39] Safety Study--"Alcohol/Drug Use and Its Impact on Railroad Safety" (NTSB/SS-88/04).

Public Law 101-641 also requires that agency heads in DOT report to the Office of the Secretary the amount of time required to complete specimen collection related to a toxicological test.

The Board believes that since Congress has passed legislation requiring timely collection of toxicological specimens from DOT employees, the Department should establish similar provisions for the transportation industry, as called for in Safety Recommendation R-88-31.

Event Recorders

Train R-331-22 was not equipped with a functioning multi-event recorder. Consequently, train handling information was largely derived from what the traincrew related. Recorded train speed was of limited usefulness since the manner in which the train was controlled in this accident was more important than speed. Vital information, such as quantified braking, throttle manipulation, and the chronological relationship between power-to-braking and braking-to-power, was not available. The Safety Board concludes that the absence of event recorder data hindered this investigation.

Section 10 of the Rail Safety Improvement Act of 1988[40] directs the Secretary of Transportation to:

> Issue such rules, regulations, standards, and orders as may be necessary to enhance safety by requiring trains to be equipped with event recorders.

The Safety Board's position regarding mandatory use of event recorders in the railroad industry has been well documented.[41] In 1989, following its investigation of a head-on collision between two freight trains in Altoona, Iowa, the Board issued the following safety recommendation to the FRA:

> R-89-50
>
> Expedite the rulemaking requiring the use of event recorders in the railroad industry.

The Safety Board subsequently reiterated this safety recommendation to the FRA, which has indicated that it expects to publish by mid-1991 a notice of proposed rulemaking that would require the use of event recorders by the railroad industry. Safety Recommendation R-89-50 has been classified "Open--Acceptable Action" pending publication of a final rule.

[40]Public Law 100-342, June 22, 1988.

[41]See, for example, Railroad Accident Report--"Head-on Collision between Iowa Interstate Railroad Extra 470 West and Extra 406 East With the Release of Hazardous Materials, near Altoona, Iowa, July 30, 1988" (NTSB/RAR-89/04); Railroad Accident Report--"Derailment of Southern Pacific Transportation Company Freight Train on May 12, 1989 and Subsequent Rupture of Calnev Pipeline on May 25, 1989 San Bernardino, California" (NTSB/RAR-90/02); and Railroad Accident Report--"Derailment of a CSX Transportation Freight Train and Fire Involving Butane, Akron, Ohio, February 26, 1909" (NTSB/HZM-90/02).

CONCLUSIONS

Findings

1. ATSF 90005 derailed due to R1 wheel lift on the leading axle and was the first car from CSX train R-331-22 to derail.

2. Track-induced dynamics, aggravated by ATSF 90005's high center of gravity, initiated the harmonic roll action that caused the wheel lift on ATSF 90005.

3. ATSF 90005 was unable to dampen these dynamic forces because of improper side bearing clearance and increased torsional resistance resulting from the truss work used to attach the load to the car.

4 The engineer's improper braking procedure may have contributed to the harmonic roll and truck slewing that resulted in the wheel lift on ATSF 90005.

5. Track conditions, combined with improper train handling, resulted in vertical displacements of the truck suspension, which could not properly respond because of the inadequate side bearing clearance of ATSF 90005.

6. ATSF had not adequately maintained or inspected ATSF 90005 when the car was made available for revenue service.

7. CSX did not adequately inspect ATSF 90005 when the car was received in interchange.

8. CSX did not consider the derailment record of ATSF 90005 before placing it in a train consist carrying hazardous materials.

9. No central clearinghouse exists for critical information about derailments involving special-use cars and excess dimensional loads.

10. The major safety deficiencies identified on heavy-capacity and special flatcars during the investigation could have been discovered earlier if the AAR had had a requirement for an appropriate periodic inspection of such cars.

11. The engineer's nullification of the deadman pedal, which eliminated the protection afforded by that safety device, underscores the need to position freight train conductors in the control compartment of the lead locomotive unit.

12. Head-shield protection on tank cars involved in this accident would have reduced the likelihood of head punctures.

13. The emergency response to this accident was timely and well organized. The duration and extent of the evacuation were necessary and appropriate.

14. Efforts to extinguish the fire involving the trimethylchlorosilane tank car were prolonged because effective fire fighting methods for large releases of chlorosilanes had not been identified.

15. The first set of toxicological samples was inappropriately and unnecessarily destroyed because of confusion on the part of CSX personnel concerning specimen collection requirements and because CSX officials improperly understood Federal requirements and did not seek advice from the FRA.

16. The lack of a functioning event recorder hindered this investigation and made accident reconstruction more difficult.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was inadequate car inspection by ATSF and CSX that, combined with other factors, including track conditions and train handling, resulted in wheel lift and the subsequent derailment of ATSF 90005. Contributing to the severity of the accident were the release of hazardous materials from tank cars that were not equipped with head-shield protection and the lack of effective fire fighting techniques for responding to large trimethylchlorosilane fires.

RECOMMENDATIONS

As a result of its investigation, the National Transportation Safety Board made the following recommendations:

--to the Federal Railroad Administration:

> Require that carriers inspect special-use rail equipment, such as heavy-capacity flatcars, before those cars are offered for service and thereafter at a frequency to be determined by the Federal Railroad Administration. (Class II, Priority Action) (R-91-51)
>
> Require that carriers immediately notify the shipper and car owner about a derailment involving a special-use, heavy-capacity flatcar. (Class II, Priority Action) (R-91-52)
>
> Require that carriers report derailments involving special-use, heavy-capacity flatcars to the Association of American Railroads, which will maintain a record of the derailment history of all such cars. (Class II, Priority Action) (R-91-53)
>
> Determine, using owners' records of derailments for special-use, heavy-capacity flatcars under load, whether handling of such equipment should be restricted in trains that include tank cars or hopper cars transporting hazardous materials and cars carrying shipments of class A and B explosives. (Class II, Priority Action) (R-91-54)

--to the Association of American Railroads:

> Urge your members to perform a complete inspection of heavy-capacity and special-use flatcars before offering them for revenue service. This inspection should include documentation that the subject cars comply with all existing requirements in the Field Manual of the AAR Interchange Rules. (Class II, Priority Action) (R-91-55)

Implement and maintain a reporting system that includes the derailment history of special-use, heavy-capacity flatcars as reported by carriers. (Class II, Priority Action) (R-91-56)

--to the Silicon Health Council:

Determine, with the assistance of Dow Corning and other chlorosilane manufacturers, the most effective emergency response procedures for handling transportation accidents involving the release of chlorosilanes, including accidents involving fires, and provide this information to the National Fire Protection Association and the U.S. Department of Transportation. (Class II, Priority Action) (I-91-1)

--to Dow Corning Corporation:

Develop, in conjunction with the Silicon Health Council, effective emergency response procedures, including the best fire fighting procedures, for handling releases of chlorosilanes in transportation accidents. (Class II, Priority Action) (R-91-57)

Modify the Material Safety Data Sheets for chlorosilanes to include the most effective emergency response procedures and to clarify or correct any conflicting information regarding the use of water to extinguish fires and warnings to avoid contact between the product and water. (Class II, Priority Action) (R-91-58)

--to CSX Transportation Corporation:

Perform a complete inspection of heavy-capacity and special flatcars accepted in interchange. This inspection should include documentation that the subject car complies with all existing requirements in the Field Manual of the AAR Interchange Rules. (Class II, Priority Action) (R-91-59)

Until the Federal Railroad Administration establishes a reporting system, immediately notify the shipper and car owner about a derailment involving a special-use, heavy-capacity flatcar. (Class II, Priority Action) (R-91-60)

Issue operating rules that require freight train conductors to ride in the controlling compartment of the locomotive. (Class II, Priority Action) (R-91-61)

Provide annual training on proper procedures for collecting toxicological samples for CSX officers who may be involved in collecting such samples. (Class II, Priority Action) (R-91-62)

--to the Atchison, Topeka and Santa Fe Railway Company:

> Perform a complete inspection of special-use and heavy-capacity flatcars before offering them for revenue service. This inspection should include documentation that the subject car complies with all existing requirements in the Field Manual of the AAR Interchange Rules. (Class II, Priority Action) (R-91-63)
>
> Until the Federal Railroad Administration establishes a reporting system, immediately notify the shipper and car owner about a derailment involving a special-use, heavy-capacity flatcar. (Class II, Priority Action) (R-91-64)

As a result of its investigation of this accident, the Safety Board also reiterates the following safety recommendation:

--to the Federal Railroad Administration:

> R-89-50
>
> Expedite the rulemaking requiring the use of event recorders in the railroad industry.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ James L. Kolstad
Chairman

/s/ Susan M. Coughlin
Vice Chairman

/s/ John K. Lauber
Member

/s/ Christopher A. Hart
Member

John A. Hammerschmidt, Member, did not participate.

July 23, 1991

Susan M. Coughlin, Vice Chairman, filed the following concurring statement:

> I am concurring with the accident report, the probable cause, and the recommendations, as revised, but wish to be on record that this accident presents an opportunity for the Safety Board to publicly adopt a position favoring random drug and alcohol testing in the railroad industry. The Safety Board approved language in the report that ". . .the brakeman aboard this train was not fit on the day of the accident as a result of cocaine and alcohol usage the previous night." Although it is recognized that the brakeman's performance was not causal in the

accident, it is troubling that such an individual, who had an important responsibility for verifying the reliability and integrity of the train's braking systems, could report for duty and have the fact that he was unfit for duty go undetected. With regard to his drug use, apparently pre-employment, reasonable suspicion, and for cause testing failed, in this case, to identify an individual with an abuse problem. So subtle are the visual cues that indicate drug abuse, even supervisors and fellow employees who may have observed the brakeman on the morning of the accident apparently took no exception to his appearance or behavior.

Random testing, while by no means a panacea, provides yet another hurdle that an individual bent on illegal drug or improper alcohol use must clear. By virtue of its random nature, it provides a strong incentive for the nonaddicted or "casual" user to refrain from use. In all probability random testing eventually would have identified the brakeman's drug use since the levels of cocaine detected in his postaccident toxicological specimens, coupled with the brakeman's own statements, suggest that he was not a novice or first-time user. While some may argue that random drug testing, and the deterrent value it suggests, might not have been sufficient to deter the brakeman in this instance, it certainly is, in my view, a valuable, additional preventative measure designed to keep illegal drugs and abuse of alcohol out of the railroad workplace.

I would have liked to see the Board amend the report on page 43 to include, following the last line: The Safety Board believes that the mandatory, random drug testing programs now in place on the major railroads will complement existing employee assistance programs, peer intervention programs such as Operation Redblock, pre-employment drug and alcohol screening, and other forms of testing designed to detect individuals troubled by alcohol and drug abuse and, more importantly, remove them from safety-sensitive positions until such time as their abuse problems no longer pose a threat to themselves, their fellow workers or the public. Additionally, random tests for alcohol, the most common drug of abuse in this country, should be added to the government-mandated random testing programs now in place throughout the railroad industry.

/s/ Susan M. Coughlin
Vice Chairman

APPENDIXES

APPENDIX A

INVESTIGATION

Investigation

The National Transportation Safety Board was notified of the accident at 3:40 p.m., eastern daylight time, on July 22, 1989, and immediately dispatched an investigator-in-charge, an emergency response group chairman, and a hazardous materials group chairman from Washington, D.C., as well as an engineering group chairman from Ft. Worth, Texas, a mechanical factors group chairman from Denver, Colorado, and an operations group chairman from Chicago, Illinois. Human performance and event recorder groups, headed by group chairmen from Washington, D.C., were formed later. Member James E. Burnett, Jr., arrived at the accident site on July 24, 1989.

Hearing/Deposition

The Safety Board convened a 3-day public hearing at Saginaw, Michigan, on October 17, 1989, as part of its investigation. Parties to the hearing included the Federal Railroad Administration, Atchison, Topeka and Santa Fe Railway Company, CSX Transportation, Inc., Chanute Manufacturing Company, the United Transportation Union, the Brotherhood of Locomotive Engineers, and the Brotherhood of Railway Carmen. Testimony was taken from 21 witnesses, and 33 exhibits were entered into the record.

APPENDIX B

PERSONNEL INFORMATION

Locomotive Engineer

James E. Willert, 36, was employed by the Chesapeake and Ohio Railway Company (C&O) as a locomotive fireman on August 4, 1971. The C&O later merged to become part of CSX. He was qualified as a hostler on September 26, 1972, and was promoted to locomotive engineer on November 1, 1974. His most recent operating rules qualification prior to the accident was on March 5, 1989.

Conductor

Clyde G. Gable, 49, was employed by the C&O as locomotive fireman on January 9, 1964. He was furloughed from that position in May 1964 owing to a labor agreement concerning firemen. He was reinstated as a switchman on August 20, 1964, and was promoted to conductor on November 7, 1966. His most recent operating rules qualification prior to the accident was on May 15, 1988.

Brakeman

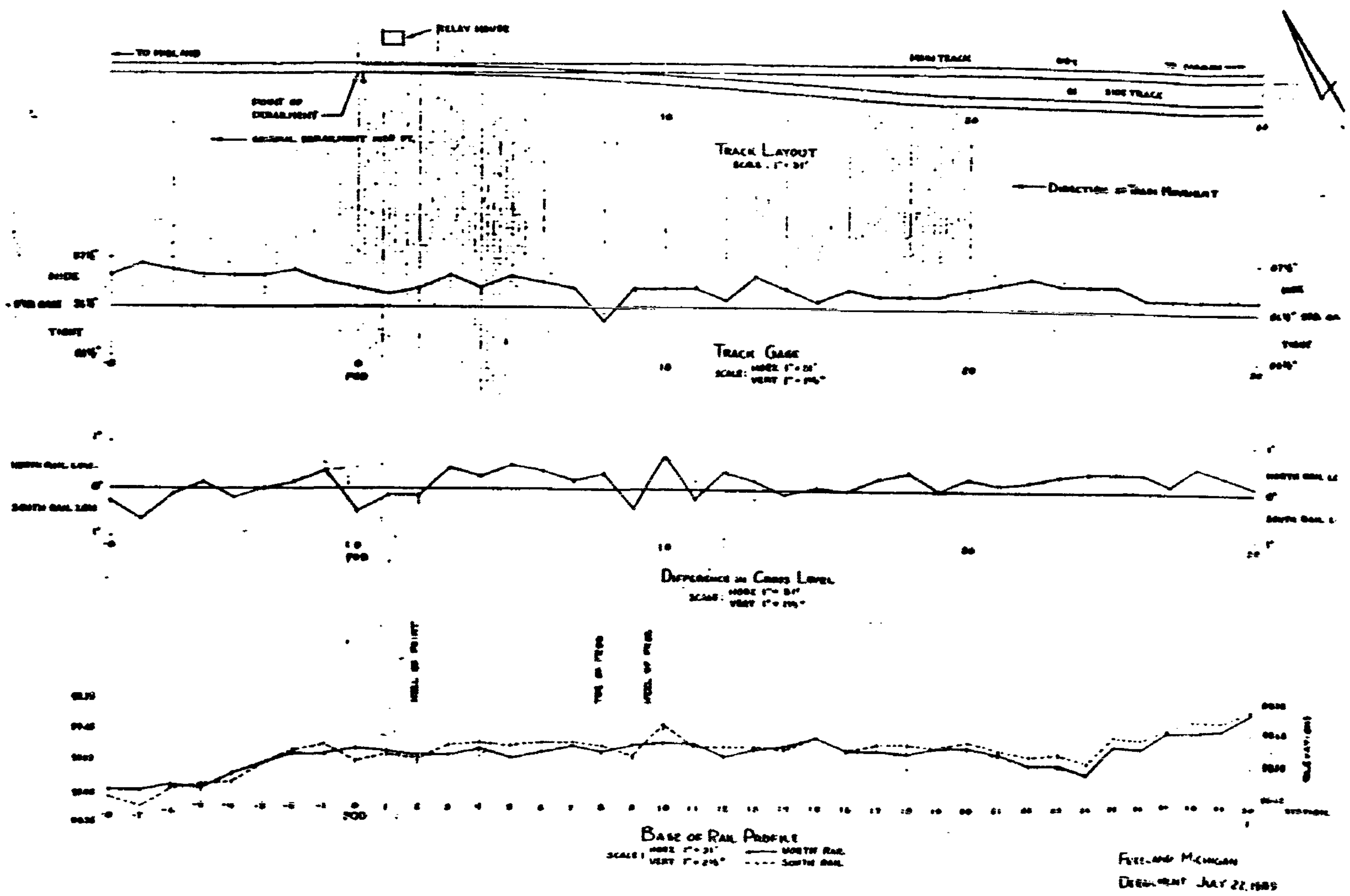
Lloyd W. Sonnenberg, 45, was employed by the C&O as a brakeman on July 2, 1964. He resigned to attend college on September 3, 1964, and was reemployed as a brakeman on January 13, 1965. He was promoted to conductor on January 1, 1974. His most recent operating rules qualification prior to the accident was on April 19, 1986.

APPENDIX C

COMMODITY LISTING FOR TRAIN R-331-22

Position Behind 2nd Engine	Car No.	DOT Car Type	Chemical/ Shipping Name	DOT Hazard Class
6	GATX 57100	Tank Car 111A100W	Styrene, Monomer	Flammable Liquid
7	DUPX 26523	TankCar 112A200W	Acrylonitrile	Flammable Liquid
10	UTLX 647038	Tank Car 111A100W6	Acrylic Acid	Corrosive material
11	UTLX 83841	Tank Car 105A300W	Flammable Liquid Corrosive, n.o.s	Flammable Liquid
12	CHVX 288071	Tank Car 111A100W1	Petroleum Naphtha	Combustible Liquid
13	ACFX 64357	Covered Hopper	Paraformaldehyde	ORM-A
14	GATX 68950	Tank Car 105A500W	Flammable Liquid, Corrosive n.o.s	Flammable liquid
15*	DOWX 3510	Tank Car 105A300W	Ethyl Chloride	Flammable liquid
16*	DOWX 8113	Tank Car 105A300W	Ethyl Chloride	Flammable liquid
17*	RUSX 3112	Tank Car 111A100W3	Petroleum Naphtha	Combustible Liquid
22*	GLNX 3613	Tank Car 111A100W3	Acrylonitrile	Flammable Liquid
28*	DOWX 5969	Tank Car 111A100W1	Sodium Hydroxide	Corrosive Material
29*	DOWX 6228	Tank Car 111A100W1	Sodium Hydroxide	Corrosive Material
30*	DOWX 8065	Tank Car 105A500W	Chlorine	Non Flammable Gas
31*	PROX 24000	Tank Car 111A100W1	Styrene Monomer	Flammable liquid

* Not derailed



TRACK GEOMETRY MEASUREMENTS

APPENDIX E

TITLE 49 CFR, PART 215, APPENDIX D

215.117 Defective roller bearing adapter.
(A) Cracked or broken.
(B) Not in design position.
(C) Worn excessively as shown on Figure 1 in relief portion.
215.119 Defective freight car trucks.
(A)(1) Side frame or bolster broken;
(2) Cracked ¼" or more in transverse direction on tension member;
(3) Cracked 1" or more in transverse direction on tension member.
(B) Has ineffective snubbing devices.
(C)(1) Missing or broken side bearing;
(2) Side bearing in contact except by design;
(3) Excessive side bearing clearance at one end of car;
(4) Excessive side bearing clearance on opposite sides at diagonal ends of car.
(D)(1) Has truck springs that will not maintain travel or load;
(2) Truck springs that are compressed solid;
(3) Has two springs broken in a cluster;
(4) Has three or more springs broken.
(E) Truck bolster and center plate interference preventing rotation.
(F) Has broken beam shelf supports worn so that shelf will not support beam.
215.121 Defective car body.
(A) Improper clearance—less than 2½" from top of rail.
(B) Center sill is:
(1) Broken;
(2) Cracked more than 6";
(3) Bent or buckled more than 2½" in any 6-foot length.
(C) Coupler carrier is:
(1) Broken;
(2) Missing;
(3) Non-resilient when used with coupler with F head.
(D) Car door not equipped with operative safety hangers.
(E) If center plate:
(1) Any portion missing;
(2) Broken or cracked as defined in this part.
(F) Broken side sills, crossbars or body bolster.
215.123 Defective couplers.
(A) Coupler shank bent.
(B) Coupler cracked in highly stressed area of head and shank.
(C) Coupler knuckle broken.
(D) Coupler knuckle pin or knuckle throw:
(1) Missing;
(2) Inoperative.
(E) Coupler retainer pin lock:
(1) Missing;
(2) Broken.
(F)(1) Coupler locklift is inoperative;
(2) No anti-creep protection;
(3) Coupler lock is (i) missing, (ii) inoperative, (iii) bent, (iv) cracked or (v) broken.
215.125 Defective uncoupling device.
(A) Fouling on curve.
(B) Unintentional uncoupling.
215.127 Defective draft arrangement.
(A) Draft gear inoperative.
(B) Broken yoke.
(C) End of car cushioning unit:
(1) Leaking;
(2) Inoperative.
(D) Vertical coupler pin retainer plate:
(1) Missing;
(2) Has missing fastener.
(E) Draft key or key retainer:
(1) Inoperative;
(2) Missing.
(F) Follower plate missing or broken.
215.129 Defective cushioning device unless effectively immobilized.
(A) Broken.
(B) Inoperative.
(C) Missing parts.
215.203 Operating a restricted car, except under conditions approved by FRA.

Stenciling

215.301 Failure to stencil car number and built date on freight car as required.
215.303 Failure to stencil restricted car as required.
215.305 Failure to stencil maintenance-of-way equipment as required.

Appendix D to Part 215—Pre-departure Inspection Procedure

At each location where a freight car is placed in a train and a person designated under § 215.11 is not on duty for the purpose of inspecting freight cars, the freight car shall, as a minimum, be inspected for the imminently hazardous conditions listed below that are likely to cause an accident or casualty before the train arrives at its destination. These conditions are readily discoverable by a train crew member in the course of a customary inspection.

1. Car body:
(a) Leaning or listing to side.
(b) Sagging downward.
(c) Positioned improperly on truck.
(d) Object dragging below.
(e) Object extending from side.
(f) Door insecurely attached.
(g) Broken or missing safety appliance.
(h) Lading leaking from a placarded hazardous material car.
2. Insecure coupling.
3. Overheated wheel or journal.
4. Broken or extensively cracked wheel.
5. Brake that fails to release.
6. Any other apparent safety hazard likely to cause an accident or casualty before the train arrives at its destination.

[45 FR 26711, Apr. 21, 1980]

APPENDIX F

CSX ROLLER BEARING INSPECTION POLICY

-ADM- #A6 L2X000103L2XL2XL90 892161410

AUGUST 4, 1989.16
FILE

TO: CSXT-EQUIPMENT LOCATIONS
MECHANICAL SUPERINTENDENTS
GENERAL CAR INSPECTORS

FROM: D. J. RODERIQUE

SUBJECT: INSPECTION OF ROLLER BEARINGS INVOLVED IN DERAILMENTS

THE PRACTICE OF MAKING A 'VISUAL INSPECTION' OF ROLLER BEARINGS INVOLVED IN A MAJOR DERAILMENT IS NOT IN COMPLIANCE WITH CSXT-EQUIPMENT UNIT POLICY NOR THE AAR INTERCHANGE RULES.

IT IS IMPERATIVE THAT STRICK COMPLIANCE TO THE REQUIREMENTS OF AAR INTERCHANGE RULE 36 A.1., SHOWN BELOW AND ON PAGE 184 OF THE FIELD MANUAL, BE ADHERED TO.

AAR INTERCHANGE RULE 36 A. 1. DERAILMENT

A. MAJOR DERAILMENT. WHEEL SET MUST BE REMOVED AND HANDLED IN ACCORDANCE WITH THE WHEEL AND AXLE MANUAL AND ROLLER BEARINGS MUST BE REMOVED AND DISASSEMBLED FOR INSEPECTION AND NECESSARY REPAIRS.

B. MINOR DERAILMENT. DERAILED TRUCKS ON EMPTY OR LOADED CARS INVOLVED IN A DERAILMENT AT A SPEED OF NOT OVER 10 MILES PER HOUR OR WHICH HAVE NOT MOVED ON THE GROUND MORE THAN 200 FEET, INSPECT BEARINGS AS FOLLOWS

1. REMOVE WHEEL SET.
2. BEARINGS MUST BE SUFFICIENTLY CLEAN TO PERMIT ADEQUATE INSPECTION OF ALL EXTERIOR PARTS.
3. CAREFULLY INSPECT THE OUTER CUP FOR CRACKS OR BREAKS.
4. INSPECT FOR LOOSE OR DAMAGED FRONT AND REAR SEALS.
5. INSPECT FOR CRACKED OR BROKEN END CAPS. MISSING OR LOOSE END CAP SCREWS.
6. INSPECT FOR LOOSE BACKING RINGS.
7. INSPECT BEARING IN ACCORDANCE WITH THE GUIDELINES IN SECTION A.3.
8. CHECK FOR BENT AXLE IN ACCORDANCE WIHT RULE 43,E.4.
9. IF THESE CHECKS ARE SATISFACTORY, CONTINUE WHEEL SETS IN SERVICE. OTHERWISE, THE BEARINGS MUST BE REMOVED, DISASSEMBLED AND INSPECTED FOR DAMAGE.

C. CARS ARRIVING HOME SHOPS, INCLUDING PRIVATE LINE AND CONTRACT SHOPS, WITHOUT RECORD OF ROLLER BEARING INSPECTION BEING PERFORMED, WHEEL SET MUST BE REMOVED AND ROLLER BEARINGS DISSEMBLED FOR INSPECTION PER PARAGRAPH A. ABOVE.

A COPY OF THIS LETTER IS TO BE GIVEN TO ALL EMPLOYEES INVOLVED IN FREIGHT CAR INSPECTION AND REPAIR BY THEIR IMMEDIATE SUPERVISOR. THE SUPERVISOR IS TO ASSURE THAT THE EMPLOYEE FULLY UNDERSTANDS AND COMPLIES WITH THIS RULE.

COMPLIANCE IS ABSOLUTELY MANDATORY.

CC - MESSRS: A. E. GLADSTONE
P. J. MORRISSEY
D. L. PETWAY
M. W. PHEBUS
J. D. WILLIAMS

GRKANGAS132544 Q9Q INSPS
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