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Railroad Special Investigation Report

Two Rear-End Collisions Involving Chicago Transit Authority Rapid Transit Trains at Chicago, Illinois June 17 and August 3, 2001

National Transportation Safety Board
Washington, D.C.

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Abstract: Within a 2-month period in 2001, the Chicago Transit Authority (CTA) experienced two similar rear-end collisions involving CTA rapid transit trains. Both accidents were preceded by the train operators' having failed to comply with operating rules designed to prevent collisions. The investigation of the two accidents highlighted deficiencies in the CTA management's approach to ensuring rules compliance among its operators. This special investigation report addresses the factors common to both collisions.

This special investigation report discusses the following safety issues: the adequacy of the CTA's programs for ensuring compliance with its operating rules, the adequacy of the CTA's system safety program plan and its internal safety audit program for identifying and resolving systemic safety issues, and the adequacy of event recorders on rail transit vehicles.

As a result of this special investigation, the Safety Board makes recommendations to the Chicago Transit Authority, the American Public Transportation Association, and the Federal Transit Administration.

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Introduction

Within a 2-month period in 2001, the Chicago Transit Authority (CTA) experienced two similar rear-end collisions involving CTA rapid transit trains. Both accidents were preceded by the train operators' having failed to comply with operating rules designed to prevent collisions. The investigation of the two accidents highlighted deficiencies in the CTA management's approach to ensuring rules compliance among its operators. This special investigation report addresses the factors common to both collisions.

The first accident occurred about 11:40 a.m., central daylight time, on Sunday, June 17, 2001, when CTA train 104, en route from downtown Chicago to O'Hare Airport, collided with standing CTA train 207 on the Blue Line near Addison Street Station. Each train consisted of four passenger cars. About 75 passengers were on train 104, and about 40 passengers were on train 207. Eighteen passengers, an off-duty CTA employee, and both train operators sustained minor injuries. The CTA estimated damages at $30,000.

The second accident occurred about 9:04 a.m., central daylight time, on Friday, August 3, 2001, when CTA Brown Line train 416, en route from Kimball to downtown Chicago, collided with standing CTA Purple Line train 505 on elevated tracks near Hill Street. Each train consisted of six passenger cars. The accident occurred during morning rush hour, and both trains had standing loads estimated at 90 passengers per car. Chicago Police Department logs indicate that 118 people were transported to area hospitals with minor injuries, none of which were life threatening. The CTA estimated damages at $136,138.

This special investigation report discusses the following safety issues:

- The adequacy of the CTA's programs for ensuring compliance with its operating rules;
- The adequacy of the CTA's system safety program plan and its internal safety audit program for identifying and resolving systemic safety issues; and
- The adequacy of event recorders on rail transit vehicles.

As a result of this special investigation, the Safety Board makes recommendations to the Chicago Transit Authority, the American Public Transportation Association, and the Federal Transit Administration.

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Factual Information

June 17 Accident[1]

Accident Narrative

At 5:40 a.m.[2] on Sunday, June 17, 2001, a train operator employed by the Chicago Transit Authority (CTA) reported for duty at O'Hare Station. The schedule called for her to operate rapid transit trains for two round trips between the O'Hare and Forest Park Stations.

When she reported for duty, she received a rail service bulletin informing her that the northbound[3] Blue Line track between the Belmont and California Stations (see figure 1) was out of service for scheduled maintenance and that trains running in either direction between the two stations would have to use the southbound track.

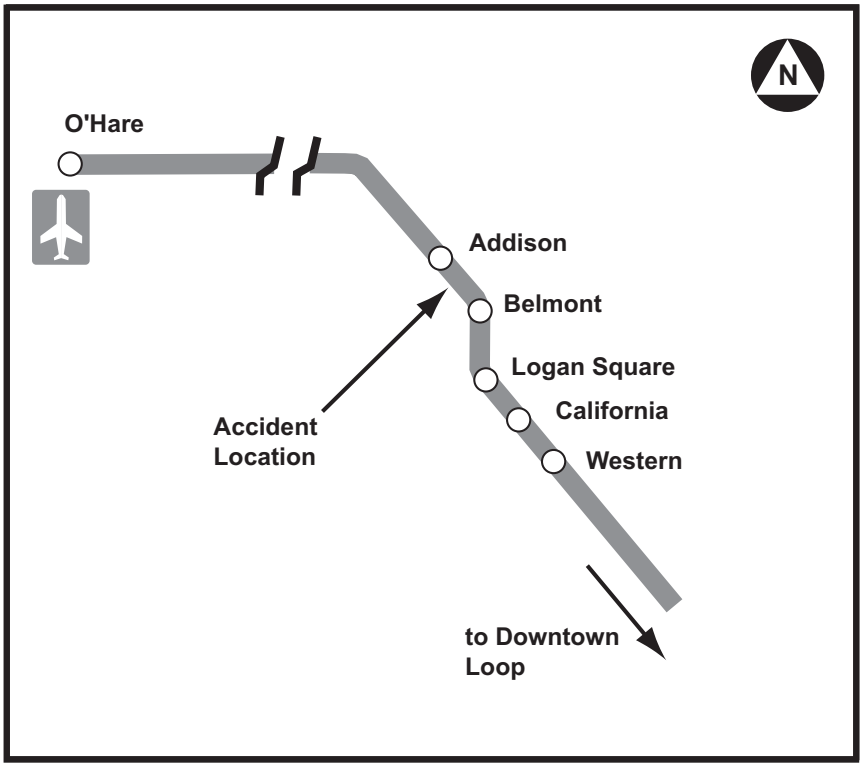

Figure 1. Location of June 17 accident.

[1] See appendix A for an accident brief on this accident.

[2] All times referenced in this report are central daylight time.

[3] The CTA's convention is to designate north and south as its railroad directions. O'Hare Airport is on the north end of the Blue Line.

Her first trip southbound from O'Hare to Forest Park was uneventful. She then operated another train back to O'Hare. On this first northbound trip, she entered cab signal territory at Western Station and stated that the cab signals cut in.[4] She then proceeded out of Western toward California Station, where she would need to cross over to the southbound track. Upon her arrival at California Station, a pilot[5] boarded her train and operated it through the single-track detour. She reported that the cab signaling system cut back in at Belmont on this first northbound trip.

The cab signal system on the CTA's Blue Line, which displays the maximum authorized speed in addition to signal indications, functions only for movements in the direction of normal traffic. That is, northbound trains using the southbound track, as required by the detour, would not receive cab signals from the signal circuits in the rails. The lack of cab signals would then cause the train to be brought to a stop (see the "CTA Operations" section of this report for more information). To prevent the stoppage of trains during the detour period, the cab signals were cut out for that section of track by means of a temporary card installed in the wayside signal equipment. Rail Service Bulletin R409-01, in effect on the day of the accident, advised northbound operators that cab signals would cut out at California and remain cut out until the train was past the detour point and had returned to the northbound track at Belmont.

The train operator stated that she took a break after completing her first trip. She then boarded the accident train, train 104, at O'Hare and made her second trip southbound to Forest Park. At Forest Park, she turned the train on a loop track and began the accident trip northbound toward O'Hare.

She stated that when her train entered cab signal territory at Western, the cab signaling did not cut in. She said she proceeded out of Western toward the single-track detour at 20 mph. If the cab signal system does not cut in within cab signal territory, the operator is required by CTA operating rule 6.5.2 and standard operating procedure M-1-100 to contact the operations control center and request authorization to proceed. The operator of train 104 stated that she did not contact the operations control center before proceeding, even though she knew the operating rules required it. She said that she thought the absence of cab signals had something to do with the single-track detour.

As train 104 proceeded northbound, it was following two trains, 210 and 207. When those trains reached the single-track detour at the California Station, the pilot authorized them to proceed northbound through the single-track area. The pilot then operated train 104 through the single-track area. (See figure 2.) The pilot stated that he chose to operate train 104 through the detour area because he was familiar with the operator of train 104 and knew that she was uncomfortable with abnormal operations, such as single tracking.

[4] A train with cab signals displays the governing signal aspect inside the cab of the train so long as the train is operating in territory with a working cab signal system. The system is designed to cut out when a train leaves cab signal territory and to cut back in when a train enters cab signal territory.

[5] The CTA uses a pilot to control conflicting train movements over a temporary single-track detour. No train can proceed through the detour area without obtaining specific authorization from the pilot or without having the pilot on the train.

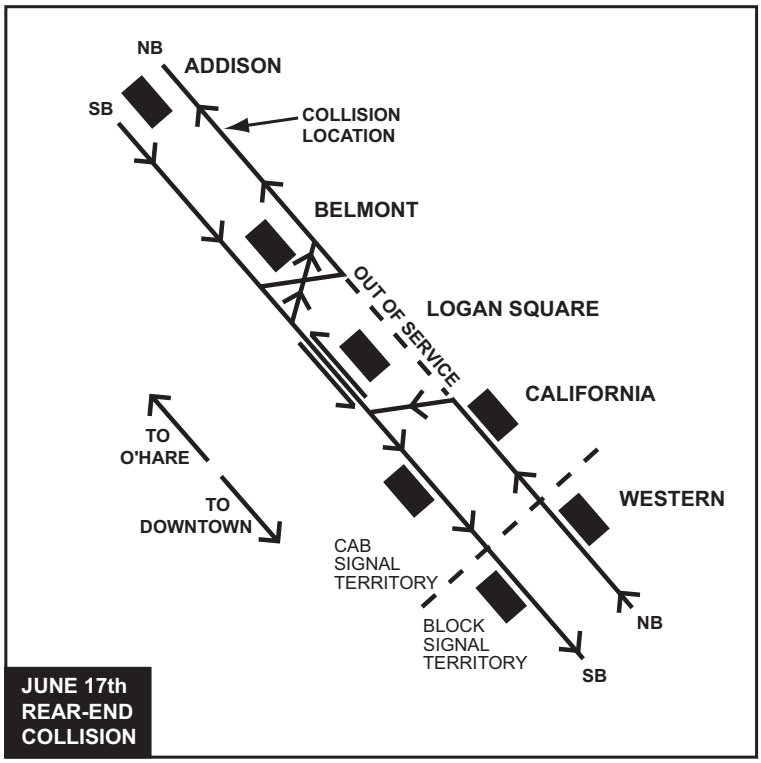

Figure 2. Single-track detour.

After leaving the single-track area, train 210, the first of the three northbound movements to go through the detour immediately before the accident, made a station stop at Belmont. The train then proceeded north toward Addison and on to O'Hare without incident.

Train 207, the second of the three northbound movements, also made a station stop at Belmont. That operator stated that the cab signal system had cut back in and functioned normally as he neared the north end of the platform. As train 207 proceeded north from Belmont, the operator said that he was stopped by the cab signal system as he approached Addison Station where train 210 was stopped. Train 207 stopped about 200 feet behind train 210.

Meanwhile, train 104 had cleared the detour area and crossed back to the northbound track. The pilot relinquished control to the train 104 operator at the south end of Belmont platform. The operator then moved the train to the north end of the platform, where she stopped to board and offload passengers. She stated that the cab signal system did not cut in at Belmont.[6] She said that she knew trains were ahead of her so she operated her train at about 15 mph out of Belmont without cab signal protection.

[6] The CTA cab signal system would not cut back in if, as in this case, a train occupied either of the two track circuits immediately ahead of the train reentering the northbound track.

She said that as she left the subway portal and exited a right-hand curve, she saw a train (train 207) stopped about 100 feet ahead. She stated that she moved the control handle to brake position 3 and then pulled the brake cord, but the train did not stop. She said she then mistakenly hit a sander button[7] while trying to depress the track brake button.[8] She indicated that when she did depress the track brake, it was too late to stop the train. She estimated her sight distance at 100 feet and the impact speed as 10 mph.

She stated that leading up to the collision, there was nothing to distract her from her duties and that she was aware of the train movement close ahead. Shortly after the collision, CTA managers arrived, coupled the two trains together, and moved them to Addison Station, where emergency personnel treated the injured.

Injuries

Eighteen passengers, one off-duty CTA employee, and both operators reported injuries. Emergency medical personnel assessed the injured at Addison Station, and five ambulances were used to transport the injured to area hospitals. None of the injuries was life threatening. (See table 1.)

Table 1. Injuries resulting from June 17 accident.

Injury Scale[a]	Employees	Passengers	Others	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	3	18	0	21
Total	3	18	0	21

[a]49 *Code of Federal Regulations* 830.2 defines fatal injury as "any injury which results in death within 30 days of the accident" and serious injury as "an injury which: (1) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, or tendon damage; (4) involves any internal organ; or (5) involves second or third-degree burns, or any burn affecting more than 5 percent of the body surface."

Damage

Equipment damage was limited to the couplers, anti-climbers, several broken windows, and impact damage to electronics on the two trains. The CTA estimated the damages at $30,000.

Personnel Information

CTA trains are crewed by a single operator. The operator of train 104 was first employed with the CTA as a customer assistant on April 27, 1998. She had qualified as an

[7] The sander button releases a quantity of sand just forward of the train wheels to provide increased traction.

[8] See the "Train Information" section of this report for information on the train braking systems.

operator on June 2, 2000. She was certified as a switchman on December 11, 2000, and as a flagman on March 14, 2001. A review of her training and operating history indicates that she failed to qualify as an operator twice and spent an additional 32 hours in training before successfully completing the program. She also failed the flagman training program twice and was qualified on the third try after receiving remedial training. She failed switchman training once and was qualified on the second try after receiving remedial training.

She was referred for remedial training after rules violations on two separate occasions during the 12 months preceding the accident. After accruing an excessive number of safety violations in May 2001, she was required to participate in a corrective case interview, the last step in the CTA's disciplinary process before discharge. At that time, she was again referred for remedial training. She completed all remedial training sessions successfully. Table 2 shows her operator's training and operating history.

Table 2. June 17 accident operator's training and operating history.

Date	Event	CTA Action
4/27/98	Hired by CTA	
5/11/98	Qualified as customer assistant	
4/24/00	Began train operator training	
5/7/00	Failed train operator test/evaluation	16 hrs. additional training
5/17/00	Failed train operator test/evaluation	16 hrs. additional training
6/2/00	Certified as Blue Line train operator	
8/2/00	Began flagman training	
8/10/00	Began switchman training	
8/23/00	Failed flagman test	16 hrs. additional training
9/2/00	Ran red signal in training	8 hrs. additional training
11/1/00	Train handling violation	Individual re-training
11/3/00	Failed switchman test	20 hrs. additional training
11/10/00	Failed flagman test	4 hrs. additional training
12/11/00	Certified as switchman	
12/31/00	Ran red signal/ran through switch	Individual re-training
2/15/01	Certified as flagman	
5/9/01	Violation/took wrong line up	Corrective interview
5/9/01	Excessive safety violations noted	Individual re-training
6/17/01	Rear-end collision occurs	Discharged

She had been off duty for about 13 hours before reporting to work on the day of the accident. She had been on duty for about 7 hours when the accident occurred. She reported that she went to bed at 9:00 p.m. on the night before the accident and got up at 2:30 a.m. She stated that she had had adequate rest before reporting for work on the day of the accident, that her health was good, that she was not taking any medications, and that she was not experiencing any problems that would interfere with her ability to perform her job.

Train Information

Both the standing train (207) and the striking train (104) consisted of four electrically propelled rapid transit cars. Both train consists were made up of 2601-3200 series rapid transit cars manufactured by the Budd Company between 1981 and 1987. The 48-foot-long cars pick up electrical power from a third rail by means of collector shoes. Sets of two cars (married pairs) are permanently coupled together.

Four traction motors, one on each axle, power CTA rail cars. High-speed braking is accomplished through electrical motor resistance (dynamic braking), while disc friction brakes automatically cut in at lower speeds. Each car is also equipped with four electro-magnetic track brakes, which can be activated separately via a push button or in conjunction with electrical resistance/friction braking by moving the control handle to the emergency, or B-4, position. When activated, the track brakes adhere magnetically to the rail and act as a skid to slow the cars.

A handle at the operator's control stand activates acceleration and braking. Pushing the handle forward from a neutral position accelerates the train; pulling the handle backward beyond the neutral position initiates braking. There are four braking positions. Braking positions 1 through 3 are routinely used for service braking. Braking position 4 is designated the emergency brake and activates the maximum brake rate as well as the track brakes. Two brake pull cords in each car may also be used to initiate braking. One pull cord is in the operator's cab, and another is in the passenger compartment of each car. Pulling the cord activates brake position 3 dynamic braking with tailored friction braking.[9] It does not activate the track brakes.

Postaccident Tests and Inspections

Mechanical. The brake system of train 104 was tested and found to function normally. A braking demonstration using similar 2601-3200 series cars indicated that with full emergency braking, an empty train traveling 10 mph is capable of stopping within 10 to 15 feet on dry, level track. When the brake cord is used, the stopping distance at 10 mph is between 15 and 20 feet. The CTA maintenance, inspection, and testing records of the accident consist indicated that the equipment was in satisfactory condition and listed no exceptions that would have prevented proper operation. The previous operator of train 104, who had the same control cab, and the pilot stated that the brakes functioned

[9] "Tailored friction braking" is defined as a variable level of friction braking added to the dynamic braking effort such that total braking does not exceed the coefficient of friction between wheels and rail.

normally. The accident operator also noted that the brakes functioned normally before the collision.

Signal System. Routine signal function tests were performed by the CTA, and no exceptions were noted. The CTA's signal maintenance, inspection, and testing records indicated that the equipment at the accident location was in satisfactory condition and listed no exceptions that would have prevented proper operation. It was noted that when a train exited the single-track detour, the cab signal system would not cut back in unless the two track circuits immediately ahead of a train entering the northbound track were unoccupied. The cab signal system is designed such that the absence of any speed signal is interpreted as a stop signal, providing a train's cab signal equipment is activated. To be activated when trains enter cab signal territory at Western or at the end of the single-track detour, the train cab signal equipment must receive a speed signal. With regard to cab signal activation when the incident train entered cab signal territory at Western Station, the CTA's manager of signal maintenance told Safety Board investigators that around the time of the accident, contractors were working at Western Station as part of the CTA's station renewal program and were involved in a major rehabilitation of the station. He said the CTA had had recurring problems with contractors damaging the train control equipment, which resulted in cab signals not activating on some trains.

Sight Distance Test. For sight distance tests, an orange cone was placed at the point of collision. Investigators then departed the Belmont Station northbound going toward the cone at about 10 mph. Investigators could see the cone as the train exited the subway portal and came out of a sweeping right-hand curve. They could see the cone from about 800 feet away (see figure 3).

Event Recorders. CTA cars do not have event recorders. While some CTA cars have maintenance data loggers that capture some operating data, the cars of train 104 did not.

Meteorological Information

The National Atmospheric and Oceanic Administration reported that at the time of the accident, the weather at O'Hare Airport was dry with high broken clouds and a temperature of about 83° F.

Toxicological Information

In accordance with Federal Transit Administration (FTA) regulations found at 49 *Code of Federal Regulations* (CFR) 653 and 654, the operator of train 104 was required to submit breath and urine specimens for postaccident toxicological testing. The specimen collection was completed at 2:41 p.m. No drugs or alcohol were detected in the specimens.

Figure 3. Operator's view as train approaches June 17 accident location.

August 3 Accident[10]

Accident Narrative

At 8:15 a.m. on Friday, August 3, 2001, a CTA operator reported for duty at the CTA's Kimball Station. His schedule called for him to make five round trips between Kimball and downtown Chicago. (See figure 4.)

For his first trip, he departed Kimball on time, at 8:25 a.m., operating train 416. He stated that although he was not exceeding the allowable speed, he experienced several cab signal overspeed indications shortly after departing Kimball, which resulted in an undesired brake application and stop.[11] He indicated that the overspeed alarms occurred while the train was operating at a low speed, as if the train wheels were slipping and

[10] See appendix B for an accident brief on this accident.

causing a false speedometer reading. He said he also experienced two "blue light" alarms.[12] The first blue light alarm activated as the train departed Addison Station. He reported that he was able to reset this first alarm from the cab when he stopped at Paulina, the next station along the line.

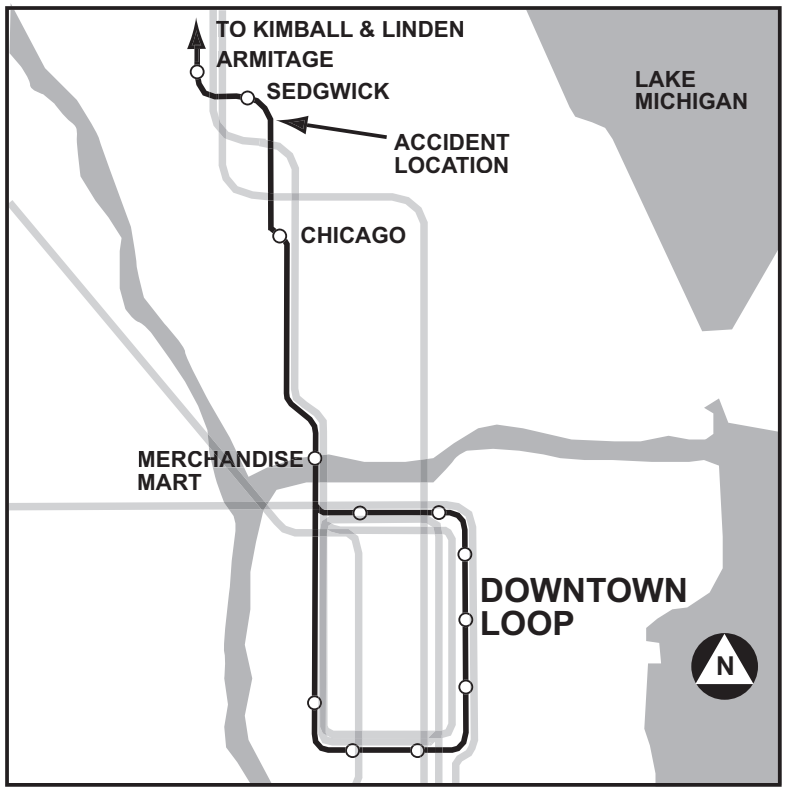

Figure 4. Location of August 3 accident.

A second blue light alarm sounded after the train left Sedgwick Station. The operator said he had intended to continue to Chicago Station, where he would troubleshoot the problem.

In CTA cab signal territory when a train's cab signal equipment is activated, a stop signal displays a red aspect inside the train cab. If the operator does not stop the train, the system will bring the train to a stop automatically. Such stops, whether automatic or in response to operator input, are commonly referred to as "R6.4" stops, after the CTA rule number that addresses them. To proceed after an R6.4 stop, the operator must depress a button in the control cab. While the train is operating in the R6.4 stop mode, the signaling system physically limits the train's speed to 15 mph. CTA rules stipulate that if the stop

[11] As noted earlier, the cab signal system displays an authorized speed to the operator and results in an automatic stop if that speed is exceeded.

[12] A blue light alarm indicates that one of the cars in the train has a propulsion or auxiliary power problem. In the event of a blue light alarm, a trouble light illuminates on the operator's console, and an alarm bell sounds in the cab. A trouble light also illuminates on both sides of the affected car.

signal is caused by a train that is known to be close ahead, the operator is to wait for the signal to clear before proceeding. If the reason for the stop is not known, the operator is to call the operations control center for authorization before he depresses the pushbutton and proceeds.

The operator said that he had experienced several R6.4 stops during the early part of his run, which, he said, was not unusual during rush hour because of the close spacing of trains. He stated that once he entered the combined Brown/Purple Line tracks at Clark Junction, he proceeded after R6.4 stops without waiting for the train ahead to clear and without contacting the operations control center. He stated that it was common practice for operators to proceed on an R6.4 without waiting or calling.

He stated that he left Armitage Station after an R6.4 stop knowing that he was following a Purple Line train close ahead and that he was leaving Sedgwick the last time he saw the taillights of the Purple Line train. After leaving Sedgwick and passing Division Avenue, he entered Church Curve, where visibility was limited by the church building. At the south[13] end of the curve, he said that he observed the taillights of a train (train 505) stopped about 100 feet ahead. He stated that when he saw the stopped train, he moved the control handle first to brake position 3 and then to the emergency position, but the train did not stop. He estimated his sight distance at 100 feet and the impact speed at 10 mph. In postaccident interviews, he said that just before the collision, he was facing forward. Several witness on the train stated that they did not feel the brakes engage before impact. Also, several witnesses on and outside the train stated that the operator had his head out the side window just before the collision. In a second, later, interview, the operator said that he might have been distracted by the blue light alarm.

Train 505, the standing train, originated at Linden, the Purple Line terminal, at 8:11 a.m. and was en route to the downtown Loop. The operator said that as he approached Chicago Station, he received an R6.4 stop through the cab signaling equipment and brought the train to a normal stop. He said that he knew that there was a train ahead, so he waited for the cab signal to clear. He said that the cab signal did not clear after a few minutes and that just as he was preparing to contact the operations control center, he felt an impact from the rear and was thrown forward into the console.

Injuries

Chicago Police Department logs indicate that 118 people were transported to area hospitals, all with minor injuries. (See table 3.) One pregnant woman who was treated and released was re-admitted to the hospital with complications believed to be related to the accident and, consequently, is listed in this report as having sustained a serious injury. Emergency medical personnel assessed the injured at the accident scene. About 12 people were removed from the elevated structure, using aerial lift equipment, and transported to local hospitals. Any other injured people were evaluated on site and removed from the train after it was moved to Chicago Station (see figure 5).

[13] The accident trains were proceeding railroad south, toward the Loop.

Table 3. Table 3. Injuries resulting from August 3 accident.

Injury Scale[a]	Employees	Passengers	Others	Total
Fatal	0	0	0	0
Serious	0	1	0	1
Minor	2	115	0	117
Total	2	116	0	118

[a]49 *Code of Federal Regulations* 830.2 defines fatal injury as "any injury which results in death within 30 days of the accident" and serious injury as "an injury which: (1) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, or tendon damage; (4) involves any internal organ; or (5) involves second or third-degree burns, or any burn affecting more than 5 percent of the body surface."

Figure 5. Emergency response personnel at accident scene.

Damage

Equipment damage consisted of damaged couplers, anti-climbers, and electronics, as well as buckled flooring and broken windows. Buckled flooring on train 505 prevented car-end doors from opening or closing properly throughout the train consist. All end doors on train 416 functioned. The CTA estimated the cost of damage repair at $136,138.

Personnel Information

The train 416 operator stated that he was first employed with the CTA as a student intern in 1988 and had worked intermittently during summer vacations until 1993, when he was hired as a permanent part-time employee. His personnel record indicates that he qualified as an operator on March 20, 1997. He had been most recently recertified as an operator on April 26, 2001.

His record indicates that while working as a switchman, he was referred for remedial training for a rules violation that occurred on August 2, 2000. The violation involved improper uncoupling procedures that resulted in damage to car side barriers. He was referred for remedial training after passing a stop signal on October 23, 1998, in violation of CTA operating rules. Table 4 shows his training and operating history.

Table 4. August 3 accident operator's training and operating history.

Date	Event
10/1/93	Hired as permanent part-time employee
5/22/95	Qualified as conductor
3/24/96	Became full-time employee
4/12/96	Qualified as flagman
3/20/97	Certified as train operator
8/22/97	Qualified as customer assistant
10/25/97	Qualified for one-man operation*
9/22/98	Qualified as switchman
10/23/98	Rules violation: passing stop signal
3/24/99	Passed train operator recertification
8/2/00	Safety violation: uncoupling procedure, individual re-training
4/26/01	Passed train operator recertification
8/3/01	Rear-end collision occurs

*For operations without a conductor.

After the June 17, 2001, rear-end collision on the CTA Blue Line, the CTA, in response to an issue identified by the Safety Board's investigation, began delivering a mandatory 4-hour refresher course on cab signal rules, operation on sight, and emergency braking to its employees. CTA officials stated that they intended to train all rail operating

personnel. The train 416 operator had not yet had the training; he had been scheduled to take it on the Monday following the accident.

The train 416 operator had been off duty about 9 hours and 45 minutes before reporting to work on the day of the accident. He had been on duty approximately 50 minutes when the accident occurred. He reported that he had gone to bed at midnight on the night before the accident and had arisen at 6:00 a.m. On April 2, the day before the accident, he worked a double shift, working from 8:15 a.m. to 5:42 p.m. as an operator and then from 6:00 p.m. to 10:30 p.m. as a customer assistant. He worked a single shift on all other workdays during the 3 weeks preceding the accident. (No State or Federal regulation limits a CTA rail transit operator's hours of service.) He stated that his rest was adequate, that he was in good health, that he was not taking any medications, and that he was not having any medical problems that would interfere with his ability to perform his job.

Train Information

Train 416, the striking train, consisted of six electrically propelled rapid transit cars manufactured by the Morrison Knudsen Company in 1993. The 48-foot-long cars pick up electrical power from a third rail by means of collector shoes. Sets of two cars (married pairs) are permanently coupled together. A handle at the operator's control stand activates acceleration and braking. Rotating the handle clockwise from a neutral position accelerates the train; rotating the handle counterclockwise initiates braking. There are four braking positions: braking positions 1 through 3 are routinely used for service braking; braking position 4 is designated the emergency brake and activates the maximum brake rate, as well as the track brakes.

Train 505, the struck train, consisted of six rapid transit cars manufactured by the Boeing Vertol Company between 1976 and 1978. The cars were generally similar in design to the cars on train 416.

Postaccident Tests and Inspections

Braking Tests. The brake system of train 416 was tested and functioned normally. A braking test using the accident train demonstrated that on dry, level track, the train could be brought from 10 mph to a stop within 28 feet if full emergency braking was used. A second test was conducted at the accident location using a six-car Brown Line revenue train with a standing load of passengers. The test train was operated at 10 mph. At the point where standing train 505 would have been visible to the train 416 operator, the brakes were applied. Using service brake position 3 (a lesser brake rate than emergency), the train stopped in 31 feet. The CTA maintenance, inspection, and testing records on the accident train consist indicated that the equipment was in satisfactory condition and listed no exceptions that would have prevented the train's stopping short of another train. Car 3455 had had a propulsion ventilation failure before the accident.[14] The failure would have resulted in a blue light alarm with the propulsion and dynamic braking no longer being operative on this car. CTA cars are designed such that when dynamic braking does not

[14] See discussion of data logger information under "Event Recorders" below.

engage, friction braking will compensate. The accident operator stated that the train brakes functioned normally before the collision.

Signals. The signal system (both wayside and car-mounted equipment) was tested and was found by the CTA to meet all test criteria.

Sight Distance. Investigators determined that the side of a train standing at the point of impact could first be glimpsed by a following train from a distance of about 373 feet as the following train exited Church Curve. The view of the rear of the train was unobstructed from about 345 feet (see figure 6).

Figure 6. Operator's view as train rounds Church Curve.

Event Recorders. The cars making up train 416 had maintenance data loggers that, in this case, provided information relevant to the accident. The collision impact knocked electrical propulsion circuit breakers on two cars of the striking train out of position. This event registered as a fault on the maintenance data loggers on those cars and caused the logging of 5 seconds of data (approximately 3 seconds before and 2 seconds after the breaker position change). The data indicated that the second car was moving 13 mph about 1 1/2 seconds before impact, when the car went from propulsion power to emergency braking. The data indicated that the speed was reduced to approximately 11 mph at impact. The fifth car (3455) was not in power because of a previous propulsion system failure and blue light alarm. Data logged on the fifth car was consistent with data from the second car in terms of speed and friction braking. The data record for the fifth car

indicated that the propulsion ventilation had failed, which would have caused a blue light alarm in the cab.

Meteorological Information

The National Atmospheric and Oceanic Administration reported that the weather at O'Hare Airport at the time of the accident was clear and dry with a temperature of about 77° F.

Toxicological Information

Pursuant to requirements at 49 CFR 654.33 and 653.45,[15] the operators of trains 416 and 505 were required to submit breath and urine specimens for postaccident toxicological testing. The specimen collection was completed at 2:30 p.m. for the operator of the standing train and at 3:15 p.m. for the operator of the striking train. CTA contractors also collected breath and urine specimens from the accident train controller and the operator of the northbound train, who witnessed the accident. No drugs or alcohol were detected in any of the specimens.

Background Information Related to Both Accidents

CTA Operations

General. The CTA operates rail and bus transit service in the city of Chicago and surrounding areas. It is the second largest transit system in the United States. The CTA operates seven rail lines, each designated by a color. In 2000, CTA trains carried more than 147 million passengers and operated trains over 222 miles of track.

Traffic Control/Signal System. The CTA O'Hare Branch of the Blue Line uses a cab signal system between O'Hare and Western Stations. From Western Station south, the signaling system comprises automatic block signals with mechanical trip stop arms. On both sections, signaling is designed to maintain one unoccupied track circuit between any two trains. A cab signal system is installed on the entire Brown Line.

The cab signal system picks up speed codes from the track circuits through an antenna and displays them to the operator on an aspect display unit in the cab (see figure 7). An operator may operate up to the indicated speed. If the indicated speed is exceeded, an alarm sounds, and the train must be put into braking position 2 or 3 and slowed to the proper speed. If the operator's response to an alarm is not timely, train braking will initiate automatically after 1 1/2 seconds, and the train will be brought to a complete stop. The system is designed such that, provided cab signaling is cut in, the absence of a speed code in the track circuit is interpreted as a stop signal, which is covered by rule R6.4 (discussed below).

[15] As a result of an October 2001 revision, these requirements are now found at 49 CFR 655.

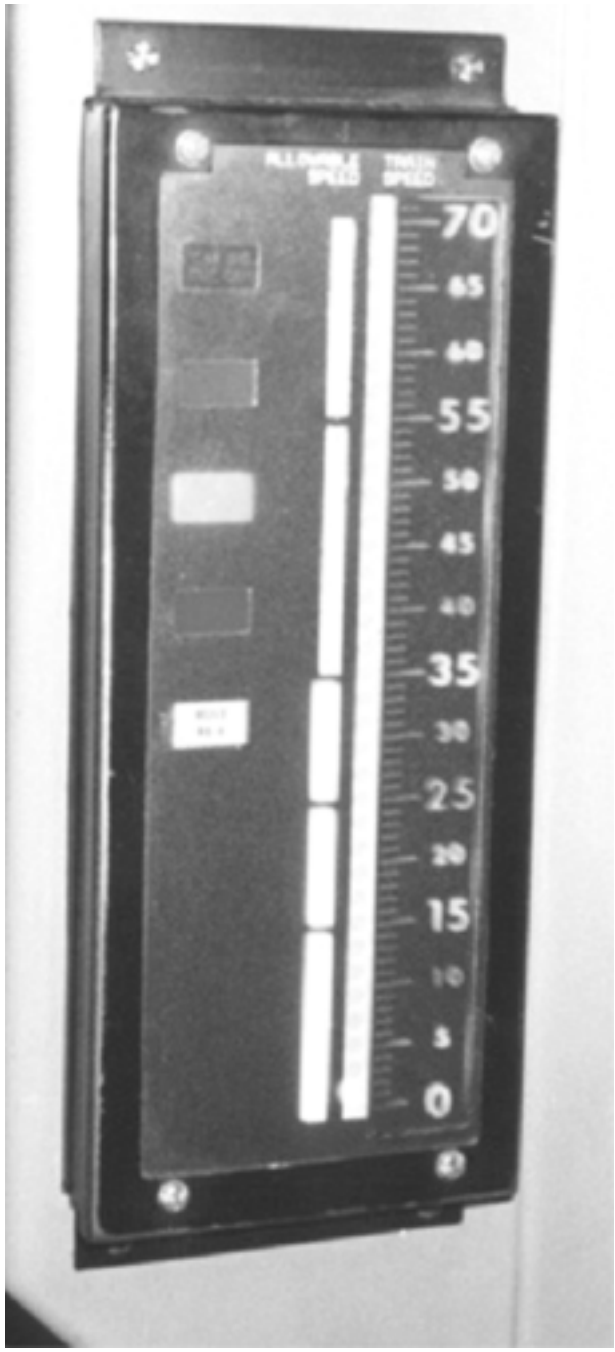

Figure 7. Cab signal aspect display unit.

At the transition from cab signal territory to block signal territory on the Blue Line, the cab signal system must be cut out; otherwise, trains will be brought to a stop because of the absence of the required speed code. The system is cut out through use of a signal card in the wayside equipment. At the transition back to cab signal territory from block signal territory, the cab signal system is designed to cut back in as soon as any speed code is detected. If a train does not detect a speed code, the cab signal system will not cut in. As

noted earlier, this same feature prevents the system from cutting back in if one or both of the two track circuits ahead are occupied.

Operating Rules. The operating rulebook current at the time of the two accidents was the *Rail System Rule Book*, dated June 1, 1995. Rule R6.4 states:

> When a train receives a red or flashing aspect of a cab or wayside signal, the train must be stopped and must NOT proceed until the motorman has been instructed to do so by the controller.
>
> If the reason for the stop is a train ahead which can be expected to proceed shortly, the motorman must wait for the signal aspect to change to a proceed indication.
>
> If the reason for the stop is not evident, or if the signal does not clear within 30 seconds, the motorman must call the controller for instructions. If communication with the controller cannot be established and it is safe to proceed:
>
> IN CAB SIGNAL TERRITORY, proceed at not to exceed 15 mph expecting to encounter a switch not properly lined or a broken rail-to next signal bond or telephone and call controller again for instructions.

The purpose of requiring an operator to obtain authorization from the operations control center before proceeding after an R6.4 stop is to allow the train controllers (1) to check that a train is not close ahead (in which case, authorization can be withheld unless closing in is desired for operational reasons) and (2) to note possible signal system maintenance problems at specific locations. When the authorization to proceed is given, it carries with it the requirement that trains "keep at a safe distance and…operate at a speed which will enable a safe stop should a train ahead make a sudden stop."[16] Rule R6.5.2 states:

> Should the ATC [automatic train control] or STEM [side trip emergency[17]] equipment of a train already in service become less than fully operational, motormen must stop and obtain authorization from the controller before proceeding. The controller will provide specific instructions, may authorize bypass of the automatic train stop (STEM, ATC or both) and may dispatch a supervisor to intercept the train.

The CTA refers to its cab signal system as "automatic train control." When active, the system enforces compliance with stop signal indications automatically. Once a train is stopped, the system allows an operator to proceed with a speed limited to 15 mph, providing a button is depressed as in the August 3 accident. If the system is disengaged, as in the June 17 accident, the operator may proceed without cab signals.

Both accident operators indicated that they had observed violations of rule R6.4 or R6.5.2 by other employees or managers. Shortly after the first accident, a Safety Board

[16] CTA *Rail System Rule Book*, rule number R8.10.2.

[17] ATC, or "automatic train control," is the term the CTA uses to refer to its cab signal system. STEM, or "side trip emergency," refers to an emergency circuit that bypasses the side trips, which are used in block signal territory to provide a physical enforcement for stop signals.

investigator who was riding in the cab of a CTA train observed a CTA manager proceed without cab signals cutting in from Western Station into cab signal territory without obtaining authorization from the operations control center, violating the same operating rule as that involved in the June 17 accident.

Regarding blue light alarms, CTA operating rule R8.35 states "defects in equipment or any dangerous or unusual condition must be reported immediately to the controller." As part of the investigation of the second accident, Safety Board investigators conducted field interviews of 22 CTA operating employees about procedures involved in R6.4 stops and blue light alarms. These employees included 10 operators, 8 controllers, and 4 training instructors. Of the 10 operators, 3 said they sometimes proceeded after an R6.4 stop without waiting for the signal to clear and without contacting the operations control center. Three of the eight controllers said they would not check for trains close ahead before authorizing further movement after an operator reported an R6.4 stop. Six of the operators said they would not report a blue light alarm until they had tried to reset it and were ready to cut out a car. Seven controllers said they expected operators to call in blue light alarms before attempting a reset.

CTA Operator Training and Performance Evaluation

Training. At the time of these accidents, the CTA's operator training consisted of 21 days of classroom and hands-on instruction. Employees who did not pass the program were allowed to take additional training on their own time. The CTA's manager of rail instruction stated that students were generally allowed three attempts to qualify as operators before being dropped from the program.

Evaluation. At the time of these accidents, the CTA monitored operator performance and rules compliance through a program of observations and ride checks. The CTA's system safety program plan (described in more detail below) describes the program as a process in which:

> Operating Rules and Procedures are constantly monitored on the Rail Lines by Rail Supervisors, Line Managers, Performance Control Specialists, Control Center Management Personnel, System Safety Inspectors and Rail Instructors riding the trains….

The system safety program plan goes on to describe how rapid transit operators are "checked by a Rail Instructor during actual job performance at regular six (6) month intervals for the rest of their career…."

Rail operations department supervisors or managers perform "point checks" and "ride checks" on operators. Point checks are observations performed at a station; ride checks involve riding with the operator. Observations and ride checks are documented on a paper form.

According to the CTA's manager of rail instruction, the schedule for twice yearly ride checks by CTA training instructors was not being met at the time of the accidents. There was no record of safety department operating rules compliance monitoring of either

operator. The CTA did not employ unannounced efficiency tests designed to monitor and evaluate operators' application and understanding of or compliance with the rules, nor were such tests required by regulation.

During the investigation of the June 17 accident, the CTA produced records indicating that the accident operator was the subject of 20 point checks and 6 ride checks between April 1, 2001, and the accident on June 17. Blue Line supervisors or managers performed these checks, and none reported any exception to the operator's performance.

The CTA did not produce any records of point checks or ride checks on the August 3 accident operator for the 60 days preceding the accident date or any records of training department checks on the operator during the 12 months before the accident. The operator said that the last time a training instructor had ridden with him was during his recertification training in April 2001. Under the category of coordination and operation, the recertification report was marked "I," which, according to the legend on the form, indicates an insufficient basis for rating. CTA officials told the Safety Board that "Insufficient" is checked when the instructor does not have the opportunity to evaluate these aspects of the operator's performance. The recertification training report was marked satisfactory for cooperation, initiative, and appearance.

The system safety program plan indicates that the CTA's safety department also conducts ride checks to monitor operator rules compliance. At the time of the accidents, there was no numerical goal for safety department ride checks, and there was no record of safety department ride checks having been performed with the June 17 operator within the 60 days preceding the accident or with the August 3 operator during the 2001 calendar year. The CTA system safety program plan indicates that performance control specialists (who work in the CTA's security department) also perform rules compliance monitoring while they are on the line. There was no record of performance control specialists monitoring the August 3 operator during the 60 days preceding the accident.

When the CTA's process of rules compliance monitoring determines that a violation of rules has occurred, the operator is typically referred to the training department for remedial instruction. During the 12 months preceding the accident, two operators were referred for remedial instruction as a result of violating rule R6.4.

CTA Oversight

In its 1991 safety study[18] on the oversight of rail rapid transit safety, the Safety Board concluded that the primary responsibility for oversight of rail rapid transit safety properly resides with the State and local governments of the localities in which the systems operate. The Board also concluded, however, that the Urban Mass Transportation Administration (UMTA), the predecessor of the FTA, had a legitimate role in ensuring safety on rail rapid transit systems and could do so by providing guidelines to States and local authorities for their development of effective oversight programs.

[18] National Transportation Safety Board, *Oversight of Rail Rapid Transit Safety.* Railroad Safety Study NTSB/SS-91/02 (Washington, D.C.: NTSB, 1991).

Consequently, on August 6, 1991, the Safety Board recommended to the 11 States that had rail rapid transit systems and to the District of Columbia that they:

> R-91-37
>
> Develop or revise, as needed, existing programs to provide for continual and effective oversight of rail rapid transit safety. The elements of the oversight program should include reviews of maintenance and inspection records, accident investigation activities, audits of system safety program plans, reviews of the transit system safety department, reviews of training programs, monitoring of accident data, and periodic inspections of equipment and infrastructure.

On the same date, the Safety Board also recommended that UMTA:

> R-91-33
>
> Document and evaluate the effectiveness of existing State oversight activities of rail rapid transit safety and develop guidelines for use by state and local governments that address the critical elements of an effective oversight program.

Safety Recommendation R-91-37 to California, Florida, New York, and Pennsylvania has been classified "Closed—Acceptable Action." The recommendation to Illinois, Maryland, Massachusetts, New Jersey, Ohio, and Virginia remains classified "Open—Acceptable Response." The recommendation to the District of Columbia and Georgia remains classified "Open—Awaiting Response."

In December 1991, Congress gave the U.S. Department of Transportation the authority to establish requirements for State safety oversight of rail fixed guideway mass transportation systems and to withhold funding for those that do not meet the requirements. In 1995, in response to the congressional mandate and after a rulemaking process, the FTA promulgated State safety oversight regulations at 49 CFR Part 659. These regulations became effective in 1996. Based on this Federal action, Safety Recommendation R-91-33 was classified "Closed–Acceptable Action" on April 16, 1996.

The FTA regulations require that:

- Each State with a rail fixed guideway system designate an oversight agency,
- Each oversight agency develop a system safety program standard that complies with the American Public Transportation Association (APTA) manual,
- The oversight agency require each rail fixed guideway system to submit a system safety program plan for approval,
- The oversight agency require each rail fixed guideway system to submit an internal safety audit report for review annually,
- The oversight agency conduct its own on-site safety review of the transit agency's system safety program plan, and
- The oversight agency establish accident investigation procedures.

System Safety Program Plan. Incorporated within the regulations, at 49 CFR 659.31 and 659.33, are requirements that fixed guideway transit systems, such as the CTA's rail transit system, develop and implement a system safety program plan that complies with the guidelines provided in APTA's *Manual for the Development of Rail Transit System Safety Program Plans*. According to the APTA document, a system safety program plan "establishes the Safety philosophy of the whole organization and provides the means of implementation." APTA identifies the overall goal of system safety program plans for fixed guideway transit systems as follows:

> To identify, eliminate, minimize, and/or control safety hazards and their attendant risks by establishing requirements, lines of authority, levels of responsibility, and accountability, and methods of documentation for the organization.[19]

A system safety program plan is a formal written document that identifies all safety-related responsibilities and assigns the fulfillment of those responsibilities to appropriate areas within the organization. The plan also establishes the specific safety objectives and procedures of the organization. Each transit system develops its own plan. The CTA issued its current plan in February 1999.

Internal Safety Audit Program. One element of the system safety program plan is an internal safety audit program. Once the system safety program plan is in place, the transit system maintains internal oversight of its own system safety program plan to ensure that all responsibilities are being fulfilled and coordinated. The CTA's safety program's effectiveness and integrity are monitored through an internal safety audit program carried out by the system safety department. The State safety oversight regulations (discussed in more detail later in this report) require that each transit system submit a report on its audit to the oversight agency. The CTA had submitted its year 2000 report to the Regional Transportation Authority of Northeastern Illinois (RTA) as required.

The CTA provided the Safety Board with its year 2000 internal safety audit report, which, in its audit of rules compliance, was limited to the Red Line. Audit checklist item 4 states, "service rail operation employees comply with safety rules and S.O.P.s [standard operating procedures]." The report found that this aspect of transportation department responsibilities met plan requirements. There was no information in the audit report about how this conclusion was reached.

The internal safety audit also looked at the CTA's training and safety departments. It did not include a checklist item specifically addressing the training department's program of twice yearly check rides with operators or the safety department operating rules compliance monitoring of operators.

State Oversight and Audits. The FTA regulations require each State to designate a State agency to provide safety oversight. Illinois designated the RTA as the oversight agency for the CTA in 1997. The RTA issued a system safety program standard as required

[19] APTA, *Manual for the Development of Rail Transit System Safety Program Plans* (Washington, D.C.: APTA, 1991), p. vi.

by FTA regulations on October 30, 1997. The standard lays out the procedures to be followed by the CTA and the RTA to address the requirements of FTA-mandated State safety oversight.

Among other things, FTA regulations require that the RTA approve the CTA's system safety program plan, investigate accidents,[20] review the CTA's annual internal audit report, and perform a triennial safety review of the CTA. In fulfilling that responsibility, the RTA has the authority to audit and observe all CTA operations. Two RTA employees devote part of their time to the State safety oversight program. The majority of RTA employees are involved in the financial and budget oversight of the CTA, METRA, and Pace.[21] The RTA reports to an appointed board of directors.

The FTA has audited several State programs to determine whether they are complying with the requirements of 49 CFR 659. Such an audit was conducted in Chicago in July 2000. The audit found one deficiency and three areas of concern.[22] The deficiency involved the RTA's not ensuring that CTA accident notifications and progress reports were submitted in a timely manner. The areas of concern involved updating and clarifying the RTA system safety program standard oversight policy and procedures. The RTA revised and reissued its system safety program standard on September 12, 2000, in response to findings of the FTA audit. The FTA advised the RTA by a letter dated September 25, 2000, that "all audit findings have been successfully addressed."

The manager of the RTA's oversight division stated that in past years, RTA staffmembers have not accompanied CTA auditors during internal safety audits. She stated that the RTA intended to participate as observers during the CTA's 2002 internal safety audits.

The RTA's first triennial on-site safety review of the CTA's system safety program plan was conducted during May and June 2001 by consultants.[23] The regulations define a safety review as:

> A formal, comprehensive, on-site examination by the oversight agency of a transit agency's safety practices to determine whether they comply with the policies and procedures required under the transit agency's system safety program plan.

The triennial on-site safety review found that CTA transportation units operate in general compliance with established rules and procedures. The review did not specifically look at the training department's program of twice-yearly check rides with operators or the safety department's operating rules compliance monitoring. The review found the CTA's training programs to be in general compliance with its established procedures.

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[20] The regulations allow the oversight agency to delegate such investigations to the transit agency, and that is what the RTA has elected to do.

[21] METRA operates commuter rail service, and Pace operates bus service.

[22] The term "deficiencies" is defined as serious findings that could jeopardize FTA funding. "Areas of concern" is defined as weaknesses that should be addressed.

[23] FTA regulations permit the designated State agency to use contractors to conduct safety reviews.

APTA Audits. The CTA participates in the voluntary APTA audit program. The audits are conducted independently of FTA State safety oversight regulations. The last APTA audit before the accidents was in 1998, and a report was issued on December 20, 1999. The audit found no problems with how transportation line management oversaw rules compliance by operators. APTA's audit did not include a checklist item specifically addressing the CTA training department's program of twice-yearly check rides with operators or the CTA safety department's ride checks.

Other Information

Postaccident CTA Actions

CTA officials told investigators that the operator in the June 17 accident had been discharged. Also, in an August 29, 2001, letter to the Safety Board, CTA management said the following steps were being implemented after the June 17 accident (the management had taken the steps in response to issues identified by the Safety Board investigation):

- In July 2001, the CTA began holding mandatory rules refresher classes for all transportation managers and operators. The classes cover signal rule compliance, the operation of trains prepared to stop short, and the use of emergency braking.
- The CTA revised its single-track procedure to eliminate the cutting out of cab signals.
- The CTA began reviewing the records of operators to identify for contact and follow up those operators with multiple rules violations.
- The CTA revised its signal test to include the aspects on the cab signal aspect display unit. All operators must pass the test with a score of 100 percent during certification and recertification.

The CTA system safety and environmental affairs department, in its report on the second accident, which was given to the Safety Board on January 3, 2002, made four recommendations. The CTA informed the Safety Board in a January 29, 2002, letter that the recommendations had been adopted and had resulted in the following actions:

- The accident operator was discharged.
- Transportation managers and rail supervisors had been directed to increase their line ride checks to ensure that employees are following rules and procedures.
- Operating employees who had not operated a train within 60 consecutive days were required to take refresher training.

In addition to these steps, the mandatory rules refresher classes implemented after the first accident were expanded to include CTA train controllers. The classes were begun

on July 23, 2001, and were completed on September 17, 2001. The CTA also placed a decal in each train operating cab to remind operators of the requirements of rule R6.4.

APTA's Standards Task Force

APTA formed a Rail Transit Standards Task Force in 2000. The task force bylaws describe its purpose as the development of standards and recommended practices by and for the transit industry through a broad-based consensus process. The task force objectives include development of industry standards and recommended practices that have a high potential to lead to safety improvements.

The task force bylaws define "standards" as covering areas that involve a safety-critical task, process, component, or system. The final adoption of a standard is through approval by a policy committee composed of the general managers of transit systems participating in the task force.

Five committees are currently working on standards and recommended practices. They are as follows:

- Vehicle inspection and maintenance;
- Operating practices;
- Fixed structure inspection and maintenance;
- Grade crossings; and
- Vehicle crashworthiness.

One of the standards in an early stage of development is entitled "General Rule Standard for Rule Compliance and Implementation." The standard is expected to be completed and issued by mid-2003. Adherence to APTA standards is voluntary. However, one of the task force objectives is to "over time, have State oversight programs reflect the work done by the task force."

Analysis

General

Both accidents occurred during daylight hours and under satisfactory visibility and track conditions. During postaccident tests and inspections, investigators found nothing to indicate that either train 104 or train 416 had any mechanical defects or deficiencies that would have prevented either one from stopping short of another train. However, a propulsion system ventilation failure resulted in a blue light alarm in the cab of the August 3 train, and the operator stated that the alarm may have distracted him. A postaccident examination of the signal system did not disclose any defects at either accident location. However, it was noted in the June 17 accident that the presence of a train one or two track circuits ahead resulted in cab signals on a following train not engaging upon exiting the single-track detour. All evidence indicated that the braking systems operated as designed during both accidents. The postaccident toxicological testing did not indicate that drugs or alcohol contributed to either accident. The Safety Board, therefore, concludes that there was no evidence of alcohol or drug use in these accidents and that the following factors were neither causal nor contributory to either accident: weather, signal system malfunction, or the braking systems of the trains.

June 17 Accident

The accident train (train 104) operator stated the cab signal system did not cut in at Western Station (four stations before the accident location). Although, she said, she understood that in such an event, CTA rules required her to obtain authorization from the operations control center for further movement, she proceeded without seeking such authorization.

Regardless of the cab signal activation status at Western Station, a temporary signal card was installed to de-activate cab signals as the train left California Station and entered the single-track detour. This was done to expedite the movement of trains through the single-track detour. With cab signals cut in, each train entering the single track would have been brought to a stop by the cab signaling equipment and been limited to a speed of 15 mph through the detour. The operating plan called for cab signals to cut back in at Belmont Station after northbound trains had cleared the single-track detour between California and Belmont Stations. Because of the close spacing of the trains, the cab signals did not cut back in for train 104, which had been operating without cab signals since Western Station. Again, the operator proceeded without seeking authorization from the operations control center. The Safety Board concludes that the CTA's practice of cutting out cab signaling and allowing trains to move through a single-track detour at close spacing set the stage for train 104 to re-enter and proceed on cab signal track with inactive cab signals, albeit in violation of the CTA's operating rules.

As a result of this accident, the CTA has discontinued the practice of cutting out cab signals when single-track detours are established.

The purpose of the CTA's requirement that an operator get authorization to proceed in cab signal territory without cab signals is to allow the operations control center to confirm that a section of track ahead of the train is clear of other trains. The controller must determine the location of the nearest train ahead and authorize movement "on sight"[24] to a specified point short of the last known position of the train ahead. When the authorization is given, the controller must maintain a manual block control sheet. The "manual block" system provides a procedural safeguard against collisions while the engineering safeguards provided by the signal system are unavailable. When the safeguards are not in place, the safety of train movements must rest entirely on the operator's ability to control the train's speed and to stop short of another train. The Safety Board, therefore, concludes that had the operator in the June 17 accident stopped and contacted the control center when the cab signals on her train did not activate and had the control center then followed existing manual block procedures, the accident would have been prevented.

The train 104 operator stated that as she proceeded out of Belmont Station, she knew that another train was close ahead and that she had previously been close enough to see its taillights. As she rounded a sweeping right-hand curve, she stated, her speed was 10 mph, and she was fully alert when she saw the train stopped ahead and applied the brakes, which, she said, did not work properly to stop the train.

The Safety Board does not find this part of her account credible. The Safety Board identified no mechanical condition or malfunction that would have prevented the train from stopping had the brakes been applied appropriately. Sight distance tests indicated that the standing train was visible from 800 feet away. At a train speed of 10 mph, the operator had more than 50 seconds to see the train ahead and bring her own train to a stop, without the need to resort to emergency braking. The Safety Board concludes that the operator in the June 17 accident had ample time to see the train ahead and bring her train to a safe stop; however, for unexplained reasons, she failed to do so.

A review of the train 104 operator's training and operating history indicates that she was trained and qualified in three safety-sensitive positions; operator, flagman, and switchman. She had failed the operator and flagman training programs twice and had qualified on the third try only after receiving remedial training. She had failed switchman training once and qualified on the second try after receiving remedial training. The CTA's manager of training stated that trainees are typically given three chances to qualify.

The operator's record indicates that she had violated several CTA safety rules during her 12-month career as an operator, including failing to stop at stop signals. The CTA's response was to refer her for additional training, which she was given multiple opportunities to pass. The CTA's system safety program plan specifies that training personnel will "make contact" with operators twice yearly to evaluate their performance.

[24] "On sight" is defined in CTA rules as "within the range of vision."

This schedule was not being met at the time of the accident, and the accident operator had not been contacted.

The CTA disciplinary process resulted in a corrective case interview, after which the operator was referred for 24 hours of additional training. She successfully completed the additional training 1 month before the accident and returned to service. Despite repeated instances of violating the CTA's operating rules, she was allowed to remain in service. The Safety Board concludes that CTA's management process for identifying and addressing operators who do not meet safety performance standards was not effective in addressing the repeated problems that the operator was experiencing. In response to this issue, which was identified by the Safety Board's investigation, the CTA implemented a program to review operators' records and follow up with those who have multiple rules violations.

August 3 Accident

The operator of train 416 said that shortly after departing Kimball Station, he experienced several cab signal stop indications (R6.4 stops). He stated that the stops were not unusual during the rush hour because of the close spacing of trains.

CTA operating rule R6.4 required that the operator wait for the signal to clear after each stop, since he knew a train was close ahead. The purpose of the requirement is to prevent trains closing on each other unnecessarily. The rule provides a procedural safeguard by maintaining at least one track circuit separation between trains. But the operator stated that once he entered the combined Brown/Purple Line tracks at Clark Junction, he repeatedly proceeded after R6.4 stops without waiting for the train ahead to clear and without contacting the operations control center. He said that he knew a Purple Line train was close ahead and that it was common practice for operators to proceed from an R6.4 stop without either waiting for a proceed signal or calling for authorization from the operations control center.

Because the operator consciously violated the rule, the safety of further train movement relied entirely on his alertness and his ability to stop short of another train from a maximum speed of 15 mph. The Safety Board concludes that had the operator in the August 3 accident complied with the CTA's operating rules and waited for his stop signal to clear before proceeding, the accident would have been prevented.

He stated that he was leaving Sedgwick (the last station before the accident site) on an R6.4 stop indication when he last saw the taillights of the Purple Line train. He said he also had a propulsion system blue light alarm at this time. (The alarm illuminates a trouble light on the console, activates a continuously ringing bell in the cab, and illuminates a trouble light on the side of the affected car.) After leaving Sedgwick and passing Division Avenue, he entered Church Curve, where visibility was limited by a church. He stated that as he exited the curve, he saw the taillights of a train stopped about 100 feet ahead. He said that he was alert and facing forward when he first saw the train. He said he then moved the

control handle first to brake position 3 and then to the emergency position, but that the train did not stop.

The Safety Board could not find any mechanical reasons why the operator failed to stop train 416 short of the standing train. Sight distance tests indicated that the standing train was visible from 373 feet away which, at 13 mph (the speed indicated on the accident train's maintenance data logger), would have given the operator 18 seconds or more to see the standing train and activate braking to safely stop and avoid an accident. But according to the maintenance logger data, the operator did not activate emergency braking until 1 1/2 seconds before impact.

Although the operator told investigators during postaccident interviews that he was facing forward as the train rounded Church Curve, several witnesses stated that he had his head out the side window just before the collision. In a second interview, he conceded that he might have been distracted by the propulsion system blue light alarm. The Safety Board concludes that the operator had ample time to see the train ahead and bring his train to a safe stop; however, for unexplained reasons, he failed to do so.

Rules Knowledge Among CTA Operating Personnel

CTA rule R6.4 does allow trains to proceed on an R6.4 stop indication under specified conditions. The rule states that after waiting at least 30 seconds, the operator must request authorization from the controller to proceed. The purpose is to allow the controllers (1) to check that a train is not close ahead and (2) to note possible signal system maintenance problems. When the authorization to proceed is given, it carries with it the requirement that the train be operated at a speed and in a manner that will allow the operator to stop short of another train, a misaligned switch, or a broken rail.

Had the operator asked for authorization to proceed, it is uncertain whether the controller would have checked for trains close ahead and withheld authorization to proceed. Three of eight interviewed controllers stated that if an operator reported an R6.4 stop, they (the controllers) would not check for trains close ahead before authorizing further movement. In other words, had the operator in the August 3 accident called the operations control center about the stop signal, he may have been given authority to proceed without waiting for the signal to clear, and the accident may still have occurred.

Some CTA employees were also confused about the proper procedures to follow after an operator received a blue light alarm. Although CTA rule 8.35 states that "defects in equipment or any dangerous or unusual condition must be reported immediately to the controller," 6 of the 10 interviewed operators said they would not report a blue light alarm to the operations control center until they had tried to reset it and were ready to cut out a car. Seven of the eight interviewed controllers said that they expected operators to call in blue light alarms immediately. The Safety Board concludes that controllers and operators were inconsistent in their application and understanding of the rules governing stop signals and blue light alarms.

After reviewing the results of the Safety Board's field interviews of the staff, CTA management included the controllers in a mandatory refresher course on signal rules compliance that initially had been targeted at operators and supervisors.

Enforcement of Operating Rules on the CTA

In both the June 17 and August 3 accidents, operators knowingly violated operating rules. Both accident operators indicated that they had observed similar rule violations by other employees or managers; and, in fact, Safety Board investigators observed a CTA manager violating a CTA operating rule. Limited field interviews with CTA operating personnel indicated such rules violations were more widespread than the occurrence of two accidents might suggest.

The CTA's system safety program plan not inappropriately assigns primary responsibility for operations rules compliance to the operations department. During the course of the investigation, the Safety Board found that the actual implementation of the CTA's rules compliance program did not match the description in the plan. For example, the primary ways management was supposed to monitor operators' rules compliance was by having rail supervisors and line managers do ride checks and point checks. But the twice yearly monitoring of operators by training instructors described in the plan was not being done. Also, the CTA safety department checks were not being made, at least in the cases of the two accident operators.

But even if the point checks and ride checks had been performed in accordance with the established schedule, the Safety Board is not convinced that they would have been effective in ensuring that operators strictly and consistently adhered to operating rules. For example, point checks are performed at a station and, thus, do not permit an evaluation of most operating rules. Ride checks are performed inside the operating cab, and the operator is aware of the evaluator's presence. Operators may be expected to follow the rules to the letter during such evaluations, but management has no assurance that the operator will exercise the same diligence when he or she is not being observed. The Safety Board concludes that the CTA's program for the enforcement of operating rules was inadequate in design and execution and that, consequently, rules violations, such as those related to these two accidents, were not uncommon.

The CTA does not have unannounced efficiency tests or tests for rules compliance in which the operator is not aware that a test is in progress, nor does the FTA require such tests. In contrast, the Federal Railroad Administration (FRA) regulations (49 CFR 217.9) specifically address a program of operational tests, inspections, and record keeping on railroads subject to FRA jurisdiction. Such rules compliance programs typically include check rides and efficiency tests.[25] Most railroads also periodically review event recorder data to confirm that engineers are following the rules.

[25] Efficiency tests involve setting up a scenario, such as a stop signal, and documenting the operating crew's actions to verify that applicable rules are complied with.

In the view of the Safety Board, rules compliance enforcement programs can be as effective in preventing accidents in the transit industry as they are in the railroad industry. Consequently, the Safety Board has previously urged transit agencies to strengthen their rules compliance enforcement programs. For example, as a result of its investigation of a collision involving two Greater Cleveland Regional Transit Authority (GCRTA) trains near 98th Street Station in Cleveland, Ohio, on July 10, 1985,[26] the Safety Board issued the following safety recommendation to the GCRTA.

> R-87-8
>
> Perform and document frequent supervisory checks using a systematic procedure to determine if train operators are complying with the operating rules, including speed restrictions and signal rules.

In a March 4, 1988, letter, the GCRTA informed the Safety Board that "rail supervisors now perform a minimum of two ride checks per day" and that:

> a field test is also conducted with automatic signals. Rail supervisors…set the signal red or dark and monitor passing trains from a concealed vantage point to observe proper adherence to operating rules.

Accordingly, Safety Recommendation R-87-8 was classified "Closed—Acceptable Action."

As a result of its investigation of another collision involving two GCRTA trains near 98th Street Station in Cleveland, Ohio, on July 2, 1991,[27] the Safety Board issued the following safety recommendation to the GCRTA:

> R-93-1
>
> Implement a management oversight program that effectively supervises train operations and enforces the operating rules.

In a July 18, 1994, letter, the GCRTA informed the Safety Board that it had created a rail oversight committee that had:

> put in place the formal structure to support an ongoing process to improve the safety of the GCRTA. The structure includes regularly scheduled meetings, a resolution tracking system and monthly safety audit summary reviews.

Accordingly, Safety Recommendation R-93-1 was classified "Closed—Acceptable Action."

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[26] National Transportation Safety Board, *Rear-End Collision of Two Greater Cleveland Regional Transit Authority Red Line Rapid Transit Trains Near the 98th Street Station, Cleveland, Ohio, July 10, 1985*, Railroad Accident Report NTSB/RAR-87/01 (Washington, D.C.: NTSB, 1987).

[27] National Transportation Safety Board, *Rear-End Collision Involving Two Greater Cleveland Regional Transit Authority Trains Near the West 98th Street Station, Cleveland, Ohio, July 2, 1991*, Railroad Accident Report NTSB/RAR-93/01/SUM (Washington, D.C.: NTSB, 1993).

As a result of its investigation of a collision involving two Metropolitan Transportation Authority/New York City Transit (NYCT) trains near 9th Avenue Station in Brooklyn, New York, on February 9, 1995,[28] the Safety Board issued the following safety recommendation to the NYCT.

> R-96-10
>
> Revise the operating employee evaluation checklist to effectively determine compliance with operation rules and instructions and include, at a minimum, unannounced speed and signal tests and radio communications procedures.

In a May 22, 1996, letter, the NYCT informed the Safety Board that the checklist had been revised to include "conducting random unannounced radar checks of train speeds." In addition, the NYCT informed the Board that it had implemented an efficiency test program. Accordingly, Safety Recommendation R-96-10 was classified "Closed—Acceptable Action."

As shown by the June 17 and August 3 accidents, the CTA would benefit from a comprehensive program of evaluations and efficiency tests similar to those in the railroad industry and in other transit agencies. The Safety Board, therefore, believes that the CTA should develop and implement systematic procedures for performing and documenting frequent management checks to ensure all operating personnel are complying with CTA operating rules, including speed restrictions and signal rules.

Such a rules compliance program might include procedures for supervisors to follow in making unannounced observations, field audits at stop signals and of speed restrictions, and periodic reviews of event recorder data.

Convening an independent panel of experts from other railroads and transit agencies is one of the methods used in the transit industry when an agency, such as the CTA, needs advice on program improvements or has had a significant series of accidents. Such a "peer review" or "blue ribbon panel"[29] is a cost-effective way to allow an agency to tap industry experts who have experience with the best industry practices in other organizations. The Safety Board hopes that the CTA will obtain the best advice possible in strengthening its operating rules compliance programs.

Another potential resource for transit agencies in establishing and maintaining a safe transit system is APTA's standards and best practices that are currently in development. The Safety Board believes that APTA should include specific guidance for transit operators on performing unannounced rules compliance observations and efficiency tests as the General Rule Standard for Rule Compliance and Implementation is developed.

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[28] National Transportation Safety Board, *Collision and Derailment of Two Subway Trains Metropolitan Transportation Authority New York City Transit in Brooklyn, New York, February 9, 1995*, Railroad Accident Report NTSB/RAR-96/01 (Washington, D.C.: NTSB, 1996).

[29] APTA has a program to organize peer reviews at the request of transit agencies, although some agencies organize such reviews on their own or through consultants.

CTA System Safety Plan

The CTA uses a system safety program plan as the basis for its overall safety policy**.** In a recent Safety Board special investigation report,[30] the Safety Board noted that the appropriate use of such plans by rail transit systems provides a reliable means of establishing and maintaining safe operations. Such plans, when fully implemented, set a standard for safe procedures in all operational departments. The plans require periodic audits to confirm that the safety standards are being satisfied. Audits are conducted by the organization itself, by the State regulatory agency, and (upon request) by APTA. A well-drafted and fully implemented plan helps ensure that the organization's approach to safety concerns is systematic, consistent, and verifiable.

The CTA's system safety program plan assigns primary responsibility for internal safety audits to the system safety and environmental affairs department. As noted earlier, the CTA's system safety program was not effective in the area of rules compliance, yet the agency's year 2000 internal safety audit found that "service rail operation employees [were complying] with safety rules and S.O.P.s." The internal safety audit did not specifically address the training department's program of twice-yearly check rides with operators or the safety department's monitoring of operators' compliance with operating rules, indicating that the CTA's internal audits may not have been sufficiently thorough. The Safety Board, therefore, concludes that the CTA's internal safety audit was not effective in identifying the inadequacies in the rules compliance program.

APTA Guidance and Audits

In addition to its own internal safety audit program, the CTA has also engaged APTA to conduct periodic safety audits. The last APTA safety audit before the accident, which was conducted in 1998, took no exception to how transportation line management oversaw operators' rules compliance. APTA's audit did not include a checklist item specifically addressing the training department's program of twice-yearly check rides with operators or the safety department's monitoring of operating rules compliance. The APTA audit process creates a unique checklist for every transit system it audits. The checklist is based on the transit system's system safety program plan.

Item 12 on the APTA System Safety Checklist in the *Manual for the Development of Rail Transit System Safety Program Plans* addresses rules/procedure reviews. The manual indicates that records reviews and supplemental spot checks are the methods to use in determining whether rules are being followed. There is little specific guidance on what rules compliance programs should entail or how they should be efficiently implemented.

[30] National Transportation Safety Board, *Maryland Transit Administration Light Rail Vehicle Accidents at the Baltimore-Washington International Airport Transit Station near Baltimore, Maryland, February 13 and August 15, 2000,* Railroad Special Investigation Report NTSB/SIR-01/02 (Washington, D.C.; NTSB, 2001).

The Safety Board concludes that the APTA *Manual for the Development of Rail Transit System Safety Program Plans*, published on August 20, 1991, does not contain the necessary specific guidance for assessing the effectiveness of rules compliance programs; as a result, the guidelines are not effective tools for regulatory authorities or transit agencies with regard to rules compliance programs.

The Safety Board, therefore, believes that APTA should modify the *Manual for the Development of Rail Transit System Safety Program Plans* to provide specific guidance for transit agencies to use in auditing the effectiveness of their operating rules compliance programs by referencing the APTA standard covering transit rules compliance and efficiency test programs as audit criteria.

Because the FTA requires that fixed guideway transit systems, such as the CTA's rail transit system, develop and implement a system safety program plan that complies with the guidelines in the 1991 APTA manual, the Safety Board believes that the FTA should adopt the APTA manual that contains updated language on auditing the effectiveness of operating rules compliance programs. Further, the Safety Board believes that the FTA should simultaneously modify 49 CFR Part 659 so that the Part always references the current APTA manual.

State Safety Oversight of Rail Rapid Transit Systems

As a result of its 1991 safety study on the oversight of rail rapid transit safety, the Safety Board issued Safety Recommendation R-91-37 to the 11 States that then had rail rapid transit systems and the District of Columbia, asking that they "develop or revise, as needed, existing programs to provide for continual and effective oversight of rail rapid transit safety." The recommendation to California, Florida, New York, and Pennsylvania was classified "Closed—Acceptable Action." The recommendation to Georgia, Illinois, Maryland, Massachusetts, New Jersey, Ohio, Virginia, and the District of Columbia remains in an "Open" status. In the same safety study, the Safety Board issued Safety Recommendation R-91-33 to UMTA, predecessor of the FTA, asking, in part, that the agency evaluate the effectiveness of existing State oversight of rail rapid transit safety and "develop guidelines for use by State and local governments that address the critical elements of an effective oversight program."

In December 1991, Congress gave the U.S. Department of Transportation the authority to establish requirements for State safety oversight of rail fixed guideway mass transportation systems. Safety Recommendation R-91-33 was classified "Closed—Acceptable Action" on April 16, 1996, after the FTA had addressed the main objectives of the recommendation by instituting rulemaking to require States with rail fixed guideway systems to designate a State oversight agency and to establish a safety oversight program.

Even though the Safety Board notes the FTA's increased role in State safety oversight, deficiencies remain. Some of the inadequacies in State safety oversight, such as

those noted in this accident investigation, can probably be attributed to the fact that State oversight agencies lack experience in overseeing their rail rapid transit systems. The role of safety regulation is still relatively new to States such as Illinois, which had no rail transit State safety oversight programs before Federal regulations were promulgated in 1996. As the States gain more experience and familiarity with the unique requirements of rail rapid transit safety, they are likely to exercise more effective safety oversight of their transit properties.

In light of the progress that has been made in formalizing State safety oversight programs for rail rapid transit, the Safety Board has reconsidered the status of Safety Recommendation R-91-37. Because the 1991 congressional mandate to the U.S. Department of Transportation, as well as the regulatory activities of the FTA, has largely met the intent of the recommendation, the Safety Board reclassifies Safety Recommendation R-91-37 to 11 States and the District of Columbia "Closed—No Longer Applicable."

State Oversight of the CTA

Illinois designated the RTA as the oversight agency for the CTA in 1997. State safety oversight regulations give the RTA a fair degree of flexibility in how active it will be in its oversight. For example, the FTA allows State agencies to delegate accident investigation to the transit agency and to review the transit agency's reports. State agencies can also have contractors perform some of their oversight functions.

In the case of the CTA, the RTA relied heavily on the CTA's internal safety audits to verify that the CTA's rules compliance program was effective. But, as noted above, the CTA's internal safety audits were not sufficiently rigorous to identify problems in rules compliance. The Safety Board, therefore, concludes that the Illinois State safety oversight program was hindered in monitoring rules compliance by its reliance on ineffective CTA internal management and safety audit programs. The Safety Board is encouraged that the RTA plans to play a more active role in carrying out its safety oversight responsibilities by participating in the CTA's internal safety audits.

Event Recorders

The investigation of the second CTA accident showed that some CTA rail transit cars contain a system for preserving a limited amount of train performance data when an accident involves a specific triggering event (in this case, propulsion breakers on two rail cars were knocked out of position by the collision impact). The data loggers record only a limited amount of data and will record over existing data if new triggering events occur. (Event recorders collect a much greater variety of data and record for a much longer period of time.) It was happenstance that the accident involved a triggering event and, thus, that data was available to investigators. Had the triggering event not occurred, as was

the case on the remainder of the cars in the train, no train performance data would have been captured. The Safety Board, therefore, concludes that, because the transit cars involved in these accidents either did not have event recorders or had event recorders with only limited data-recording capability, insufficient information was available to provide the basis for a thorough analysis of the actions of the operators and the performance of the trains before the collisions.

Previous Safety Board Event Recorder Recommendations

On November 14, 1996, as a result of the Safety Board's investigation of an accident on the Washington Metrorail system,[31] the Safety Board issued Safety Recommendation R-96-46 to the FTA, which called for the FTA to:

> R-96-46
>
> Develop, with the assistance of the American Public Transit [Transportation] Association, guidelines for the monitoring/recording devices that capture critical performance and event data for rapid rail transit cars and urge transit agencies to install these devices on new and rehabilitated cars.

The FTA, with APTA, prepared a report, dated June 1998, entitled *Event Recorders for Rail Rapid Transit Systems*. In a September 4, 1998, letter, the FTA provided the Safety Board with a copy of the report and indicated that the report would be distributed to transit agencies developing specifications for rehabilitated and new rapid transit vehicles and that the FTA would urge the installation of the devices. The report explored the effectiveness and efficiency of using event recorders on rapid rail cars. It presented and analyzed data; defined various aspects of using accident/accident event recorders; included a cost, feasibility, and benefit analysis; and identified the technical requirements for these devices in rapid rail transit. Based on this response, the Safety Board classified Safety Recommendation R-96-46 "Closed—Acceptable Action" on January 6, 1999.

When, on November 14, 1996, the Safety Board issued Safety Recommendation R-96-46 to the FTA, it also issued Safety Recommendation R-96-47 to APTA. The recommendation asked APTA to:

> R-96-47
>
> Develop, with the assistance of the Federal Transit Administration, guidelines for the monitoring/recording devices that capture critical performance and event data for rapid rail transit cars and urge transit agencies to install these devices on new and rehabilitated cars.

In addition to working with the FTA to develop the 1998 *Event Recorders for Rail Rapid Transit Systems* report, APTA has, through various APTA-sponsored conferences

[31] National Transportation Safety Board, C*ollision of Washington Metropolitan Area Transit Authority Train T-111 with Standing Train at Shady Grove Passenger Station, Gaithersburg, Maryland, January 6, 1996*, Railroad Accident Report NTSB/RAR-96/04 (Washington, D.C: 1996).

and symposia, urged transit agencies to install these devices on new and rehabilitated cars. Based on this information, Safety Recommendation R-96-47 has been classified "Closed—Acceptable Action."

Event Recorder Regulations

The FTA has issued no regulations that apply to event recorders on rail transit vehicles. The FRA regulations concerning the requirements for event recorders on railroad locomotives are at 49 CFR 229.135. These regulations do not apply to event recorders on rail transit vehicles. According to the railroad locomotive safety standard definitions provided at 49 CFR 229.5(g):

> (g) Event recorder means a device, designed to resist tampering, that monitors and records data on train speed, direction of motion, time, distance, throttle position, brake applications and operations (including train brake, independent brake, and, if so equipped, dynamic brake applications and operations) and, where the locomotive is so equipped, cab signal aspect(s), over the most recent 48 hours of operation of the electrical system of the locomotive on which it is installed. A device, designed to resist tampering, that monitors and records the specified data only when the locomotive is in motion shall be deemed to meet this definition provided the device was installed prior to [insert the effective date of the rule] [*sic*]and records the specified data for the last eight hours the locomotive was in motion.

APTA Event Recorder Working Group

APTA is sponsoring a working group, the APTA Rail Transit Standards Development Vehicle Inspection and Maintenance Committee, that is addressing event recorders on rail transit vehicles, as well as a variety of other maintenance issues. The committee consists of representatives from APTA, various transit properties, consultants, and government entities. The committee is addressing inspection and maintenance standards and recommended practices for rail transit event recorders. The committee's recorder standard is expected to detail maintenance intervals and techniques for data, voice, and image recording systems (where available) on transit vehicles. The group defers to the Institute of Electrical and Electronics Engineers (IEEE) Standard (1482.1) for any recommended operational and crashworthiness standards. The committee expects to have a final draft standard for rail transit event recording systems by the end of 2002.

In response to Safety Board recommendations to the transit industry through APTA**,** the CTA has developed a draft specification and intends to equip its new rail transit cars with event recorders meeting the IEEE 1482.1 standard. While the Safety Board is encouraged by the CTA's plans to equip its future rail rapid transit cars with event recorders, the Board is concerned that other transit agencies may not share the commitment. To help expedite expanded employment of event recorders in rail transit vehicles, the Safety Board believes that the FTA should require that new or rehabilitated vehicles funded by FTA grants be equipped with event recorders meeting IEEE standard 1482.1 for rail transit vehicle event recorders.

Positive Train Control

The Safety Board is concerned about the safety of rail passenger service when backup systems are not available to intervene if an operator operates his train improperly or fails to comply with wayside signals. The Safety Board has long maintained that the most effective way to avoid train-to-train collisions is through the use of positive train control (PTC) systems. Such systems prevent train collisions by automatically assuming some control of the train when the operator does not comply with the signal indication.

In both of these accident locations, cab signal systems with automatic train stop features were installed. While this system is not a full PTC system, it does have several attributes that the Safety Board has long proposed as part of a PTC system. The CTA's cab signal system enforces restrictive signals by stopping a train if the operator does not comply with the requirements of the signal; however, the operator can proceed after such a penalty stop if a button is pressed, but the train's speed is limited to 15 mph. The CTA's operating rules add further restrictions.

In the case of the June 17 accident, to allow track maintenance, trains were routed against the normal current of traffic where wayside cab signal equipment was not installed. A temporary signal card was installed in wayside equipment to disengage the cab signal system on northbound trains entering the single-track detour. The cab signal system did not reactivate on the incident train when it returned to the normal track because it was closely following a train ahead. The operator proceeded without any cab signal protection, thus ignoring the CTA's operating rules. After the accident, the CTA discontinued the practice of disengaging the cab signal system. As a result, a train that enters a single-track detour where cab signals are not in force is limited to a speed of 15 mph or less until it returns to the normal track where higher cab signal codes are present.

In the August 3 accident, the cab signal system was functioning as designed, and the train was stopped by the system. However, as noted above, the equipment design allowed the operator to proceed, not exceeding 15 mph. Again, this was not in compliance with operating rules.

Train operations in manual or bypass mode, although undesirable, are required with any train control system, including PTC systems, in case of equipment malfunction or maintenance activities. For example, fully automated systems that are considered to have PTC, such as the San Francisco BART and the Washington, D.C., Metro, may be operated in a reduced-speed manual mode that overrides restrictions imposed by the PTC system. Operating rules restricting and controlling such manual or bypass operations are required on such systems. Violation of such rules on a PTC system still creates a risk of collision just as it did on the CTA's cab signal system. However, PTC systems and cab signaling systems with reduced speed functions for manual operations lessen the severity of a collision, as the reduced speed function did in the August 3 accident. While PTC remains a highly desirable safety improvement on any rail system, the circumstances of these two accidents demonstrate the need for stringent enforcement of operating rules, even in environments with PTC or cab signal systems.

Conclusions

Findings

1. There was no evidence of alcohol or drug use in these accidents, and the following factors were neither causal nor contributory to either accident: weather, signal system malfunction, or the braking systems of the trains.

2. The Chicago Transit Authority's practice of cutting out cab signaling and allowing trains to move through a single-track detour at close spacing set the stage for train 104 to re-enter and proceed on cab signal track with inactive cab signals, albeit in violation of the Chicago Transit Authority's operating rules.

3. Had the operator in the June 17 accident stopped and contacted the control center when the cab signals on her train did not activate and had the control center then followed existing manual block procedures, the accident would have been prevented.

4. The operator in the June 17 accident had ample time to see the train ahead and bring her train to a safe stop; however, for unexplained reasons, she failed to do so.

5. The Chicago Transit Authority's management process for identifying and addressing operators who do not meet safety performance standards was not effective in addressing the repeated problems that the operator in the June 17 accident was experiencing.

6. Had the operator in the August 3 accident complied with the Chicago Transit Authority's operating rules and waited for his stop signal to clear before proceeding, the accident would have been prevented.

7. The operator in the August 3 accident had ample time to see the train ahead and bring his train to a safe stop; however, for unexplained reasons, he failed to do so.

8. Controllers and operators were inconsistent in their application and understanding of the rules governing stop signals and blue light alarms.

9. The Chicago Transit Authority's program for the enforcement of operating rules was inadequate in design and execution; and, consequently, rules violations, such as those related to these two accidents, were not uncommon.

10. The Chicago Transit Authority's internal safety audit was not effective in identifying the inadequacies in the rules compliance program.

11. The American Public Transportation Association *Manual for the Development of Rail Transit System Safety Program Plans*, published on August 20, 1991, does not contain the necessary specific guidance for assessing the effectiveness of rules compliance programs; as a result, the guidelines are not effective tools for regulatory authorities or transit agencies with regard to rules compliance programs.

12. The Illinois State safety oversight program was hindered in monitoring rules compliance by its reliance on ineffective Chicago Transit Authority internal management and safety audit programs.

13. Because the transit cars involved in these accidents either did not have event recorders or had event recorders with only limited data-recording capability, insufficient information was available to provide the basis for a thorough analysis of the actions of the operators or the performance of the trains before the collisions.

Recommendations

As a result of its investigation of the two Chicago Transit Authority accidents discussed in this report, the National Transportation Safety Board makes the following safety recommendations:

New Recommendations

To the Federal Transit Administration:

Adopt the American Public Transportation Association manual that contains updated language on auditing the effectiveness of operating rules compliance programs, and simultaneously modify 49 *Code of Federal Regulations* Part 659 so that the Part always references the current American Public Transportation Association manual. (R-02-18)

Require that new or rehabilitated vehicles funded by Federal Transit Administration grants be equipped with event recorders meeting Institute of Electrical and Electronics Engineers Standard 1482.1 for rail transit vehicle event recorders. (R-02-19)

To the American Public Transportation Association:

Include specific guidance for transit operators on performing unannounced rules compliance observations and efficiency tests as the General Rule Standard for Rule Compliance and Implementation is developed. (R-02-20)

Modify the *Manual for the Development of Rail Transit System Safety Program Plans* to provide specific guidance for transit agencies to use in auditing the effectiveness of their operating rules compliance programs by referencing the American Public Transportation Association standard covering transit rules compliance and efficiency test programs as audit criteria. (R-02-21)

To the Chicago Transit Authority:

Develop and implement systematic procedures for performing and documenting frequent management checks to ensure all operating personnel are complying with Chicago Transit Authority operating rules, including speed restrictions and signal rules. (R-02-22)

Recommendation Reclassified in this Report

To the Governors of the States of Georgia, Illinois, Maryland, Massachusetts, New Jersey, Ohio, and Virginia and the Mayor of the District of Columbia:

R-91-37

Develop or revise, as needed, existing programs to provide for continual and effective oversight of rail rapid transit safety. The elements of the oversight program should include reviews of maintenance and inspection records, accident investigation activities, audits of system safety program plans, reviews of the transit system safety department, reviews of training programs, monitoring of accident data, and periodic inspections of equipment and infrastructure.

Safety Recommendation R-91-37, previously classified "Open—Acceptable Response" (Illinois, Maryland, Massachusetts, New Jersey, Ohio, and Virginia) and "Open—Awaiting Response" (Georgia and the District of Columbia) is reclassified "Closed—No Longer Applicable" in the "State Safety Oversight of Rail Rapid Transit Systems" section of this report.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

CAROL J. CARMODY
Acting Chairman

JOHN A. HAMMERSCHMIDT
Member

JOHN J. GOGLIA
Member

GEORGE W. BLACK, JR.
Member

Adopted: September 5, 2002

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Appendix A

Brief: June 17, 2001, Chicago Transit Authority Accident

National Transportation Safety Board
Washington, D.C. 20594
Railroad Accident Brief

Railroad Accident Number:	DCA-01-FR-005
Rail System:	Chicago Transit Authority
Train:	Blue Line trains 104 and 207
Accident Type:	Rear-end collision
Location:	Near Addison Station, Chicago, Illinois
Date and Time:	June 17, 2001, 11:40 a.m.
Fatalities/Injuries:	No fatalities; 22 injuries (none serious)

Accident Synopsis

On Sunday, June 17, 2001, at approximately 11:40 a.m., central daylight time, Chicago Transit Authority (CTA) northbound train 104 collided with the rear end of standing CTA train 207, about 1,200 feet south of the Addison Street Station. It was estimated that train 104 had been traveling between 10 and 15 mph.

Each train consisted of four passenger cars. Train 104 had approximately 75 passengers, and train 207 had approximately 40. Eighteen passengers, an off-duty CTA employee, and both train operators reported non-life threatening injuries. The collision did not result in a derailment or fire. Damage was estimated at $30,000.

Investigation

The operator of the striking train reported for duty at 5:40 a.m. on Sunday, June 17, at O'Hare Station. Her schedule called for two trips from O'Hare to Forest Park and back.

The northbound Blue Line track between California and Belmont Stations was out of service for scheduled maintenance on the morning of the accident. Trains going in either direction had to operate on the same single track between a left-hand crossover (to

the southbound track) at California (the southernmost station) and a diamond crossover at Belmont (the northernmost station). The detour was within cab signal[1] territory. Because the cab signal system was designed to function only for traffic proceeding in the normal direction of travel (in this case, southbound), cab signals had been temporarily cut out for the detour area. Cab signals for the detoured trains were expected to cut back in when the trains reached Belmont Station and returned to the northbound track.

Just before the accident, three trains (210, 207, and 104) had proceeded northbound through the single-track area. Train 210, the first of the three, made its scheduled station stop at Belmont after leaving the single track. It then proceeded north toward Addison and on to O'Hare without incident.

The operator of train 207, the second of the three, also made a station stop at Belmont. The operator stated that the cab signal system cut back in and functioned normally as he neared the north end of the Belmont platform. As the train proceeded north from Belmont, the operator stated, he received a stop signal on the cab signal system as he approached Addison Station because train 210 was stopped in the station ahead. The operator of train 207 stopped his train about 200 feet behind train 210. Shortly after stopping, he said, he felt an impact and was thrown forward into the control stand.

The operator of the striking train (104) entered cab signal territory at Western, where, she stated, the cab signaling did not cut in. She proceeded from Western toward the single-track detour at 20 mph. At California, a pilot[2] operated her train through the detour. Once back on the northbound track, she took control of her train from the pilot at the south end of Belmont platform. She then operated to the north end of Belmont and stopped to board and offload passengers. She stated that the cab signal system did not cut in. She stated that she knew trains were ahead of her and consequently operated her train at about 15 mph out of Belmont without cab signal protection. CTA cab signal territory rules allow a train operator to proceed when the cab signal system is inoperative only when he or she had received authorization from CTA's operations control center. The operator stated that she did not contact the operations control center when she was at Western or at Belmont, even though she knew the operating rules required that she do so.

She stated that as she left the subway portal and exited a right-hand curve, she observed a train stopped about 100 feet ahead. She stated that she moved the control handle to brake 3 position and then pulled the brake cord, but the train did not stop. She then mistakenly hit a sander button while trying to depress the track brake button. She stated that when she did depress the track brake button, it was too late to be effective. She estimated her sight distance as 100 feet and the impact speed as 10 mph.

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[1] A train with cab signals displays the governing signal aspect inside its cab as long as the train is operating in territory equipped with a working cab signal system. The system is designed to cut out when a train leaves cab signal territory and to cut back in when a train enters cab signal territory.

[2] The CTA uses a pilot to control conflicting train movements over a temporary single-track detour. No train can proceed through the detour without obtaining specific authorization from the pilot or without having the pilot on board the train.

The sight distance was determined to be an unobstructed 800 feet to the point of impact. Tests indicate that CTA cars going 10 mph are capable of stopping within 10 to 15 feet. Consequently, the Safety Board determined that the operator of train 104 had adequate time and distance to stop her train short of the rear of train 207 but that for unknown reasons, she failed to do so.

The train braking and signal systems were tested and found to function as designed. However, it was noted that a train's cab signals would not cut in after the train left the single-track area if another train occupied one of the two blocks immediately ahead.

The CTA's system safety program indicated that several departments constantly monitored operating rules compliance. The Safety Board's investigation found that this was not the case. For example, the agency's year 2000 internal safety audit found that "service rail operation employees [were complying] with safety rules and S.O.P.s." Yet, the internal safety audit did not specifically address a training department program of twice-yearly check rides with train operators that was not being done. The audit also did not address the safety department's monitoring of train operators' compliance with operating rules, which also appears to have not been done. The CTA's internal audits may not have been sufficiently thorough and were not effective in identifying these inadequacies in the rules compliance program.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the operator of train 104 to comply with operating rules. Contributing to the accident was the failure of the Chicago Transit Authority's management to exercise adequate operational safety oversight.

Appendix B

Brief: August 3, 2001, Chicago Transit Authority Accident

National Transportation Safety Board
Washington, D.C. 20594
Railroad Accident Brief

Railroad Accident Number:	DCA-01-FR-007
Rail System:	Chicago Transit Authority
Train:	Brown and Purple Line trains 416 and 505
Accident Type:	Rear-end collision
Location:	Near Chicago Station, Chicago, Illinois
Date and Time:	August 3, 2001, 9:04 a.m.
Fatalities/Injuries:	No fatalities; 118 injuries (one serious)

Accident Synopsis

On Friday, August 3, 2001, at approximately 9:04 a.m., central daylight time, Chicago Transit Authority (CTA) Brown Line train 416 collided with the rear end of standing CTA Purple Line train 505 on elevated tracks near Hill Street in Chicago, Illinois. Both trains were southbound. It was estimated that train 416 had been traveling 11 mph. Each train consisted of six passenger cars. The accident occurred during the morning rush hour, and both trains had standing loads estimated at 90 passengers per car. Chicago Police Department logs indicate that 118 people were transported to area hospitals, all with minor injuries. One injury was later upgraded to serious.

Investigation

The operator of the striking train reported for duty at 8:15 a.m. on August 3 at Kimball Station. His schedule called for five trips from Kimball to downtown Chicago, around the Loop, and back to Kimball.

He departed Kimball on time for his first trip, at 8:25 a.m. He stated that he experienced several cab signal overspeed malfunctions when he first operated the train out

of Kimball. He also experienced two propulsion system blue light[3] alarms. The first alarm sounded in the cab as the train departed Addison Station. The operator stated he was able to reset the first alarm from the cab when he stopped at the next station, which was Paulina. A second alarm sounded after the train left Sedgwick Station. The operator stated that he had intended to continue to Chicago Station, where he planned to troubleshoot the problem.

He said that he had had several cab signal system stops before the collision and remarked that the number of stops was not unusual during the rush hour due to the close spacing of trains.[4] According to the CTA's operating rules, when a train operator has a stop signal, he should wait for the signal to indicate proceed when another train is known to be ahead. If the train operator does not know why he received a stop, he must contact the operations control center for authorization to move. The operator stated that once he entered the combined Brown/Purple Line tracks at Clark Junction, he proceeded after receiving stop signals without waiting for the train ahead to clear and without contacting the operations control center. He stated that it was not uncommon for operators to proceed without waiting or calling.

He stated that he left Armitage Station with his cab signal displaying a stop indication, knowing that he was following a Purple Line train close ahead. He stated that he was leaving Sedgwick the last time he saw the taillights of the Purple Line train. After leaving Sedgwick and passing Division Avenue, he entered Church Curve, where visibility was limited by a church. At the south end of the curve, he stated, he observed the taillights of a train stopped about 100 feet ahead. He said that when he saw the train, he moved the control handle first to brake position 3 and then to the emergency position, but the train did not stop. He estimated his sight distance at 100 feet and the impact speed as 10 mph. He told investigators that he might have been distracted by a blue light propulsion alarm.

The train braking and signal systems were tested and found to function normally. A braking test at the accident location with a train of similar weight indicated that the stopping distance was 31 feet. Sight distance tests determined that the side of a train standing at the point of impact could first be glimpsed by a following train from a distance of about 373 feet as the following train exited Church Curve. The view of the rear of the train was unobstructed from about 345 feet.

Several witnesses told investigators that they observed the train operator with his head out the side window of the train just before the collision. Data from a propulsion event logger on the train indicated that the brakes were not applied until about 1.5 seconds before impact.

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[3] A blue light alarm indicates that one of the cars in the train has a propulsion or auxiliary power problem. In the event of a blue light alarm, a trouble light illuminates on the operator's console, and an alarm bell sounds in the cab. A trouble light also illuminates on both sides of the affected car.

[4] A train with cab signals displays the governing signal aspect inside its cab as long as the train is operating in territory equipped with a working cab signal system. A stop indication is displayed when another train is occupying the block ahead.

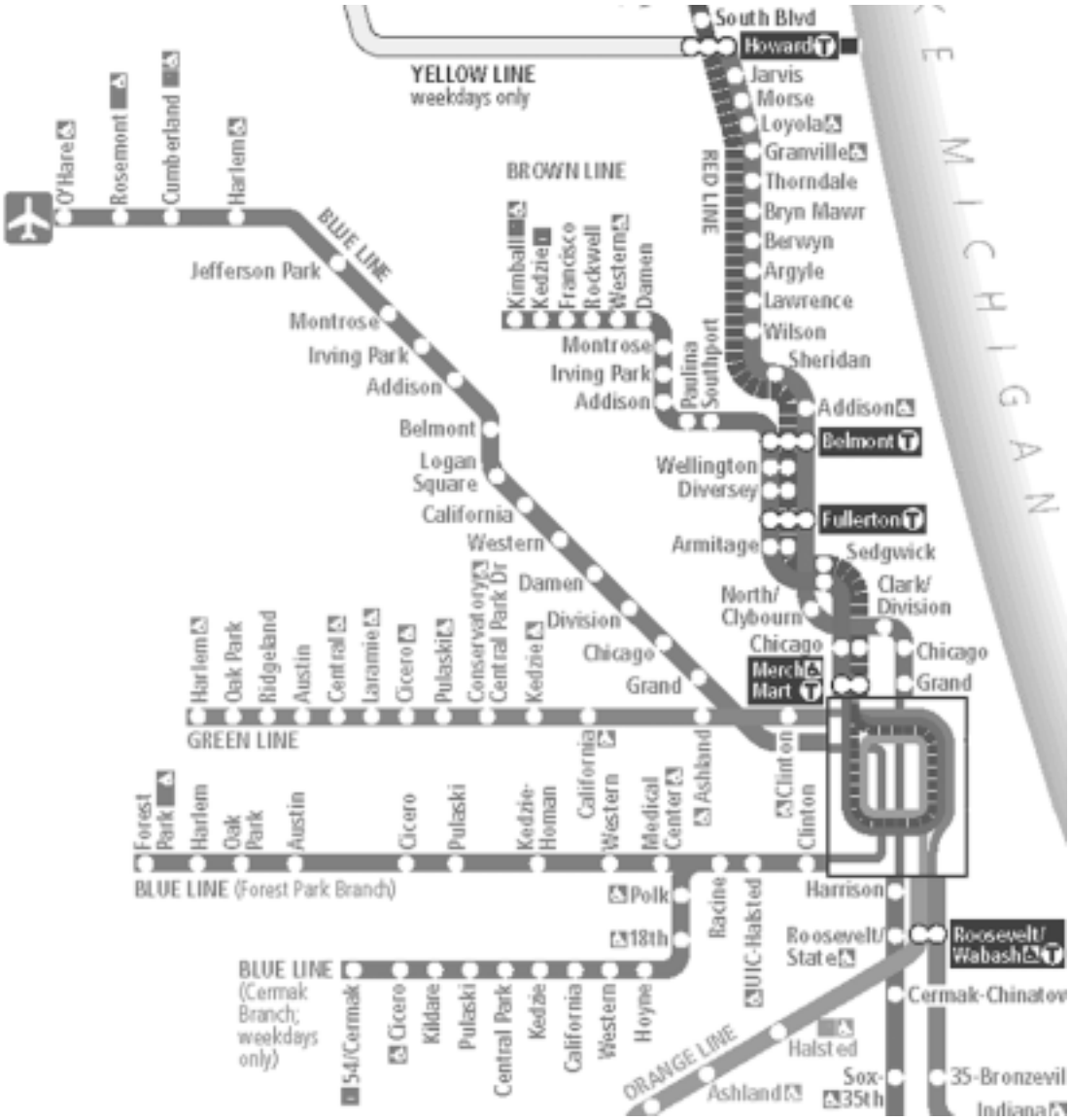
The CTA's system safety program indicated that several departments constantly monitored operating rules compliance. The Safety Board's investigation found that this was not the case. For example, the agency's year 2000 internal safety audit found that "service rail operation employees [were complying] with safety rules and S.O.P.s." Yet, the internal safety audit did not specifically address a training department program of twice-yearly check rides with train operators that was not being done. The audit also did not address the safety department's monitoring of train operators' compliance with operating rules, which also appears to have not been done. The CTA's internal audits may not have been sufficiently thorough and were not effective in identifying these inadequacies in the rules compliance program.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the operator of train 416 to comply with operating rules. Contributing to the accident was the failure of the Chicago Transit Authority's management to exercise adequate operational safety oversight.

Appendix C

CTA Brown and Blue Lines



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