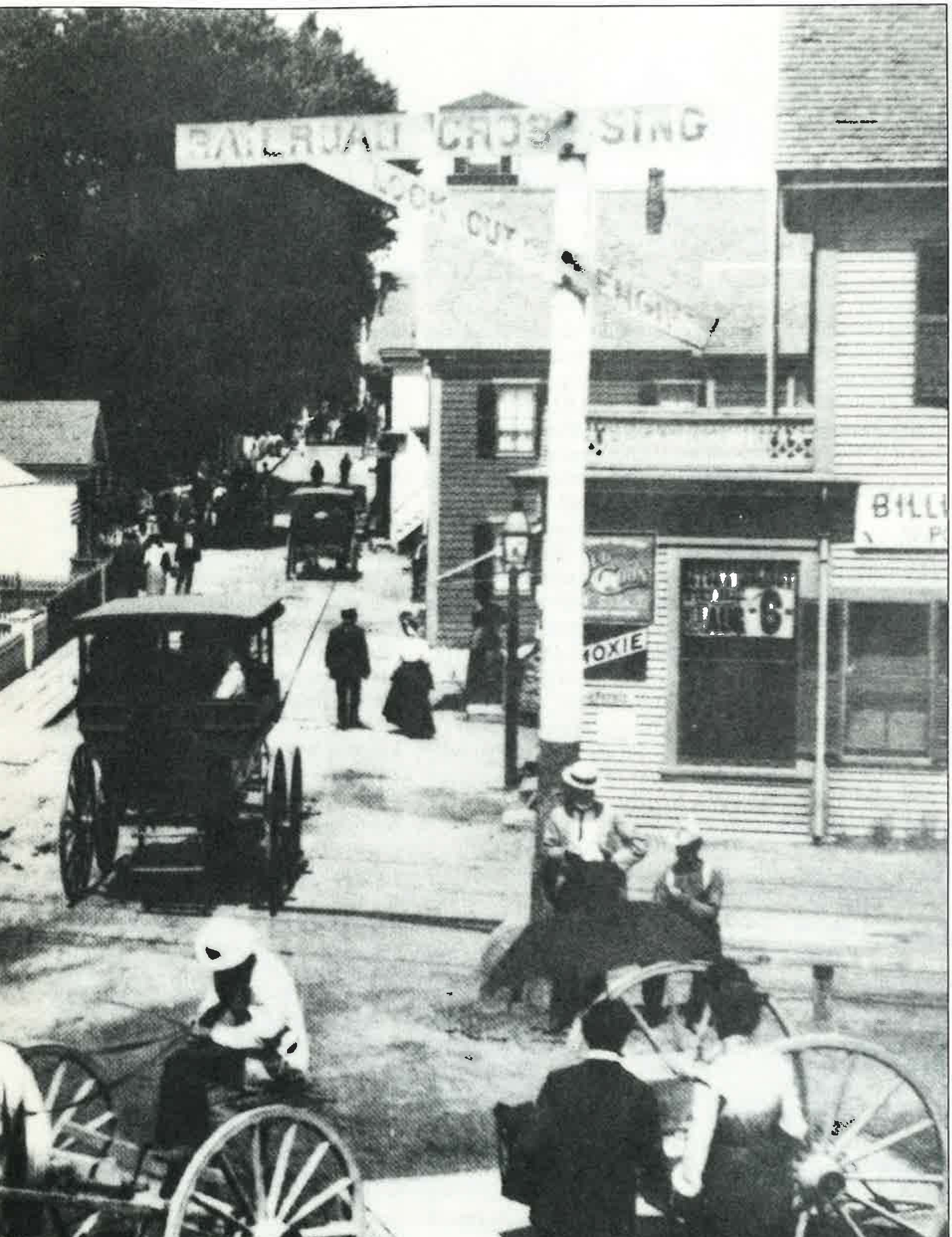
"A Train is Coming!"

Full Barrier Gates Improve Safety at Railroad-Grade Crossings

SAMUEL C. TIGNOR

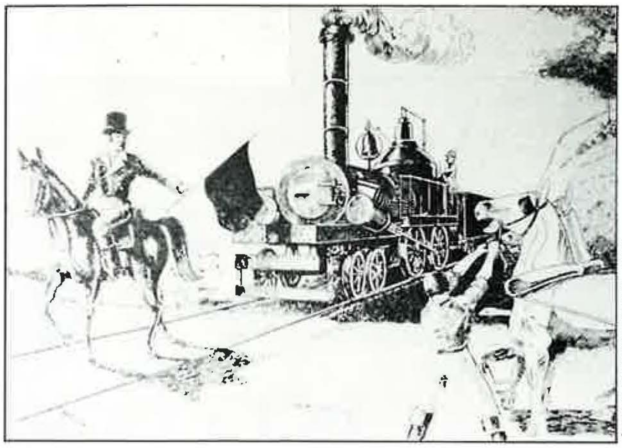
Accidents and fatalities at railroad-grade crossings have been a problem in the United States since the first railroad system started in 1827 when charters were granted to the Baltimore and Ohio Railroad and the Charleston and Hamburg Railroad. These railroads and others that followed were instrumental in the national development of the eastern and later the western United States. Not only did railroads enhance transportation, but they permitted much of the economic growth in the late 1800s and



RICK STUHL, DOVER PUBLICATIONS

Railroad crossing in Providence, Rhode Island at turn of the century.

"A signalman on horseback preceded the train, waving a red flag, shouting 'A train is coming!' to warn drivers away from the tracks."



SIGNALMAN'S JOURNAL, 1950

early 1900s. By the end of 1835, only 918 miles of track had been constructed, but by 1860, about 31,000 miles of track were in service, and the mileage continued to increase until the 1920s (*1*, p. 14).

After Henry Ford invented the automobile in 1893, its popularity steadily increased, and the use of the horse-drawn carriage faded rapidly during the 1920s (*2*, p. 21; *3*, p. 318; *4*, p. 276). At the same time the number of miles of railroad began to decline while the number of motor vehicles continually increased, reaching about 180 million in 1987.

Early Control Devices

It soon became clear that some type of warning device was needed to prevent horse drawn carriages, wagons, and motor vehicles from colliding with the larger and heavier trains at public crossings. Thus warning devices were erected on highway approaches to alert drivers of both motor vehicles and wagons of the potential hazards. A signalman on horseback preceded the train, waving a red flag, and shouting "A train is coming!" to warn drivers away from the tracks (*5*). From this evolved the practice of a signalman standing at the crossing waving a red flag or paddle during the day and a red-colored lantern at night.

Flagmen were replaced around 1890 when automatic switches were used to detect trains and activate a wigwag that simulated a signalman waving a flag or lantern (*6*). The forerunner of the alternately flashing horizontal red lights was used by the Central Railroad of New Jersey in 1913 (*7*). During the next 20 years, the railroads used about 60 different warning devices, including manual gates operated by a signalman. Today's standard warning device—the short-arm automatic gate—was first used in 1936 (*8*, p. 6).

Many accidents and fatalities have occurred at railroad-highway grade crossings. Since 1928, when the number of fatalities at public crossings reached 2,568, the number has generally declined to a low of 444 in 1986 (*9*, p. 5; *10*, p. 12). Although there has been considerable progress, problems still exist. Currently, about 28 percent of all public railroad-highway grade crossing control devices are of an active type. About 50 percent of all grade crossing accidents still occur at crossings equipped with active systems.

FHWA Study

A research study conducted in 1988 by the Federal Highway Administration Office of Safety and Traffic Operations R&D and the University of Tennessee Transportation Center investigated ways to improve safety at grade crossings that were equipped with active warning devices, particularly gate-type systems (*8*). Part of the study focused on the use of railroad crossing gate systems and how existing gates could be improved and safety enhanced. One of the objectives of the study was to evaluate in the field the effectiveness of full barrier or four-quadrant gate systems in which the crossing was closed during the passage of the train.

The study reviewed warning and control practices in Australia, Canada, Denmark, Germany, Great Britain, Japan, the Netherlands, and Sweden. Although various configurations of signs, signals, and markings are used in these countries, crossings with full or half barriers provided the highest level of safety; that is, they offered the lowest accident risks (*11*, p. 51).

Site Selection

The Southern Railroad Systems tracks at Cherry Street in Knoxville, Tennessee, was the site selected for the research. The active warning devices at the Cherry Street crossing were automatic, two-quadrant gates, standard railroad flashing light signals without constant warning time equipment, a bell, and pavement markings. Using the hazard rating approach, this two-track crossing was in the top seven percent of all hazardous public railroad-highway grade crossings in Tennessee. The roadway had four lanes and straight and level approaches to the crossing. The distance between the gates was 42 feet. The average daily traffic was about 14,000 vehicles, and the average through train volume was about 10 trains per day. The speed limit on Cherry Street was 30 miles per hour and train speeds ranged from 20 to 40 miles per hour.

Although only one automobile-train accident had occurred at Cherry Street in the past five years, large numbers of motorists were observed driving around extended gate arms. This type of behavior made the Cherry Street crossing potentially dangerous. Four-quadrant gates with skirts were installed and evaluated at this location.

The top horizontal bars of the four gates were identical to standard wooden gate arms. The horizontal and vertical

With the two-quadrant gate system, motorists could drive around the extended gate arms; four-quadrant gates with skirts have eliminated these violations at railroad-grade crossings.

members of the four skirts were constructed of kiln-dried redwood, sealed and painted to industry standards, and covered with 16-inch strips of red and white, high-intensity retroreflective sheeting. Each of the prototype skirts was 30 feet long, 3-1/2 feet high (when in the extended position), and weighed about 40 pounds. To prevent vehicles from becoming trapped between the gates, a delay of the downward motion of the downstream gate arm was incorporated into the system.

Data Collection

Both train movement and driver behavior data were collected for approximately two months before (March and April 1985) and two months after (December 1985 and January 1986) the four-quadrant gates with skirts were installed. The two main measures used to assess the effectiveness of the gate systems were the number of violations and clearance time. Violations occurred whenever motorists drove around the extended gate arms. Clearance time was defined as the difference in time between the last vehicle to cross and the train's arrival at the crossing.

With the original two-quadrant gate system, motorists could drive around the extended gate arms. In the cases in which vehicles were present before the train's arrival, of 93 train arrivals, 78 gate violations (84 percent) with one or more motorists driving around the extended gate arm were observed. In one violation, 14 motorists were observed driving around the extended gate arm. After the four-quadrant gates with skirts were installed, all violations were eliminated, and no vehicles crossed the railroad tracks after the gates were extended.

Short clearance times were prevalent with the two-quadrant gate system partly because of the large number of violations. For the 90 cases in which vehicles were present before the train arrived, 31 of the drivers (34 percent) cleared the tracks in less than 20 seconds and 5 drivers (6 percent) cleared the tracks in less than 10 seconds. With the four-quadrant gates with skirts, all clearance times were in excess of 30 seconds.

Conclusion

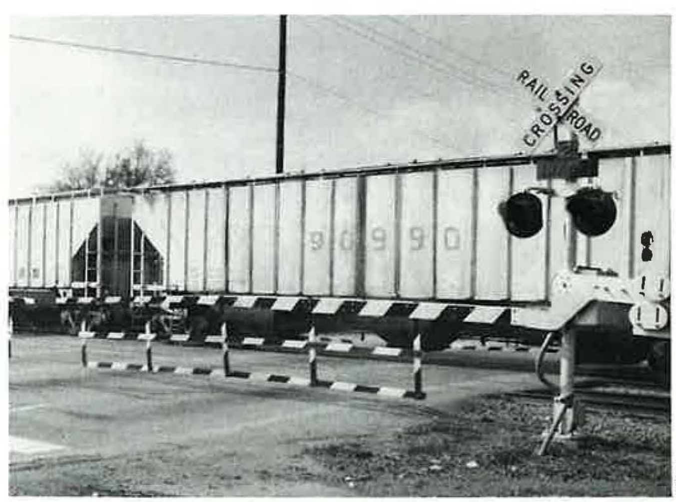
The operational performance of the four-quadrant gates with skirts was found to be consistent with that for two-quadrant systems. No motorists were trapped on the tracks, and the four-quadrant gates with skirts did not interfere with the operation of emergency vehicles. There were no adverse public and media comments about the gates. The estimated added cost of installing four-quadrant gates with skirts, compared with the cost of a standard two-quadrant gate system, is approximately $32,750, using standard railroad pricing. The additional maintenance cost is about $740 per year.

The study identified five categories for the use of four-quadrant gates with skirts:

1. Crossings on four-lane divided roads;
2. Multitrack crossings where the distance between tracks is greater than the length of a motor vehicle;
3. Crossings without train predictors where train warning times are long and variable;
4. Crossings where there are school buses, trucks transporting hazardous materials, or high-speed passenger trains; and

continued on page 26

Today's standard warning device, the short-arm signal gate, was first used in 1936.



Prototype gate arm and skirt assembly at Cherry Street crossing, Knoxville, Tennessee.