Safety of High Speed Trains

Three speakers at Western Railway Club meeting review demands that faster schedules imposed on tracks, signals and brake equipment

WHAT THE operation of the new higher-speed trains means in the construction and maintenance of tracks, in the design of signal systems, and in the more exacting demands imposed on brake equipment was the subject of discussion at the meeting of the Western Railway Club at the Hotel Sherman, Chicago, on March 18. The subject was introduced by Elmer T. Howson, vice-president and western editor of the *Railway Age,* who reviewed the progress in the stepping-up of train speeds during the last 12 months and discussed the refinements in track maintenance that the faster schedules imposed. W. F. Zane, signal engineer, Chicago, Burlington & Quincy, outlined the more exacting requirements for adequate signaling protection. J. C. McCune, assistant director of engineering, Westinghouse Airbrake Company, described the tests made with the Burlington's Zephyr for the purpose of establishing the various constants affecting brake operation at speeds appreciably in excess of those for which these values had been previously known. He also presented a number of conclusions, based on these studies, concerning the rates of retardation that may be obtained in the practical operation of the new high-speed trains. The high point of Mr. McCune's paper was that, as a result of recent tests, it appears physically possible, after further development and experience, to stop trains of the articulated type from speeds of 90-100 m.p.h. in about the same distance as conventional locomotive trains from speeds of 60-70 m.p.h. Abstracts of the two other papers are presented below.

The Beginning of a New Era

By Elmer T. Howson

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SPEED IS a characteristic of the age through which we are passing. Whether we like it or not, we cannot ignore the trend. Nowhere are the demands for speed more pressing than in transportation.

It is for this reason that the past year has been so momentous for the railway industry. After years of more or less prosaic operation along established lines, the railways have suddenly recaptured public interest. Orders for new trains of new and novel designs have followed one another in rapid succession, while records for speeds have been broken so frequently and in so many parts of the country as to demonstrate that we are in the beginning of a new era of speeds in regular routine operation that were unthought of as recently as two years ago.

Records Broken

It is less than 10 months ago—May 26, 1934, to be exact—that the Burlington's Diesel-powdered Zephyr traversed the 1,015 miles from Denver, Colo., to Chicago non-stop in 13 hr. 5 min., an average speed for the entire distance of 77.5 miles per hour, with a speed of more than 100 miles per hour for 19 miles and a maximum speed of 112.5 miles per hour. This was a reduction of 5 hr. 48 min., or 30 per cent, from the previous record between these points, which had stood since 1897. It compares with a regular schedule of 26 hr. 15 min.

Less than two months later, on July 20, the Milwaukee established a new record for sustained speed by a steam train when it operated a train in regular service for the 85 miles between Chicago and Milwaukee, Wis., in 67 min. 35 sec., or at an average speed for the entire distance of 75.5 miles per hour. On this run, a speed of 91.1 miles per hour was maintained for the 69.9 miles from Mayfair, Ill., to Lake, Wis., and a speed of 93 miles per hour for the 31 miles from Russell, Ill., to Lake, while the last five miles into Lake were traversed at a speed of 103 miles per hour. This record of 67½ min. compares with a scheduled time a year ago of 110 min.

Then in October the Union Pacific established another world record when its six-car Diesel-powered train traveled the 2,298 miles from Los Angeles, Cal., to Chicago in 38 hr. 49 min., an average speed of 59.2 miles per hour, and the 3,258 miles from Los Angeles to New York in 56 hr. 55 min., an average speed across the continent of 57.2 miles per hour. On this run, the 508 miles between Cheyenne, Wyo., and Omaha, Neb., were covered at the rate of 84 miles per hour, while a maximum speed of 120 miles per hour was attained at one point. This record of 38 hr. 47 min. from Los Angeles to Chicago compares with the best previous record of 44 hr. 55 min., made by "Death Valley" Scotty in 1905, while the 56 hr. 58 min. record to New York compares with the fastest previous run of 72 hr. 27 min., made by E. H. Harriman in 1906—reductions of 6 hr. 7 min. and 15 hr. 32 min., respectively.

Nor have the developments of the past year been confined to demonstration runs. On November 11, the Burlington placed its Zephyr in regular service between Kansas City, Mo., Omaha, Neb., and Lincoln on a schedule of 5½ hr., which, with stops, requires operation in excess of 80 miles per hour, and reduced the running time approximately 2 hr. On January 2, the Chicago & North Western placed in operation between Chicago and St. Paul-Minneapolis its "400," a six-car steam-operated train which makes the 408 miles to St. Paul, Minn., in 420 min., as compared with a schedule of 10¼ hr. between these points heretofore.

On January 31, the Union Pacific placed its three-car streamlined train in semi-local service between Salina, Kan., and Kansas City, Mo., where the 187 miles are traversed in 3½ hr., with six intermediate stops. The Pennsylvania is now operating its Congressional Limited and certain other trains with electric locomotives between New York and Washington, a distance of 225 miles, on schedules that will be reduced gradually until they reach 3½ hr., as compared with 4 hr. 15 min. now. During the year the New York Central has streamlined one of its locomotives, which is now hauling the Twentieth Century Limited regularly between Chicago and Toledo, Ohio.

Other developments of like character are immediately before us. Already the Union Pacific has announced that it will place three Diesel-powered streamlined trains in service this spring between Chicago and Los Angeles, Cal., San Francisco and Portland, Ore., respectively, on schedules of less than 40 hr., as compared with minimum existing schedules of 53¾ to 59 hr. The Burlington has likewise announced that it will place two additional Zephyr trains in service between Chicago and St. Paul on schedules of 6½ hr., or 390 min., for the 431 miles.

The Milwaukee is also planning to meet these schedules with trains of light-weight construction, drawn by streamlined steam locomotives of new design, while the Illinois Central has under construction a five-car Diesel-powered streamlined train for use between Chicago and St. Louis, Mo., on a 5-hr. schedule, as compared with 6½ hr. now. In New England, the Boston & Maine will soon place in service its Flying Yankee between Boston, Mass , and Bangor, Me., reducing the overall time each way by 1 hr. 55 min. and calling for average speeds between Boston and Portland of more than 65 miles per hour.

Nor are these all of the high-speed trains now under construction, for the New Haven will receive its Zeppelin from the builders early in April; the Baltimore & Ohio is completing two trains, one with steam and the other Diesel power, shortly thereafter; the Santa Fe is building a 3,600-hp. Diesel locomotive to pull its Chief between Los Angeles and Chicago on a materially shortened schedule; and the Gulf, Mobile & Northern has two two-car trains under construction, while within the last few days the Burlington has announced that it will soon order still another Zephyr for semi-local service between St. Louis and Burlington, Iowa.

This development is not confined to any one area but is taking place throughout the country. Fostered by competition within as well as without the railway industry, it may be expected to spread like a prairie fire until its influence is felt throughout the entire field of railway transportation. It is not too much to expect that passenger service between major cities may be speeded up as much as 25 per cent within the next few years as the possibilities of the newer as well as the present types of equipment are more fully developed.

That the public has been quick to respond to this new service is shown by the volume of traffic carried by these new trains. The Burlington's Zephyr, for illustration, carried 193 per cent more passengers during December and January than were handled during the same two months of the preceding year by the steam trains which it replaced, while the increase on the system as a whole was 26 per cent. Likewise, the North Western's "400" train has been crowded to such an extent that an extra car has been required from the beginning, while the Union Pacific train has on several trips carried twice as many persons as there were seats available.

This business is coming in part from the trains replaced, it is coming in part from other trains, but it is also coming in part from competitive transportation agencies on the highways and in the air. On the Burlington's Zephyr, inquiry of passengers using the train during the first two months showed that 16 per cent came from other agencies.

Signaling for Higher Train Speeds

By W. F. Zane

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DURING THE PAST few years, there has been a gradual increase in the speeds of both passenger and freight trains, particularly the latter. The recent introduction, on certain railroads, of articulated streamline trains operating at high speeds, makes it important that the automatic block wayside signals be properly spaced to insure sufficient braking distance so that such trains may be brought to a stop before reaching a signal indicating danger. The Burlington's signal department has for some time been alert to these changing conditions, and the more recent installations of signals were made with these requirements in view. In some cases, the older systems had also been brought up to date to meet this situation.

Consideration From an Engineman's Standpoint

An automatic block signal system does not begin or end with the signal, the aspect of which is only an intelligent manifestation to the engineman of the condition of the track in advance. To insure safe train operation the signal must be a correct visual indication of the operation of a somewhat complicated combination of apparatus and circuits, which must be as nearly infallible as it is humanly possible to make them.

From the viewpoint of the engineman, the signal indication is influenced by two conditions: First, the necessity for proper braking distance at the maximum speed—in determining this distance it is necessary to consider track, grade, weight or tonnage of the train; second, the visibility of the signal, as seen by the engineman, which is also important, because the signal must be located where it may be observed far enough in advance to permit the engineman to apply the brakes and bring the train to a stop in ample time. The location of wayside signals on curves, at the leaving end of deep cuts or near the leaving end of bridges, where steel work obstructs the view, is not desirable.

Consideration of Signaling System

Before the inception of the present popular articulated streamline trains, the operation of trains by signal indication had for years been studied by signal engineers. The Burlington is well equipped with automatic block signaling on all of its principal lines, and has also numerous interlocking plants of several types, sections of centralized traffic control, power-operated remotely-controlled switches and signals, as well as highway crossing signal protection at many locations. Therefore, the problem brought about by higher train speeds becomes primarily an analysis of the older signal systems which were installed years ago when speeds of trains were much lower than at present. Portions of the lines are equipped with electric semaphore signals, but in the last few years color-light signals have been installed on other parts of the lines. Obviously, the signal department was vitally concerned in the braking ability of the new high-speed trains and also in the shunting of the existing track circuits by such trains. This latter is essential to the proper operation of any block signal system.

Information was obtained from the mechanical department regarding the braking distance required for such a train to stop, using the regular service application at different speeds and on different grades. Signal department representatives rode the high-speed trains during test runs, and used stop watches to check the time required to operate the different combinations of signal circuits and to determine whether sufficient time was available for each signal function to perform correctly.

Changes Required

The increased speed of freight and passenger trains in recent years had previously required the moving of certain signals. The changes made recently to correct the signaling on the territory between Chicago and St. Paul, Minn., a distance of 431 miles, are as follows: Between Chicago and Aurora, Ill., 38 miles, the Burlington has a three and four-track system with short automatic blocks employing color-light signals. In this territory, it was not necessary to move any of the signals, the additional braking distances being obtained by repeating the caution indication on the two signal bridges approaching the bridge carrying the stop indication. Between Aurora, Ill., and Miner, Wis., a distance of 290 miles, the block signals are of the semaphore type, installed many years ago when trains operated at less speed that at present. These signals indicate "STOP" or "PROCEED," and have a separate caution signal for each "STOP" signal and, in some cases, the braking distance was between 2,500 and 3,000 ft. A thorough study by the signal department indicated that 153 caution signals should be moved to obtain greater distance between them and their governing home signal. The location of some of the home signals was such that the caution signal could be taken back to the next home signal and placed on the same mast, making a two-arm signal. In certain cases, it was necessary to move the signal in its entirety, including the concrete battery well and instrument cases, relays and other control equipment. Between Miner, Wis., and St. Paul, the automatic block signals are of the color-light type, which are of comparatively recent development. Only four of these signals were moved because of insufficient braking distance.

Some of the signals which were respaced form an integral part of the automatic block system and others are part of the centralized traffic control system, interlockings, etc. All semaphore signals in this territory were approach-lighted. The introduction of high-speed trains in this territory required the extension of the control of the approach lighting to a full length of the block, approximately 2.5 miles. In the territory equipped with automatic color-light block signals, the continuous-lighting system is used, and no changes in circuits were made. All of this work was completed in 75 days, and the entire signal system is now operating satisfactorily.

When the new high-speed trains were first developed, the question arose as to whether the existing track-circuit equipment would function properly owing to the lighter weight of such trains, as well as the greater speed and reduction in length of train. A study developed the fact that the existing track-circuit equipment is highly efficient and reliable to meet all of these new operating problems.

Controls for Crossing Protection Extended

The question of the operation of highway crossing signals arose at the same time. The Signal Section, A.A.R., requires that the crossing signals shall operate 20 sec. in advance of the fastest trains, a provision also required by various states. There would seem thus to be quite a spread between a train speed of between 80 and 100 m.p.h. for a passenger train and about 30 m.p.h. for a freight train, with the result that the highway crossing signal would be operated for too long a time for the freight train, as compared with the faster passenger train. However, it was found that the speed of freight trains has also been increased so that the spread between such trains and high-speed passenger trains is now about the same as it was formerly between slower freight trains and 60 m.p.h. passenger trains. Consequently, it was necessary to lengthen the approach track circuits at highway crossings to provide 20 sec. advance warning for the fastest train.

Between Chicago and St. Paul, Minn., the Burlington has installed additional highway crossing signals and will shortly install reflectorized warning signs at certain highway crossings not equipped with crossing signals. These new installations result in greater protection for vehicles under high-speed train operation than was obtained with the slow-speed train operation previously in effect.

The line between Chicago and St. Paul has been divided into zones for the purpose of regulating the speed of streamline trains. The signal department designed reflex signs to be placed along the roadway 3,000 ft. in advance of each speed zone. A reflex sign with the letter "Z" indicates the beginning of a zone, and on the post below, figures indicate the maximum speed for an articulated train in that particular zone. If a curve is located within the speed zone, another reflex sign with the letter "C" is placed 3,000 ft. in advance of the curve, employing reflex buttons, and the speed limit is indicated immediately below. As soon as a train leaves the curved track, the zone speed is resumed until the train reaches the next zone or curve sign, when the engineman is governed accordingly. At present, these zone- and curve-speed reflex signs apply only to the Zephyr trains, other trains being governed by timetables and train rules in-so-far as speeds at different locations are concerned. Train rules have been prepared for the guidance of the motormen of the Zephyr trains through these speed zones.

General Considerations

There is every indication that the art of signaling has advanced just as rapidly as the increase in the speed of trains. Earlier systems of signaling have been modified and improved from time to time to meet changes in the operation of trains, and the results have been highly pleasing. Train operation by signal indication entirely, which eliminates written train orders, is used extensively on the Burlington, with savings in time and with complete safety. This, in turn, created the development of remotely-controlled interlocking plants and centralized traffic control systems, employing power-operated switches, resulting in the elimination of unnecessary train stops. These new systems are inherently adapted to operate in conjunction with the higher train speeds now prevalent.

During the speed tests of the Zephyr train, signalmen were located at wayside signals to take electrical readings of track and signal equipment, to check the operation of control relays, signals, etc., with the result that we obtained valuable data which will be useful in the future. The introduction of the new Zephyr trains resulted in the respacing of the wayside signals as heretofore mentioned, but it is believed that these changes will be of as much benefit to the high-speed freight trains as to the Zephyr trains.

Recent experience has shown that the entire signal system is meeting the needs of high-speed train operation, and the results obtained between Chicago and St. Paul are gratifying. This is not only true of the signal system but also of the highway crossing signal protection, which is highly dependable and is of the type which holds the confidence and respect of the public.