Safety of High Speed Trains

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

The Beginning of a New Era

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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 novel 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, III., to Lake, Wis., and a speed of 93 miles per hour for the 31 miles from Russell, III., to Lake, while the last five miles into Lake were traversed at a speed of 103 miles per hour. This record of 67 1/4 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 3,288 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.

Nore 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 5 1/4 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 101 1/2 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 3 1/4 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 3 1/4 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 regu-
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Signaling for Higher Train Speeds

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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 signal system 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 Engineer’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
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watches to check the time required to
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
cautions on the two signal
bridges approaching the bridge carry-
ing 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 "PRO-
CEED," 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. At
study by the signal depart-
ment indicated that 153 caution sig-
als 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 com-
paratively recent development. Only
four of these signals were moved be-
cause 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 sema-
phone 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 com-
pleted in 75 days, and the entire sig-
nal system is now operating satisfac-
torily.

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 ad-
vanec of the fastest trains, a provi-
sion 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
signals were 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 be-
tween 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 ap-
proach 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 high-speed
crossings not equipped with crossing
signals. These new installations re-
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 de-
partment designed reflex signs to be
placed along the roadway 3,000 ft. in
advanec 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 loc-
cated 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 immedi-
ately below. As soon as a train leaves
the curved track, the zone speed is re-
sumed until the train reaches the next
zone or curve sign, when the engine-
man 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 the trains, and the re-
results have been highly pleasing. Train
operation by signal indication entirely,
which eliminates written train orders,
which used extensively on the Burlington,
with savings in time and with com-
plete safety. This, in turn, created
the development of remotely-con-
trolled interlocking plants and cen-
tralized traffic control systems, employ-
ning power-operated switches, result-
ing in the elimination of unnecessary
train stops. These new systems are
inherently adapted to operate in con-
junction 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 equip-
ment, to check the operation of con-
tral relays, signals, etc., with the re-
sult 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 men-
tioned, 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 opera-
tion, 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 cross-
ing signal protection, which is highly
dependable and is of the type which
holds the confidence and respect of the
public.