Editorial Comment

Multiple-Aspect Signaling

THE NEW high-speed passenger trains, which are attracting so much attention from the traveling public, should also serve to awaken railroad managements to the necessity for revising their signaling to meet requirements for braking distance for today's trains. Those roads which are inaugurating faster schedules with steam locomotives and standard passenger equipment, requiring longer braking distances, have more serious problems in respacing signals than do those roads that are using lightweight diesel-propelled trains, which permit the use of higher braking ratios and are equipped with special automatically-controlled braking equipment.

In order to allow an adequate factor of safety, a distance of about 3,500 ft. should be allowed for stopping an 18-car train of standard passenger equipment from a speed of 65 m.p.h. on level track. Since the energy to be dissipated in stopping a train increases as the square of the speed, the stopping distance increases to 5,500 to 6,000 ft. for speeds of 80 to 90 m.p.h. Some of the new six-car steam-operated trains require as much as 7,000 ft. for stopping from speeds of 100 m.p.h. These distances were obtained with the use of the full-service application of the brakes. When using an emergency reduction, a six-car steam-train should stop in 4,500 ft. from a speed of 100 m.p.h.

Whereas the fast passenger trains have focused attention on the importance of braking distances, the operation of fast, heavy freight trains really gives rise to the most serious situations with regard to braking distances, for if a freight train should strike the rear of a passenger train, it would result in greater personal hazard than if a passenger train should strike the rear of a freight train.

Braking Ratio

An important consideration in the study of braking distances is the braking ratio, which is the result derived by dividing the total shoe pressure by the total weight of the car. The standard A.A.R. ratio for passenger equipment is 90 per cent, based on 60 lb. cylinder pressure, and for empty freight cars 60 per cent, based on 50 lb. cylinder pressure. When 110-lb. brake pipe pressure is used for passenger train equipment an emergency application develops 100-lb. brake cylinder pressure or 150 per cent braking ratio, although a full service brake application is limited to 60-lb. brake cylinder pressure which results in only 90 per cent braking ratio.

The light weight of a passenger car is used in fixing the braking ratio, since the addition of passengers does not change this greatly. However, for freight cars the ratio is fixed for the empty car weight, and is reduced in proportion to the load. For example, an ordinary 40-ft. box car weighs about 44,000 lb. empty, and when loaded to an extent that will increase the total, including the car, to three times the light weight of the car, a 60 per cent braking ratio is reduced to 20 per cent. Another factor in freight train operation is the fact that some appreciable time is required for the brake application to extend to the rear of a long freight train. As a consequence of all these variations, each freight train has its own individual braking distance which is further varied by the way in which the engineman handles the train. However, a distance of 7,500 ft. should be allowed to stop a train of 80 cars loaded to three times their empty weight when traveling on level track at 50 m.p.h. In all of the above, full-service brake application is understood because this application, rather than emergency, must be considered with reference to signal train-stopping distances.

Thus it is evident that the signaling problem as affected by braking distances is not confined to the comparatively few roads which have introduced passenger trains operating at spectacularly high speeds, for the speeds of freight as well as passenger trains have been increased gradually on many roads during the past decade. Therefore, unless signal engineers and railroad managements are willing to take chances, the signaling on numerous main lines must be respaced and reconstructed in the near future.

Of course, each road must study its local conditions as to train speeds, tonnage and grades, but it is the consensus of those who have made investigations that where passenger trains are operated at 80 m.p.h. and freight trains of 4,000 tons are handled at speeds up to 60 m.p.h., signal stopping distances of approximately 8,000 ft. are necessary under certain circumstances to allow adequate braking distances with a reasonable margin for variations in braking equipment and the handling of trains.

The Use of Three-Aspect Signaling

With the ordinary three-aspect system of signaling, an engineman encountering a caution aspect is supposed to stop short of the next signal, and, if the distance is less than 8,000 ft., he may not be able to do so. On territories where the traffic, even in the peak periods of the day, is such that trains can be spaced two miles or more apart over extended mileage, the logical solution is to respace the signals for 8,000-ft. to 10,000-ft. blocks.

On territories where the volume of traffic cannot be handled efficiently by spacing following trains about two miles apart, shorter blocks with multiple aspects are necessary. This is true especially where suburban trains, making local stops, are mixed in with through passenger and freight trains. On main lines outside of suburban territories, the track capacity is not limited by the number of trains daily but by the preponderance of trains which should be moved promptly in one direction during certain peak periods.

On high-speed lines where diverging or conflicting routes and switching at interlockings are involved, short blocks and multiple aspects are required to prevent unnecessary reductions in speed or stops for through trains. Where long blocks are used, delays may be introduced, under various circumstances. For example, where a plant is not lined up for an approaching train, the engineman, when passing the approach signal, is, according to the code rule, required to reduce to medium speed at the approach signal and further reduce speed prepared to stop at the home signal. In the meantime, the plant may have been lined up for the train, but nevertheless, nine chances out of ten, the train, if a heavy freight, must be stopped in order to release the brakes, for otherwise it may be pulled in two. By the time the air is pumped up, and the train gets under way again, from 15 to 20 min. delay has resulted. Such delays are ordinarily accepted as a matter of necessity, but two or three such occurrences on an overnight run of a merchandise train will disrupt connections or next-morning delivery in a terminal city.

Working on the theory that these heavy fast freights must be kept moving wherever consistent with safety, shorter blocks with multiple-aspect signals offer a decided benefit. Take for example, the instance of the freight train approaching the interlocking, as explained above. With four-aspect signaling properly spaced, the engineman would get an "approach medium" indication at the second signal in approach to the home. This would give him a chance to shut off steam and use his engine brakes to reduce speed gradually, so that if the next signal indicated that his route had been lined up, he could release these brakes and pick up speed again. The same possibility applies when approaching the home signal at a lower speed.

Arguments can be advanced that heavy trains have been operated at high rates of speed for years, and that no complaints have been made regarding delays caused by the present system of three-aspect signals and, furthermore, that as a rule trains are so spaced, that only on rare occasions does a train get anything but a clear signal when running over an entire division. All of this is, in many instances, true, and a detailed analysis of train operation is required to visualize the benefits of using more aspects on certain territories. The importance of providing multiple-aspects to facilitate trains, as explained, may seem far-fetched to many, especially on account of the expenditure required for additional apparatus. However, the results obtained on such roads as the Boston & Maine, the Erie, the New York Central and the Lackawanna warrant this measure.

In considering the use of more than three aspects, most roads will be governed by the necessity for using the salient features of their existing system, and building thereon. The Standard Code includes aspects and indications, rules 281 and 292 inclusive, which on many roads will be the basis upon which new aspects may be added as necessary. In this respect the progress made on the roads mentioned in the pervious paragraph is of special interest.

Suggestions As to a Fourth Aspect

The subject of multiple aspects is acknowledged as being akin to thin ice but a few ideas, which have been acquired by conversation with various persons interested in signaling, are offered here for consideration.

Some roads prefer a simple system of signaling, using one blade or light for all aspects, and object seriously to the use of color combinations to secure additional aspects. This reduces the accepted colors to three—red, yellow and green. Serious difficulty has been encountered in recent years in securing signal glasses of such individual characteristics as to prevent confusion in even these three colors. However, the use of an additional color affords such decided advantages as to warrant research. Purple has been used on many roads for years for the stop aspect for interlocked dwarf signals, but enginemen have experienced so much difficulty in seeing a purple light that numerous roads have discontinued it, using red instead. However, during the last few years, a different purple has been developed by using two glasses to secure a more effective purple aspect. Lunar white has been used extensively for position-light signals as well as for certain aspects in color-position-light signals. Therefore, improved purple and lunar white offer possibilities.

Furthermore, the idea of flashing a lamp to give an aspect different from a steady-burning lamp has already been used on certain roads. One method is to use a flashing-green aspect for a signal governing a block in which there are no track conditions limiting the speed, but to use a steady-burning green for blocks where speed restrictions are in effect on account of curves or other local conditions. Of course, speed restrictions are given by time table rules and wayside markers, but where high train speeds are in effect, additional precautionary reminders are considered desirable. Flashing red has been adopted by the Signal Section for a certain aspect for hump yard signaling. The Southern Pacific uses flashing yellow for a call-on aspect, while two other large roads use a flashing-light for a train order signal.

On certain territories, some roads are using a yellow aspect on two signals approaching a stop signal. This practice is recognized as undesirable, but is being used temporarily to provide adequate stopping distance. If the first of the two yellow signals could be flashed, this would be one means of readily securing a fourth aspect, as applied to an existing signal layout until the signals can be respaced. This fourth aspect would require an additional line control which might possibly be secured over existing line circuits by using some of the schemes incorporating split battery, rectifiers and, if necessary, transmitters of interrupted current.

Too Many Red Lights

A few years ago, the late H. M. Sperry, proposed a system of aspects in which a red light did not appear except for a restricting-speed or a stop aspect. The multiple-aspect system used on the Lackawanna practically conforms to this idea. Mr. Sperry's thought was that the usual system of aspects had been built up on the use of semaphore arms and oil lamps, neither of which could be made to disappear when not needed in an aspect. Now that signals using electric lamps, especially signals of the searchlight type, are in general use, it is pertinent to inquire whether a new set of multiple aspects could not well be prepared in which the color red would not appear except when required. The objection to having too many red lights is that red can ordinarily be seen farther than green, and an engineman approaching an interlocking first sees a large number of red lights; then as he comes closer he is forced to search out the signal for the track on which he is running and may finally find a green light in a group with two or more red lights. At speeds of 60 to 90 m.p.h. he has to do this in a very short period of time. It is granted that approach signals give him advance information, but, nevertheless, the safe operation of trains without the engineman seeing and being governed by home signals is beyond consideration.

Of course, a ready answer to the suggestion of extinguishing a lamp in a signal is that the filament might be burned out, and no aspect would then be shown when a stop aspect should be displayed. One answer to this is the use of light-out relays, controlled in series with lamp filaments, to switch from certain aspects to more restrictive aspects in case of burnouts. The use of double-filaments is another solution. In case of a failure of all these precautionary features, a dark signal is accepted as displaying its most restrictive aspect. This introduces the point that an engineman may not see a signal at all in the event of a light failure. Roads using aluminum paint on signal cases, masts and bridges find that the reflection of light from the locomotive headlight makes the location distinct, even in stormy weather. In order to be ultra-conservative, it might be a practical idea to use a marker made of reflector buttons or to incorporate such buttons in the number plate. Another idea would be to use an auxiliary lamp controlled through a light-out relay to light the number plate. One road now uses illuminated number plates on color-light signals, with the auxiliary lamp lighted only in conjunction with the red aspect.