signals, their indication being "proceed at slow speed prepared to stop." In his opinion, "such a signal expedites traffic and it is a far safer practice to move a train under a slow-speed signal than under a hand signal through an interlocking plant. If conditions are such that a signal cannot be given, Rule 663, of the Standard Code, is then followed."

Cost of a Train Stop

"What is the estimated average cost of a train stop on your road, (a) passenger, (b) freight? How do you arrive at this figure?"

Figures Showing Average "Out-of-Pocket" Cost to Stop and Start Trains Have Been Computed by Superintendent of Transportation, Illinois Central—Cost Varies from $0.50 to $2.30 Per Stop

By H. G. Morgan
Signal Engineer, Illinois Central, Chicago

OUR superintendent of transportation has prepared a statement covering the estimated average cost to start and stop trains on the Illinois Central. The figures given in this statement are the ones which are in use on our road. This statement follows:

"A study to show a conservative figure of costs to stop and start trains is of useful information, as it enables constructive suggestions where train stoppages may be avoided by various improvements in operating facilities, curtailing of flag stops, and making flag stops out of as many regular time-table stops as possible. Arriving at the cost to stop and start trains by taking all of the usual items in the unit of train costs, per mile or per minute, and applied to the actual time lost by reason of making the stop, would not be representative, as there is no additional expense created for wages of crew unless they be on overtime; neither would there be any additional cost for roundhouse supplies, roundhouse men or train supplies. There may be a small additional cost for locomotive and car repairs over and above brake shoe wear, but under ordinary conditions this expense would be small and difficult to estimate. A cost calculated on such a basis would be inflated and would be a poor figure on which to make an estimate of savings in a contemplated investment for improved facilities.

"The cost to stop and start trains will vary according to whether the start is made on a heavy grade, a curve, level track and with weather conditions, size of locomotive, number of cars in train, price of fuel delivered on tender, etc., which would require a large number of tests to cover each condition. It is not infrequent for a freight train to meet with an unexpected stop, incurring a loss of 9 min. which may be the direct cause of 1 to 2 hr. delay further down the line, by reason of their not being able to make the meeting and passing points lined up for them, in which case these costs would be much more than indicated. A cost, therefore, which covers a train movement under favorable conditions would seem to be more representative for general requirements.

"For this purpose, a series of tests and checks were made on the Illinois Central dynamometer car in connection with other tests being made at the time. Tests were made on approximately level straight track and under favorable weather conditions. Additional coal was arrived at by scoop count, and its cost includes both transportation and coal chute expense. Additional water costs were apportioned on ratio of additional fuel costs per rate of evaporation of the engine. Locomotive and car brake shoe wear were based on tests made to ascertain the life of a brake shoe. Experiments have shown that brake shoe wear on the wheel itself, under action of most all types of shoes, is exceedingly small and would not materially affect these costs. 'Superheat oil' is based on cost per minute, per average cost and consumption over a train district, it being understood that 'superheat oil' feeds during a short time the locomotive is standing. Cost for per diem on foreign cars is based on $1.00 per day, or the *same amount* if an ownership car as the *net earnings* of a 'home' car approximate this figure.

Passenger Train Stop

"To stop and start an 11-car passenger train with a Pacific type locomotive on level straight track, summer conditions, from a speed of 50 miles an hour and to regain the same speed:

	Distance	Time
After locomotive shut off steam to stopping point	0.44 mi. 2,344.0 ft.	60 sec.
Standing		60 sec.
Regain speed 50 m.p.h.	2 mi.	240 sec.
Total		360 sec.
Less time required to run entire distance of 2.44 mi. at 50 m.p.h. had stop not been made		175 sec.
Actual time lost		185 sec.
Equivalent to		3 min.

Cost of Passenger Train Stop

Additional coal, 296 lb. at $0.0015 per lb.	$0.444
Water, 7 cents per 1,000 gal. (3.4 per cent of coal costs above)	.015
Brake shoe wear on 8 ownership cars (24 shoes per car), tender 8 shoes, total 200 shoes at $0.0002 per one brake shoe stop	.04
Brake shoe wear on locomotive ($0.00055 one brake shoe per stop), 6 shoes	.0033
Superheat oil, $0.00078 per min. (3 min.)	.0023
Total cost	$0.5046

Freight Train Stop

"Estimated cost to stop and start an average 50-car freight train having a 2-8-2 class superheat locomotive when running on level straight track (summer conditions) from speed of 25 m.p.h. and to regain the same speed:

	Distance	Time
After locomotive shuts off steam to stopping point	0.375 mi. 1,980.0 ft.	114 sec.
Standing		69 sec.
Regain speed of 25 m.p.h.	2.6 mi.	780 sec.
Total		963 sec.
Less time required to run entire distance of 2.9 mi. at 25 m.p.h. had stop not been made		417 sec.
Actual time lost		546 sec.
Equivalent to		9 min.

Cost of Freight Train Stop

Additional coal, 343 lb. at $0.0015 per lb.	$0.514
Water, 7 cents per 100 gal. (3.4 per cent of coal cost above)	.0174
Brake shoe wear locomotive ($0.00055 one shoe per stop), 8 shoes	.0044
Brake shoe wear 50 cars and tender (8 shoes each), 408 shoes at cost of $0.00013 per shoe, per stop	.053
Superheat oil, $0.00033 per min.	.0029
Per diem on foreign cars or net earning capacity of 50 ownership cars at $1.00 per day or $0.000694 per car-min.	.312
Cost non-overtime train	$0.9037

If train and engine crew are on overtime, add 9 min. at overtime wages, $0.0889 per min	.8001
Cost of train on overtime	$1.7038

Cost Data for 2-10-2 Type Locomotive 80-Car Train

	Cost 9 min. lost
Additional coal, 550 lb. at $0.0015 per lb	$0.825
Water, 7 cents per 1,000 gal. (3.4 per cent of coal cost)	.028
Brake shoe wear locomotive ($0.00055 one shoe per stop), 10 shoes	.0055
Brake shoe wear 80 cars and tender (8 shoes each), 648 shoes at cost of $0.00013 per shoe, per stop	.0842
Superheat oil, $0.00051 per min	.0045
Per diem on foreign cars or net earning capacity of 80 ownership cars at $0.000694 per car-min	.499
Cost of non-overtime train stop	$1.4462
If train and engine crew on overtime add 9 min. at rate of $0.0952 per min	.856
Cost of overtime train stop	$2.3022

Summary of Costs

Average cost passenger train stop	$0.50
Average cost 50-car freight train stop (non-overtime)	.90
Average cost 50-car freight train stop (overtime)	1.70
Average cost 80-car freight train stop (non-overtime)	1.45
Average cost 80-car freight train stop (overtime)	2.30

Fuel Cost Is Biggest Item of Expense in Stopping a Freight Train on an Adverse Grade

By J. A. Johnson
Signal Engineer, Missouri-Kansas-Texas, Denison, Texas

On the Missouri-Kansas-Texas, I believe it is generally estimated that the average cost of stopping a passenger train is $1.50, and that the average cost of stopping a freight train is at least $3.00. The biggest item to be considered in making a train stop is loss of fuel. A freight train that is stopped under adverse conditions, such as on an ascending grade, will easily consume a ton of coal more than it would have consumed had the train not been stopped. Other items to consider are time lost and wear and tear on brake equipment in making the train stop. A heavy train, either freight or passenger, making a stop on a descending grade causes considerable wear on the brake equipment.

Automatic Signals Within Yard Limits

"When installing automatic signaling, do you provide signals on main tracks through yards to permit high-speed movements, or are trains operated at reduced speed under yard limit rules without automatic signal protection?"

Does Not Believe It Good Practice to Have a Stretch of Dead Track in Continuous Automatic Signal Territory

By F. H. Bagley
Signal Engineer, Seaboard Air Line, Savannah, Ga.

It is our practice to install signals on main track through yards. This is not done to permit high-speed movements through yards, since our rules in all cases provide for reduced speed under yard limit rules under such conditions.

I have noticed it is usually the case that yardmasters are prejudiced against automatic signals through yard territory, and usually object to the signals until they get better acquainted with them. It has always followed in my experience that yardmasters, after having experience with automatic signals in yard territory are well pleased with them. Our idea in installing signals through such territory is to give full automatic protection and to eliminate manual blocking. We do not feel that it is a good idea to have a stretch of dead track in continuous automatic territory. Automatic signals provide head-on and rear-end protection between switching moves, and also check the position of switches and give broken rail protection.

If the proper thought is given to the location of signals through yard territory, the installation can be made without seriously hampering switching moves and the advantages obtained will considerably offset any disadvantages. Yard limit rules are not superseded by the automatic signal installation.

Dwarf Signals of the Light Type Are Ideal for Yard Use Because They Introduce No Clearance Problems

By R. D. Moore
Assistant Signal Engineer, Southern Pacific, San Francisco, Calif.

Appreciating the fact that greater hazards of accident exist in yards than elsewhere we carry signal protection throughout all terminal yards except at points where the speed is so restricted that the likelihood of accident is practically negligible. In the early days the expense involved in signaling yards often influenced us to omit protection where the speeds were moderate. Now, however, practically all such places are protected.

We have found the dwarf light signal a life saver for yard signaling. Where formerly the difficulty in providing sufficient clearance for high signals often presented a serious problem, now we are able to install dwarf light signals wherever desired without clearance difficulties. As they can be located between tracks with 13-ft. centers and are considered suitable for speeds up to 25 or 30 m.p.h., they make an ideal signal for yard use.

In attempting to signal a large yard one soon realizes that it is necessary to provide either plenty of signals, so that the block sections will be short, or to leave them out entirely, in order to permit flexible operation of the yard. Therefore yard signaling is bound to be expensive. We find that the use of dwarf signals considerably reduces the expense and permits locating them where it would be out of the question to use other types.

Advocates Signal Protection Through Yards

By W. D. Leonard
Assistant Signal Supervisor, Chicago & Eastern Illinois, Evansville, Ind.

It seems a logical procedure to safeguard main line or through trains through yard or congested limits as much as feasible consistent with local conditions. Naturally blocking should be shortened considerably and more signals would be needed than on other main tracks. Assume the conditions existing in a yard without signal protection and depending upon restricted speed of main line trains to assure protection. First there is no broken rail protection, second no switch point protection, third no fouling protection, and fourth the blocking protection is not as efficient due to the human element involved, and last but not least, signals do not need time to think, neither do they fail to think.