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.

They act at once, and where delays may be occasioned the factor of safety is much greater than if they were not used. By all means let us have signal protection through yards.

Not Believed to Be of Much Value Under Ordinary Conditions

By C. A. Christofferson
Signal Engineer, Northern Pacific, St. Paul, Minn.

It has not been our practice to provide automatic signal protection through large terminal yards whether on single or double track. The beginning of automatic block signals outside of a yard is at the yard switch, and usually they end braking distance into the yard from the last switch. Yard limits usually extend a train length outside of the last switch. There are, however, conditions where signal protection is afforded all through a large terminal. This is where an arrangement has been made so that no switching is done on the main track. Under ordinary conditions we do not believe that automatic signals through yards would be of any benefit.

A. H. Rice, signal engineer, Delaware & Hudson, writes that, "When we installed automatic signals, we provided signals on main tracks through the yard to permit of high-speed movements with the exception of one yard where track arrangements and operation would not permit of signaling without an expense that was not warranted. At this yard the circuits of the automatic signals in each direction are terminated and the end of the automatic protection is indicated in our time-table."

Frequency of Lamp Renewals

"What is the proper method of handling electric lamp renewals in semaphore signals? Should lamps be changed out at stated intervals or left in until burned out? Should records be kept by maintainers on lamp renewals?"

Signal Maintainer Finds It Good Practice to Renew Lamp Bulbs When Replacing Primary Battery

By C. H. Brown
Signalman, Chicago, Burlington & Quincy, Ottumwa, Iowa

On my territory, 3.5-volt electric lamps are used, operated from four cells of primary battery, and I have found it a good practice to change light bulbs every time that I renew batteries. This policy is followed on those circuits where one light only is operated from one set of primary battery. If there are two lamps at a location, both fed from one battery, the lamp should not be renewed more frequently than every other battery renewal. Similarly if three lamps are used on one battery circuit, the bulb should not be changed more frequently than every third battery renewal. This, of course, is the logical plan, because it is reasonable to assume that the battery life is correspondingly reduced as the number of lamps is increased.

Under no circumstances should an electric lamp bulb be left in place until burned out. It is far cheaper to replace a bulb that appears to be about ready to burn out than it is to have a light-out failure with a consequent train stop at night. Where storage atteries are used, I believe a record should be kept, and by adhering to this record all bulbs should be changed before they are burned out.

Booster Transformers Must Be Handled Safely

"Why is it dangerous to open the primary winding of a 200/220-volt booster transformer with the secondary connected in the circuit?"

Excessive Transient Voltages Are Set Up When Primary Is Opened Under Load

By Harry M. Jacobs
Commercial Engineer, General Electric Co. Schenectady, N. Y.

The standard connections of a booster auto-transformer are shown in Fig. 1. If the primary winding is disconnected by opening cut-out No. 3, the line voltage is impressed across the secondary winding in series with the primary windings of the distribution transformers connected in multiple, the circuit being as in Fig. 2. The voltage across the secondary and the group of distribution transformers is, therefore, divided in

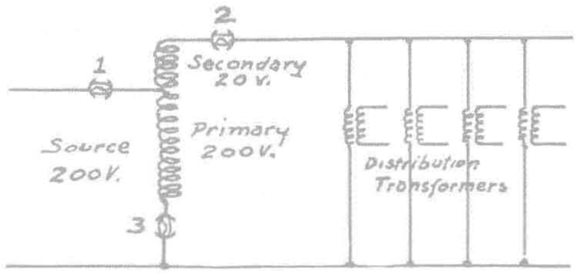

Fig. 1—Standard connections of booster auto-transformer as used in a-c. distribution lines for signaling

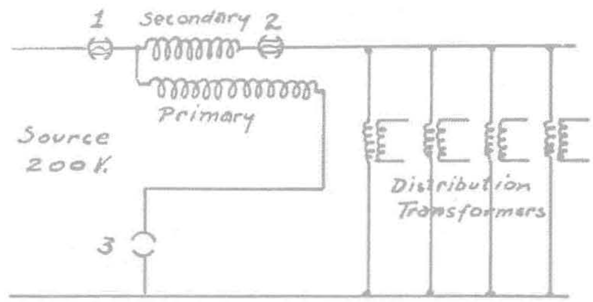

Fig. 2—Voltage distribution after primary winding is opened under load

proportion to their impedances. The greater the number of distribution transformers, the lower will be their combined impedance and the higher will be the voltage impressed across the secondary winding of the booster auto-transformer.

An auto-transformer designed to boost the voltage from 200 to 220, has a 200-volt primary and a 20-volt secondary winding and the turn ratio is 10 to 1. If the impedance of the secondary winding and the combined impedance of all the distribution transformers is such that 100 volts is impressed across the secondary windings, the turn ratio would give a primary voltage of 1,000. This might be obtained as an instantaneous value, but because of the saturation of the iron core in a normally designed transformer, the primary voltage would immediately drop to approximately *two times normal* or 400 volts as a steady value.

The worst condition would be a line short circuit which would impose the full line voltage of 200 across the secondary winding. The instantaneous voltage across the primary winding might attain a value as high as 1,200 volts, but this would quickly settle to approxi-