

OPERATING A LIGHT RAIL SYSTEM

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The most important parts of a transit operation—movement and control of vehicles—are discussed. Scheduling and control of trains in a hypothetical system are described. Examples of movement and control in light rail systems in Boston, Newark, Shaker Heights, and Cleveland are given.

The most important parts of any transit operation are the movement and control of vehicles.

SCHEDULING

All schedules are made up of fundamentals. The physically defined route over which the vehicle operates should be examined carefully, and any problems incurred en route caused by topographical conditions or complications of multiple routing and passenger-carrying difficulties should be noted. The physical route will dictate the running time or the time allowed from one terminal to the other terminal; the time usually is expressed in minutes. This time also is determined, of course, by the capabilities or operating characteristics of the vehicle. It must include the boarding and alighting time of the passengers at each intermediate stop, the combined running times in each direction, and any layover or turn-around time required at the ends of the route. This provides the overall round trip time for a particular vehicle. The size of the train matters little except a longer train generally will move more slowly over a route with physical restrictions such as sharp curves or steep grades. And a multivehicle train will, of course, take longer at terminals if the turning movement is accomplished on tail tracks behind the station or on sharp radius loops.

Having determined the round trip time, one must next decide on the amount of service that is needed to operate on the route. Frequency of service can be determined by the number of passengers to be handled past a maximum load point or by an arbitrary minimum or maximum frequency of service. Most rush-hour service, of course, is based on the numbers of passengers to be carried; off-peak service is based on certain desirable frequencies and economic use of personnel.

One further requirement in a schedule or movement plan for a transit system includes use of personnel on the train. Because peak-hour requirements of on-train personnel far exceed off-peak requirements, the extra rush-hour personnel should be used to increase off-peak frequency, particularly during midday and evening hours; they also can be used to operate an economical all-night service. The secret of good personnel use requires that all on-train personnel work at least 1 peak-hour period. Any personnel not used this way simply add to the operating expenses of the off-peak

service without contributing anything to reducing the peak-hour expenses.

In the use of light rail vehicles, an operator or attendant is required on each individual vehicle (whether they are running singly or in trains) if car-borne fare collection is required. Consideration should be given to prepayment of fares over all or certain sections of the light rail route, which would permit 1-person operation. If street operation is required on the outer ends of a light rail line with car-borne fare collection, then individual attendants could be assigned to work only the cars in this area. This type of operation is planned by San Francisco Municipal Railway. Careful study of the optimum use of both on-train operating and off-train station personnel should always be made when planning a new light rail system.

Service levels and capacities can be controlled by using a train with the maximum number of cars in the peak hour and 1- or 2-unit trains in the off-peak hours. A good rule for operation in off-peak hours is to use a 2-unit train in the daytime and a 1-unit train in the evening. A combination of these factors, frequency of service and length of train, will produce the best possible service to the public at the least possible expense to the operating agency.

CONTROL

Control of trains is important to the movement of the trains. New light rail system vehicles can be run manually without a signal system. The operator runs the train and observes the right-of-way while controlling the movement of the train. In the past, this has led to dangerous and undesirable operating practices. Therefore, even the simplest light rail transit systems must use a signal system for rear-end protection and control of trains at interlockings or diverging routes. The signal system also must control operation when physical restrictions require slower speeds. These various types of signals must be obeyed manually by the operator unless inductive or track-trip features are installed that override the operator's control of the vehicle.

A more sophisticated control system consists of a semiautomatic operation in which the signal system itself, by means of track codes or wayside devices, determines the operation of a train between stations; the operator merely presses a button when he or she is ready to leave a particular station or terminal. This feature tends to improve the abilities of even the most marginal operator, but there is no reason to believe that an exceptional operator cannot simulate this semiautomatic feature while running the train under full manual control. The time saved by a semiautomatic operation has proved its worth where it is used. It equalizes the abilities of the train operators and makes them all equal to the best.

The most advanced method of control is an automatic system in which the operator simply monitors the train operation while a central control, presumably with computers, runs the train from terminal to terminal. Unless there is full manual backup for the controllers and operators to use in emergencies, this system can cause many problems in train operation particularly if multiple delays occur on a route. The inability of present computer-control systems to control more than 1 or 2 unusual situations magnifies the problem. In bad weather, many unusual situations occur at the same time, and most require manual control for solution.

A further refinement of the automatic control would be full automation with no employees on the train. This, of course, would be a great advantage because the personnel element would not have to be considered in the process of scheduling trains. Fully automatic control, however, has all the problems of automatic control with an attendant. In emergencies there would be no one on board to handle any of the control functions except the passenger.

EXAMPLES

The simplest type of light rail transit system in the United States is the Mattapan-Ashmont Hi-Speed Line in Boston. Its main function is to provide extension feeder

service to a major Boston heavy-duty rapid transit line. It handles about 14,000 rides each weekday on a very short route with about a 20-min round-trip time. Frequencies during rush hour are about every 2 min; only 1-unit vehicles are used. Off-peak service varies from 6 to 24 min; there is no 1:00 a.m. to 5:00 a.m. operation. Control of the vehicles on this line is strictly by the sight of the operator; there is no signal system. Average speeds between stops are about 30 mph (48 km/h). There are few blind spots on the line, and this simple system has proved to be very safe during its many years of operation. The regularly used switches on the line, which are at only 1 terminal, are manually controlled. Simplicity and success describe this small but important light rail operation.

Another excellent example of a simple light rail rapid transit system is the Newark subway. This line is approximately 4 miles (6 km) long and has a running time in each direction of about 12 min. Round trips can easily be made in 30 min; rush-hour operation runs on an even tighter turn-around time. The line runs a single-vehicle operation each day from about 5:00 a.m. to 1:00 a.m. the next morning. On weekdays, headways vary from better than 2 min in the rush hours to 30 min in the late evening. Midday services range from 4 to 7 min. The Newark line runs from one terminal to another without any diverging routes. Operation over most of the route is controlled by a signal system that provides rear-end protection and a few timing devices to control speed. The operator of the vehicle observes these signals when making the round trip. At one end of the line cars are stored in a yard. In this area, during rush hours, switches are controlled from a tower. A simple display board that shows track occupancy is available for the control to use. All other switches on the line, which consist mostly of emergency crossovers, are manually operated.

A slightly more complicated type of operation is the Shaker Heights, Ohio, rapid transit system. This line, which has a 60-min round-trip cycle, has frequent rush-hour service but includes a route diversion in the form of 2 branches. Rush-hour frequencies on the trunk portion of the line are as close as 2 min; there is both single-unit and multiunit train operation. Base service is generally 10 to 30 min. A turnback loop with a 30-min round trip is available at the junction of the 2 branches for certain short-routed schedules. Control of the system is by simple signals that give rear-end protection and must be observed by the operators. The switches at the diverging point and at wayside turning loops are controlled manually by the operator. A further complication in the movement and control of this system is its 2-mile (3-km) joint operation with the Cleveland Transit System (CTS) rapid transit line. Trains of both systems are given preference automatically on this joint section of track in the order in which they entered the section. A manual override of this system is available to a central dispatcher who controls only CTS trackage. The signal system in the joint track area is equipped with track trips to give positive rear-end protection for both Shaker Heights and CTS vehicles. Surprisingly, the Shaker Heights rapid transit downtown terminal has all of its switches manually controlled, which alleviates the need for a control center or dispatcher. The equivalent of a dispatcher is always on Shaker Heights rapid transit property mainly to coordinate the crew assignments and to manually control the train operation by issuing orders.

The most complicated type of light rail operation running today is the Green Line System in Boston. This system currently handles about 175,000 rides each weekday. The trunk portion of this system is an amalgamation of 5 outer-end branches, and there are many forms of short-turn operations on both the trunk and branch lines. Multicar operation is used during the rush hour for most services; and branch-line headways are about 4 min. The trunk headway is therefore better than 1 min and is controlled by a simple rear-end-protection signal system. Because of the density of operation on the trunk portion, there are certain locations where vehicles or trains can close up on each other only by using sight observation. Timing devices also are used when they are needed for further protection. Switches at the diverging points and at most short-turn points are controlled by the power on-power off method. There is no central control over this heaviest of light rail operation.

SUMMARY

In summary, it can be seen that light rail is readily adaptable to the simplest of movement and control systems. If greater sophistication is desired in either of these areas, light rail can be adapted to perform but at greatly added expense and with higher maintenance problems. If the purpose of light rail is simplicity and if it is to be a cost-cutting method of obtaining fixed guideway transit service, simple operating methods and controls should be considered. If used properly, they will ensure a safe, convenient, and popular transit service.