Automated Rail Trans

A decentralized approach to automation is best suited to meet the basic criteria for rail rapid transit, which is reliability and safety. So stated J. E. Wallace, equipment product planning and marketing research, Locomotive & Car Equipment department, General Electric Co. before a joint Institute of Electrical and Electronics Engineers and American Society of Mechanical Engineers meeting in Atlanta, Ga., last month. An abstract of Mr. Wallace's comments follows:

The decentralized approach to automation is particularly well suited to a process which requires continuity of operation or an unusually high degree of safety. Should a malfunction occur with one of the local operations, the remaining operations can continue as long as all local safety requirements are met. The malfunctioning operation can be temporarily controlled manually without affecting the rest of the process except for a possible less than optimum performance.

The purpose of the train operation system of automated rail rapid transit is to provide a reliable and flexible operation of train movement designed for maximum safety, passenger convenience and comfort, minimum operating cost and optimum performance and utilization of facilities.

The Train Running element provides automated operation of trains on station to station runs and accurate positioned stopping at station platforms in an optimum manner. An optimum stopping performance is one that is accomplished in the shortest time and distance consistent with passenger comfort.

Train performance dictates the number of trains that can be run in a system, hence a decrease in train performance requires more trains to obtain the same frequency of service. The decentralized approach to train automation can make use of the full performance capabilities of each train regardless of such variables as train loading, track profile, alignment, etc. The optimum design is one that balances superior train performance against cost of power, maintenance expense and comfort of the rider.

The decentralized approach to automation of the train running element can be accomplished by means of a closed loop regulating system in the train control. Wayside information can be made available inductively to the train as a proper reference for the control of train speed for each section of track. This information is interpreted by the train carrier regulator as a maximum allowable speed reference for each section of track, taking into account track alignment, track profile and other external restrictions.

Approximately five levels of performance should be available from the train control. One of these levels would be used in operating according to the normal schedule. Lower or higher levels can be utilized as necessary to regulate headway between trains as determined by the System Regulating element.

In order to minimize equipment maintenance train speed must be controlled by selection of the propulsion power level which will most closely maintain the speed specified for each section of track. Propulsion power should be modulated rather than switched on and off.

Two modes of manual train control should be possible with neither being permitted to override the automated operation. To operate manually, a transfer switch must be turned from automatic to the manual position. The two manual modes of operation or hostling are: (1) road movement subject to the receipt of a speed reference; and (2) emergency operation without the receipt of a speed reference. To observe safety requirements, the first mentioned manual operating mode should be subject to override by the Train Separation element. Emergency operation should be possible only at reduced speed and with prior knowledge of the dispatcher.

The first requirement of the Train Separation system is the recognition of the fact that the safety of passengers is the primary consideration in public transportation. The purpose of this element is to provide maximum protection to the operation of trains by preventing train-to-train collisions, excessive speeds into and throughout sections of track or routes where fixed speed restrictions pertain and preventing movement of trains over or through switches not properly lined or otherwise hazardous to the movement of trains. The Train Separation element must provide the final and absolute means of insuring that the operations of the Train Running and System Regulating elements will in no way sacrifice passenger safety.

The Train Separation element for manually operated rapid transit must fulfill three primary functions: (1) protection against train accidents caused by the limitations of human perception; (2) protect against train accidents caused by man's occasional fallibility; and (3) provide limited headway regulations through distance spacing of trains.

The Train Separation element for automated rail rapid transit is less complex than is necessary for manual operation as it need not be concerned with the functions listed above since: (1) manual operation is not the normal mode; and (2) the System Regulating element provides the complete headway regulating functions.

DETECT PRESENCE OF TRAINS

Thus, the primary requirement for the Train Separation element for automated rail rapid transit is to detect continuously and automatically the presence of all trains or parts thereof on all sections of track where the presence of a train may imperil the safety of a train being operated manually or automatically. This detection of train presence must be equally effective and dependable regardless of the direction of the train's present or prior movement or if standing. All circuits directly or indirectly associated with the Train Separation element must employ the closed-circuit, fail-safe principle of operation and design. The detection of train presence by the Train Separation element must have priority in establishing the speed references, including zero speed, to be transmitted to the train.

The purpose of the System Regulating element is to achieve maximum effective utilization of all facilities, including trains, and of manpower. Thus the primary requirements of this element are to provide the riding public with the correct number of trains, each with the proper number of cars; to maintain a predictable headway between trains; and to allow an adequate train dwell time at all stations on an individual basis.

Trains can be automatically dispatched onto the line from yard ready tracks and off of the line to yard set off tracks in accordance with a program which represents anticipated passenger requirements.

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The desired headway (time spacing) of trains should be aintained to prevent headway unbalance or bunching of ains. Monitoring or headway should be accomplished as ach train departs from most, if not all, stations on its ute. If a train varies from its assigned headway, which ay be different from that of the preceding or following ain, the train should make the next station run at the lternate performance level determined by the System Reg-lating element. In the event the desired headway correc-on is not effected, the System Regulating element should etermine and display to the dispatcher whether the non-orrection resulted from a station delay or a running delay.

When the noncorrection is the result of a faulty train, he dispatcher should be alerted. The train immediately ehind the faulty train should not recognize the apparent hort headway and thus prevent the headway gap from eing reflected back along the route. The faulty train hould be replaced as soon as practical and perferably with-ut affecting passengers.

LERTING THE DISPATCHER

In the event a route blockage occurs due to a dead rain, the dispatcher should be alerted at the end of one eadway time. In order to deliver the greatest number of assengers to their desired destinations, trains following he dead train should continue to operate normally as ar as the Train Separation element will permit.

Increased utilization of equipment and some control ver passenger movement can be obtained through intelli-ent adjustment of station dwell time in accordance with careful continuing analysis of passenger habits, flow and eadway conditions. It is therefore desirable that the Sys-m Regulating element include the ability to make this djustment on a predictable basis. Since these conditions re most often unique to a particular station location and e nature of the passenger flow through that station, aximum use of this ability can be obtained by having dividually programmed station dwell times for each sta-on in each direction of operation. A means for the dis-atcher to override the station dwell program manually hould be provided to accommodate emergency or other nprogrammed occurrences. This override ability should be esigned so as to prevent any detrimental effect to system peration as a result of inadvertent or inadvisable action y the dispatcher.

To achieve maximum continuity of service, headway egulation and programmed station dwell time should be tation oriented. Thus, a malfunction relating to an in-lividual station should not seriously disrupt the overall peration, unless it is permitted to continue for an exten-ive period of time.

The three primary functions of the System Regulating lement; station dwell, dispatching and headway regula-on programs; all should operate in a programmed sequence hich represents a pattern established by the best judg-ent of management personnel, with appropriate manual verride capabilities for a central dispatcher who can act his best judgment in the event of emergency or an nexpected occurrence.

It may be desirable for an extremely complex train peration system that an additional aid to the manage-ent function be furnished, by the System Regulating element, in the form of a program directing computer which can collect such information as passenger flow from automatic fare collection systems, trends and recurrences of unusual delays, area growth patterns and other pertinent data and make continual changes to the established program or programs of the System Regulating element in accordance with these considerations. Such a computer would do no actual process controlling except as reflected through changes in programs, but would extract the last bit of optimization possible from the process.

The primary function of the Yard Supervision element is to have available on ready tracks a train or trains of the proper number of cars to permit the dispatch of trains onto the line by the System Regulating element and to have vacant set off tracks available to receive trains dispatched off the line by the System Regulating element. A corollary to the dispatching portion of this primary function is that yard supervision should have available at all times on a ready track, a train which can substitute for any train that may become faulty on the line. Also, trains should be checked out prior to placement on ready tracks in order to avoid as much as possible the headway destructions caused by faulty trains.

A second function of the Yard Supervision element is the scheduling of trains for inspection and preventative maintenance. In this regard, train consists should be maintained during nonrush periods to the extent practical to avoid unnecessary make-up and breakup of trains and to obtain maximum utilization of equipment.

The requirements for the automated operation of the Yard Supervision element are difficult to determine for a generalized solution. It is questionable whether completely automated operation can be economically justified, at least for the foreseeable future. It is most likely that the Yard Supervision operation will be performed by a combination of automatic, manual and remote controlled means.

PROGRESS IN TRANSIT AUTOMATION

The New York City Transit Authority's Grand Central-Times Square shuttle train is the only fully automated mass transit line in revenue service at the time of their report to the IEEE-ASME meeting, commented C. M. Hines, engineering manager Westinghouse Air Brake Co. Co-authored by J. R. Pier, manager, mass transit engineering, WABCO, the report said that automation of the new San Francisco transit system is a definite possibility. Also, automation is being considered for Los Angeles. Other transit systems either studying or making tests on train automation include Stockholm, Sweden, Moscow, USSR, and London, England. The Metropolitan Transit Authority in Boston, Mass., has considered a pilot project for the Revere Beach line by automating existing car equipment and with signaling techniques that are well established.

No automation of intercity passenger trains is presently being contemplated in the U.S. However, the new Tokaido line in Japan, connecting Tokyo and Osaka will be completely automated. This passenger train will operate at a maximum speed of 125 mph and will average 105 mph over a distance of 320 miles. Automation is considered mandatory for safe operation under these conditions even though an operator will be retained as a monitor of the system. RSC