3. SIGNALLING

3.1 INTRODUCTION

Present Operation - Facts and Figures

Trains on theYonge/University/Spadina (Y/U/S) route of the TTC subway network are presently scheduled at a constant time interval (headway) of 130 seconds apart during normal peak service periods. A short turn operation is instituted on the Spadina portion of the route, wherein alternate trains turnback at St. Glair West Station rather than proceeding to Wilson Station, resulting in scheduled headways between St. Clair West and Wilson of 260 seconds.

Scheduled operation at 130 second headways corresponds to a service level of approximately 28 trains per hour. This in turn corresponds to a passenger carrying capacity of approximately 34,000 passengers per hour per direction (pphpd), based on the Commission's Vehicle Loading Standard of 1200 passengers per subway train.[1]

A total of 45 trains are operated in service on the Y/U/S route during peak periods. Of this total, 20 trains are involved in the short turn operation (Finch Station to St. Clair West Station), while the remaining 25 trains are operated over the entire route, Finch Station to Wilson Station.

The present Y/U/S fleet is composed of a mixture of three different types of rolling stock. The original red subway cars acquired in the 1950's for the first segment of the Toronto subway (Union to Eglinton) are still operated on the Y/U/S route. These cars, manufactured by the Gloucester Railway Carriage and Wagon Co. Ltd. (G-cars), have performed well for over 30 years, but are heavy and slow by modern standards, and are at the end of their design life. The first series of aluminum cars, manufactured by the Montreal Locomotive Works Ltd. (M-cars) were introduced in the early 1960's. These cars are longer and lighter than the G-cars, and are capable of higher performance operation. Subsequent series of aluminum cars, manufactured by Hawker Siddeley Canada Ltd. (H-cars), are essentially identical to the M-cars in terms of performance, but contain several design enhancements to improve reliability and increase passenger comfort levels.

The foregoing facts and figures related to present peak hour operation on the Y/U/S subway are summarized in Exhibit 3.1.1. The Toronto Rapid Transit System is shown in Exhibit .2.

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[1] The subway Vehicle Loading Standard is the acceptable average number of passengers per train passing the peak point of the route during the peak hour of operation. Loading standards are designed to ensure passenger comfort and operating efficiency, and include allowance for some reserve standing capacity to accommodate surge loads.

EXHIBIT 3.1.1
YONGE/UNIVERSITY/SPADINA
SUBWAY SUMMARY OF PRESENT PEAK HOUR OPERATION

SCHEDULED HEADWAY

- 130 seconds, Finch to St. Clair West
- 260 seconds, St. Clair West to Wilson (due to short turn operation at St. Clair West)

TRAIN FREQUENCY

- 28 trains per hour, Finch to St. Clair West
- 14 trains per hour, St. Clair West to Wilson

CAPACITY

- 34,000 pphpd, Finch to St. Clair West
- 17,000 pphpd, St. Clair West to Wilson

FLEET

- 45 trains in service (20 trains Finch to St. Clair West, 25 trains Finch to Wilson)
- mixed fleet of G, M and H cars
- G trains scheduled .to be retired in 1989
- total fleet of 302 cars (converted to H and M type cars)

Subway Design Capacity

The Toronto subway network is designed to safely support a continuous 120 second headway operation in accordance with the Commission's Subway Design Standards. In other words, the design objective is to provide the capability to safely operate trains at a constant time interval of 120 seconds apart, at all points on the line including the terminal stations. This design objective is applicable to all the various systems which form the subway network, including the trackwork and traction power systems, but is particularly applicable to the signalling system. It is primarily the signalling system which governs the operating headway (or time interval between trains) on the subway line. However, as discussed in Section 3.2, there are a large number of factors which combine to dictate the minimum achievable headway.

There are also several factors which combine to prevent the Commission from operating the Y/U/S subway at its design level of 120 seconds headway. The principal constraint is imposed by the heavy congestion at Bloor Station, where large volumes of passengers transferring between the Yonge and Bloor-Danforth subways lead to extended station dwell times and hence delays to subsequent trains. Further operating constraints are imposed at Finch Station, where the time required for a train to traverse the crossover northbound, dwell at the platform, and clear the crossover southbound limits the attainable headway. Presently there is no constraint at Wilson Station due to the wide headway of 260 seconds between St. Glair West and Wilson.

Study Objectives

In general terms, the passenger carrying capacity of the Y/U/S subway is a direct function of train length (or number of cars per train), the capacity of each car, and the frequency of service (or number of trains per hour). Increasing train length (by adding one or more cars to present trains) has been proposed in the past, but such measures were not adopted due to the fact that trains would extend beyond station platform limits. (Increased train length is however discussed in Section 3.3 "Vehicle Considerations"). Slightly increased car capacity could be obtained by providing fewer seats and allowing for more standees, but such increases would likely be outweighed by a general deterioration in passenger comfort and satisfaction levels. There is, however, evidence to suggest that an increase in train frequency, and thus subway capacity, can be achieved.

The purpose of the Commission's Improved Headway Study is therefore to identify means of increasing the frequency of service on the Yonge/University/Spadina subway, in order to provide increased passenger carrying capacity and hence better accommodate increasing subway ridership. The goal is to identify means of ultimately achieving the capability to operate at a 90 second headway (or a service of 40 trains per hour) on the Yonge/University/Spadina subway as shown in Exhibit 3.1.3.

The ability to successfully provide a 90 second headway transit service is primarily dependent on two transit system attributes:

1. The ability to consistently and safely operate trains at 90 second intervals over the entire line, including dispatching of trains from terminal stations every 90 seconds. An allowance for operating fluctuations must be included.

2. The ability for passengers to safely and efficiently move through station areas and to rapidly board or leave trains. This is necessary in order to limit station dwells to a level consistent with 90 second headway operation.

Accordingly, the study has concentrated on identifying means of achieving these two characteristics.

Study Process

The Commission's Improved Headway Study has been a joint effort of several Engineering groups, including both Commission staff and external consultants.

Transmode Consultants Inc., of Toronto, was engaged to study the present Y/U/S subway operation in order to identify opportunities for gradual or "incremental" increases in capacity over the short term. Transmode's task was to determine the feasibility of achieving incremental increases in train operating frequency on the Y/U/S subway through modification of the existing signalling system.

Gibbs & Hill Inc., of New York, was engaged to determine the feasibility of achieving 90 second headway operation utilizing the present signalling technology in the Y/U/S subway, and additionally, to determine the feasibility of achieving 90 second headway operation with Automatic Train Control (ATC) technology. This necessitated a detailed review of the existing signalling system, and also a review of signalling technology utilized in other rapid transit systems worldwide for applicability to the TTC subway system.

Commission staff within the Engineering Department reviewed the existing stations, structures, and trackwork or the Y/U/S subway, in order to identify areas where station dwells would be extended or where overcrowding would occur, if 90 second headway operation was undertaken. Proposed modifications have been developed as required to alleviate identified problem areas.

Additionally, Commission staff within the Engineering Department performed several analyses, related to the signalling and traction power systems, which were intended to be complementary to the Consultants' studies.

This report presents a summary of the two Consultants' Final Reports and is therefore primarily concerned with signalling considerations. Some additional material is also

included, based upon the findings of staff within the Commission's Engineering Department.

References

1. Opportunities for Incremental Increases in Yonge Subway Frequency, Transmode Consultants Inc., February 1988.
2. Yonge/University/Spadina Line Increased Capacity Study, Gibbs & Hill Inc. April 1988.