Option 2 - Convert to Automatic Train Control (ATC) Signalling Technology

Option 2 is substantially different from the previous options, in that replacement of the existing signalling system, rather than modification, is proposed. Option 2 also differs from the previous options, as an incremental approach to achieving reduced headway capability is not possible when changing signalling technology, as will be explained below. Based on the findings of Gibbs & Hill, Inc., Option 2 represents the only signalling option available that, if implemented, would provide 90 second headway capability on the Y/U/S subway.

After concluding that 90 second headway operation is not possible with the existing Y/U/S signalling technology, Gibbs & Hill conducted a review of signalling technologies operating in other transit systems in North America, South America and Europe. The purpose of this review was to identify a signalling technology suitable for implementation on the Y/U/S subway which could provide 90 second headway capability. Gibbs & Hill concluded that the type of signalling system presently operating in Washington, Atlanta and Sao Paulo, Brazil would be best suited to implementation on the Y/U/S subway, and that 90 second headway capability could be achieved with this type of signalling technology. Gibbs & Hill therefore recommended the installation of this type of signalling system on the Y/U/S subway in order to achieve 90 second headway operation.

The recommended type of signalling system is an Automatic Train Control (ATC) System, which utilizes audio-frequency coded track circuits for train detection. Automatic Train Control Systems are typically composed of three subsystems:

1. Automatic Train Protection (ATP) which maintains safe train separation, enforces train speed limits, and prevents conflicting moves at crossover areas.
2. Automatic Train Operation (ATO) which performs acceleration, speed control, braking and station stopping functions. Door operation can also be automated.
3. Automatic Train Supervision (ATS) which performs train routing, dispatching and schedule regulation functions. Other more sophisticated functions are also possible.

The ATP subsystem, the lowest in the ATC hierarchical structure, provides the primary reduction in headway due to provision of continuous speed control (which permits closer train separation) and due to a reduction in equipment operation and operator reaction times. Basic ATS functions, such as train dispatching, route selection and schedule regulation would be essential for efficient and reliable operation at 90 second headways. Gibbs & Hill suggested that the ATO capability is optional, however, it is recognized that ATO capability would be very desirable in order to achieve smooth and consistent operation. If consistent with Commission policy, it would also be technically possible to reduce train crew size to one operator, resulting in substantial savings in operating labour costs, if ATO capability was provided. Basic ATS and ATO capabilities have therefore been included in the cost estimate. More consistent operation compared to present operation is likely to result from implementation of an ATC System comprised of the three subsystems discussed above.

Extensive testing of proposed ATC train detection equipment would be required before the final selection of an ATC system was made in order to confirm electromagnetic compatibility with the TTC vehicle fleet. Selection of a particular type of ATC System could, however, result in the Commission being "locked in" to a technology which may only be available from one supplier, and which may become obsolete before the project is completed. Close co-ordination between the ATC system supplier, the vehicle manufacturer, and the Commission would be essential in order to ensure compatibility of all system components, both wayside and on-board.

In order to achieve 90 second headway capability in the Y/U/S subway, the existing signalling system must be replaced with the ATC system described above. Signals at trackside would, however, be left at crossover areas and possibly at the leaving end of station platforms. On-board ATC equipment must also be installed in all Y/U/S vehicles. Modification of the existing traction power system would be necessary (as discussed under "Impact on Traction Power System").

In order to maintain service during implementation, conversion to ATC would have to be done in segments. Conversion of a segment would be a complex task, requiring a great deal of planning and co-ordination. Much of the difficulty would be related to conversion of the train detection (track circuit) equipment. As work was completed in a segment, ATC operation in that segment could be introduced. However, introduction of ATC operation would not be possible until all trains to be operated on the segment were equipped with ATC equipment. In addition to field work at trackside, extensive modifications would also be required at all signal equipment and control rooms, as well as at the Hillcrest Transit Control Centre, and at the zone control centres at St. George and Eglinton. The extensive modifications at Hillcrest would suggest that the new Transit Control Centre should be constructed if ATC is adopted.

In addition to the signalling modifications described above, reconstruction of Bloor Station would be required to reduce station dwell time to about 30 seconds[7]. Reconstruction of Finch and Wilson terminals would also be required, in order to provide train turnaround capabilities consistent with 90 second headway operation. The proposed terminal configuration is identical to that proposed under Options IB and 1C, and is shown in Exhibit 3.3.3. Alternatively, subway extensions could be constructed to new terminal facilities designed for 90 second headway operation. (Reconstruction of Bloor and Finch may already be completed under Option IB, if an implementation sequence of 1A, IB, 2 is adopted).

Operation at a 90 second headway would correspond to a service of 40 trains per hour. This level of service would provide a capacity increase of about 14,400 pphpd over present levels. Gibbs & Hill estimated that in the ultimate system in which station dwells

[7] Gibbs & Hill concluded that 90 second headway operation would be possible with a 45 second dwell at Bloor. However, the operation at Bloor would be extremely sensitive to variations in station dwell. Reconstruction of Bloor Station is therefore considered essential to achieve acceptable operation.

average 30 seconds, a total of 88 trains would be required in service, based on standard rate of operation and train turnaround behind modified terminal stations. If it is assumed, however, that the average station dwells in the ultimate system will be similar to dwells that exist today (i.e. less than 30 seconds at most stations), a total of 83 trains would be required in service. Allowing 12% spare cars, a total fleet of 558 cars would be required. All cars would have to be equipped with ATC equipment. A fleet increase of 196 cars over Option IB (or 256 cars over present) would be required, which would necessitate construction of additional yard storage facilities. Part of the fleet increase would be due to the increase in round trip time which would result from reduced speeds associated with achieving 90 second headway capability. New and existing yard facilities would have to be equipped with ATC test and repair facilities, including an ATC test track. Maintenance vehicles would also have to be equipped with ATC equipment. It must be noted that the current ability to interchange vehicles between the Y/U/S and Bloor-Danforth subways would be lost

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Implementation of ATC in the Y/U/S subway could be completed within about 15 years from approval based on the present duration of the line shutdown period each night. Most of this time (11 years) is required for the segment conversion process previously described which must be done during non-revenue hours. An additional 2 years would be required for system planning and design, and a further 2 years would be needed for testing and training. It is considered however, that the duration of the implementation period could be reduced to 8 years minimum, (after completion of planning activities), if sections of the Y/U/S Line could be closed at 10:00 p.m. each night on a regular basis. It is recognized however, that the impact of closing the subway early at night would be significant.

It is important to note that no benefit, in terms of reduced headway capability, would be realized until the entire project was completed. Interruptions and delays to service would be unavoidable during the implementation period, and temporary shutdowns of the subway (during evenings or weekends) would be required.

The estimated cost for the implementation of an ATC system is $132,850,000 including removal of the existing signalling equipment. Traction power modifications are estimated to cost $1,150,000 based on standard rate of operation. Signals and trackwork at Finch are estimated to cost $10,800,000. Signals and trackwork at Wilson are estimated to cost up to $32,600,000 including a new connection to Wilson Yard.

Retrofitting of the existing vehicle fleet (as of Option 1B) to accept ATC equipment is estimated to cost $36,200,000 (including work vehicles). Procurement of 196 additional ATC-equipped cars is estimated to cost $372,400,000. Two relief crews would be required at each terminal station at an estimated cost of $200,000 annually per relief crew, over and above the cost of operating and maintaining the additional service.

The primary features of Option 2 are summarized in Exhibit 3.3.5.

EXHIBIT 3.3.5
OPTION 2 SUMMARY
CONVERT TO ATC SIGNALLING TECHNOLOGY

PROPOSED OPERATION

- capacity increased by about 14,400 pphpd
- 90 seconds headway operation (40 trains/hour)
- train turnaround accomplished behind modified terminals
- provide 2 relief crews at each terminal

MODIFICATIONS REQUIRED

- replace existing signalling system with ATC technology
- replace central control panel at Hillcrest, and zone control panels at St. George and Eglinton
- replace all auxiliary control panels on Y/U/S line
- retrofit existing vehicles with on-board ATC equipment
- construct a new yard to accommodate increased fleet
- provide ATC test and repair facilities in all yards
- provide increased traction power capacity
- reconstruct Bloor Station to reduce dwell time
- reconstruct Wilson terminal, or alternatively, extend the subway to a new terminal north of Wilson.
- reconstruct Finch terminal

FLEET REQUIREMENTS

- 83 service trains required to provide 90 second headway operation (based on standard rate, station dwells similar to existing dwells, and train turnaround behind modified terminals)
- fleet increase of 196 cars (over Option IB) required including spares
- all cars to be equipped with on-board ATC equipment

IMPLICATIONS

- major change in signalling and operating philosophy
- increased trip time due to reduced speed and increased travel distance at terminals
- lost value of existing signalling system which is not at the end of its design life
- reduced vehicle reliability due to on-board ATC equipment
- more complex train control system

BENEFITS OF ATC TECHNOLOGY

- potential for reduced manpower operating cost
- provision of continuous train overspeed protection
- more consistent train operation compared to wayside signalling
- design objective of 90 second headway achieved

IMPLEMENTATION

- long implementation period (8 years minimum after planning and related studies are completed.)
- benefits only realized when entire project completed
- significant disruption to service during implementation
- the Commission would be "locked in" to an ATC technology which may become obsolete before the project is completed

ESTIMATED COST ($1988)

- $134,000,000 for ATC equipment and traction power
- $43,400,000 for signals & trackwork at Finch & Wilson
- $36,200,000 to retrofit existing vehicles for ATC
- $372,400,000 for 196 additional ATC-equipped cars

TOTAL COST OF OPTION 2 (SEQUENCE 1A,1B,2) $708,000,000

INCREMENTAL COST OF OPTION 2 (OVER IB) $575,200,000

(Structural modifications at Bloor, Finch and Wilson, plus new yard facilities. not included.)