TORONTO TRANSIT COMMISSION
REPORT NO.

MEETING DATE: **April 3, 2009**

SUBJECT: **POWER OUTAGE JANUARY 15 and 16, 2009**
- LESSONS LEARNED

INFORMATION ITEM

RECOMMENDATION

It is recommended that this report be received for information noting that lessons were learned and action is being taken in the following three areas:

1) Redundancy of Utility Electrical Supply
2) Backup Generation
3) Loss of Radio Communication

BACKGROUND

On January 15 and 16, 2009 there was a widespread outage due to the loss of Toronto Hydro's Dufferin substation located at 1045 Dufferin Street (Dufferin, just north of Bloor). The power outage area spanned from St Clair Avenue West (to the north) and Queen Street West (to the south); Jane Street (to the west) and Spadina Avenue (to the east).

The Toronto Hydro Dufferin substation loss impacted a number TTC subway stations from Jane to Bathurst on the Bloor Danforth line. The passenger stations affected by the loss of power were: Jane, Runnymede, High Park, Dundas West, Lansdowne, Dufferin, Ossington, Christie, and Bathurst. In all cases the subway stations were fed directly off the Toronto Hydro (TH) low voltage 120/208 volt network via the TH Dufferin substation. TTC's Keele passenger station was not affected since it has a redundant TH feed from TH's Wiltshire substation. All previously mentioned subway stations experienced the power outage since all of their incoming low voltage lines are direct feeds from the failed Toronto Hydro Dufferin substation.

Power was lost at 9:59 PM on January 15 to all the affected subway stations. Power to these subway stations was restored over the following 15.5 hours with the last subway station being restored at 1:27 PM on January 16.

Also impacted by the power failure were a number of TTC traction power substations, namely Jane, Lansdowne, Delaware, Lippincott, and the Indian Grove substation (lost one incoming line). Lippincott and Lansdowne substations feed the surface routes and Jane, Delaware and Indian Grove substations feed the subway. All of these impacted substations that lost power have redundant feeds separate from TH Dufferin substation,

however, there is no backup if the entire substation is lost. Due to redundancy in the high voltage TH network and our own substation configuration we were able to maintain subway traction power to the affected area due to the available feeds at Indian Grove and Prince Edward substations in the west end and our Bedford substation located next to St. George subway station east of the impacted area. The only traction power impacted was surface feeder 2209-2409 College Street line, from Bathurst Street to just east of Dundas Street West, and DC power was restored to this area by approximately 8:30am on the morning of January 16 2009.

Backup power supplied from battery banks provided power for:

- Emergency lighting in the station and tunnels (approximately 10% lighting)
- Fire alarm and station PA systems
- Intrusion and hold up alarms for collector booths
- Subway radio system
- Supervisory equipment such as emergency trip, SCADA etc

We were unable to maintain power supply to escalators and elevators in the subway stations and fire ventilation equipment in the tunnels. Our battery banks are not designed to provide power to these systems.

Staff responded well to the situation, bringing in standby generation to charge the battery banks as the outage became prolonged. These battery banks are only designed to provide back up power for four hours.

DISCUSSION

There were three lessons learned from this widespread outage.

1) Redundancy of Utility Electrical Supply:

Our current design standards require that TTC substations be fed by two feeders from different utility substations or, as an alternative, by two feeders from different high voltage buses in the same substation. Two feeders from different substations provide redundancy in the event of single line loss and/or single substation loss, while two feeders from different buses in the same substation will provide redundancy for single line loss only. The decision as to how to feed a TTC substation is dependent on the utility line and substation configuration, geography, electrical loading etc. While the current supply configuration met the design standard in place at the time of construction of that portion of the subway, the high voltage and low voltage feeder configuration from Hydro's Dufferin substation will not provide redundancy in situations where the entire TH substation is off line.

This exposure to loss of an entire Hydro substation exists at various locations across the subway, particularly from the perspective of low voltage supply to subway stations. High voltage supply is less problematic as there is usually enough flexibility (redundancy) on the utility high voltage network and our own traction power network to recover/maintain traction power in the event of a loss of a utility substation.

We are reviewing high voltage and low voltage supplies to all subway stations and traction power substations to identify exposures, and will meet with Toronto Hydro to discuss if alternate configurations of feeders and substations supplying the TTC will reduce our exposure in the event of the loss of an entire substation. This will require a detailed engineering review and discussions with Toronto Hydro.

2) Backup Generation:

We are generally able to cope quite readily with the loss of power to a single subway station by bringing a portable generator to site and making connections to the emergency panel, which feeds emergency lighting, hold up alarms, subway radio system, fire alarm systems, station PA systems and supervisory systems such as SCADA and Emergency Trip systems. These systems are connected to battery banks that provide four hours of supply, more than enough time to get a generator to site to keep these systems working. Getting multiple generators to multiple sites is more problematic as resources are constrained. There is a project underway in the ten year capital budget to provide a quick connection point for generators at subway stations. This will make connection of portable generators an easier process, and this will greatly assist in multiple station situations. We have currently installed connection points at six subway stations and are proceeding with installations at two locations per year.

Fire ventilation systems are not connected to the emergency panels supplying backup battery banks. In the event of loss of power to a single subway station we can still run service. However, our operating practices do not allow us to run service through more than one station without operable ventilation systems. The loss of a number of adjacent passenger stations, such as what occurred, effectively prohibited us from running service even though we had traction power available.

In the stations affected by this outage, and in other older areas of the subway, it may be feasible to add the fire ventilation systems to the quick connection point to allow service to run in future events of widespread outages through the use of portable generators. However, the loads needed to supply the current ventilation systems may make it very difficult to obtain and set up the larger generators in some of the more congested areas. In addition, upgrades completed and planned to the fire ventilation systems as part of the capital program will ultimately make supplying these systems from emergency generators impractical.

We need to review the modifications and costs necessary to our current backup power systems to determine if we can practically operate ventilation equipment during outages affecting multiple stations. This may allow us to run service through affected stations and avoid turn backs.

3) Loss of Radio Communication

The subway radio system is also not connected to the emergency panels in subway stations. Supply from the emergency panels is 129 volts dc, and all equipment connected must be capable of accepting this voltage. When the subway radio system was designed and installed in the 1990's, a decision was made to have the radio equipment in the subway supplied from the normal ac power (120/208 volts ac), which feeds a 50 volt dc supply to battery banks that power the radio amplification equipment in the stations and tunnels. Therefore, it is not currently feasible to directly connect the radio equipment to the emergency panels.

There are a number of alternatives that need to be investigated that would allow us to provide backup power to the radio system in the event of extended outages at multiple locations. These include DC to AC inverters supplied from the traction power system, DC to DC converters to allow for feed off the existing 129 volt dc supply, adding the radio system power supply to the quick connection points for portable generators, or the use of portable battery packs that can be moved to affected locations. We will investigate these options and proceed in the most cost effective manner, as it is imperative that we maintain radio coverage during power outages. In addition, we will ensure that the radio replacement project makes provision for backup supply for extended power outages.

JUSTIFICATION

While the TTC responded well to the subject power outage, staff are taking the action set out herein to minimize any future impacts if a similar failure were to occur.

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March 6, 2009
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