RONDAR INC.

MIDLAND PUC
SUBSTATION EVALUATION

Prepared For: Wayne Dupuis, C.E.T.

Prepared By: Dan Brown, A.Sc.T.

Date: September 25, 2006

RONDAR INC.

September 25, 2006

Midland PUC
16984 Highway 12
Midland, Ontario
L4R 4P4

Attention: **Mr. Wayne Dupuis, C.Tech.**

Subject: **Distribution Substation Evaluations**
Our Reference No. C1753

Dear Sir,

We are enclosing the results of the assessment of Midland PUC's six (6) distribution substations. The inspections were completed on August 2, 3, 17 and 18, 2006.

The results indicate that the order of priority to complete the repairs is as follows. We recommend that the work at Scott Street and Brandon Street be completed as soon as possible.

1) Scott Street Substation
2) Brandon Street Substation
3) Fourth Street Substation
4) Dorion Street Substation
5) Montreal Street Substation
6) Queen Street Substation

Before construction commences, we also recommend that the following engineering studies be completed to support equipment selection: protection co-ordination study, short circuit analysis, ground grid study, and equipment evaluation study.

We trust that the contents, comments and recommendations of the assessment meet your satisfaction. If any further information or explanations are required, please do not hesitate to contact our office.

RONDAR INC.

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RONDAR INC.

TABLE OF CONTENTS

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TABLE OF CONTENTS

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Section 1

SCOTT STREET SUBSTATION

1.1 System Overview

The Scott Street Substation is supplied by the Hydro One 44kV Feeder designated as the 'M4' circuit. It is connected to the gang-operated 46kV air break switch designated 'C37T1-L' located at the station. The equipment located in the outdoor substation consists of one (1) gang-operated air break switch, one set of three (3) lightning arresters, one (1) set of three (3) over current protection fuses and one (1) three phase, 3 MVA, power transformer. The secondary of the transformer is directly connected to the main bus of the indoor switchgear via a metal enclosed bus duct. The indoor switchgear has four (4) cells that contain three (3) oil-filled circuit breakers, metering device, protection and control equipment.

1.2 Ground Grid and Bonding Assessment

The ground grid consists of five (5) copper ground rods, ½ inch in diameter and is interconnected utilizing 2/0 AWG bare copper forming a continuous loop around the substation equipment. The thermal (CAD) welded connections between the 2/0 AWG bare copper loop, ground rods and bonding conductors are in good condition and correct for a direct burial installation. The exterior fence enclosure is bonded together via a 2/0 AWG bare copper loop connected to six (6) ¾ inch, ten foot copper rods. This ground loop was found not physically connected to the substation ground grid and is located within the perimeter of the metallic fence enclosure.

The bonding of the equipment to the substation ground grid was found to be as follows:
A connection to each footing of the tower structure; one (1) connection to the transformer tank; one (1) connection to the indoor switchgear, one (1) connection to the lightning arresters and one (1) connection to the gang-operated high voltage switch but not the switch handle.

Based on our assessment, we recommend the following deficiencies be corrected:

1) As per the *Ontario Electrical Safety Code 36-310(2)(a)(b)* and *Table 52*, and in the interest of personnel safety, we recommend installing a metallic gradient control mat to ensure the touch voltage is minimized to a tolerable level during switching operations. The gradient control mat maximizes the safety of the operator(s) during switching operations.
2) As per the *Ontario Electrical Safety Code 36-312(1) and Table 52*, we recommend installing a ground conductor that loops one (1) metre outside the perimeter of the existing substation metallic fence enclosure and connect this loop directly to the substation ground grid. This ensures that the step and touch potential between the metallic fence and one (1) metre from the fence is minimized and eliminates a potential shock hazard during a fault.
3) As per the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and tank for the power transformer. The second connection is a redundant bonding connection to ensure the tank remains bonded to the ground grid if an internal fault occurs.

4) As per the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and ground bus within the indoor switchgear. The second connection is a redundant bonding connection to ensure the switchgear remains bonded to the ground grid if an external and/or internal fault occurs.
5) As per the *Ontario Electrical Safety Code 36-304(5), Table 52* and in the interest of personnel safety, we recommend removing the yard debris (i.e. leaves) and installing 12 inches of ¾ crushed stone to provide a dielectric layer that minimizes the touch and step potential.
6) We recommend upgrading the bonding connection between the three (3) lightning arresters located on the tower structure to include a continuous loop to a second connection to the ground grid. A second connection provides a redundant path to discharge equipment damaging voltages and currents during a severe power surge.
7) As per the *Ontario Electrical Safety Code 36-312(4)*, the ground conductor should be woven throughout the fence fabric in at least two (2) places. We recommend adding split bolts to secure the bonding conductor to the fence fabric in at least two places per conductor.
8) The steel removable section of the substation brick wall is covered with asbestos. Due to the health hazard associated with asbestos as it becomes brittle, we recommend that the asbestos be labelled as a health hazard and removed prior to any construction work being completed.

1.3 Tower Structure and Components Assessment

Galvanized Tower Structure

The galvanizing of the steel and hardware on the tower structure is presently in good condition with very slight rust development. The visual inspection of the two (2) tower concrete footings and steel bases concluded that there is no significant deterioration.

The current carrying bus work is ¾ inch copper IPS and supported with polymer station post insulators. The insulation ratings of the insulators and clearances between the primary buses and grounded surfaces are suitable for the voltage rating.

The tower structure and primary bus work are suitable for continued service.

No further action is required.

Primary 44kV Air Break Switch

The primary air break switch is rated for 46kV and 600 amperes. The ratings of this switch are satisfactory for the application; however, this product is no longer supported by the manufacturer, making replacement parts unavailable. The design of the switch is as an air break switch and does not have load breaking capabilities. The necessary 'kirk' key system is in place and provides the necessary sequence to ensure the switch is not operated under load. Our preventative maintenance reports indicate that the current carrying components are in

satisfactory condition and have undergone slight deterioration caused by the outdoor environment.

Based on the unavailability of parts and manufacturer support, we recommend upgrading the air break switch to an S&C, Alduti Rupter load break switch rated for a maximum voltage of 48.6kV, a continuous current of 600A and interrupt capacity of 40000 amperes.

Primary Fuse Protection

The primary protection fuses mounted vertically on the tower structure are manufactured by S&C Electric and replacement fuse links are available.

The short circuit, voltage and over current ratings the fuse units provide is excellent equipment protection and suitable for this application.

No further action is required.

Lightning Arresters

The three (3) lightning arresters located on the tower structure and connected to the 44kV bus work are a porcelain gap type constructed arrester and manufactured by EMP Electric. The gap type arrester is prone to failure due to moisture ingress into the semi-conductive material within the unit. The moisture reduces the resistance of the components within the arresters directly affecting the kV and maximum continuous operating voltage (M.C.O.V.) rating of the device and the reliability of surge protection.

We recommend replacing the three (3) lightning arresters with polymer, metal oxide station class arresters rated for 48kV and 39 MCOV. This type of arrester will provide adequate protection of the insulation of the power transformer by dissipating damaging system over voltages and surges.

1.4 Transformer Assessment

The Ferranti-Packard power transformer, s/n 1-1028, has a capacity of 3 MVA and is configured with a primary 44000 volt, delta connected, primary winding and a secondary 4160 volt, wye configured, winding. The secondary neutral bushing is directly connected to the substation ground grid and is commonly referred to as a "solidly grounded Wye system". The Ferranti-Packard transformer was constructed in 1959 and has provided service for approximately 47 years.

The primary 44kV porcelain bushings are generally in fair condition with damage to the centre, H2 bushing caused by a flash as result of animal contact. As stated in our preventative maintenance reports, this damage has not affected the insulation properties of the bushing; however, will require replacement in the future.

The insulation resistance of each winding to ground and winding to winding has remained relatively constant since 2000.

The results of the oil analysis indicate that the levels of Furfuraldehyde (Furan) have steadily increased since October 1999 with levels expected to continue increasing. Furans are produced when the paper insulation used to insulate each winding has been damaged by elevated heat levels in the insulation. In October 2004, the actual furan level in this transformer was 567 parts per billion (ppb) indicating that the paper insulation has undergone significant deterioration due to heat stress. A transformer that has furan levels equal to or greater than 500 ppb can no longer be considered reliable; therefore, Rondar Inc. recommends that a provision for replacement be developed as soon as possible. The furan concentration is assessed as follows:

Rondar Inc. Furan Assessment	
< 100 ppb	Good Condition
250 ppb	Fair to Poor Condition
> 500 ppb	Undergone Severe Deterioration
*ppb = parts per billion	

Based on the results of the oil analysis trending, preventative maintenance reports and our assessment, we recommend replacing and increasing the capacity of this transformer. The degradation of the paper insulation confirms that this transformer cannot be considered reliable; furthermore, refer to our comments and recommendations pertaining to the indoor switchgear.

1.5 Enclosure Assessment

The indoor switchgear is mounted in a residential style building that is suitable for this application and appears to be in satisfactory condition. The temperature within the building was found to be warm. We recommend installing a climate control system to regulate the inside temperature which would benefit the life span of any electronic devices, especially the DC battery bank.

We request that a company specializing in structural assessments be contacted if further details regarding structural condition of the building are required.

1.6 Switchgear Assessment

Switchgear Enclosure

The General Electric Switchgear is a Metal Clad type enclosure. Based on the manufacturing date of the transformer and available drawings, it is approximately 47 years old. The switchgear contains the following components:

- One set of three (3) metering potential transformers.
- One set of three (3) metering current transformers.

- Revenue metering equipment.
- Three (3) oil-filled circuit breakers with DC controls.
- Three (3) bar type current transformers per breaker. The current transformers are mounted on the load side bus of the breakers.
- Two (2) phase over current relays per breaker.
- One (1) neutral over current relay per breaker.

The main bus work of the switchgear is a copper tubular bus bar that is horizontally mounted in the top front area behind covers. The bus bars are insulated throughout and isolated from each cell by a metal plate. Our preventative maintenance reports have concluded that the measured insulation resistance, with reference to the *NETA Standard Table 10.1*, is suitable for continued service. Based on the age of the insulation and assuming a moderate temperature, the elasticity of the insulation has deteriorated. The amount of deterioration is unknown and it is difficult to visually inspect the main bus work due to barriers. As the elasticity properties of the insulation deteriorates, it causes the insulation to become brittle and can cause the insulation to crack or break during a fault.

The components and wiring of the switchgear are operating as required to provide the necessary control power to the associated equipment. As above, the components have reached or are near the end of their service life and reliability is questionable. The repair time necessary to locate, investigate and retrofit new control equipment into this switchgear will be time consuming, expensive and significant downtime would be required.

Based on the age of the switchgear, insulation, components and wiring, we recommend replacing the switchgear as soon as possible.

5kV Oil Circuit Breakers (OCB)

The OCB's are breakers that use insulating oil as a dielectric medium to insulate the 'live' parts from metal surfaces and minimize the electric arc during opening/closing operations. The breaker consists of six (6) bushings, two (2) sets of contacts per phase, one (1) closing coil (cc), one (1) tripping coil (tc) and necessary operating mechanisms to perform opening and closing functions. The breakers can be either opened or closed manually or electrically. We consider the age of the oil-filled circuit breakers to be the same vintage as the switchgear and transformer which indicates they were purchased near the end of their production by General Electric in the early 1950's; they are 47 years old.

The main contacts, current carrying components and most of the operating mechanism are submersed in 15 U.S. gallons of oil and can only be visually inspected by removing the tank. The internal components have not been inspected since 1999 and at that time damage to the contact surfaces was noted. Based on the age of the device, the spring tensions and excessive wearing on various shafts, bearings and latches can contribute to trip free and mechanical nuisance problems that affect the reliability of these breakers. The availability of replacement parts is limited and often do not work without further modifications during installation.

Based on the age of the breakers, high maintenance costs and decreasing reliability, we recommend that the breakers and switchgear be replaced.

Relay Protection

A solidly grounded system provides a high level of safety and fault detection when the proper protective devices are applied and coordinated correctly. The existing configuration of the protection devices provides over current protection on the 'A' and 'C' phases along with residual ground fault protection. This protection design was adequate when the system was designed, however, does not provide complete protection for the components of the distribution network supplied by the phase 'B' circuit.

This deficiency can be corrected by adding an additional induction disc relay or upgrading the relay protection to a modern microprocessor based device. A modern microprocessor based device can provide significant advantages to Midland PUC including personnel safety and system reliability through the following:

- Fault Location:
  An event recorder can provide information pertaining to the system prior to a breaker operation and general fault location.
- Remote Monitoring:
  This requires a supervisory-type communication between the relay and a remote location. This can provide a variety of information such as: voltages, currents, watts, Vars, VA, device status, remote operation (i.e. hold offs) and can be configured to meet your requirements.
- Equipment Protection (Voltage and Current):
  More sensitive relay settings can be applied to provide optimum equipment protection.
- Other Available Features:
  Re-closure, synchronism check, directional elements, frequency check, etc.

Based on our assessment of the metal clad switchgear, oil-filled circuit breakers, induction disc relays and various components, we recommend installing new switchgear complete with vacuum air circuit breakers and a remote relay panel. We further recommend installing a transformer and switchgear package to simplify the installation.

Battery Bank

The battery bank appears to be within five (5) years old and the general condition of the charger, liquid levels and terminal connections are satisfactory. If replacement of the indoor switchgear commences, the output voltage of the existing bank, 48 VDC would require upgrading to match the required DC controls of the new equipment.

1.7 Arc Flash Protection (NFPA 70E)

Generally, the equipment meets the requirements of the *National Fire Protection Association Code 70E (NFPA 70E)*, except as noted below:

With reference to *Annex K of the NFPA 70E*, the design of medium voltage metal clad switchgear does not provide an arc pressure relief device(s) that would allow the pressures developed during an internal arc to be vented away safely from the front and rear of the switchgear. This feature assists in the protection of personnel in proximity to the switchgear from dangerous temperatures and the pressures that are developed when an internal arc flash occurs. The vent(s) or flaps are designed and placed in areas that safely direct the pressure, gases away from the operator and areas where personnel generally position themselves.

Article 210.5 and 410.9(B)(1)(a) recommends that the protective devices be maintained and able to withstand or interrupt the available fault current and provide proper current protection. The breakers, current transformers and relays are suitable to interrupt the fault current; however, the configuration of the relay protection devices does not include ground fault protection and relies solely on the over current elements to clear a fault. We recommend upgrading the relay protection to a three (3) phase and ground fault over current protection scheme to provide optimum equipment and personnel protection.

The oil filled circuit breakers utilize a vertical lift type insertion system that requires the door to be open and operator to be directly in front of the breaker in the cell. This inherently places the operator in the most dangerous position if the insertion system or an electrical component(s) fails during its operation or racking onto the live 5kV bus. Furthermore, to manually operate the breaker places the operator in the same position. *NFPA 70E, Table 130.7(C)(9)(a), page 70E-31, for "Metal Clad Switchgear, 1kV and Above"* assesses the hazard/risk of the manual operation, insertion and removal of this type of breaker from live bus work to be their highest category of 4. Based on the hazard/ risk assessment, we recommend that the breakers not be racked in or removed from energized bus work and electrically operated only with the door closed.

1.8 Conclusion

Based on the results of our assessment and preventative maintenance reports, the condition of the primary fuse assembly is suitable for continued service. We recommend upgrading the primary lightning arresters to increase the surge protection for the downstream devices. Due to age, availability of replacement parts, maintenance costs and low reliability, we recommend replacing and upgrading the primary air break switch, the main transformer and switchgear assembly. Modernizing the substation to meet current Ontario Electrical Safety Code, National Fire Protection and IEEE Standards would increase system reliability and ensure safety to both utility personnel and the general public.

The following is a summary of our recommendations;

1) As per the *Ontario Electrical Safety Code 36-310(2)(a)(b)* and *Table 52*, and in the interest of personnel safety, we recommend installing a metallic gradient control mat to ensure the touch voltage is minimized to a tolerable level during switching operations. The gradient control mat maximizes the safety of the operator(s) during switching operations.
2) As per the *Ontario Electrical Safety Code 36-312(1) and Table 52*, we recommend installing a ground conductor that loops one (1) metre outside the perimeter of the existing substation metallic fence enclosure and connect this loop directly to the substation ground grid. This ensures that the step and touch potential between the metallic fence and one (1) metre from the fence is minimized and eliminates a potential shock hazard during a fault.
3) As per the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and tank for the power transformer. The second connection is a redundant bonding connection to ensure the tank remains bonded to the ground grid if an internal fault occurs.
4) As per the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and ground bus within the indoor switchgear. The second connection is a redundant bonding connection to ensure the switchgear remains bonded to the ground grid if an external and/or internal fault occurs.
5) As per the *Ontario Electrical Safety Code 36-304(5)*, *Table 52* and in the interest of personnel safety, we recommend removing the yard debris (i.e. leaves) and installing 12 inches of ¾ crushed stone to provide a dielectric layer that minimizes the touch and step potential.
6) We recommend upgrading the bonding connection between the three (3) lightning arresters located on the tower structure to include a continuous loop to a second connection to the ground grid. A second connection provides a redundant path to discharge equipment damaging voltages and currents during a severe power surge.
7) As per the *Ontario Electrical Safety Code 36-312(4)*, the ground conductor should be woven throughout the fence fabric in at least two (2) places. We recommend adding split bolts to secure the bonding conductor to the fence fabric in at least two places per conductor.
8) The steel removable section of the substation brick wall is covered with asbestos. Due to the health hazard associated with asbestos as it becomes brittle, we recommend that the asbestos be labelled as a health hazard and removed prior to any construction work being completed.
9) We recommend upgrading the air break switch to a S&C, Alduti Rupter load break switch rated for a maximum voltage of 48.6kV, a continuous current of 600A and interrupt capacity of 40000 amperes.

10) We recommend replacing the three (3) lightning arresters with polymer, metal oxide station class arresters rated for 48kV and 39 MCOV. This type of arrester will provide adequate protection of the insulation of the power transformer by dissipating damaging system over voltages and surges.

11) Based on the results of the oil analysis trending, preventative maintenance reports and our assessment, we recommend replacing and increasing the capacity of this transformer. The degradation of the paper insulation confirms that this transformer can not be considered reliable; furthermore, refer to our comments and recommendations pertaining to the indoor switchgear.

12) Based on our assessment of the metal clad switchgear, oil-filled circuit breakers, induction disc relays and various components, we recommend installing new switchgear complete with vacuum air circuit breakers and a remote relay panel. We further recommend installing a transformer and switchgear package to simplify the installation.

13) We recommend modernizing the protection relays to a microprocessor based device and mounting the relays in a stand alone panel adjacent to the switchgear panel. This will allow personnel to view the relay information without standing directly in front of the switchgear.

14) *NFPA 70E, Table 130.7(C)(9)(a), page 70E-31, for "Metal Clad Switchgear, 1kV and Above"* assesses the hazard/risk of the manual operation, insertion and removal of this type of breaker from live bus work to be their highest category of 4. Based on the hazard/ risk assessment, we recommend that the breakers not be racked in or removed from energized bus work and electrically operated only with the door closed.

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Section 2

DORION STREET SUBSTATION

2.1 System Overview

The Dorion Street Substation is supplied by the Hydro One 44kV Feeder designated as the 'M2' circuit. It is connected to the gang-operated 46kV air break switch designated 'D37T1-L' located at the station. The equipment located in the outdoor substation consists of one (1) gang-operated air break switch, one set of three (3) lightning arresters, one (1) set of three (3) over current protection fuses and one (1) three phase, 5 MVA, power transformer. The secondary of the transformer is directly connected to the main bus of the indoor switchgear via a copper IPC bus. The indoor switchgear has four (4) cells that contain two (2) oil-filled and one (1) air blast circuit breaker, metering device, protection and control equipment.

2.2 Ground Grid and Bonding Assessment

The original substation ground grid does not exist. The switchgear and transformer are bonded to the system neutral which is providing a ground reference and a current return path. The fate of the original ground grid cannot be determined as we were only able to locate remnants west of the spare switchgear.

Based on the results of our assessment, we recommend constructing a new substation ground grid to comply with the requirements outlined in *sections 10 and 36 of the Ontario Electrical Safety Code*. The condition of the ground grid and the bonding to the structures may cause a step and touch potential hazard for personnel during a fault since the ground grid is not consistent throughout the substation and the potential rise exceeds the allowable step and touch voltages outlined in *Table 52 of the Ontario Electrical Safety Code*. This is an item that should be addressed, as soon as possible, to ensure safety to the public and utility personnel.

2.3 Tower Structure and Components Assessment

Galvanized Tower Structure

The tower structure was constructed using galvanized steel and hardware and is presently in fair condition with slight rust development. The visual inspection of the two (2) tower concrete footings and steel bases concluded that there is no significant visual deterioration and therefore suitable for continued use.

The current carrying IPC bus work is supported with polymer and porcelain station post style insulators. The ratings of the insulators and clearances between the primary buses and grounded surfaces are suitable for the voltage rating.

No further action is required.

Primary 44kV Air Break Switch

The primary air break switch is rated for 46kV and 600 amperes. The ratings of this switch are satisfactory for the application; however, this product is no longer supported by the manufacturer, making replacement parts unavailable. The design of the switch is as an air break switch and does not have load breaking capabilities. Our preventative maintenance

reports indicate that the current carrying components are in satisfactory condition and have undergone slight deterioration caused by the outdoor environment.

Based on the unavailability of parts and manufacturer support, we recommend upgrading the air break switch to an S&C, Alduti Rupter load break switch rated for a maximum voltage of 48.6kV, a continuous current of 600A and interrupt capacity of 40000 amperes.

Primary Fuse Protection

The primary protection fuses mounted vertically on the tower structure are manufactured by S&C Electric and replacement fuse links are available.

The short circuit, voltage and over current ratings the fuse units provide is excellent equipment protection and is suitable for this application.

No further action is required.

Lightning Arresters

The three (3) lightning arresters located on the tower structure and connected to the 44kV bus work are of a porcelain gap type constructed arrester and manufactured by CLM Industries. The gap type arrester is prone to failure due to moisture ingress into the semi-conductive material within the unit. The moisture reduces the resistance of the components within the arresters directly affecting the kV and maximum continuous operating voltage (M.C.O.V.) rating of the device. This affects the reliability of surge protection for the electrical equipment downstream from these devices.

We recommend replacing the three (3) lightning arresters with polymer, metal oxide station class arresters rated for 48kV and 39 MCOV.

2.4 Transformer Assessment

The Moloney Electric power transformer, s/n 238691, has a capacity of 5 MVA and is configured with a primary 44000 volt, delta connected, primary winding and a secondary 4160 volt, wye configured winding. The secondary neutral bushing is directly connected to the substation ground grid and is commonly referred to as a "solidly grounded Wye system". The Moloney Electric transformer was constructed in 1967 and has provided service for approximately 39 years.

The primary 44kV porcelain bushings are in fair condition, however; H3 bushing has a large chip in one (1) skirt of the porcelain housing. As stated in our preventative maintenance reports, this damage has not affected the insulation properties of the bushing but the integrity has been damaged and moisture will start to affect the bushing in the future.

The insulation resistance of each winding to ground and winding to winding has remained relatively constant since 2000.

The results of the oil analysis indicate that the levels of Furfuraldehyde (Furan) have slightly increased since November 1999. Furans are produced when the paper insulation used to

insulate each winding has been damaged by elevated heat levels in the insulation. In October 2004, the actual furan level in this transformer was 76 parts per billion (ppb) indicating that the paper insulation is in good condition. The dissolved gas-in-oil results indicate that between October 1999 and October 2004, acetylene had been produced but is no longer being produced at this time. Our concern is that it has been produced and the reason for the problem was not repaired. A reoccurrence is probable and because acetylene is produced by an internal arc, this can lead to rapid equipment failure.

Rondar Inc. Furan Assessment	
< 100 ppb	Good Condition
250 ppb	Fair to Poor Condition
> 500 ppb	Undergone Severe Deterioration
*ppb = parts per billion	

Based on the results of the oil analysis and preventative maintenance results, we consider this transformer, s/n 238691 to be suitable for continued service and recommend completing annual oil sampling to monitor the oil properties and dissolved gases. A change in these concentrations would indicate a fault is developing within the transformer and corrective action is required.

2.5 Switchgear and Enclosure Assessment

The enclosure is a prefabricated metal clad building that incorporates the switchgear with three (3) breakers and one (1) metering cell into the overall design.

The paint condition of the exterior has deteriorated, however, is in satisfactory condition.

The three (3) top mounted 5kV bushings that provide the connection between the transformer and the internal bus work are in good condition and free from any mechanical damage.

The ambient temperature within the enclosure was found to be excessive and contributes to insulation deterioration.

We recommend installing a climate control system to benefit the long term reliability of the electrical equipment, especially the DC battery bank.

2.6 Switchgear Assessment

The General Electric Switchgear is a Metal Clad type enclosure and contains the following components:

- One set of three (3) metering potential transformers.
- One set of three (3) metering current transformers.
- Two (2) oil-filled circuit breakers with DC controls.
- One (1) air blast circuit breaker with DC controls.

- Three (3) bar type current transformers per breaker. The current transformers are mounted on the load side bus of the breakers.
- Two (2) phase over current relays per breaker.
- One (1) neutral over current relay per breaker.

The main bus work of the switchgear is a copper tubular bus bar that is horizontally mounted in the top front area behind covers. The bus bars are insulated throughout and isolated from each cell by a metal plate. Our preventative maintenance reports have concluded that the measured insulation resistance, with reference to the *NETA Standard Table 10.1*, is suitable for continued service. Based on the age of the insulation and assuming a moderate temperature, the elasticity of the insulation has deteriorated. The amount of deterioration since original construction is unknown and it is difficult to visually inspect the main bus work due to barriers. As the elasticity properties of the insulation deteriorates, it causes the insulation to become brittle and can cause the insulation to crack or break during a fault.

The components and wiring of the switchgear are operating as required to provide the necessary control power to the associated equipment. As above, the components have reached or are near the end of their service life and reliability is questionable. The repair time necessary to locate, investigate and retrofit in new control equipment into this switchgear will be time consuming, expensive and significant downtime would be required.

5kV Oil Circuit Breakers (OCB)

The OCB's are breakers that use insulating oil as a dielectric medium to insulate the 'live' parts from metal surfaces and minimize the electric arc during opening/closing operations. During each operation of the breaker, carbon is produced and it slowly contaminates the oil, affecting the dielectric properties. This requires the insulating oil to be replaced and increases the annual preventative maintenance costs. There is not a time frame which the oil has to be replaced but is determined by the results of a dielectric oil sample analysis.

The main contacts, current carrying components and most of the operating mechanism are submersed in 15 U.S. gallons of oil and can only be visually inspected by removing the tank. The internal components have not been inspected since 1999 and at that time damage to the contact surfaces was noted. Based on the age of the device, the spring tensions and excessive wearing on various shafts, bearings and latches can contribute to trip free and mechanical nuisance problems that affect the reliability of these breakers. Replacement parts are not available and therefore 'used' parts are the only option. Used parts are difficult to locate for these breakers and often do not work without further modifications.

Relay Protection

A solidly grounded system provides a high level of safety and fault detection when the proper protective devices are applied and coordinated correctly. The existing configuration of the protection devices provides over current protection on the 'A' and 'C' phases along with residual ground fault protection. This protection design was adequate when the system was

designed, however, does not provide complete protection for the components of the distribution network supplied by the phase 'B' circuit.

This deficiency can be corrected by adding an additional induction disc relay or upgrading the relay protection to a modern microprocessor based device. A modern microprocessor based device can provide significant advantages to Midland PUC including personnel safety and system reliability through the following:

- Fault Location:
  An event recorder can provide information pertaining to the system prior to the breaker operation, faulted phase, fault type, and general fault location.
- Remote Monitoring:
  This requires a supervisory-type communication between the relay and a remote location. This can provide a variety of information such as: voltages, currents, watts, Vars, VAs, device status, remote operation (i.e. hold offs) and can be configured to meet your requirements.
- Equipment Protection (Voltage and Current):
  More sensitive relay settings can be applied to provide optimum equipment protection.
- Other Available Features:
  Re-closure, synchronism check, directional elements, frequency check, breaker controls.

Based on our assessment of the metal clad switchgear, oil-filled circuit breakers, induction disc relays and various components, we recommend replacing the existing switchgear, breakers and relay protection devices. We also recommend installing a residual connected ground fault relay to sense and trip the associated breaker, as soon as possible, to prevent equipment damage and ensure personnel safety.

Battery Bank

The battery bank appears to be within five (5) years old and the general condition of the charger, liquid levels and terminal connections are satisfactory. If replacement of the indoor switchgear commences, the output voltage of the existing bank, 48 VDC, may have to be upgraded to match the required DC controls of the new equipment.

2.7 Arc Flash Protection (NFPA 70E)

Generally, the equipment meets the requirements of the *National Fire Protection Association Code 70E (NFPA 70E)*, except as noted below:

With reference to *Annex K of the NFPA 70E*, the design of medium voltage metal clad switchgear does not provide an arc pressure relief device(s) that would allow the pressures developed during an internal arc to be vented away safely from the front and rear of the switchgear. This feature assists in the protection of personnel in proximity to the switchgear from dangerous temperatures and the pressures that are developed when an internal arc flash

occurs. The vent(s) or flaps are designed and placed in areas that safely direct the gases away from the operator and areas where personnel generally position themselves.

Article 210.5 and 410.9(B)(1)(a) recommends that the protective devices be maintained and able to withstand or interrupt the available fault current and provide proper current protection. The breakers, current transformers and relays are suitable to interrupt the fault current; however, the configuration of the relay protection devices does not include sensing on the phase 'B' circuit and relies on the other phases and neutral protection to sense and clear a fault. We recommend upgrading the relay protection to a three (3) phase and neutral over current protection scheme to provide optimum equipment and personnel protection.

The oil-filled circuit breakers utilize a vertical lift type insertion system that requires the door to be open and the operator to be directly in front of the breaker in the cell. This inherently places the operator in the most dangerous position should the insertion system or an electrical component(s) fail during its operation or racking onto the live 5kV bus. Furthermore, to manually operate the breaker places the operator in the same position. *NFPA 70E, Table 130.7(C)(9)(a), page 70E-31, for "Metal Clad Switchgear, 1kV and Above"* assesses the hazard/risk of the manual operation, insertion and removal of this type of breaker from live bus work to be their highest category of 4. Based on this hazard/risk assessment, we recommend implementing a procedure to eliminate this hazard.

2.8 Conclusion

Based on the results of our assessment and preventative maintenance reports, we recommend installing a new ground grid and replacing the primary switch, lightning arresters, prefabricated switchgear and protection relays. Furthermore, we recommended completing annual oil sampling to closely monitor the condition of the transformer.

The following is a summary of our recommendations made in the report;

1) We recommend constructing a new substation ground grid to comply with the requirements outlined in *sections 10 and 36 of the Ontario Electrical Safety Code*. The condition of the ground grid and the bonding to the structures may cause a step and touch potential hazard for personnel during a fault since the ground grid is not consistent throughout the substation and the potential rise exceeds the allowable step and touch voltages outlined in *Table 52 of the Ontario Electrical Safety Code*. This is an item that should be addressed, as soon as possible, to ensure safety to the public and utility personnel.
2) Based on the unavailability of parts and manufacturer support, we recommend upgrading the air break switch to an S&C, Alduti Rupter load break switch rated for a maximum voltage of 48.6kV, a continuous current of 600A and interrupt capacity of 40000 amperes.
3) We recommend replacing the three (3) lightning arresters with polymer, metal oxide station class arresters rated for 48kV and 39 MCOV. The new arresters will increase the surge protection.

4) Based on the results of the oil analysis and preventative maintenance results, we consider this transformer, s/n 238691 to be suitable for continued service and recommend completing annual oil sampling to monitor the oil properties and dissolved gases. A change in these concentrations would indicate a fault is developing within the transformer and corrective action is required.
5) We recommend installing a climate control system to benefit the long term reliability of the electrical equipment, especially the DC battery bank.
6) Based on our assessment of the metal clad switchgear, oil-filled circuit breakers, induction disc relays and various components, we recommend replacing the existing switchgear, breaker and relay protection devices. We also recommend installing a residual connected ground fault relay to sense and trip the associated breaker, as soon as possible, to prevent equipment damage and ensure personnel safety.
7) We recommend modernizing the protection relays to a microprocessor based device and mounting the relays in a remotely mounted panel adjacent to the switchgear panel. This will allow personnel to view the relay information without having to be directly in front of the switchgear and will also provide more sensitive protection.
8) *NFPA 70E, Table 130.7(C)(9)(a), page 70E-31, for "Metal Clad Switchgear, 1kV and Above"* assesses the hazard/risk of the manual operation, insertion and removal of this type of breaker from live bus work to be their highest category of 4. Based on this hazard/risk assessment, we recommend that the breakers not be racked in or removed from energized bus work and electrically operated only with the door closed.

RONDAR INC.

Section 3

BRANDON STREET SUBSTATION

3.1 System Overview

The Brandon Street Substation is supplied by the Hydro One 44kV Feeder designated as the 'M2' circuit. It is connected to the gang-operated 48.3kV load break switch designated 'G37T1-L' located at the station. The equipment located in the outdoor substation consists of one (1) gang-operated air break switch, one set of three (3) lightning arresters, one (1) set of three (3) over current protection fuses and three (3) single phase, 1.667 MVA, power transformers. The secondary of the transformer is directly connected to the main bus of the indoor switchgear via aluminium IPC bus. The indoor switchgear has five (5) cells that contain four (4) oil-filled circuit breakers, metering devices, protection and control equipment.

3.2 Ground Grid and Bonding Assessment

The ground grid consists of two (2) copper ground rods, ½ inch in diameter and interconnected utilizing 2/0 AWG bare copper forming a continuous loop around the substation equipment. The thermal (CAD) welded connections between the 2/0 AWG bare copper loop, ground rods and bonding conductors are in good condition and correct for a direct burial installation.

The bonding of the equipment to the substation ground grid was found to be as follows:
A connection to each footing of the tower structure, one (1) connection to the transformer tank, one (1) connection to the outdoor switchgear, one (1) connection to the lightning arresters and one (1) connection to the gang-operated high voltage switch but not the switch handle.

Based on our assessment, we recommend the following deficiencies be corrected:

1) As per the *Ontario Electrical Safety Code 36-302*, a minimum of four (4) ground rods are required. We recommend installing two (2) additional ground rods and connecting these rods to the existing ground loop.
2) As per the *Ontario Electrical Safety Code 36-312(1) and Table 52*, we recommend installing a ground conductor that loops one (1) metre outside the perimeter of the existing substation metallic fence enclosure and connecting this loop directly to the substation ground grid. This ensures that the step and touch potential between the metallic fence and one (1) metre from the fence is minimized and eliminates a potential shock hazard during a fault.
3) As per the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and tank of each power transformer. The second connection is a redundant bonding connection to ensure the tank remains bonded to the ground grid if an internal fault occurs.
4) With reference to the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and ground bus within the switchgear. The second connection is a redundant bonding connection to ensure the switchgear remains bonded to the ground grid if an external and/or internal fault occurs.

5) As per the *Ontario Electrical Safety Code 36-304(5)* and *Table 52* and in the interest of personnel safety, we recommend removing the yard debris (i.e. leaves), applying a herbicide and adding three (3) inches of crushed stone to the substation to ensure the dielectric protection is maintained.
6) As per the *Ontario Electrical Safety Code 36-310(1)*, we recommend installing flexible connections between the ground grid and the operating switch handle to ensure the potential difference is minimized.
7) We recommend upgrading the bonding connection between the three (3) lightning arresters located on the tower structure to include a continuous loop to a second connection to the ground grid. A second connection provides a redundant path to discharge equipment damaging voltages and currents during a severe power surge.
8) As per the *Ontario Electrical Safety Code 36-312 and Table 52*, we recommend connecting the fence ground loop to the station ground grid with a minimum of two (2) connections.
9) As per the *Ontario Electrical Safety Code 36-312(4) and Table 52*, the ground conductor should be woven throughout the fence fabric in at least two (2) places. We recommend adding split bolts to secure the bonding conductor to the fence fabric in at least two places per conductor.

NOTE:
The size of the existing substation is not required for the amount of equipment installed. Additionally, we recommend installing a new fence enclosure around the existing equipment and removing what is not required of the existing fence. This will minimize the costs associated with upgrading the station ground grid and associated grounding and bonding connections.

3.3 Tower Structure and Components Assessment

Aluminium Tower Structure

The condition of the aluminium outdoor tower structure is presently in good condition. The visual inspection of two (2) concrete footings and tower bases concluded there is no significant deterioration.

The current carrying bus work is aluminium IPC and supported with porcelain and polymer station post insulators. The insulation rating and clearances between the primary buses and grounded surfaces are suitable for the voltage rating.

No further action is required.

Primary 44kV Air Break Switch

The primary air break switch is rated 48.3kV, 600A with a basic impulse level of 250kV. The ratings of the switch are satisfactory for this application and the product is supported by the manufacturer making replacement parts readily available.

No further action is required.

Primary Fuse Protection

The primary protection fuses mounted vertically on the tower structure are manufactured by S&C Electric and replacement fuse links are available.

The short circuit, voltage and over current ratings of the fuse units provide excellent equipment protection and are suitable for this application.

No further action is required.

Lightning Arresters

The three (3) lightning arresters located on the tower structure and connected to the 44kV bus work are a porcelain gap type constructed arrester. The gap type arrester is prone to failure due to moisture ingress into the semi-conductive material within the unit. The moisture reduces the resistance of the components within the arresters directly affecting the kV and maximum continuous operating voltage (M.C.O.V.) rating of the device. This affects the reliability of surge protection for the electrical equipment downstream from these devices.

We recommend replacing the three (3) lightning arresters with polymer, metal oxide station class arresters rated for 48kV and 39 MCOV.

3.4 Transformer Assessment

The Packard Electric three (3) single phase transformers, phase 'A':, s/n 213274, phase 'B', s/n 213273, phase 'C', s/n 213275, and spare, s/n 213272, have a combined capacity of 5 MVA and is configured with a primary winding 44000 volts, delta connected winding and a secondary 4160 volt, wye configured winding. The primary and secondary bus work connections accommodate the delta and wye connections between the single phase transformers. The secondary neutral bushings are bonded together and directly connected to the substations ground grid. This connection is commonly referred to as a "solidly grounded wye system". The Packard Electric transformers were constructed in 1956.

The primary 44kV porcelain bushings are in fair condition with damage to one (1) 5kV bushing that has been temporarily repaired and will require replacement in the future. Due to the age of the transformers, replacement bushings are difficult to locate.

The results of the oil analysis indicates that the level of Furfuraldehyde (Furan) in each of the single phase transformers, excluding the spare, indicate that the paper insulation has undergone extensive deterioration. Furans are produced when the paper insulation used to insulate each winding has been damaged by elevated temperatures in the insulation. In October 2004, the actual furan levels in the phase 'A', 'B' and 'C' transformers were 1344, 1144 and 1145, respectively, parts per billion (ppb).

Rondar Inc. Furan Assessment	
< 100 ppb	Good Condition
250 ppb	Fair to Poor Condition
> 500 ppb	Undergone Severe Deterioration
*ppb = parts per billion	

The results of the dissolved gas-in-oil analysis for the phase 'A', s/n 213274, transformer indicate an elevated level of carbon monoxide and dioxide. These gases are produced in conjunction with excessive heating of the paper insulation and support our comments regarding furan levels.

The results of the dissolved gas-in-oil analysis for the phase 'B', s/n 213273, transformer indicate an elevated level of carbon monoxide and dioxide. These gases are produced in conjunction with excessive heating of the paper insulation and support our comments regarding furan levels. Furthermore, hydrogen is starting to be produced and we suspect it involves the deterioration of the paper insulation. Although the fault was not severe in October 2004, corona will continue to deteriorate the insulation and worsen over time. Failure of this unit is imminent.

The results of the dissolved gas-in-oil analysis for the phase 'C', s/n 213275, transformer indicate an elevated level of carbon monoxide and dioxide. These gases are produced in conjunction with excessive heating of the paper insulation and support our comment regarding furan levels.

Based on the trending results from the oil analysis and preventative maintenance reports, we recommend replacing these transformers in one (1) year and consider the three single phase transformers to have a high potential for failure. We also recommend installing a single three (3) phase 8-10 MVA transformer to meet current and future residential and commercial growth.

3.5 Switchgear Assessment (a)

The enclosure is a prefabricated metal clad building that incorporates the switchgear with four (4) breakers and one (1) metering cell into the overall design. We estimate the age of the enclosure to be 45–50 years old.

The exterior paint condition was repainted two (2) years ago and is in satisfactory condition.

The three (3) top mounted 5kV bushings that provide the connection between the transformer and internal bus work are in good condition and free from any mechanical damage.

The ambient temperature within the enclosure was found to be excessive and contributes to insulation deterioration.

We recommend installing a climate control system which would benefit the long-term reliability of the electrical equipment, especially the DC battery bank.

3.6 Switchgear Assessment (b)

The Crompton Parkinson Electrical Switchgear is a Metal Clad type enclosure that is approximately 50+ years old based on the manufacturing date of the transformer. The switchgear contains the following components:

- One set of three (3) metering potential transformers
- One set of three (3) metering current transformers
- Four (4) oil-filled circuit breakers with DC controls
- Three (3) bar type current transformers per breaker. The current transformers are mounted on the load side bus of the breakers.
- Three (3) phase over current relays per breaker

The main bus work of the switchgear is horizontally mounted in the top rear area behind covers. The bus bars are insulated throughout and isolated from each cell by a metal plate. Our preventative maintenance reports have concluded that the measured insulation resistance, with reference to the *NETA Standard Table 10.1*, is suitable for continued service. Based on the age of the insulation and assuming a moderate temperature, the elasticity of the insulation has deteriorated. The amount of deterioration since original construction is unknown and it is difficult to visually inspect the main bus work due to barriers. As the elasticity properties of the insulation deteriorates, it causes the insulation to become brittle and can cause the insulation to crack or break during a fault.

The components and wiring of the switchgear are operating as required to provide the necessary control power to the associated equipment. As above, the components have reached or are near the end of their service life and reliability is questionable. The repair time necessary to locate, investigate and retrofit in new control equipment into this switchgear will be time consuming, expensive and significant downtime would be required.

5kV Oil Circuit Breakers (OCB)

The OCB's are breakers that use insulating oil as a dielectric medium to insulate the 'live' parts from metal surfaces and minimize the electric arc during opening/closing operations. The breaker consists of six (6) bushings, two (2) sets of mechanism operating contacts per phase, one (1) closing coil (cc), one (1) tripping coil (tc) and necessary operating mechanisms to perform opening and closing functions. The breakers can be either opened or closed manually or electrically. We consider the age of the oil-filled circuit breakers to be the same vintage as the switchgear and transformers.

The main contacts, current carrying components and most of the operating mechanism are submersed in 12.5 imperial gallons of oil and can only be visually inspected by removing the tank. Our records indicate that the internal components have not been inspected and significant component deterioration is expected. Based on the age of the device, the spring tensions and excessive wearing on various shafts, bearings and latches can contribute to trip free and mechanical nuisance problems that affect the reliability of these breakers. Factory replacement parts for this type of breaker are not available and therefore 'used' parts are the only option.

Used parts are difficult to locate for these breakers and often do not work without further modifications.

Relay Protection

A solidly grounded system provides a high level of safety and fault detection when the proper protective devices are applied and coordinated correctly. The existing configuration of the protection devices provides over current protection on the 'A' and 'C' phases along with residual ground fault protection. This protection design was adequate when the system was designed, however, does not provide complete protection for the components of the distribution network supplied by the phase 'B' circuit.

This deficiency can be corrected by adding an additional induction disc relay or upgrading the relay protection to a modern microprocessor based device. A modern microprocessor based device can provide significant advantages to Midland PUC including personnel safety and system reliability through the following:

- Fault Location:
  An event recorder can provide information pertaining to the system prior to the breaker operation, faulted phase, fault type, and general fault location.
- Remote Monitoring and Control
  This requires a supervisory type communication between the relay and a remote location. This can provide a variety of information such as: voltages, currents, watts, Vars, VAs, device status, remote operation (i.e. hold offs) and can be configured to meet your requirements.
- Equipment Protection (Voltage and Current):
  More sensitive relay settings can be applied to provide optimum equipment protection.
- Other Available Features:
  Re-closure, synchronism check, directional elements, frequency check, breaker controls.

Based on our assessment of the metal clad switchgear, oil-filled circuit breakers, induction disc relays and various components, we recommend installing new switchgear complete with vacuum air circuit breakers and a remote relay panel. Furthermore, we recommend that a transformer and prefabricated switchgear be purchased to simplify the installation.

Battery Bank

The battery bank appears to be within five (5) years old and the general condition of the charger, liquid levels and terminal connections are satisfactory. The output voltage of the existing bank, 120 VDC, is suitable for use with new equipment.

3.7 Arc Flash Protection (NFPA 70E)

Generally, the equipment meets the requirements of the *National Fire Protection Association Code 70E (NFPA 70E)*, except as noted below:

With reference to *Annex K of the NFPA 70E*, the design of medium voltage metal clad switchgear does not provide an arc pressure relief device(s) that would allow the pressures developed during an internal arc to be vented away safely from the front and rear of the switchgear. This feature assists in the protection of personnel in proximity to the switchgear from dangerous temperatures and the pressures that are developed when an internal arc flash occurs. The vent(s) or flaps are designed and placed in areas that safely direct the pressure, gases away from the operator and areas where personnel generally position themselves.

Article 210.5 and 410.9(B)(1)(a) recommends that the protective devices be maintained and able to withstand or interrupt the available fault current and provide proper current protection. The breakers, current transformers and relays are suitable to interrupt the fault current; however, the configuration of the relay protection devices does not include ground fault protection and relies solely on the over current elements to clear a fault. We recommend upgrading the relay protection to a three (3) phase and ground fault over current protection scheme to provide optimum equipment and personnel protection.

The oil filled circuit breakers utilize a vertical lift type insertion system that requires the door to be open and operator to be directly in front of the breaker in the cell. This inherently places the operator in the most dangerous position if the insertion system or an electrical component(s) fails during its operation or racking onto the live 5kV bus. Furthermore, to manually operate the breaker places the operator in the same position. *NFPA 70E, Table 130.7(C)(9)(a), page 70E-31, for "Metal Clad Switchgear, 1kV and Above"* assesses the hazard/risk of the manual operation, insertion and removal of this type of breaker from live bus work to be their highest category of 4. Based on the hazard/ risk assessment, we recommend that the breakers not be racked in or removed from energized bus work and electrically operated only with the door closed.

3.8 Conclusion

The existing equipment poses a reliability and personnel safety concern. The existing power equipment has provided exceptional service life; however, replacement components and parts are difficult to source which can lead to expensive repairs and extended downtime. Modernizing the substation to meet current Ontario Electrical Safety Code, National Fire Protection and IEEE Standards would increase system reliability and safety to the personnel that operate these devices and the public.

To summarize our assessment, we recommend that a new transformer and switchgear package be installed to replace the existing equipment within one (1) year. To address the concern of future residential and commercial growth, we recommend increasing the capacity of the transformer between 8 to 10 MVA. To comply with the safety requirements outlined by the

Ontario Electrical Safety Code the station ground grid and equipment bonding connections would require upgrading as outlined in our report.

The following is a summary of our recommendations;

1) As per the *Ontario Electrical Safety Code 36- 302*, a minimum of four (4) ground rods are required. We recommend installing two (2) additional ground rods and connecting them to the existing ground loop.

2) As per the *Ontario Electrical Safety Code 36-312(1) and Table 52*, we recommend installing a ground conductor that loops one (1) metre outside the perimeter of the existing substation metallic fence enclosure and connecting this loop directly to the substation ground grid. This ensures that the step and touch potential between the metallic fence and one (1) metre from the fence is minimized and eliminates a potential shock hazard during a fault.

3) As per the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and tank of each power transformer. The second connection is a redundant bonding connection to ensure the tank remains bonded to the ground grid if an internal fault occurs.

4) With reference to the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and ground bus within the switchgear. The second connection is a redundant bonding connection to ensure the switchgear remains bonded to the ground grid if an external and/or internal fault occurs.

5) As per the *Ontario Electrical Safety Code 36-304(5)* and *Table 52* and in the interest of personnel safety, we recommend removing the yard debris (i.e. leaves), applying a herbicide and adding three (3) inches of crushed stone to the substation to ensure the dielectric protection is maintained.

6) As per the *Ontario Electrical Safety Code 36-310(1)*, we recommend installing flexible connections between the ground grid and the operating switch handle to ensure the potential difference is minimized.

7) We recommend upgrading the bonding connection between the three (3) lightning arresters located on the tower structure to include a continuous loop to a second connection to the ground grid. A second connection provides a redundant path to discharge equipment damaging voltages and currents during a severe power surge.

8) As per the *Ontario Electrical Safety Code 36-312 and Table 52*, we recommend connecting the fence enclosure to the ground grid with a minimum of two (2) connection points.

9) As per the *Ontario Electrical Safety Code 36-312(4) and Table 52*, the ground conductor should be woven throughout the fence fabric in at least two (2) places. We recommend adding spilt bolts to secure the bonding conductor to the fence fabric in at least two (2) places per conductor.

NOTE.

The size of the existing substation is not required for the amount of equipment installed. Additionally, we recommend installing a new fence enclosure around the existing equipment and removing what is not required of the existing fence. This will minimize the costs associated with upgrading the stations ground grid and the connections required to adequately ground and bond the equipment.

10) We recommend replacing the three (3) lightning arresters with polymer, metal oxide station class arresters rated for 48kV and 39 MCOV.
11) We recommend installing a climate control system which would benefit the long-term reliability of the electrical equipment, especially the DC battery bank.
12) Based on the trending results from the oil analysis and preventative maintenance reports, we recommend replacing these transformers in one (1) year and consider the three single phase transformers to have a high potential for failure. We also recommend installing a single three (3) phase 8-10 MVA transformer to meet current and future residential and commercial growth.
13) We recommend installing a residual connected ground fault relay to sense and trip the associated breaker as soon as possible and/or strongly recommend modernizing the protection relays to a microprocessor based device and mounting the relays in a stand alone panel adjacent to the switchgear panel. This will allow personnel to view the relay information without having to be directly in front of the switchgear and will also provide more sensitive protection.
14) Based on our assessment of the metal clad switchgear, oil-filled circuit breakers, induction disc relays and various components, we recommend installing new switchgear with breakers and microprocessor based protection relays. Furthermore, we recommend that a transformer and prefabricated switchgear be purchased to simplify the installation.
15) *NFPA 70E, Table 130.7(C)(9)(a), page 70E-31, for "Metal Clad Switchgear, 1kV and Above"* assesses the hazard/risk of the manual operation, insertion and removal of this type of breaker from live bus work to be their highest category of 4. Based on the hazard/ risk assessment, we recommend that the breakers not be racked in or removed from energized bus work and electrically operated only with the door closed.

RONDAR INC.

Section 4

QUEEN STREET SUBSTATION

4.1 System Overview

The Queen Street Substation is supplied by the Hydro One 44kV Feeder designated as the 'M4' circuit. It is connected to the gang-operated 46kV air break switch designated 'B37T1-L' located at the station. The equipment located in the outdoor substation consists of one (1) gang-operated air break switch, one set of three (3) lightning arresters, one (1) set of three (3) over current protection fuses and one (1) three (3) phase, 5 MVA, power transformer. The secondary of the transformer is directly connected to the main bus of the indoor switchgear via a copper IPC bus. The indoor switchgear has five (5) cells that contain four (4) oil-filled circuit breakers, metering devices, protection and control equipment.

4.2 Ground Grid and Bonding Assessment

The ground grid consists of seven (7) ½ inch diameter, copper ground rods that are interconnected utilizing 4/0 AWG bare copper. It was found during our inspection that a complete loop around the equipment was not completed at the time of construction. One link between two (2) copper rods is required to complete this repair and will satisfy the Ontario Electrical Code requirement. The mechanical connectors used to connect the bare copper wire to the ground rods are suitable for direct burial and in good condition.

The bonding of the equipment to the substation ground grid was found to be as follows:
A connection to each footing of the tower structure, two (2) connections to the transformer tank, one (1) connection to the indoor switchgear, one (1) connection to the lightning arresters, and one (1) connection to the gang-operated high voltage switch but not to the switch handle. The fence fabric was found to be isolated from the ground grid and is grounded via a separate ground loop around the perimeter of the fence. Due to the proximity of the substation ground grid, we recommend that a minimum of two (2) connections between the ground conductor connected to the fence fabric and the substation ground grid be installed, as soon as possible, to prevent a step and touch potential hazard.

The integrity of the fence enclosure was inspected and six (6) fence posts were found broken at ground level and the barbed wire on the south-east corner was also broken. The six (6) broken posts and strand of barbed wire should be replaced, as soon as possible, to prevent unauthorized entry into the substation.

Based on our assessment, we recommend the following deficiencies be corrected:

1) As per the *Ontario Electrical Safety Code 10.002(a), 36-312(1) and Table 52*, we recommend installing a ground conductor that loops one (1) metre outside the perimeter of the existing substation metallic fence enclosure and connecting this conductor to the substation ground grid. This ensures that the step and touch potential between the metallic fence and one (1) metre from the fence is minimized and eliminates a potential shock hazard during a fault.

2) As per the *Ontario Electrical Safety Code 36-302(c)*, we recommend completing the copper loop around the equipment located in the outdoor substation by installing a 4/0 copper link between the two (2) rods located at the east end of the transformer concrete pad.
3) With reference to the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and ground bus within the switchgear. The second connection is a redundant bonding connection to ensure the switchgear remains bonded to the ground grid if a fault occurs.
4) As per the *Ontario Electrical Safety Code 36-304(5)* and *Table 52*, and in the interest of personnel safety, we recommend removing the yard debris (i.e. leaves), applying a herbicide and adding three (3) inches of crushed stone to the substation to ensure the dielectric protection.
5) As per the *Ontario Electrical Safety Code 36-310(1)*, we recommend installing flexible connections between the ground grid and operating switch handle to ensure the potential difference is minimized.
6) We recommend upgrading the bonding connection between the three (3) lightning arresters located on the tower structure to include a continuous loop to a second connection to the ground grid. A second connection provides a redundant path to discharge equipment damaging voltages and currents during a severe power surge.
7) As per the *Ontario Electrical Safety Code 36-312(4) and Table 52*, the ground conductor should be woven throughout the fence fabric in at least two (2) places with a maximum of three (3) spans between connections. We recommend adding split bolts to secure the bonding conductor to the fence fabric in at least two places per conductor.
8) As per the *Ontario Electrical Safety Code 26-300*, we recommend that the six (6) broken fence posts and top strands of barbed wire be replaced, as soon as possible, to prevent unauthorized entry into the substation.

4.3 Tower Structure and Components Assessment

Tower Structure

The condition of the galvanized steel and hardware on the outdoor tower structure was found to be in satisfactory condition.

The current carrying aluminium IPC bus is supported by polymer and porcelain station post insulators. The rating of the insulators and clearances between the bus work and grounded surfaces are suitable for continued service.

No further action is required.

Primary 44kV Air Break Switch

The primary air break switch is rated 48.3kV, 600A with a basic impulse level of 250kV. The ratings of the switch are satisfactory for this application and the product is supported by the manufacturer making replacement parts readily available.

No further action is required.

Primary Fuse Protection

The primary protection fuses mounted vertically on the tower structure are manufactured by S&C Electric and replacement fuse links are readily available.

The design of the SMD-2C fuses provide adequate short circuit protection, excellent over current protection and is suitable for continued service.

No further action is required.

Lightning Arresters

The three (3) lightning arresters located on the tower structure and connected to the 44kV bus work are a polymer, metal oxide type, intermediate class arrester manufactured by Ohio Brass.

Considering the 5000kVA rating of the power transformer, we recommend upgrading the lightning arresters from an intermediate to station class arrester.

4.4 Transformer Assessment – McGraw Edison, s/n C4620611.

This transformer was purchased in an emergency situation as a 'used' transformer by Midland PUC and its paper insulation had previously undergone significant deterioration prior to Midland PUC's ownership.

The primary 44kV porcelain bushings are in fair condition with damage to one (1) 44kV bushing which has been temporarily repaired. A replacement bushing has been supplied and will be installed.

The result of the Furfuraldehyde (Furan) analysis concludes that the paper insulation is in poor condition. Furans are produced when elevated temperatures cause damage to the paper insulation. In October 2005, the actual furan level was 438 parts per billion (ppb) and had remained relatively stable since April 2003. See our assessment table below.

Rondar Inc. Furan Assessment	
< 100 ppb	Good Condition
250 ppb	Fair to Poor Condition
> 500 ppb	Undergone Severe Deterioration
*ppb = parts per billion	

The results of the dissolved gas-in-oil indicate that the levels of ethylene, carbon monoxide and carbon dioxide have increased; caused by a higher than normal temperature in the insulation. These three (3) gases are produced in conjunction with excessive heating of the paper insulation and provide support our comments regarding furan levels.

We consider the reliability of the transformer to be moderate and without an increase in the supplied load; the transformer is suitable for continued service. However, due to previous damage to the paper insulation, we recommend completing annual oil sampling to monitor the oil properties and dissolved gases. A change in these concentrations would indicate a fault is developing within the transformer and corrective action is required.

4.5 Switchgear and Enclosure Assessment

The indoor switchgear is mounted in a residential style building that is suitable for this application and appears to be in satisfactory condition. The temperature within the building was found to be suitable; however, we recommend installing a climate control system to regulate the inside temperature which would benefit the life span of any electronic devices, especially the DC battery bank.

We request that a company specializing in structure assessments be contacted if further details regarding the structural condition of the building are required.

Switchgear Assessment

The General Electric Switchgear is a Metal Clad type enclosure that is approximately 50 years old. The switchgear contains the following components:

- One set of three (3) metering potential transformers
- One set of three (3) metering current transformers
- Four (4) oil-filled circuit breakers with DC controls
- Three (3) bar type current transformers per breaker. The current transformers are mounted on the load side bus of the breakers and used for relay protection
- Three (3) phase over current relays per breaker

The main bus work of the switchgear is horizontally mounted in the top front area behind covers. The bus bars are insulated throughout and isolated from each cell by a metal plate. Our preventative maintenance reports have concluded that the measured insulation resistance, with reference to the *NETA Standard Table 10.1*, is suitable for continued service. Based on the age of the insulation and assuming a moderate temperature, the elasticity of the insulation has deteriorated. The amount of deterioration since original construction is unknown and it is difficult to visually inspect the main bus work due to barriers. As the elasticity properties of

the insulation deteriorates, it causes the insulation to become brittle which can result in cracks or breakage during a fault.

The components and wiring of the switchgear are operating as required to provide the necessary control power to the associated equipment. As above, the components have reached or are near the end of their service life and reliability is questionable. The repair time necessary to locate, investigate and retrofit new control equipment into this switchgear will be time consuming, expensive and significant downtime would be required.

5kV Oil Circuit Breakers (OCB)

The General Electric oil circuit breakers use insulating oil as a dielectric medium to insulate the 'live' parts for metal surfaces and minimize the electric arc during opening/closing operations. During each operation of the breaker, carbon is produced and it slowly contaminates the oil, affecting the dielectric property. This requires the insulating oil to be replaced and increases the annual preventative maintenance costs.

The main contacts, current carrying components and a majority of the operating mechanisms are submersed in 15 U.S. gallons of oil and can only be visually inspected by removing the tank. Our records indicate that the internal components were inspected in 1999; the arcing contact was reported to be in very poor condition. At this time, we would expect significant component deterioration and replacement would be necessary. Furthermore, based on the age of the device, the spring tensions and excessive wearing on various shafts, bearings and latches can contribute to trip free and mechanical nuisance problems that affect the reliability of these breakers. Factory replacement parts for this type of breaker are not available and therefore 'used' parts are the only option. Used parts for these breakers are difficult to locate and often do not work without further modifications.

Relay Protection

A solidly grounded system provides a high level of safety and fault detection when the proper protective devices are applied and coordinated correctly. The existing configuration of the protection devices provides over current protection on the 'A' and 'C' phases along with residual ground fault protection. This protection design was adequate when the system was designed, however, does not provide complete protection for the components of the distribution network supplied by the phase 'B' circuit.

This deficiency can be corrected by adding an additional induction disc relay or upgrading the relay protection to a modern microprocessor based device. A modern microprocessor based device can provide significant advantages to Midland PUC including personnel safety and system reliability through the following:

- Fault Location:
  An event recorder can provide information pertaining to the system prior to the breaker operation, faulted phase, fault type, and general fault location.
- Remote Monitoring and Control
  This requires a supervisory type communication between the relay and a remote location. This can provide a variety of information such as: voltages, currents, watts, Vars, VAs, device status, remote operation (i.e. hold offs) and can be configured to meet your requirements.
- Equipment Protection (Voltage and Current):
  More sensitive relay settings can be applied to provide optimum equipment protection.
- Other Available Features:
  Re-closure, synchronism check, directional elements, frequency check, breaker controls.

Based on our assessment of the metal clad switchgear, oil-filled circuit breakers, induction disc relays and various components, we recommend replacing the existing switchgear, breakers and relay protection devices.

Battery Bank

The battery bank appears to be within five (5) years old and the general condition of the charger, liquid levels and terminal connections are satisfactory. The output voltage of the existing bank is 50VDC and would require upgrading to a 120VDC system, if the switchgear is replaced.

4.6 Arc Flash Protection (NFPA 70E)

Generally, the equipment meets the requirements of the *National Fire Protection Association Code 70E (NFPA 70E)*, except as noted below:

With reference to *Annex K of the NFPA 70E*, the design of medium voltage metal clad switchgear does not provide an arc pressure relief device(s) that would allow the pressures developed during an internal arc to be vented away safely from the front and rear of the switchgear. This feature assists in the protection of personnel, in proximity to the switchgear, from dangerous temperatures and the pressures that are developed when an internal arc flash occurs. The vent(s) or flaps are designed and placed in areas that safely direct the pressure, gases away from the operator and areas where personnel generally position themselves.

Article 210.5 and 410.9(B)(1)(a) recommends that the protective devices be maintained and able to withstand or interrupt the available fault current and provide proper current protection. The breakers, current transformers and relays are suitable to interrupt the fault current; however, the configuration of the relay protection devices does not include ground fault protection and relies solely on the over current elements to clear a fault. We recommend upgrading the relay protection to a three (3) phase and ground fault over current protection scheme to provide optimum equipment and personnel protection.

The oil-filled circuit breakers utilize a vertical lift type insertion system that requires the door to be open and operator to be directly in front of the breaker in the cell. This inherently places the operator in the most dangerous position if the insertion system or an electrical component(s) fails during its operation or racking onto the live 5kV bus. Furthermore, to manually operate the breaker places the operator in the same position. *NFPA 70E, Table 130.7(C)(9)(a), page 70E-31, for "Metal Clad Switchgear, 1kV and Above"* assesses the hazard/risk of the manual operation, insertion and removal of this type of breaker from live bus work to be their highest category of 4. Based on the hazard/ risk assessment, we recommend that the breakers not be racked in or removed from energized bus work and to be electrically operated only with the door closed.

4.7 Conclusion

Based on the results of our assessment and preventative maintenance reports, the condition of the primary switch, fuse and transformer are suitable for continued service at this time. We recommend upgrading the primary lightning arresters to increase the surge protection for the downstream devices. Due to age, availability of replacement parts, maintenance costs and low reliability, we recommend replacing the complete switchgear assembly. Modernizing the substation to meet current Ontario Electrical Safety Code, National Fire Protection and IEEE Standards would increase system reliability and ensure safety to both utility personnel and the general public.

The following is a summary of our recommendations;

1) As per the *Ontario Electrical Safety Code 10.002(a), 36-312(1) and Table 52*, we recommend installing a ground conductor that loops one (1) metre outside the perimeter of the existing substation metallic fence enclosure and connecting this conductor to the substation ground grid. This ensures that the step and touch potential between the metallic fence and one (1) metre from the fence is minimized and eliminates a potential shock hazard during a fault.

2) As per the Ontario Electrical Safety Code 36-302(c), we recommend completing the copper loop around the equipment located in the outdoor substation by installing a 4/0 copper link between the two (2) rods located at the east end of the transformer concrete pad.

3) With reference to the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and ground bus within the switchgear. The second connection is a redundant bonding connection to ensure the switchgear remains bonded to the ground grid if a fault occurs.

4) As per the *Ontario Electrical Safety Code 36-304(5)* and *Table 52* and in the interest of personnel safety, we recommend removing the yard debris (i.e. leaves), applying a herbicide and adding three (3) inches of crushed stone to the substation to ensure the dielectric protection.

5) As per the *Ontario Electrical Safety Code 36-310(1)*, we recommend installing flexible connections between the ground grid and operating switch handle to ensure the potential difference is minimized.
6) We recommend upgrading the bonding connection between the three (3) lightning arresters located on the tower structure to include a continuous loop to a second connection to the ground grid. A second connection provides a redundant path to discharge equipment damaging voltages and currents during a severe power surge.
7) As per the *Ontario Electrical Safety Code 36-312(4) and Table 52,* the ground conductor should be woven throughout the fence fabric in at least two (2) places and a maximum of three (3) spans between connections. We recommend adding split bolts to secure the bonding conductor to the fence fabric in at least two (2) places per conductor.
8) As per the *Ontario Electrical Safety Code 26-300*, we recommend that the six (6) broken fence posts and top strands of barbed wire be replaced, as soon as possible, to prevent unauthorized entry into the substation.
9) Considering the 5000kVA rating of the power transformer, we recommend upgrading the lightning arresters from an intermediate to station class arrester.
10) We recommend installing a climate control system to regulate the inside temperature of the building which would benefit the life span of any electronic devices, especially the DC battery bank.
11) We consider the reliability of the transformer to be moderate and without an increase in the supplied load; the transformer is suitable for continued service. However, due to previous damage to the paper insulation, we recommend completing annual oil sampling to monitor the oil properties and dissolved gases. A change in these concentrations would indicate a fault is developing within the transformer and corrective action is required.
12) Based on our assessment of the metal clad switchgear, oil-filled circuit breaker, induction disc relays and various components, we recommend installing new switchgear complete with vacuum air circuit breakers and a stand alone relay panel.
13) *NFPA 70E, Table 130.7(C)(9)(a), page 70E-31, for "Metal Clad Switchgear, 1kV and Above"* assesses the hazard/risk of the manual operation, insertion and removal of this type of breaker from live bus work to be their highest category of 4. Based on the hazard/ risk assessment, we recommend that the breakers not be racked in or removed from energized bus work and to be electrically operated only with the door closed.

RONDAR INC.

Section 5

FOURTH STREET SUBSTATION

5.1 System Overview

The Fourth Street Substation is supplied by the Hydro One 44kV Feeder designated as the 'M4' circuit. It is connected to the gang-operated 46kV air break switch designated 'A37T1-L' located at the station. The equipment located in the outdoor substation consists of one (1) gang-operated air break switch, one set of three (3) lightning arresters, one (1) set of three (3) over current protection fuses and one (1) three phase, 3 MVA, power transformer. The secondary of the transformer is directly connected to the main bus of the indoor switchgear via a three (3) conductor cable. The indoor switchgear has six (6) cells that contain three (3) oil-filled circuit breakers, metering device, protection and control equipment.

5.2 Ground Grid and Bonding Assessment

The ground grid consists of five (5) ¾ inch diameter, copper ground rods that are interconnected utilizing 4/0 AWG bare copper and forms a loop around the equipment located in the substation. The mechanical connectors used to connect the bare copper wire to the ground rods are suitable for direct burial and are in good condition.

The bonding of the equipment to the substation ground grid was found to be as follows:
A connection to each footing of the tower structure, two (2) connections to the transformer tank, one (1) connection to the indoor switchgear, one (1) connection to the lightning arresters and one (1) connection to the gang-operated high voltage switch but not to the switch handle. The fence fabric was found to be connected to the ground grid and requires the connections to the fence fabric and barbed wire to be revamped to meet the Ontario Electrical Safety Code.

The integrity of the fence enclosure was inspected and found to be generally in suitable condition but does not prevent unauthorized entry. A significant gap located between the south corner fence post and the north wall of the Parks and Recreation Building would allow a smaller person to gain entry into the substation. A temporary solution should be developed and administered, as soon as possible, to ensure public safety.

Based on our assessment, we recommend the following deficiencies be corrected.

1) As per the *Ontario Electrical Safety Code 10.002(a), 36-312(1) and Table 52*, we recommend installing a ground conductor that loops one (1) metre outside the perimeter of the existing substation metallic fence enclosure, where possible, and connect this conductor to the substation ground grid. This ensures that the step and touch potential between the metallic fence and one (1) metre from the fence is minimized and eliminates a potential shock hazard during a fault.
2) With reference to the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and ground bus within the switchgear. The second connection is a redundant bonding connection to ensure the switchgear remains bonded to the ground grid if an external and/or internal fault occurs.

3) As per the *Ontario Electrical Safety Code 36-304(5)*and *Table 52* and in the interest of personnel safety, we recommend removing the yard debris (i.e. leaves), applying a herbicide and adding three (3) inches of crushed stone to the substation to ensure the dielectric protection.
4) As per the *Ontario Electrical Safety Code 36-310(1)*, we recommend installing flexible connections between the ground grid and the operating switch handle to ensure the potential difference is minimized.
5) We recommend upgrading the bonding connection between the three (3) lightning arresters located on the tower structure to include a continuous loop to a second connection to the ground grid. A second connection provides a redundant path to discharge equipment damaging voltages and currents during a severe power surge.
6) As per the *Ontario Electrical Safety Code 36-312(4) and Table 52,* the ground conductor should be woven throughout the fence fabric in at least two (2) places and maximum of three (3) spans between connections. We recommend adding split bolts to secure the bonding conductor to the fence fabric in at least two (2) places per conductor.

5.3 Tower Structure and Components Assessment

The condition of the galvanized steel and hardware on the outdoor tower structure was found to be in satisfactory condition.

The current carrying bus work is copper IPC and supported by polymer station post and porcelain cap and pin style insulators. The clearances between the bus work and grounded surfaces are suitable for continued service, however, we recommend replacing the cap and pin insulators as soon as possible. We have experienced a higher than normal failure of this type of insulator and believe it to be a result of natural deterioration.

Primary 44kV Air Break Switch

The primary air break switch is rated for 46kV and 600 amperes. The ratings of this switch are satisfactory for the application; however, this product is no longer supported by the manufacturer, making replacement parts unavailable. The design of the switch is as an air break switch and does not have load breaking capabilities and requires a key interlock system to prevent operation of the switch under load. Our preventative maintenance reports indicate that the silver plating on the main contact surfaces and current carrying flex braids have significantly deteriorated.

Based on the unavailability of parts, manufacturer support and the condition of the existing switch, we recommend upgrading the air break switch to an S&C, Alduti Rupter, load break switch rated for a maximum voltage of 48.3kV with a continuous current of 600A and interrupt capacity of 40000 amperes.

Primary Fuse Protection

The primary protection fuses mounted vertically on the tower structure are manufactured by General Electric and have since been discontinued.

Based on the availability of parts and manufacturer support, we recommend upgrading the primary fuses to an S&C, SMD fuse assembly.

Lightning Arresters

The three (3) lightning arresters located on the tower structure and connected to the 44kV bus work are of a porcelain gap type constructed arrester and manufactured by General Electric. The gap type arrester is prone to failure due to moisture ingress into the semi-conductive material within the unit. The moisture reduces the resistance of the components with the arresters directly affecting the kV and maximum continuous operating voltage (M.C.O.V.) rating of the device and the reliability of surge protection.

We recommend replacing the three (3) lightning arresters with polymer, metal oxide, station class arresters rated for 48kV and 39 MCOV.

5.4 Transformer Assessment – General Electric, s/n 280019.

The General Electric power transformer, s/n 280019, has a capacity of 3 MVA and is configured with a primary 44000 volt, delta connected primary winding and a secondary 4160 volt, wye configured, winding. The secondary neutral bushing is directly connected to the substation ground grid and is commonly referred to as a "solidly grounded Wye system". The General Electric transformer was constructed in 1954 and has provided service for approximately 52 years.

The south side of the concrete pad that supports the transformer has shifted resulting in that side of the pad settling lower into the ground. This causes the transformer to lean and is presently at an approximate 5 to 10 degree angle. This can affect the cooling of the dielectric fluid and can cause the transformer to operate at a higher temperature.

The primary 44kV porcelain bushings are in poor condition with evidence of tracking on the H2 and H3 bushings. At the time of the last inspection, the insulation resistance of the bushings had not been affected however, integrity and reliability are questionable.

The result of the Furfuraldehyde (Furan) analysis concludes that the paper insulation is in poor condition. Furans are produced when elevated temperatures cause damage to the paper insulation. In October 2005, the actual furan level was 301 parts per billion (ppb) and had increased since October 2003. See our assessment table below.

Rondar Inc. Furan Assessment	
< 100 ppb	Good Condition
250 ppb	Fair to Poor Condition
> 500 ppb	Undergone Severe Deterioration
*ppb = parts per billion	

The results of the dissolved gas-in-oil indicate that the levels of carbon monoxide and carbon dioxide had increased due to a higher than normal temperature in the insulation. These gases are produced in conjunction with excessive heating of the paper insulation and support our comment regarding furan levels.

Based on the moderate degradation of the paper insulation and the condition of primary bushings, we recommend replacing the transformer within one (1) year. We also recommend that the oil filled lead secondary cable connecting the transformer to the indoor switchgear be replaced at this time.

5.5 Switchgear and Enclosure Assessment

The indoor switchgear is mounted within a commercial building that is suitable for this application and appears to be in satisfactory condition. The temperature within the building was found to be acceptable.

We request that a company specializing in structure assessments be contacted if further details regarding structural condition of the building are required.

5.6 Switchgear Assessment

The General Electric Switchgear is a Metal Clad type enclosure that is approximately 50 years old. The switchgear contains the following components:

- One set of three (3) metering potential transformers
- One set of three (3) metering current transformers
- Three (3) oil-filled circuit breakers with DC controls
- Three (3) bar type current transformers per breaker. The current transformers are mounted on the load side bus of the breakers and used for relay protection.
- Three (3) phase over current relays per breaker

The main bus work of the switchgear is horizontally mounted in the top front area behind covers. The bus bars are insulated throughout and isolated from each cell by a metal plate. Our preventative maintenance reports have concluded that the measured insulation resistance, with reference to the *NETA Standard Table 10.1*, is suitable for continued service. Based on the age of the insulation and assuming a moderate temperature, the elasticity of the insulation has deteriorated. The amount of deterioration since original construction is unknown and it is

difficult to visually inspect the main bus work due to barriers. As the elasticity properties of the insulation deteriorates, it causes the insulation to become brittle which can result in the insulation starting to crack or break during a fault.

The components and wiring of the switchgear are operating as required to provide the necessary control power to the associated equipment. As above, the components have reached or are near the end of their service life and their reliability is questionable. The repair time necessary to locate, investigate and retrofit in new control equipment into this switchgear will be time consuming, expensive and significant downtime would be required.

5kV Oil Circuit Breakers (OCB)

The General Electric oil blast circuit breakers use insulating oil as a dielectric medium to insulate the 'live' parts from metal surfaces and minimize the electric arc during opening/closing operations. The breaker consists of six (6) bushings, two (2) sets of contacts per phase, one (1) closing coil (cc), one (1) tripping coil (tc) and necessary operating mechanisms to perform opening and closing functions. The breakers can be either opened or closed manually or electrically. We consider the age of the oil-filled circuit breakers to be the same vintage as the switchgear and transformer.

The main contacts, current carrying components and a majority of the operating mechanisms are submersed in 15 U.S. gallons of oil and can only be visually inspected by removing the tank. We do not have any records of an inspection of the internal components of the breakers. Furthermore, based on the age of the device, the spring tensions and excessive wearing on various shafts, bearings, latches and contact surfaces can contribute to trip free and mechanical nuisance problems that affect the reliability of these breakers. Factory replacement parts for this type of breaker are not available and therefore 'used' parts are the only option. Used parts are difficult to locate for these breakers and often do not work without further modifications.

Relay Protection

A solidly grounded system provides a high level of safety and fault detection when the proper protective devices are applied and coordinated correctly. The design of the protection system incorporates three (3) bar type current transformers, one per phase per breaker, that provide a current signal to each phase over current relay. Each breaker is equipped with one (1) over current relay per phase, however, is not equipped with a relay to sense a ground fault on the system. This is an error in the design of the relay protection system which can result in significant equipment damage in the event of a ground fault. The 4160 volt system is a solidly grounded wye system and based on the present relay settings, an electrical arc could develop between any one (1) phase and ground before the relay protection recognizes a fault is occurring. Whether or not the ground fault is sensed, depends solely on the resistance of the ground fault, I=V/R, with the resistance being variable. Furthermore, the existing protection may not sense a ground fault until it develops into a two (2) phase or three (3) phase fault; resulting in significant equipment damage.

The induction disc relays have provided an exceptional service life but are limited to visual indication of the protection function that operates during a fault. Upgrading the relay

protection to a modern microprocessor based device can provide significant advantages to Midland PUC, personnel safety, system protection and reliability through the following:

- Fault Identification
  An event recorder can provide information pertaining to the system prior to the breaker operation, faulted phase, fault type, and general fault location.
- Remote Monitoring and Control
  This requires a supervisory type communication between the relay and a remote location. This can provide a variety of information such as: voltages, currents, watts, Vars, VAs, device status, remote operation (i.e. hold offs) and can be configured to meet your requirements.
- Equipment Protection (Voltage and Current):
  More sensitive relay settings can be applied to provide optimum equipment protection.
- Other Available Features:
  Re-closure, synchronism check, directional elements, frequency check, breaker controls.

Based on our assessment of the metal clad switchgear, oil-filled circuit breakers, induction disc relays and various components, we recommend installing new switchgear, breakers and protection relays.

Battery Bank

The battery bank appears to be within five (5) years old and the general condition of the charger, liquid levels and terminal connections are satisfactory. The output voltage of the existing bank is 50VDC and would require upgrading to a 120VDC system, if the switchgear is replaced.

5.7 Arc Flash Protection (NFPA 70E)

Generally, the equipment meets the requirements of the *National Fire Protection Association Code 70E (NFPA 70E)*, except as noted below.

With reference to *Annex K of the NFPA 70E*, the design of medium voltage metal clad switchgear does not provide an arc pressure relief device(s) that would allow the pressures developed during an internal arc to be vented away safely from the front and rear of the switchgear. This feature assists in the protection of personnel in proximity to the switchgear from dangerous temperatures and the pressures that are developed when an internal arc flash occurs. The vent(s) or flaps are designed and placed in areas that safely direct the pressure, gases away from the operator and areas where personnel generally position themselves.

Article 210.5 and 410.9(B)(1)(a) recommends that the protective devices be maintained and able to withstand or interrupt the available fault current and provide proper current protection. The breakers, current transformers and relays are suitable to interrupt the rated current; however, the configuration of the relay protection devices does not include three (3) phase over

current protection and relies solely on the over current elements to clear a fault on the phase 'B'. We recommend upgrading the relay protection to a three (3) phase and ground fault over current protection scheme to provide optimum equipment and personnel protection.

The oil-filled circuit breakers utilize a vertical lift type insertion system that requires the door to be open and operator to be directly in front of the breaker in the cell. This inherently places the operator in the most dangerous position if the insertion system or an electrical component(s) fails during its operation or racking onto the live 5kV bus. Furthermore, to manually operate the breaker places the operator in the same position. *NFPA 70E, Table 130.7(C)(9)(a), page 70E-31, for "Metal Clad Switchgear, 1kV and Above"* assesses the hazard/risk of the manual operation, insertion and removal of this type of breaker from live bus work to be their highest category of 4. Based on the hazard/risk assessment, we recommend that the breakers not be inserted or removed from energized bus work and electrically operating the breaker(s) only with the door closed.

5.8 Conclusion

Based on the results of our assessment and preventative maintenance reports, we recommend replacing the complete substation from the 44kV incoming feeder to the 5kV feeder cables. All of the major and minor components are obsolete and deteriorated to the point of replacement. Modernizing the substation to meet current Ontario Electrical Safety Code, National Fire Protection and IEEE Standards would increase system reliability and ensure safety to both utility personnel and the general public.

The following is a summary of our recommendations;

1) As per the *Ontario Electrical Safety Code 10.002(a), 36-312(1) and Table 52*, we recommend installing a ground conductor that loops one (1) metre outside the perimeter of the existing substation metallic fence enclosure, where possible, and connect this conductor to the substation ground grid. This ensures that the step and touch potential between the metallic fence and one (1) metre from the fence is minimized and eliminates a potential shock hazard during a fault.
2) With reference to the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and ground bus within the switchgear. The second connection is a redundant bonding connection to ensure the switchgear remains bonded to the ground grid if an external and/or internal fault occurs.
3) As per the *Ontario Electrical Safety Code 36-304(5)* and *Table 52* and in the interest of personnel safety, we recommend removing the yard debris (i.e. leaves), applying a herbicide and adding three (3) inches of crushed stone to the substation to ensure the dielectric protection.
4) As per the *Ontario Electrical Safety Code 36-310(1)*, we recommend installing flexible connections between the ground grid and the operating switch handle to ensure the potential difference is minimized.

5) We recommend upgrading the bonding connection between the three (3) lightning arresters located on the tower structure to include a continuous loop to a second connection to the ground grid. A second connection provides a redundant path to discharge equipment damaging voltages and currents during a severe power surge.

6) As per the *Ontario Electrical Safety Code 36-312(4) and Table 52,* the ground conductor should be woven throughout the fence fabric in at least two (2) places and a maximum of three (3) spans between connections. We recommend adding split bolts to secure the bonding conductor to the fence fabric in at least two (2) places per conductor.

7) We recommend replacing the cap and pin insulators as soon as possible. We have experienced a higher than normal failure of this type of insulator and believe it to be a result of natural deterioration.

8) Based on the unavailability of parts, manufacturer support and the condition of the existing switch, we recommend upgrading the air break switch to an S&C, Alduti Rupter, load break switch rated for a maximum voltage of 48.3kV with a continuous current of 600A and interrupt capacity of 40000 amperes.

9) Based on the availability of parts and manufacturer support, we recommend upgrading the primary fuses to a S&C, SMD fuse assembly

10) We recommend replacing the three (3) lightning arresters with polymer, metal oxide, station class arresters rated for 48kV and 39 MCOV.

11) Based on the moderate degradation of the paper insulation and the condition of primary bushings, we recommend replacing the transformer within one (1) year. We also recommend that the oil filled lead secondary cable connecting the transformer to the indoor switchgear be replaced at this time.

12) Based on our assessment of the metal clad switchgear, oil-filled circuit breakers, induction disc relays and various components, we recommend installing new switchgear, breakers and protection relays.

13) We recommend modernizing the protection relays to a microprocessor based device and mounting the relays in a stand alone panel adjacent to the switchgear panel. This will allow personnel to view the relay information without having to be directly in front of the switchgear and provide more sensitive protection.

14) *NFPA 70E, Table 130.7(C)(9)(a), page 70E-31, for "Metal Clad Switchgear, 1kV and Above"* assesses the hazard/risk of the manual operation, insertion and removal of this type of breaker from live bus work to be their highest category of 4. Based on the hazard/risk assessment, we recommend that the breakers not be inserted or removed from energized bus work and electrically operating the breaker(s) only with the door closed.

RONDAR INC.

Section 6

MONTREAL STREET SUBSTATION

6.1 System Overview

The Montreal Street Substation is supplied by the Hydro One 44kV Feeder designated as the 'M4' circuit. It is connected to the gang-operated 48.3kV load break switch designated 'E37T1-L' located at the station. The equipment located in the outdoor substation consists of one (1) gang-operated air break switch, one (1) set of three (3) lightning arresters, one (1) set of three (3) over current protection fuses and one (1) three phase, 10 MVA, power transformer. The secondary of the transformer is directly connected to the main bus of the indoor switchgear via a metal enclosed bus duct. The indoor switchgear has six (6) cells that contain five (5) circuit breakers, metering devices, protection and control equipment.

6.2 Ground Grid and Bonding Assessment

The ground grid consists of four (4) ¾ inch diameter, copper ground rods that are interconnected utilizing 4/0 AWG bare copper and forms a loop around the equipment located in the substation. The mechanical connectors used to connect the bare copper wire to the ground rods are suitable for direct burial and are in good condition. No further action is required

The bonding of the equipment to the substation's ground grid was found to be as follows:

A connection to each footing of the tower structure; two (2) connections to the transformer tank; one (1) connection to the indoor switchgear, one (1) connection to the lightning arresters and one (1) connection to the gang-operated high voltage switch and switch handle. The fence, fence fabric, posts and barbed wire were found to be connected to the ground grid and meet the requirements of the Ontario Electrical Safety Code. No further action is required

The integrity of the fence prevents unauthorized entry into the substation, therefore, provides adequate protection to the public. No further action is required.

Based on our assessment, we recommend the following deficiencies be corrected:

1) As per the *Ontario Electrical Safety Code 10.002(a),36-312(1) and Table 52*, we recommend installing a ground conductor that loops one (1) metre outside the perimeter of the existing substation metallic fence enclosure, where possible, and connect this conductor directly to the substation ground grid. This ensures that the step and touch potential between the metallic fence and one (1) metre from the fence is minimized and eliminates a potential shock hazard during a fault.
2) As per the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and ground bus within the switchgear. The second connection is a redundant bonding connection to ensure the switchgear remains bonded to the ground grid if an external and/or internal fault occurs.
3) We recommend upgrading the bonding connection between the three (3) lightning arresters located on the tower structure to include a continuous loop to a second connection to the ground grid. A second connection provides a redundant path to discharge equipment damaging voltages and currents during a severe power surge.

6.3 Tower Structure and Components Assessment

Aluminium Tower Structure

The condition of the aluminium outdoor tower structure is presently in good condition. The visual inspection of the two (2) concrete footings and tower bases concluded there is no significant deterioration.

The current carrying bus work is four (4) inch aluminium IPC and supported with porcelain station post style insulators. The insulation rating and clearances between the primary buses and grounded surfaces are suitable for the voltage rating.

No further action is required.

Primary 44kV Air Break Switch

The air break switch located on the top of the tower structure was manufactured by CLM Industries and as per our preventative maintenance reports, the condition of the current carrying components are suitable for continued service.

The voltage, current and basic impulse level of the switch is suitable for the application and suitable for continued service

Primary Fuse Protection

The primary protection fuses mounted vertically on the tower structure are manufactured by S&C Electric and replacement fuse links are readily available, if required.

The short circuit, voltage and over current ratings the fuse units provide excellent equipment protection and are suitable for this application.

No further action is required.

Lightning Arresters

The three (3) lightning arresters located on the tower structure and connected to the 44kV bus work are of a polymer, metal oxide type arrester and manufactured by General Electric.

We recommend replacing the three (3) lightning arresters with polymer, metal oxide station class arresters rated for 48kV and 39 MCOV.

6.4 Transformer Assessment – Northern Transformer, s/n 290-711.

The Northern Transformer power transformer, s/n 290-71, has a capacity of 10 MVA and is configured with a primary 44000 volt, delta connected primary winding and a secondary 4160 volt, wye configured winding. The secondary neutral bushing is directly connected to the substation ground grid and commonly referred to as a "solidly grounded Wye system". This transformer was constructed in 1990 and has provided approximately 16 years of service.

Based on the inspection and test results from the 2005 preventative maintenance, the condition of the transformer is satisfactory.

The results of the standard, water content, dissolved gas-in-oil and furan analyses conclude that the fault gas and oil properties are within normal operating limits and suitable for continued service.

We consider the transformer to have a low potential for failure and at this time no further action is required.

6.5 Enclosure Assessment

The indoor switchgear is mounted within a residential style building that is suitable for this application and appears to be in satisfactory condition. The temperature within the building was found to be suitable; however, we recommend installing a climate control system to regulate the inside temperature which would benefit the life span of any electronic devices.

We request that a company specializing in structural assessments be contacted if further details regarding structural condition of the building are required.

6.6 Switchgear Assessment

Switchgear Enclosure

The CLM Industries switchgear is a Metal Clad type enclosure that is approximately 20-25 years old. The switchgear contains the following components:

- One set of three (3) metering potential transformers.
- One set of three (3) metering current transformers.
- Five (5) breakers with DC controls.
- Three (3) bar type current transformers per breaker. The current transformers are mounted on the load side bus of the breakers and used for relay protection.
- Three (3) phase over current relays per breaker.

The main bus work of the switchgear is horizontally mounted in the bottom rear area behind covers.

Our preventative maintenance reports have concluded that the measured insulation resistance, with reference to the *NETA Standard Table 10.1*, is suitable for continued service. Based on the age of the insulation and assuming a moderate temperature, the elasticity of the insulation has deteriorated. The amount of deterioration since original construction is unknown and it is difficult to visually inspect the main bus work due to barriers. As the elasticity properties of the insulation deteriorates, it causes the insulation to become brittle which can result in the insulation starting to crack or break during a fault.

The components and wiring of the switchgear are operating as required to provide the necessary control power to the associated equipment.

We consider the reliability of the switchgear and its components to have a low potential for failure, however, recommend completing breaker timing tests to measure the contact travel time, rebound and actual opening time to ensure the operating mechanism is functioning within the manufacturer's recommended limits.

A serious safety hazard is present involving the cable connections between the main secondary bus duct from the outdoor transformer and the cell designated 'Main B'. The stress cones at both ends of the cables are left unguarded and in open air, lying on the top cover of the switchgear. The potential for equipment damage, electrical shock or serious injury could occur if the area is accidentally contacted. We recommend removing the existing cables and installing them into the back of the switchgear and routing them through the cable pit to the 'Main B' switchgear cell. Furthermore, power fuses should be installed to protect the cable and to co-ordinate with the primary transformer protection fuses. Installing fuses will ensure that a cable fault will not disrupt the entire distribution system.

5kV Air Circuit Breakers

The type of circuit breaker, voltage, continuous current, interrupt capacity and basic impulse level (BIL) meet the requirements of the supply system and are suitable for continued service.

Based on comments from our previous reports, we consider the reliability of the switchgear and its components to be suitable for continued service.

Relay Protection

A solidly grounded system provides a high level of safety and fault detection when the proper protective devices are applied and coordinated correctly. The design of the protection system incorporates three (3) bar type current transformers, one per phase per breaker, that provide a current signal to each phase over current relay. Each breaker is equipped with one (1) over current relay per phase, however, is not equipped with a relay to sense a ground fault. This is an error in your protection system that can result in significant equipment damage in the event of a ground fault. The 4160 volt system is a solidly grounded wye system and based on the present relay settings, an electrical arc could develop between any one (1) phase and ground before the relay protection recognizes a fault is occurring. Whether or not the ground fault is sensed, depends solely on the resistance of the ground fault, I=V/R, with the resistance being variable. Furthermore, the existing protection may not sense a ground fault until it develops into a two (2) phase or three (3) phase fault.

The induction disc relays have provided an exceptional service life but are limited to visual indication of the protection function that operates during a fault.

Upgrading the relay protection to modern microprocessor based devices can provide significant advantages to Midland PUC, personnel safety, system protection and reliability through the following:

- Fault Identification
  An event recorder can provide information pertaining to the system prior to the breaker operation, faulted phase, fault type, and general fault location.
- Remote Monitoring and Control
  This requires a supervisory type communication between the relay and a remote location. This can provide a variety of information such as: voltages, currents, watts, Vars, VAs, device status, remote operation (i.e. hold offs) and can be configured to meet your requirements.
- Equipment Protection (Voltage and Current):
  More sensitive relay settings can be applied to provide optimum equipment protection.
- Other Available Features:
  Re-closure, synchronism check, directional elements, frequency check, breaker controls.

We recommend installing a residual connected ground fault relay to sense and trip the associated breaker, as soon as possible, and/or strongly recommend modernizing the protection relays to a microprocessor based device and mounting the relays in a stand alone panel adjacent to the switchgear panel. This will allow personnel to view the relay information without having to be directly in front of the switchgear and provide more sensitive protection.

6.7 Arc Flash Protection (NFPA 70E)

Generally, the equipment meets the requirements of the *National Fire Protection Association Code 70E (NFPA 70E)*, except as noted below:

With reference to *Annex K of the NFPA 70E*, the design of medium voltage metal clad switchgear does not provide an arc pressure relief device(s) that would allow the pressures developed during an internal arc to be vented away safely from the front and rear of the switchgear. This feature assists in the protection of personnel in proximity to the switchgear from dangerous temperatures and the pressures that are developed when an internal arc flash occurs. The vent(s) or flaps are designed and placed in areas that safely direct the pressure, gases away from the operator and areas where personnel general position themselves.

Article 210.5 and 410.9(B)(1)(a) recommends that the protective devices be maintained and able to withstand or interrupt the available fault current and provide proper current protection. The breakers, current transformers and relays are suitable to interrupt the rated current; however, the configuration of the relay protection devices does not include ground fault protection. As stated above, we recommend upgrading the relay protection to include ground fault protection that would increase the safety of your distribution system and personnel.

The CLM air circuit breakers are mounted on a truck assembly that allows the breaker to be inserted and removed on a horizontal track system. In order to insert or remove the breaker from the cell, the operator must access the racking mechanism by opening the cell door. This inherently places the operator in the most dangerous position if the insertion system or an electrical component(s) fails during its operation or racking onto or off of live 4160V bus. Furthermore, to manually operate the breaker places the operator in the same position.

NFPA 70E, Table 130.7(C)(9)(a), page 70E-31, for "Metal Clad Switchgear, 1kV and Above" assesses the hazard/risk of the manual operation, insertion and removal of this type of breaker from live bus work to be their highest category of 4. Based on the hazard/ risk assessment, we recommend that the breakers not be inserted or removed from energized bus work and electrically operating the breaker(s) only with the door closed.

6.8 Conclusion

Our assessments indicate that minor upgrades to equipment bonding, relocation of the 'Main B' power cables and installation of ground fault protection relays to improve the safety of your electrical distribution system are required. We recommend your consideration to upgrade the existing induction disc relays with a microprocessor based system that would provide more information pertaining to the daily operation of the power system.

The following is a summary of our recommendations:

1) As per the *Ontario Electrical Safety Code 10.002(a),36-312(1) and Table 52*, we recommend installing a ground conductor that loops one (1) metre outside the perimeter of the existing substation metallic fence enclosure, where possible, and connect this conductor directly to the substation ground grid. This ensures that the step and touch potential between the metallic fence and one (1) metre from the fence is minimized and eliminates a potential shock hazard during a fault.

2) As per the *Ontario Electrical Safety Code 36-308(2)(b)*, we recommend installing a second bonding connection between the ground grid and ground bus within the switchgear. The second connection is a redundant bonding connection to ensure the switchgear remains bonded to the ground grid if an external and/or internal fault occurs.

3) We recommend upgrading the bonding connection between the three (3) lightning arresters located on the tower structure to include a continuous loop to a second connection to the ground grid. A second connection provides a redundant path to discharge equipment damaging voltages and currents during a severe power surge.

4) We recommend replacing the three (3) lightning arresters with polymer, metal oxide station class arresters rated for 48kV and 39 MCOV.

5) We consider the reliability of the switchgear and its components to have a low potential for failure, however, recommend completing a breaker timing test to measure the contact travel time, rebound and actual opening time to ensure the operating mechanism is functioning within the manufacturer's recommended limits.

6) A serious safety hazard is present involving the cable connections between the main secondary bus duct from the outdoor transformer and the cell designated 'Main B'. The stress cones at both ends of the cables are left unguarded and in open air, lying on the top cover of the switchgear. The potential for equipment damage, electrical shock or serious injury could occur if the area is accidentally contacted. We recommend removing the existing cables and installing them into the back of the switchgear and routing them through the cable pit to the 'Main B' switchgear cell. Furthermore, power fuses should be installed to protect the cable and to co-ordinate with the primary transformer protection fuses. Installing fuses will ensure that a cable fault will not disrupt the entire distribution system.

7) We recommend installing a residual connected ground fault relay to sense and trip the associated breaker, as soon as possible, and/or strongly recommend modernizing the protection relays to a microprocessor based device and mounting the relays in a stand alone panel adjacent to the switchgear panel. This will allow personnel to view the relay information without having to be directly in front of the switchgear and provide more sensitive protection.

8) *NFPA 70E, Table 130.7(C)(9)(a), page 70E-31, for "Metal Clad Switchgear, 1kV and Above"* assesses the hazard/risk of the manual operation, insertion and removal of this type of breaker from live bus work to be their highest category of 4. Based on the hazard/ risk assessment, we recommend that the breakers not be inserted or removed from energized bus work and electrically operating the breaker(s) only with the door closed.

RONDAR INC.

Section 7

2005 & 2003 MAINTENANCE REPORTS
Fourth, Queen & Montreal Street Substations

RONDAR INC.

January 5, 2006

Midland PUC
16984 Hwy #12
P.O. Box 820
Midland, Ontario
L4R 4P4

Attention: **Mr. Wayne Dupuis**

Subject: **Preventive Maintenance @ Fourth, Queen and Montreal Street Substations**
Our Ref. C1616

Dear Sir:

We are enclosing the results of the maintenance carried out at the Fourth, Queen and Montreal Street substations on October 17th, 18th & 19th, 2005, respectively.

In general, the results of the tests and inspections indicate that the equipment is suitable for service except as noted in the comments and recommendations.

If you have any questions or require further information, please do not hesitate to contact our office.

RONDAR INC.

Dan Brown, A.Sc.T.
Technical Service Representative

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RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Fourth Street Substation

1. The galvanization of the tower structure located in the outdoor substation has depleted. Although the deterioration is not a safety issue at this time, we recommend that it be monitored on a regular basis to ensure the integrity of the structure is not jeopardized.
2. The outdoor substation yard was found to have an excess of debris within it. We recommend that qualified personnel clean out this debris on a regular basis to ensure the dielectric properties of the yard.
3. The outdoor substation yard was found to have an excess of weeds growing within it. We recommend that an herbicide be applied annually to control this on-going problem and to ensure the dielectric properties of the crushed stone.
4. The depth of the crushed stone in the outdoor substation yard was found to be low. As per the Ontario Electrical Safety Rule 36-304 (5), we recommend that 150mm of crushed stone be added to the substation yard as soon as possible.
5. The fence enclosure surrounding the outdoor substation yard was found damaged. The top rail barbed wire holder was found broken and the corresponding middle rail was severely bent. We recommend that these items be repaired, as soon as possible, to ensure that unauthorized personnel do not gain entry into this area.
6. The main access gate and the man gate were found to be without corresponding bonds to ground. As per the Ontario Electrical Safety Rule 36-312 (3), we recommend that these grounds be installed, as soon as possible, to ensure that the touch potential of this enclosure stay within acceptable limits.
7. As previously reported, the flexible braided shunts on the high voltage air break switch located on the tower structure were found to be deteriorating. Due to the excessive deterioration, we recommend to replace these shunts during your next shutdown to ensure proper operation of the air break switch and prevent a potential failure
8. The insulators of the High Voltage Air Break Switch on the top of the tower were found contaminated with a type of carbon spray from the arcing whips operation. This has not affected their insulation value nor is it an immediate concern, but it should be noted since this problem will only get worse each time the switch is operated under potential. The remaining insulators appear to be significantly weathered and we recommend annual inspection.

COMMENTS AND RECOMMENDATIONS

Fourth Street Substation

9. The stationary and moving contact surfaces on the 'B' phase primary fuse located on the tower were found to have severe pitting. The contact surfaces were refurbished as much as possible during the last maintenance, however, the pitting seems to have reappeared. We recommend that this pitting be re-inspected during the next maintenance to monitor the severity of this problem.

10. It was noted that there is no Silica Gel Breather located on the Main Transformer, s/n 280019. As the temperature and load for this transformer increases and decreases, the oil level rises and falls creating a breathing effect. As the transformer "breathes", the possibility of moisture contaminating the insulating fluid is likely. Therefore, we recommend installing a silica gel breather on this transformer, at your earliest convenience, to help prevent the insulating fluid from absorbing moisture.

11. Evidence of tracking was found on the H2 and H3 high voltage bushings for the Main Transformer, s/n 280019 during the 2003 preventative maintenance and at this time no further deterioration has occurred. The insulation resistance value of the primary windings and bushings indicate that the insulation resistance has not deteriorated since the previous inspection; however, the integrity of the bushings remains questionable. We recommend replacing the three (3) primary bushings, as soon as possible, to prevent equipment failure during operation. Due to the age of this transformer, a replacement bushing would be difficult to locate in an emergency situation.

12. Fresh oil was found around both of the sample valves at the bottom of the tank on the Main Transformer, s/n 280019, which was also encountered during the 2003 preventative maintenance. The oil residue was removed and we recommend periodic inspection to determine the severity.

13. The paint condition of the Main Transformer, s/n 280019, is deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

14. The concrete pad of the Main Transformer was found to be sitting at an angle and will start to affect the effectiveness of the cooling radiators. We recommend levelling the transformer, as soon as possible, to ensure the heat can be dissipated from the oil as the manufacturer's design was intended.

COMMENTS AND RECOMMENDATIONS

Fourth Street Substation

15. The results of the standard analysis of the insulating fluid in the Main Transformer, s/n 280019, indicate that the interfacial tension and dielectric properties of the oil are below the minimum rating and the measured neutralization number is approaching the maximum limit. The results conclude that there is oxidization occurring and that polar contaminates are present within the oil. We recommend completing an inhibitor analysis, as soon as possible, to assess the level of oxidation resistance in the insulating fluid. Furthermore, based on previous results, our perception is that the oil has reached the end of its service life and a retro fill is recommended for continued service reliability.

16. The results of the dissolved gas-in-oil analysis on the Main Transformer, s/n 280019, indicate that the levels of carbon monoxide and carbon dioxide have increased since December 2003 and are a result of higher than normal temperature in the paper insulation. We recommend procuring a dissolved gas-in-oil sample in April 2006 to monitor and trend the gas content. The results will be used to further predict the end of service life of this transformer.

17. The results of the furan analysis on the Main Transformer, s/n 280019, indicate that the level of furans has increased since October 2003 indicating that the paper insulation has been subjected to heat stress during this time period. The furfuraldehyde (Furan) level has increased from 230 ppm (2003) to 301 ppm (2005) and is increasing at a rate of 1 PPB per day. The level of furans at this time is assessed as moderate deterioration of the paper insulation with a maximum level of 500 ppm. Based on previous furan results, trending for this transformer, the maximum furan level and the rate of rise of the furan gases, the reliable service life of the transformer has passed and replacement will be necessary within one (1) year. In the interim, we recommend procuring a sample for furan analysis in April 2006 to confirm the rate of rise to further predict the end of service life.

18. The entrance door to the indoor substation room was found to be missing a ground connection to a corresponding ground bus in this room. We recommend installing a ground bus in this room as well as bonding the door to ground, as soon as possible, to ensure that all non-current carrying components are bonded to ground.

19. The end cabinet of the indoor switchgear was found to be full of old equipment. We recommend that this debris be cleared out of this cell to ensure that no extra equipment be damaged or create a hazard during an emergency situation.

20. We were unable to locate a rubber switching mat for the indoor switchgear. As per the Ontario Electrical Safety Code 2-306 and table 52, we recommend that a rubber switching mat be installed, as soon as possible, directly in front of the breaker cells to maintain a tolerable level of step and touch potential.

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Fourth Street Substation

21. We recommend that a co-ordination study be completed involving all of the electrical protection equipment associated with the Fourth Street Substation. The relays were tested and calibrated as per Midland PUC requirements; however, a study would verify proper co-ordination of the protective devices and a settings table that the relays would be calibrated to during the preventative maintenance inspection.
22. The standard oil analysis for the Feeder #2 oil circuit breaker, s/n 39697, concluded that the insulating properties of the fluid are within normal operating limits. We recommend sampling as per your maintenance schedule.
23. The Feeder #2 oil circuit breaker, s/n 39697, Phase 'A' load side bushings was found to have been taped top to bottom which was completed by another contractor before Rondar serviced this location. Regular electrical tape is not a recommended insulation material used in high voltage repair work and defeats the electrical insulation of the high voltage bushing. We recommend sourcing a suitable replacement bushing and installing as soon as possible.
24. The standard oil analysis for the Feeder #3 oil circuit breaker, s/n 39695, and Feeder #4 oil circuit breaker, s/n 39696, concluded that the dielectric breakdown is low for high voltage rating. We recommend replacing the insulating oil in each breaker at your earliest convenience. Furthermore, our records indicate that the internal mechanism of these breakers have not been inspected since 1999 and in conjunction with the oil replacement, we recommend completing an internal inspection of the operating mechanisms to identify defective components.
25. The instantaneous element on the phase 'B' protective relay for Feeder #3 was found to be defective. We recommend replacing the protection relay, as soon as possible, to ensure equipment protection.

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RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Queen Street Substation

1. The barbed wire surrounding the outdoor substation was found broken. We recommend replacing the broken areas of barbed wire, as soon as possible, in order to prevent access to unauthorized personnel.

2. The fence fabric located in the northwest corner of the substation was found without a ground conductor woven through it. As per the Ontario Safety Code 36-312(4), we recommend a ground conductor be woven through the fence fabric with corresponding connections to the top rail, as soon as possible, to ensure all metal, non-current carrying components are bonded to ground.

3. The outdoor substation yard was found with excessive weed growth. As per the Ontario Electrical Safety Code 36-304(5), Table 52, we recommend that the yard debris and weeds be removed and 50-75mm of 19mm crushed stone be added, as soon as possible, to prevent the step and touch potential from exceeding acceptable tolerances.

4. The paint condition of the Main Transformer, s/n C-46206-1, is deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

5. The standard oil sample analysis results for the Main Transformer, s/n C-46206-1, indicate that the insulating properties of the oil are suitable for continued service. We recommend sampling as per your preventative maintenance schedule.

6. The dissolved gas analysis results for the Main Transformer, s/n C-46206-1 indicate that the acetylene level has decreased. The ethylene, carbon monoxide and carbon dioxide have increased since May 2003 indicating a high temperature thermal fault most likely involving the paper insulation. The combustible gas content is increasing at a rate of approximately 1 ppm/day indicating that the fault is not severe at this time. We recommend re-sampling for dissolved gases in April 2006 to monitor the gas content.

7. The furan sample analysis results for the Main Transformer, s/n C-46206-1, indicate that the fururaldehyde (furan) level has remained relatively stable since April 2003 indicating that the paper insulation has not been subjected to heat stress during this period, however, the present level indicates the insulation has sustained extensive deterioration. We recommend sampling as per your preventative maintenance schedule.

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Queen Street Substation

8. We were unable to locate a rubber switching mat for the indoor switchgear. As per the Ontario Electrical Safety Code 2-306 and Table 52, we recommend that a rubber switching mat be installed directly in front of the breaker cells, as soon as possible, in order to maintain a tolerable level of step and touch potential.

9. As previously reported, the arcing contacts (stationary and moving) on the oil circuit breakers designated CCT#2, CCT#3 and CCT#4 were found to have deteriorated, however, the arcing contacts on the oil circuit breaker designated CCT#1 were found to be in very poor condition in comparison to the other breakers. Based on our service records of the four (4) oil circuit breakers, we insist that the internal mechanism be inspected during the next preventative maintenance shutdown to ensure the mechanism is suitable for continued service and replacing the stationary and moving arcing contacts on the oil circuit breaker designated CCT#1, s/n 37213, to prevent a failure from occurring.

10. The oil analysis results completed on the four (4) indoor oil circuit breakers, Circuit #1, s/n 37213, Circuit #2, s/n 37214, Circuit #3, s/n 37211, and Circuit #4, s/n 37212, indicate that all oil properties are within normal operating limits and suitable for continued service.

11. During testing of the Neutral over current relay for CCT #1, it was found to have resistance of the magnetic disk which impeded the operational characteristics of the relay and directly affected the current pick-up. This relay was replaced and the original settings were reapplied and left in satisfactory condition.

12. During testing of the Neutral over current relay for CCT #2, the current pick-up was found to exceed the manufacturer's recommend limits. At the request of Midland PUC personnel, the current pick-up was re-calibrated and left in satisfactory condition.

13. During testing of the Red phase over current relay for CCT #2, the seal-in unit was found to be defective. We recommend that this unit be replaced, as soon as possible, to ensure proper breaker operation in the event of a fault.

14. During the calibration testing of the neutral over current relay for CCT #3, the current pick-up was found to exceed the manufacturer's recommended limits. At the request of Midland PUC personnel, the current pick up was re-calibrated and left in satisfactory condition.

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Montreal Street Substation

1. The weed growth in the main outdoor substation was found to be suitable and we recommend applying an herbicide in April or May 2006 to prevent any new weed growth.

2. The sample valve located close to the bottom of the tank for the Main Transformer, s/n 90-711, was found with a small amount of oil residue around the valve and fittings. The presence of fresh oil was observed around the valve but is not serious at this time. We recommend continued monitoring of this oil leak.

3. The results of the dissolved gas-in-oil and standard oil analysis for the Main Transformer, s/n 90-711, indicate the gas levels and insulating oil properties have remained relatively stable and are suitable for continued service. We recommend continued sampling as per your maintenance schedule.

4. The results of the furan analysis for the Main Transformer, s/n 90-711, conclude that the furan levels have remained relatively low. This indicates that the paper insulation is in acceptable condition and has not been subjected to heat stress during the period. No further action is required at this time.

5. The main access doors to the indoor substation were found without any warning signs posted. As per the Ontario Electrical Safety Code 36-006, we recommend installing a warning sign on each entrance door to this room as soon as possible.

6. The main access doors to the indoor substation were found with the door frame grounded but missing a corresponding jumper to the doors. As per the Ontario Electrical Code 36-308(1)(2)(a)(i) and Table 52, we recommend installing a ground jumper, as soon as possible, to ensure all metal, non-current carrying components are bonded to ground and maintain a tolerable level of step and touch potential.

7. We were unable to locate a rubber switching mat for the indoor switchgear. As per the Ontario Electrical Safety Code 2-306 and Table 52, we recommend that a rubber switching mat be installed directly in front of the breaker cells, as soon as possible, in order to maintain a tolerable level of step and touch potential.

8. We recommend that a co-ordination study be completed involving all of the electrical equipment associated with the Montreal Street Substation. All of the protective relays were found to have discrepancies and a coordination study would determine if the values are correct or if these relays are in need of repair.

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COMMENTS AND RECOMMENDATIONS

Montreal Street Substation

9. The insulation resistance of the phase 'B' cable for the Feeder #1 Circuit was found to have significantly deteriorated since November 2003. The insulation resistance is suitable for the voltage rating, however, we recommend monitoring the insulation resistance in September 2007 to ensure reliability of the service.

10. The contact pressure between the main current carrying contact components on phase 'C' of the breaker designated 'Feeder #2', s/n 1149, was found to be defective. There was evidence of surface pitting and possible arcing damage to the contact surfaces. This breaker was removed from service and the 'Spare' breaker, s/n 1152, was installed into the Feeder #2 cell. The trip coil on the 'Feeder #2' breaker, s/n 1152, was found defective during the 2003 preventative maintenance inspection and was exchanged, at this time, with the trip coil from the 'Spare' breaker, s/n 1149. We recommend replacing the moving and stationary contact components and the trip coil, as soon as possible, to maintain a functional spare breaker.

11. The insulation resistance of the phase 'C' cable for the Feeder #2 Circuit was found low for the voltage rating. We recommend replacing this cable, as soon as possible, to ensure reliability of the service.

12. The resistance of the tripping coil for the breaker designated 'Spare', s/n 1149, was found high. This increased resistance prohibits proper operation, therefore, we recommend replacing the coil, as soon as possible, to ensure a suitable spare breaker is available for use in an emergency situation.

RONDAR INC.

January 7, 2003

Midland Power Business Group
16984 Hwy #12
P.O. Box 820
Midland, Ontario
L4R 4P4

Attention: **Mr. Wayne Dupuis**

Subject: **Preventive Maintenance @ Queen, Fourth and Montreal Street Substations**
Our Ref. C1213

Dear Sir:

We are enclosing the results of the maintenance carried out at the Queen, Fourth and Montreal Street substations on October 14, 2003, October 20, 2003, and November 10, 2003, respectively.

In general, the results of the tests and inspections indicate that the equipment is suitable for service, except as noted in the comments and recommendations.

If you have any questions or require further information, please do not hesitate to contact our office.

RONDAR INC.

Dan Brown
Technical Service Representative

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RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Queen Street Substation

1. The barbed wire surrounding the outdoor substation was found broken. We recommend replacing the broken areas of barbed wire and trimming the surrounding tree growth, as soon as possible, to prevent further deterioration of the substation enclosure.

2. The fence fabric located in the northwest corner of the substation was found without a ground conductor woven through it. As per the Ontario Safety Code, we recommend a ground conductor be woven through the fence fabric, as soon as possible, with corresponding connections to the top rail to ensure all metal, non-current carrying components are bonded to ground.

3. The outdoor substation yard was found with excessive weed growth. As per the Ontario Electrical Safety Code 36-304(5), table 52, we recommend that the yard debris and weeds be removed and 50-75mm of 19mm crushed stone to be added, as soon as possible, to prevent the step and touch potential from exceeding acceptable tolerances.

4. The paint condition of the Main Transformer, s/n C-46206-1, is deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

5. The standard, dissolved gas-in-oil and furan analysis on the Main Transformer, s/n C-46206-1, could not be completed at the time of inspection due to poor weather and will be completed, as soon as possible, in conjunction with the high voltage bushing replacement.

6. We were unable to locate a rubber switching mat for the indoor switchgear. As per the Ontario Electrical Safety Code 2-306 and table 52, we recommend that a rubber switching mat be installed, as soon as possible, directly in front of the breaker cells to maintain a tolerable level of step and touch potential.

7. Insulating oil was added to each of the four (4) oil circuit breakers, Circuit #1, s/n 37213, Circuit #2, s/n 37214, Circuit #3, s/n 37211, and Circuit #4, s/n 37212, to ensure an acceptable level is maintained and to allow for further sampling. We recommend continued monitoring of the oil level during your maintenance period.

8. The oil analysis completed of the four (4) indoor oil circuit breakers, Circuit #1, s/n 37213,
   Circuit #2, s/n 37214, Circuit #3, s/n 37211, and Circuit #4, s/n 37212, indicates all oil properties are within normal operating limits and suitable for continued service.

9. As previously reported, the arcing contacts (stationary and moving) on the oil circuit breakers designated CCT#2, CCT#3 and CCT#4 were found to be deteriorated. However, the arcing contacts on the oil circuit breaker designated CCT#1 were found to be in very poor condition compared to the other breakers. We recommend that both the stationary and moving arcing contacts on the oil circuit breaker designated CCT#1, s/n 37213, be replaced, as soon as possible, to prevent a failure from occurring.

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Fourth Street Substation

1. The outdoor substation yard was found to have an excess of debris within it. We recommend that qualified personnel clean out this debris on a regular basis to ensure the dielectric properties of the yard.

2. The outdoor substation yard was found to have an excess of weeds growing within it. We recommend that an herbicide be applied annually to control this on-going problem and also to ensure the dielectric properties of the crushed stone.

3. The depth of the crushed stone in the outdoor substation yard was found to be low. As per the Ontario Electrical Safety Rule 36-304 (5), we recommend that 150mm of crushed stone be added to the substation yard, as soon as possible.

4. The fence enclosure was found damaged during our inspection. The top rail barbed wire holder was found broken and the corresponding middle rail was severely bent. We recommend that these problems be repaired, as soon as possible, to ensure that unauthorized personnel do not gain entry into this area.

5. It was found that both the main access gate and the man gate did not have corresponding bonds to ground. As per the Ontario Electrical Safety Code Rule 36-312 (3), we recommend that these grounds be installed, as soon as possible, to ensure that the touch potentials of this enclosure stay within acceptable limits.

6. The flexible braided shunts on the High Voltage Air Break Switch on the tower were found to be deteriorating as previously reported. However, the rate of deterioration is low and we recommend replacing these shunts during your next shutdown to prevent further breakdown and a potential failure.

7. The insulators of the High Voltage Air Break Switch on the top of the tower were found contaminated with a type of carbon spray from the arcing whips operation. Although this has not affected their insulation value, nor is it an immediate concern, it should be made note of since this problem will only get worse each time the switch is operated under potential. No further action is required at this time.

8. The stationary and moving contact surfaces on the 'B' phase primary fuse located on the tower were found to have severe pitting. The contact surfaces were repaired and left in satisfactory condition. We recommend monitoring the condition of these contacts to ensure a low resistance connection is maintained.

COMMENTS AND RECOMMENDATIONS

Fourth Street Substation

9. It was noted that there is no Silica Gel Breather located on the Main Transformer, s/n 280019. As the temperature and load increases and decreases for this transformer, the oil level rises and falls creating a breathing effect. As the transformer breathes, the possibility of moisture contaminating the insulating fluid is likely. Therefore, we recommend installing a silica gel breather on this transformer, at your earliest convenience, to help prevent the insulating fluid from absorbing moisture.

10. Evidence of tracking was found on the H2 and H3 high voltage bushings for the Main Transformer, s/n 280019. Although the insulation resistance value of the primary windings and bushings indicate that this has not yet affected their insulation, the integrity of the bushings is questionable. We recommend inspecting and further testing of these bushings in six (6) months in an attempt to determine the severity of the problem and their reliability. From this investigation, a corrective course of action, if necessary, can be developed.

11. It was noticed that oil was leaking around both of the sample valves at the bottom of the tank on the Main Transformer, s/n 280019. We recommend that this problem be monitored, on an annual basis, to determine what corrective action, if any, is required.

12. The paint condition of the Main Transformer, s/n 280019, is deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

13. The concrete pad of the Main Transformer was found to be sitting at an angle possibly affecting its cooling properties. We recommend replacing the transformer pad, as soon as possible, to ensure that the transformer operates as designed.

14. The results of the standard analysis of the insulating fluid in the Main Transformer, s/n 280019, showed that the Neutralization Number is merely fair, indicating that there is some oxidization occurring in the oil. As well, the Interfacial Tension indicates that there are polar contaminates and oxidation products in the oil. Although these issues are not severe at this time, they do warrant noting. We recommend including an oxidation inhibitor analysis during your next substation maintenance to monitor the level of inhibitor in the insulating fluid.

15. The results of the furan analysis on the Main Transformer, s/n 280019, indicate that the level of furans has remained relatively stable since June 2003 indicating that the paper insulation has not undergone heat stress during this period. However, present levels indicate that the insulation has undergone moderate deterioration. We recommend continuing to sample for furans during your substation maintenance work to monitor the condition of the paper insulation.

COMMENTS AND RECOMMENDATIONS

Fourth Street Substation

16. The results of the dissolved gas-in-oil analysis on the Main Transformer, s/n 280019, indicate that the level of carbon monoxide has increased since June 2003 with the furan analysis indicating that the level is due to heat stress in the paper insulation. We recommend resampling in May 2004 to continue monitoring the level of these gases.

17. We were unable to locate a warning sign on the entrance door to the indoor substation room. As per the Ontario Electrical Safety Code Rule 36-006 (1)(a), we recommend that a sign be affixed, as soon as possible, to warn unqualified personnel of the potential hazard present in this room.

18. The entrance door to the indoor substation room was found to be missing a ground connection to a corresponding ground bus in this room. We recommend installing a ground bus in this room and bonding the door to ground, as soon as possible, to ensure that all non-current carrying components are bonded to ground.

19. The end cabinet of the indoor switchgear was found to be full of old equipment. We recommend that this debris be cleared out of this cell to ensure that no extra equipment can be damaged or create extra hazard during an emergency situation.

20. We were unable to locate a rubber switching mat for the indoor switchgear. As per the Ontario Electrical Safety Code 2-306 and table 52, we recommend that a rubber switching mat be installed, as soon as possible, directly in front of the breaker cells to maintain a tolerable level of step and touch potential.

21. We recommend that a co-ordination study be completed involving all of the electrical equipment associated with the Fourth Street Substation. All of the protective relays were found to have discrepancies and we recommend verifying with the coordination study to determine if the values are correct or if these relays are in need of repair.

22. The standard oil and water analysis for the Feeder #2 oil circuit breaker, s/n 39697, concluded that the insulating properties of the fluid are within normal operating limits and we recommend sampling as per your maintenance schedule.

23. The White phase overcurrent relay protecting the Feeder #2 breaker, s/n 39697, was found with the pick-up function exceeding recommended limits. An attempt was made to adjust and repair the relay but to no avail. Two (2) relays provided by Mid-Ontario Energy Services were used to replace the White & Red phase relays and were set as requested with the instantaneous settings adjusted from 55 to 30. The test results indicate the relays are suitable for service and were put into service on November 10, 2003. We recommend completing a co-ordination study to prevent any unnecessary nuisance tripping.

COMMENTS AND RECOMMENDATIONS

Fourth Street Substation

24. The insulation resistance of the 5kV cables for the Feeder #2 circuit were found at an unacceptable level for continued service. We recommend replacing the cables, as soon as possible, to ensure the reliability of the service.

25. The standard oil and water analysis for the Feeder # 3 oil circuit breaker, s/n 39695, concluded that the insulating properties of the fluid are within normal operating limits and we recommend sampling as per your maintenance schedule.

26. The standard oil and water analysis for the Feeder # 4 oil circuit breaker, s/n 39696, concluded that the insulating properties of the fluid are within normal operating limits and we recommend sampling as per your maintenance schedule.

27. The insulation resistance of the phase 'A' 5kV cable for the Feeder #4 circuit was found at an unacceptable level for continued service. Further investigation determined that the low insulation resistance was not related to the terminations and that the cable was defective. We recommend replacing this cable, as soon as possible, to ensure the reliability of the service.

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Montreal Street Substation

1. During the 2001 preventative maintenance, a sticky residue was found coating the insulators on the tower and the source was believed to be the surrounding trees. The condition of these insulators during the 2003 preventative maintenance has not worsened and we continue to recommend monitoring the tree growth and trimming the branches surrounding the substation as deemed necessary.

2. The weed growth in the main outdoor substation was found to be suitable and we recommend applying an herbicide in April/May 2004 to prevent any new weed growth.

3. The sample valve located close to the bottom of the tank for the Main Transformer, s/n 90-711, located in the outdoor substation, was found with a small amount of oil residue around the valve and fittings. However, there was no presence of fresh oil on the ground and we recommend monitoring this oil leak to determine if further action is required.

4. The results of the dissolved gas-in-oil and standard oil analysis for the Main Transformer, s/n 90-711, indicate the gas levels and insulating oil properties have remained relatively stable and are suitable for continued service. We recommend continued sampling as per your maintenance schedule.

5. The results of the furan analysis for the Main Transformer, s/n 90-711, indicate the paper insulation is in acceptable condition and has not been subjected to heat stress. At this time, no further action is required.

6. The main access doors to the indoor substation were found without any warning signs posted. As per the Ontario Electrical Safety Code 36-006, we recommend installing a warning sign on each entrance door to this room, as soon as possible.

7. The main access doors to the indoor substation were found with the door frame grounded but missing a corresponding jumper to the doors. As per the Ontario Electrical Code 36-308(1)(2)(a)(i) and table 52, we recommend installing a ground jumper to ensure all metal non-current, carrying components are bonded to ground and to maintain a tolerable level of step and touch potential.

8. As previously reported in 2001, the rear compartments of the indoor switchgear were inspected for moisture with a minimal amount found in the cable pit. We recommend continuing to monitor these compartments for moisture on a regular basis to prevent deterioration of the equipment.

COMMENTS AND RECOMMENDATIONS

Montreal Street Substation

9. We were unable to locate a rubber switching mat for the indoor switchgear. As per the Ontario Electrical Safety Code 2-306 and table 52, we recommend that a rubber switching mat be installed, as soon as possible, directly in front of the breaker cells to maintain a tolerable level of step and touch potential.

10. We recommend that a co-ordination study be completed involving all of the electrical equipment associated with the Montreal Street Substation. All of the protective relays were found to have discrepancies and we recommend verifying with the coordination study to determine if the values are correct or if these relays are in need of repair.

11. The resistance of the tripping coil for the breaker designated Spare, s/n 1152, was found high. This increased resistance prohibits proper operation and we recommend replacing the coil, as soon as possible, to ensure a suitable spare breaker is available for use in an emergency situation.

12. During re-energization it was found that the coil located in the electrical control cell for the breaker designated Feeder #3, s/n 1150, was defective. The problem was repaired and left in satisfactory condition. A similar problem was reported during the 1999 substation maintenance; therefore, we recommend upgrading the coils located in each of the feeder breaker electrical control cells to prevent further complications and unnecessary downtime.

13. The insulation resistance of the phase 'C' cable for the Feeder #2 circuit was found low for the voltage rating. We recommend replacing this cable, as soon as possible, to ensure reliability of the service.

RONDAR INC.

Section 8

2004 & 2002 MAINTENANCE REPORTS
Brandon, Dorion & Scott Street Substations

RONDAR INC.

January 11, 2005

Mid-Ontario Energy Services Inc.
16984 Hwy #12
P.O. Box 820
Midland, Ontario
L4R 4P4

Attention: **Mr. Wayne Dupuis**

Subject: **2004 Preventative Maintenance @ Brandon Street Substation**
Our Ref. C1399

Dear Sir,

We are enclosing the results of the maintenance work carried out at your Brandon Street Substation on October 12, 2004.

In general, the results of the tests and inspections indicate that the equipment is suitable for service except as noted in our comments and recommendations section.

The furan analysis completed on each of the single phase transformers 'A', s/n 213274, 'B', s/n 213273, and 'C', s/n 213275, conclude that the paper insulation in each transformer has undergone extensive deterioration, probably caused by thermal heating, and are in very poor condition. Based on results from previous years, the maximum temperature of these transformers has been 60°C which is a relatively high operating temperature and over the 48 years of service, 1956-2004, thermal heating has caused the insulation to deteriorate. Due to these high levels of furans, we recommend to budget for the replacement of these three (3) single phase transformers within the next year and to consider upgrading the total capacity of this station due to the higher operating temperature.

Rondar Inc. would be interested to work with Mid-Ontario Energy Services Inc. in any capacity to develop and/or implement a solution for this station.

If you have any questions or require further information, please do not hesitate to contact our office.

RONDAR INC.

Dan Brown
Technical Service Representative

20 Venture Drive, Unit #9, Scarborough, Ontario M1B 3R7
Tel: (416) 286-2444 Fax: (416) 286-2445 E-mail: dbrown@rondar.com

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Outdoor Substation and Tower

1. The substation yard was found to have an excess of weeds growing within it. We recommend that an herbicide be applied annually to control this on-going problem and ensure the dielectric properties of the crushed stone.

2. As found previously during the 2002 preventative maintenance and confirmed this year, the high voltage air break switch on the tower structure was found to have a defective arc interrupter with a very high resistance on the load side of phase 'B'. We recommend that this interrupter be changed during your next substation maintenance.

3. It was noted that there are no silica gel breathers installed on any of the oil filled transformers located in this substation. As the temperature and load increases and decreases for these transformers, the oil level rises and falls respectively creating a breathing effect. As the transformers breathe, the possibility of moisture contaminating the insulating fluid is likely. Therefore, we recommend installing silica gel breathers on these transformers, at your earliest convenience, to help prevent the insulating fluid from absorbing moisture.

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COMMENTS AND RECOMMENDATIONS

Outdoor Phase 'A' Transformer, s/n 213274

1. As found during previous inspections, the oil level for this transformer is slightly low but has not worsened since October 2004. We recommend periodic monitoring to ensure this level does not diminish further thereby affecting the service reliability.

2. A small crack was found on the porcelain of the secondary neutral bushing of this transformer. The crack was inspected and found not to have worsened since the 2002 preventative maintenance. We recommend monitoring the condition of this bushing to ensure the insulation integrity does not deteriorate thereby affecting the reliability of the equipment. Additionally, we recommend completing a 'hot' collar test on the bushing during your next substation maintenance to further assess the condition of the unit.

3. As found during previous inspections, a small oil leak was present around the base gasket of the secondary neutral bushing. The amount of fresh oil found during this years maintenance around the gasket indicates that this leak has not further developed. We recommend this leak be monitored and repaired when deemed necessary.

4. The paint condition of this transformer was found to be deteriorating thereby allowing rust to develop. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

5. The results of the standard and water content analysis conclude that insulation properties of the insulating fluid are within normal operating ranges. We recommend continued standard and water content sampling in October 2005 to allow further trending of the oil properties. Furthermore, based on the age of the oil, we recommend adding inhibitor analysis to your sampling in October 2005.

6. The results of the furan analysis on this transformer indicate that the paper insulation has undergone extensive deterioration and has an actual level of 1,344 parts per billion, accounting for the retrofil in November 2000. The level of furans have increased gradually and is expected as the age of a transformer increases. Due to these high levels of furans, we recommend to budget for the replacement of this transformer within the coming year.

7. The results of the dissolved gas-in-oil analysis indicate that the levels of carbon monoxide and carbon dioxide have increased since October 2002. The results from the furan analysis conclude that these levels are due to deterioration of the paper insulation. We recommend continued sampling in October 2005 to continue monitoring the level of these gases.

COMMENTS AND RECOMMENDATIONS

Outdoor Phase 'B' Transformer, s/n 213273

1. As found during previous inspections, the oil level of this transformer is slightly low but not worsened since October 2004. We recommend periodic monitoring to ensure this level does not diminish further thereby affecting the service reliability.

2. The porcelain of the secondary neutral bushing of this transformer was found to be cracked and was sealed at the time of inspection. We recommend replacing this bushing, at your earliest convenience, to ensure the insulation integrity of the equipment and service continuity.

3. The paint condition for this transformer was found to be deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

4. The results of the standard and water content analysis conclude that insulation properties of the insulating fluid are within normal operating range. We recommend continued standard and water content sampling in October 2005 to allow further trending of the oil properties. Furthermore, based on the age of the oil, we recommend adding inhibitor analysis to your sampling in October 2005.

5. The results of the furan analysis on this transformer indicate that the paper insulation has undergone extensive deterioration and has an actual level of 1,144 parts per billion, accounting for the retrofil in November 2000. The level of furans have increased gradually and is expected as the age of a transformer increases. Due to the high level of furans, we recommend to budget for the replacement of this transformer within the coming year.

6. The results of the dissolved gas-in-oil analysis indicate that the level of hydrogen has increased since October 2002 indicating the presence of corona, possibly involving the paper insulation. Rate of rise of the total combustible gas content indicates that the fault is not severe at this time, while all other fault gases have remained within normal range. We recommend resampling in January 2005 to continue monitoring the level of these gases.

COMMENTS AND RECOMMENDATIONS

Outdoor Phase 'C' Transformer, s/n 213275

1. As found during previous inspections, the oil level of this transformer is slightly low but has not worsened since October 2004. We recommend periodic monitoring to ensure this level does not diminish further thereby affecting the service reliability.

2. One of the primary bushings for this transformer was found with a chip out of the porcelain. The chip was sealed with Glyptal at the time of maintenance and left in adequate condition. We recommend monitoring the insulation integrity of this bushing during the 2006 preventative maintenance.

3. The X1 secondary bushing of this transformer was found to be cracked. The crack was sealed with a conformal coating lacquer at the time of maintenance and was left in adequate condition. We recommend that this crack be monitored and that the bushing be replaced, when deemed necessary.

4. The inspection cover of this transformer was found to be slightly leaking oil. As previously reported in 2002, we recommend that this leak be periodically monitored to ensure that this leak does not further develop.

5. The paint condition for this transformer was found to be deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

6. The results of the standard and water content analysis conclude that insulation properties of the insulating fluid are within normal operating ranges. We recommend continued standard and water content sampling in October 2005 to allow further trending of the oil properties. Furthermore, based on the age of the oil, we recommend adding inhibitor analysis to your sampling in October 2005.

7. The results of the furan analysis on this transformer indicate that the paper insulation has undergone extensive deterioration and has an actual level of 1,145 parts per billion, accounting for the retrofil in November 2000. The level of furans have been gradually increasing and is expected as the age of a transformer increases. Due to the high level of furans, we recommend to budget for the replacement of this transformer within the coming year.

8. The results of the dissolved gas-in-oil analysis indicate that the levels of carbon monoxide and carbon dioxide have increased since October 2002. The results from the furan analysis conclude that these levels are due to deterioration of the paper insulation. We recommend continued sampling in October 2005 to continue monitoring the level of these gases.

COMMENTS AND RECOMMENDATIONS

Outdoor Spare Transformer, s/n 213272

1. We were unable to perform any electrical tests on this transformer as there were no bushings and thereby, no corresponding external electrical connections.

2. The gaskets on all bushing ports along with the tapchanger were found to be leaking oil. We recommend that these gaskets be replaced to maintain a suitable spare transformer.

3. The oil level gauge on this transformer was found to have been previously removed and as a result, the oil level is unknown. We recommend that this gauge be replaced to maintain a fully equipped spare transformer should you require these components for the future.

4. The paint condition for this transformer was found to be deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

5. The results of the standard and water content analysis conclude that insulation properties of the insulating fluid are within normal operating ranges. We recommend continued standard and water content sampling in October 2005 to allow further trending of the oil properties. Furthermore, based on the age of the oil, we recommend adding inhibitor analysis to your sampling in October 2005.

6. The results of the furan analysis on this transformer indicate that the paper insulation has undergone extensive deterioration and has an actual level of 357 parts per billion, accounting for the retrofil in November 2000. The level of furans have been gradually increasing and is expected as the age of a transformer increases. Due to the high level of furans, we recommend that this transformer not be placed into service.

7. The results of the dissolved gas-in-oil analysis indicate that the levels of carbon monoxide and carbon dioxide have increased. The results from the furan analysis conclude that these levels are due to deterioration of the paper insulation. We recommend continued sampling in October 2005 to continue monitoring the level of these gases.

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Indoor Substation

1. It was found that the floor and wall paint within the indoor substation room were in poor condition. We recommend that the floor and walls be painted, as soon as possible, in order to minimize the dust within this room.

2. We were unable to locate a rubber switching mat for the indoor switchgear. As per the Ontario Electrical Safety Code 2-306, we recommend that a rubber switching mat be installed, at your earliest convenience, to maintain adequate dielectric properties for personnel during switching operations.

3. We were unable to locate any smoke detection devices within the indoor substation room. We recommend that a device be installed and wired to an alarm panel as soon as possible.

4. The results of standard oil analysis of the insulating oil for Main Oil Circuit Breaker, s/n 633363P1, indicate that the oil properties are within normal operating ranges and suitable for continued service. We recommend completing a standard sample during your 2006 preventative maintenance inspection.

5. The time-delay operation of the phase 'B' protection relay for the Main Oil Circuit Breaker, s/n 633363P1, is operating lower than the manufacturer's recommended limits. At the time of maintenance, adjustments were attempted to increase the time delay, however, further investigation is required to determine if the relay should be replaced or if repairs can be made.

6. The resistance of the phase 'A' contacts for the Feeder Breaker #1, s/n 633363P7, have increased and warrant further internal investigation. We recommend inspecting the internal contacts, at your earliest convenience, to determine the source of the increased resistance.

7. The results of standard oil analysis of the insulating oil for Feeder Breaker #1, s/n 633363P7, indicate that the oil properties are within normal operating ranges and suitable for continued service. We recommend completing a standard sample during your 2006 preventative maintenance inspection.

8. The results of standard oil analysis of the insulating oil for Feeder Breaker #2, s/n 633363P3, indicate that the oil properties are within normal operating ranges and suitable for continued service. We recommend completing a standard sample during your 2006 preventative maintenance inspection.

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Indoor Substation

9. The results of standard oil analysis of the insulating oil for Bus Tie Breaker, s/n 633363P5, indicate that the oil properties are within normal operating ranges and suitable for continued service. We recommend completing a standard sample during your 2006 preventative maintenance inspection.

10. Based on the insulation resistance test result of the phase 'A' power cable for the Feeder #2 circuit, the condition of the insulation with respect to ground is lower when compared to the other cables, however, the cable is suitable for continued service at this time. We recommend monitoring the insulation resistance value during your 2006 preventative maintenance inspection.

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RONDAR INC.

January 17, 2005

Mid-Ontario Energy Services Inc.
16984 Hwy #12
P.O. Box 820
Midland, Ontario
L4R 4P4

Attention: **Mr. Wayne Dupuis**

Subject: **2004 Preventative Maintenance @ Dorion Street Substation**
Our Ref. C1399

Dear Sir,

We are enclosing the results of the maintenance work carried out at your Dorion Street Substation on October 13, 2004.

In general, the results of the tests and inspections indicate that the equipment is suitable for service except as noted in our comments and recommendations section.

If you have any questions or require further information, please do not hesitate to contact our office.

RONDAR INC.

Dan Brown
Technical Service Representative

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RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Outdoor Substation

1. The insulation resistance of the three (3) lightning arresters located on the substation tower indicates that the surge protection operation has internally faulted and replacement is required. As well, the rating of the existing lightning arresters does not meet current standards for equipment protection. We recommend replacing and upgrading the three (3) lightning arresters, as soon as possible, to meet current surge protection requirements.

2. We were unable to locate a complete set of spare fuse links for the primary protection fuses for the Main Transformer. We recommend verifying that one (1) complete set of fuses is available for use in an emergency situation.

3. It was noted that there was no silica gel breather installed on the Main Transformer, s/n 238691. As the temperature and load increases and decreases for this transformer, the oil level rises and falls creating a breathing effect. As the transformer breathes, the possibility of moisture contaminating the insulating fluid is likely. Therefore, we recommend installing a silica gel breather on this transformer, at your earliest convenience, to help prevent the insulating fluid from absorbing moisture.

4. The Main Transformer, s/n 238691, was found to have minor oil leaks around the level gauge on the conservator tank and around the valve between the conservator and main tank. We recommend that these leaks be monitored for severity and repaired during your next substation maintenance, if deemed necessary.

5. A large chip out of the H3 primary bushing was found on the Main Transformer, s/n 238691. This chip was sealed with an insulating glyptal paint at the time of maintenance and was left in satisfactory condition. We recommend continued monitoring during your preventative maintenance schedule to ensure the insulation integrity does not deteriorate.

6. The paint condition of the Main Transformer, s/n 238691, is deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

7. The results of the standard and water content analysis conclude that insulation properties of the insulating fluid are within normal operating ranges. We recommend continued standard and water content sampling in October 2005 to allow further trending of the oil properties.

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RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Outdoor Substation

8. The results of the dissolved gas-in-oil analysis indicate that the level of acetylene has decreased and in a breathing transformer this indicates that the gas is either being produced at a very low rate or no longer being produced. Our concern is that acetylene has been produced in the past and involves arcing between an energized component and ground. We recommend resampling in April 2005 to ensure that if acetylene again starts to be produced, a corrective course of action can be developed prior to equipment failure.

9. The results of the furan analysis on this transformer indicate that the paper insulation has not undergone any heat stress since October 2002. With respect to the age of the Main Transformer, s/n 238691, we recommend completing annual furan analysis to allow for accurate trending of the condition of the paper insulation. This information will assist Rondar in reporting and determining a time frame when this transformer should be removed from service.

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Indoor Substation

1. The entrance doors to the indoor substation room were found to not have any warning signs. As per the Ontario Electrical Code Rule 36-006(1)(a), we recommend that warning signs be installed as soon as possible in order to inform unauthorized personnel of the hazard present in this room.

2. The floor and wall paint within the indoor substation room were found to be in poor condition. We recommend that the floor and walls be repainted, as soon as possible, in order to minimize the dust within this room.

3. We were unable to locate any smoke detection devices within the indoor substation room. We recommend that a smoke detection device be installed and wired to an alarm panel as soon as possible.

4. The results of standard oil analysis of the insulating oil for Feeder Breaker #1, s/n 56068, indicate that the oil properties are within normal operating ranges and suitable for continued service. We recommend completing a standard sample during your 2006 preventative maintenance inspection.

5. The results of standard oil analysis of the insulating oil for Feeder Breaker #2, s/n 56067, indicate that the oil properties are within normal operating ranges and suitable for continued service. We recommend completing a standard sample during your 2006 preventative maintenance inspection.

RONDAR INC.

January 17, 2005

Mid-Ontario Energy Services Inc.
16984 Hwy #12
P.O. Box 820
Midland, Ontario
L4R 4P4

Attention: **Mr. Wayne Dupuis**

Subject: **2004 Preventative Maintenance @ Scott Street Substation**
Our Ref. C1399

Dear Sir,

We are enclosing the results of the maintenance work carried out at your Scott Street Substation on October 26, 2004.

In general, the results of the tests and inspections indicate that the equipment is suitable for service except as noted in our comments and recommendations section.

If you have any questions or require further information, please do not hesitate to contact our office.

RONDAR INC.

Dan Brown
Technical Service Representative

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RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Outdoor Substation

1. The substation yard was found to have an excess of debris within it. We recommend that qualified personnel clean out this debris on a regular basis to ensure the dielectric properties of the yard are maintained.

2. The fence fabric for the substation enclosure was found to not have a ground conductor woven through it. As per the Ontario Electrical Safety Code Rule 36-312(4), we recommend that a ground conductor be woven through the fence fabric in at least two places at your earliest convenience to ensure all metallic, non-current carrying components are bonded to ground.

3. The operating handle for the high voltage switch located on the substation tower was found without a direct connection to the ground grid. As per the Ontario Electrical Safety Code 36-310, we recommend installing a flexible jumper to the operating handle, as soon as possible, to ensure the safety of personnel during switching operations.

4. The high voltage switch on the substation tower does not have a metallic gradient control mat (switching mat). As per the Ontario Electrical Safety Code Rule 36-301(2)(a), we recommend that a switching mat be installed, as soon as possible, in order to maintain touch voltages at tolerable levels, as outlined in Table 52 of the Ontario Electrical Safety Book, at the location where the switch operator is normally standing.

5. The ratings of the three (3) lightning arresters located on the substation tower do not meet current standards. We recommend upgrading the three (3) lightning arresters, at your earliest convenience, to prevent equipment damage due to line surges.

6. A silica gel breather is not located on transformer, s/n 1-1028. As the temperature and load increases and decreases, the oil level rises and falls respectively creating a breathing effect. As the transformer breathes, the possibility of moisture contaminating the insulating fluid is likely. Therefore, we recommend installing a silica gel breather on this transformer, at your earliest convenience, to help prevent the insulating fluid from absorbing moisture.

7. A burn mark along with a melted splash mark were found on the top metal globe of the phase 'B' primary bushing on the main transformer, s/n 1-1028, due to a flashover that has occurred in the past. Although these marks do not seem to affect the electrical properties of the transformer, it should be monitored during future inspections.

20 Venture Drive, Unit #9, Scarborough, Ontario M1B 3R7
Tel: (416) 286-2444 Fax: (416) 286-2445 E-mail: dbrown@rondar.com

COMMENTS AND RECOMMENDATIONS

Outdoor Substation

8. Two (2) oil leaks were found on the main transformer, s/n 1-1028. One leak was noticed on the transformer end of the conservator piping while the second leak was found at the tap changer handle. We recommend that these leaks be monitored to determine their severity and to determine if corrective action is required.

9. The paint condition of the main transformer, s/n 1-1028, was found to be deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

10. The main outdoor transformer, s/n 1-1028, was found bonded to the ground grid by the use of only one (1) ground connection. As per the Ontario Electrical Safety Code Rule 36-308(e)(iii), we recommend installing a second ground connection between the ground grid and the main frame of the transformer, as soon as possible, to ensure redundant ground protection in a fault condition.

11. The results of the standard and water content analysis completed on the insulating fluid in the main transformer, s/n 1-1028, conclude that insulation properties of the insulating fluid are within normal operating ranges. We recommend continued standard and water content sampling in October 2005 to allow further trending of the oil properties.

12. The results of the furan analysis on the main transformer, s/n 1-1028, indicate that the paper insulation has undergone extensive deterioration but has remained within 10% of the previous result obtained in June 2003. This indicates that during this time period the insulation has not been subjected to heat stress, however, our test results do not account for the retro-filling of this transformer (believed to have been completed between 1994 and 1997), therefore, the actual level could be significantly higher. The furan trending chart shows that the levels have steadily increased since October 1999. With respect to the age of this transformer, we recommend to budget for the replacement and upgrading of this transformer within the next two (2) years.

13. The results of the dissolved gas-in-oil analysis completed on the main outdoor transformer, s/n 1-1028, indicate that the gas concentrations have remained within normal ranges and are suitable for continued service. We recommend continued dissolved gas-in-oil sampling in October 2005 to continue monitoring the level of these gases.

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Indoor Substation

1. We were unable to locate a warning sign on the entrance door to the indoor substation room. As per the Ontario Electrical Safety Code Rule 36-006 (1)(a), we recommend that a sign be affixed, as soon as possible, to warn unqualified personnel of the potential hazard present.

2. As previously reported in our 1999 Preventative Maintenance report, the entrance door of the indoor substation was found to be missing a ground connection to a corresponding ground bus. We recommend installing a ground bus in this room and bonding the door to ground, as soon as possible, to ensure that all metallic, non-current carrying components are bonded to ground.

3. We were unable to locate a rubber switching mat for the indoor switchgear. As per the Ontario Electrical Safety Code 2-306, we recommend that a rubber switching mat be installed, at your earliest convenience, to maintain adequate dielectric properties for personnel during switching operations.

4. We were unable to locate any smoke detection devices within the indoor substation room. We recommend that a device be installed and wired to an alarm panel as soon as possible.

5. We were unable to locate any warning signs on the switchgear located in this room. As per the Ontario Electrical Safety Code Rule 36-006(1)(a), a warning sign should be installed at your earliest convenience.

6. The results of the standard oil analysis of the insulating oil in Feeder Breaker #1, s/n 53315, indicate that the oil properties are within normal operating ranges and suitable for continued service. We recommend completing a standard sample during your 2006 preventative maintenance inspection.

7. The results of the standard oil analysis of the insulating oil in Feeder Breaker #2, s/n 53317, indicate that the oil properties are within normal operating ranges and suitable for continued service. We recommend completing a standard sample during your 2006 preventative maintenance inspection.

8. The results of the standard oil analysis of the insulating oil in Feeder Breaker #3, s/n 56069, indicate that the oil properties are within normal operating ranges and suitable for continued service. We recommend completing a standard sample during your 2006 preventative maintenance inspection.

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COMMENTS AND RECOMMENDATIONS

Indoor Substation

9. The time delay test results for the overcurrent relays protecting the breakers designated Feeder #1, s/n 53315, Feeder #2, s/n 53317, and Feeder #3, s/n 56069, were found exceeding the manufacture limits. We recommend verifying the correct setting and calibrating the time delay function on these relays, as soon as possible, to function as per the time dial setting.

RONDAR INC.

November 18, 2002

Mid-Ontario Energy Services Inc.
16984 Hwy #12
P.O. Box 820
Midland, Ontario
L4R 4P4

Attention: **Mr. Erik Kussen**

Subject: **2002 Preventative Maintenance @ Brandon Street Substation**
Our Ref. C1011

Dear Sir,

We are enclosing the results of the maintenance work carried out at the Brandon Street Substation on October 3, 2002.

In general, the results of the tests and inspections indicate that the equipment is suitable for service except as noted in our comments and recommendations section.

If you have any questions, or require further information, please do not hesitate to contact our office.

RONDAR INC.

Ian Dobson
Technical Service Representative

20 Venture Drive, Unit #9, Scarborough, Ontario M1B 3R7
Tel: (416) 286-2444 Fax: (416) 286-2445 E-mail: rondarto@look.ca

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Outdoor Substation and Tower

1. The warning signs that were installed on the substation fence were in satisfactory condition, however, it was noted that there are not enough warning signs for the size of the enclosure. For an enclosure of this size, we recommend installing one (1) warning sign for every three spans of fence.

2. The substation yard was found to have an excess of weeds growing within it. We recommend that an herbicide be applied annually to control this on-going problem and to ensure the dielectric properties of the crushed stone.

3. The high voltage air break switch on the tower structure was found to have a defective arc interrupter with a very high resistance on the load side of phase B. We recommend that this interrupter be changed during your next substation maintenance.

4. The line side clip of the phase A high voltage fuse holder on the tower structure was found to be defective. Since this type of fuse clip is meant to release the fuse holder when the fuse link clears a fault, this component was replaced with a spare clip found in the substation and was left in satisfactory condition.

5. It was noted that there are no silica gel breathers installed on any of the oil filled transformers located in this substation. As the temperature and load increases and decreases for these transformers, the oil level rises and falls respectively creating a breathing effect. As the transformers breath, the possibility of moisture contaminating the insulating fluid is likely. Therefore, we recommend installing silica gel breathers on these transformers, at your earliest convenience, to help prevent the insulating fluid from absorbing moisture.

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Outdoor Phase A Transformer, s/n 213274

1. The oil level of this transformer was found to be low. We recommend that this level be topped up during your next substation maintenance.

2. The porcelain of the secondary neutral bushing of this transformer was found to have a small crack. At this time, the crack was sealed with a conformal coating lacquer and the bushing was left in adequate condition. We recommend that this crack be monitored to determine if the bushing needs to be replaced.

3. The secondary neutral bushing of this transformer was found to have an oil leak at its gasket. We recommend that this leak be monitored and repaired, if necessary.

4. The two top ports of this transformer were found to be leaking oil. We recommend that these leaks be monitored and repaired, if necessary.

5. The paint condition of this transformer was found to be deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

6. The results of the furan analysis on this transformer indicate that the paper insulation has undergone some heat stress since June 2001. We recommend resampling this transformer in April 2003 to continue to monitor the condition of the paper insulation.

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RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Outdoor Phase B Transformer, s/n 213273

1. The oil level of this transformer was found to be slightly low. We recommend that this level be topped up during your next substation maintenance.

2. The paint condition for this transformer was found to be deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

3. The results of the furan analysis on this transformer indicate that the paper insulation has undergone some heat stress since June 2001. We recommend resampling this transformer in April 2003 to continue to monitor the condition of the paper insulation.

4. The results of the dissolved gas-in-oil analysis indicate that the level of hydrogen has increased since July 2001 indicating the presence of corona. Total combustible gas content indicates that the fault is moderately severe at this time, while all other fault gases have remained within normal range. We recommend resampling in January 2003 to continue monitoring the level of these gases.

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RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Outdoor Phase C Transformer, s/n 213275

1. The oil level of this transformer was found to be slightly low. We recommend that this level be topped up during your next substation maintenance.

2. One of the primary bushings for this transformer was found to have a chip out of the porcelain. At this time, the chip was sealed with a conformal coating lacquer and was left in adequate condition.

3. The X1 secondary bushing on this transformer was found to have a crack. At this time, the crack was sealed with a conformal coating lacquer and the bushing was left in adequate condition. We recommend that this crack be monitored and that the bushing be replaced, if necessary.

4. The top port of this transformer was found to be leaking oil. We recommend that this leak be monitored and repaired, if necessary.

5. The paint condition for this transformer was found to be deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

6. The results of the furan analysis on this transformer indicate that the paper insulation has undergone some heat stress since June 2001. We recommend resampling this transformer in April 2003 to continue to monitor the condition of the paper insulation.

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RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Outdoor Spare Transformer, s/n 213272

1. We were unable to perform any electrical tests on this transformer as there were no bushings and thereby, no corresponding external electrical connections.

2. The gaskets on all bushing ports along with the tapchanger were found to be leaking oil. We recommend that these gaskets be replaced to maintain a properly working spare transformer.

3. The oil level gauge on this transformer was found to have been previously removed. As a result, the oil level is unknown. We recommend that this gauge be replaced to maintain a fully equipped spare transformer should you require these components again in the future.

4. The paint condition for this transformer was found to be deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

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RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Indoor Substation

1. We were unable to locate a rubber switching mat for the indoor switchgear. As per the Ontario Electrical Safety Code 2-306, we recommend that a rubber switching mat be installed, at your earliest convenience, to maintain adequate dielectric properties for personnel during switching operations.

2. It was found that the floor and wall paint within the indoor substation room were in poor condition. We recommend that the floor and walls be repainted, as soon as possible, in order to minimize the dust within this room.

3. We were unable to locate any smoke detection devices within the indoor substation room. We recommend that a device be installed and wired to an alarm panel, as soon as possible.

4. We recommend that a coordination study be completed involving all of the electrical equipment associated with the Brandon Street Substation, as soon as possible. All of the protective relays were found to have discrepancies and we recommend verifying with the coordination study to determine if the values obtained are correct or if these relays are in need of repair.

5. The dielectric breakdown for the Main Oil Circuit Breaker, s/n 633363P1, was found to be low for its high voltage rating. We recommend resampling this breaker, immediately, to verify these results.

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RONDAR INC.

November 18, 2002

Mid-Ontario Energy Services Inc.
16984 Hwy #12
P.O. Box 820
Midland, Ontario
L4R 4P4

Attention: **Mr. Erik Kussen**

Subject: **2002 Preventative Maintenance @ Dorion Street Substation**
Our Ref. C1011

Dear Sir,

We are enclosing the results of the maintenance work carried out at the Dorion Street Substation on October 2, 2002.

In general, the results of the tests and inspections indicate that the equipment is suitable for service except as noted in our comments and recommendations section.

If you have any questions, or require further information, please do not hesitate to contact our office.

RONDAR INC.

Ian Dobson
Technical Service Representative

20 Venture Drive, Unit #9, Scarborough, Ontario M1B 3R7
Tel: (416) 286-2444 Fax: (416) 286-2445 E-mail: rondarto@look.ca

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Outdoor Yard, Transformer and Tower

1. The barbed wire on the fence in the main outdoor yard that had been reported as loose in our 2000 Preventative Maintenance Report was repaired, by Rondar personnel, during this years maintenance and was left in a satisfactory condition.

2. The outdoor substation yard was found to have an excess of weeds growing within it. We recommend that an herbicide be applied annually to control this on-going problem and also to ensure the dielectric properties of the crushed stone.

3. The depth of crushed stone depth in the outdoor substation yard was found to be thin in some areas. For the moment, the depth of stone is acceptable, however, we recommend considering the need to top up the depth of the crushed stone at some point in the future.

4. We were unable to locate spare fuse links for the high voltage primary protection fuses on the tower structure in the outdoor substation. We recommend that a set of three (3) spare fuse links be purchased, at your earliest convenience, for use in an emergency situation.

5. It was noted that there is no Silica Gel Breather located on the Main Transformer, s/n 238691. As the temperature and load increases and decreases for this transformer, the oil level rises and falls creating a breathing effect. As the transformer breathes, the possibility of moisture contaminating the insulating fluid is likely. Therefore, we recommend installing a silica gel breather on this transformer, at your earliest convenience, to help prevent the insulating fluid from absorbing moisture.

6. The Main Transformer, s/n 238691, was found to have an oil leak around the level gauge on the conservator tank. We recommend that this leak be monitored for severity and repaired during your next substation maintenance, if necessary.

7. A large chip was found out of the H3 primary bushing on the Main Transformer, s/n 238691. At this time, the chip was sealed with an insulating lacquer that will ensure moisture does not seep into the porcelain and the bushing was left in satisfactory condition.

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Outdoor Yard, Transformer and Tower

8. The paint condition of the Main Transformer, s/n 238691, is deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

9. The results of the standard analysis of the insulating oil for the Main Transformer, s/n 238691, indicated that the dielectric breakdown is low for the high voltage rating. We recommend resampling this transformer, immediately, to verify these results.

10. The results of the dissolved gas-in-oil analysis on the Main Transformer, s/n 238691, showed an increase in acetylene since October 2001. This level is still not severe at this time, however, it seems to be slowly increasing at a rate of <1PPM/day. We recommend that an internal inspection of this transformer be completed if these gas levels continue to rise. We also recommend that resampling in April 2003 to continue monitoring the level of these gases.

COMMENTS AND RECOMMENDATIONS

Indoor Substation

1. It was found that the indoor substation room entrance doors do not have any warning signs. As per the Ontario Electrical Code Rule 36-006(1)(a), we recommend that warning signs be installed, as soon as possible, to inform unauthorized personnel of the hazard present in this room.

2. The indoor substation room was found to have no ground bus installed and no corresponding ground connection to the room door. We recommend installing a ground bus and door ground, as soon as possible, to comply with the Ontario Electrical Safety Code Rule 36-308 (1), to ensure that all metal, non-current carrying components are bonded to ground.

3. We were unable to locate a rubber switching mat for the indoor switchgear. We recommend that a rubber switching mat be installed, at your earliest convenience, to maintain adequate dielectric properties for personnel during switching operations.

4. It was found that the floor and wall paint within the indoor substation room were in poor condition. We recommend that the floor and walls be repainted, as soon as possible, in order to minimize the dust within this room.

5. We were unable to locate any smoke detection devices within the indoor substation room. We recommend that a smoke detection device be installed and wired to an alarm panel, as soon as possible.

6. We recommend that a co-ordination study be completed involving all of the electrical equipment associated with the Dorion Street Substation. The protective relay for Feeder #2 was found to have discrepancies and we recommend verifying with the coordination study to determine if the values are correct or if this relay is in need of repair.

RONDAR INC.

November 29, 2002

Mid-Ontario Energy Services Inc.
16984 Hwy #12
P.O. Box 820
Midland, Ontario
L4R 4P4

Attention: **Mr. Erik Kussen**

Subject: **2002 Preventative Maintenance @ Scott Street Substation**
Our Ref. C1011

Dear Sir,

We are enclosing the results of the maintenance work carried out at the Scott Street Substation on October 4, 2002.

In general, the results of the tests and inspections indicate that the equipment is suitable for service except as noted in our comments and recommendations section.

If you have any questions, or require further information, please do not hesitate to contact our office.

RONDAR INC.

Ian Dobson
Technical Service Representative

20 Venture Drive, Unit #9, Scarborough, Ontario M1B 3R7
Tel: (416) 286-2444 Fax: (416) 286-2445 E-mail: rondarto@look.ca

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Outdoor Substation Yard and Tower

1. The outdoor substation yard was found to have an excess of debris within it. We recommend that qualified personnel clean out this debris on a regular basis to ensure the dielectric properties of the yard.

2. The fence fabric of the main fence enclosure was found to not have a ground conductor woven through it. As per the Ontario Electrical Safety Code Rule 36-312(4), we recommend that a ground conductor be woven through the fabric in at least two places at your earliest convenience.

3. The High Voltage Air Break Switch feeding the main outdoor tower does not have a metallic gradient control mat, (switching mat). As per the Ontario Electrical Safety Code Rule 36-301(2)(a), we recommend that a switching mat be installed as soon as possible, to maintain touch voltages at the tolerable levels as outlined in Table 52, of the Ontario Electrical Safety Book, at the location where the switch operator is normally standing.

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RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Main Transformer, s/n 1-1028

1. It was noted that there is no Silica Gel Breathers located on this transformer. As the temperature and load increases and decreases for this transformer, the oil level rises and falls creating a breathing effect. As the transformer breathes, the possibility of moisture contaminating the insulating fluid is likely. Therefore, we recommend installing a silica gel breather on this transformer, at your earliest convenience, to help prevent the insulating fluid from absorbing moisture.

2. A burn mark was noticed on the porcelain along with a melted splash mark on the top metal globe of the phase B primary bushing from a flashover that has occurred in the past. Although these marks did not seem to affect the electrical properties of the transformer, it should be noted for future inspections.

3. Two (2) oil leaks were found on this transformer. One leak was noticed on the transformer end of a pipe that feeds from the conservator tank down to the main transformer casing while the other leak was found at the tap changer handle. We recommend that these leaks be monitored to determine their severity, and if corrective action is required.

4. The paint condition of this transformer was found to be deteriorating. We recommend that this transformer be sandblasted and repainted, at your earliest convenience, to ensure that the transformer casing remains in satisfactory condition.

5. The results of the furan analysis indicate that the level of furans have increased since September 2000, meaning that this transformer has undergone heat stress during this period with a rate of increase of <1 ppb/day. We recommend resampling this transformer for furans in April 2003 to continue to monitor the condition of the paper insulation.

RONDAR INC.

COMMENTS AND RECOMMENDATIONS

Main Indoor Substation

1. We were unable to locate a warning sign on the entrance door to the indoor substation room, as previously reported in our 1999 Preventative Maintenance report. As per the Ontario Electrical Safety Code Rule 36-006 (1)(a), we recommend that a sign be affixed, as soon as possible, to warn unqualified personnel of the potential hazard present in this room.

2. The entrance door of the indoor substation was found to be missing a ground connection to a corresponding ground bus in this room, as previously reported in our 1999 Preventative Maintenance report. We recommend installing a ground bus in this room and bonding the door to ground, as soon as possible, to ensure that all non-current carrying components are bonded to ground.

3. We were unable to locate a rubber switching mat for the indoor switchgear. We recommend that a rubber switching mat be installed, at your earliest convenience, to maintain adequate dielectric properties for personnel during switching operations.

4. During the maintenance, it was noticed that there are no warning signs located on the switchgear located in this room. As per the Ontario Electrical Safety Code rule 36-006 (1) (a), a warning sign should be installed at your earliest convenience.

5. We were unable to locate any smoke detection devices within the indoor substation room. We recommend that a device be installed and wired to an alarm panel, as soon as possible.

6. We recommend that a co-ordination study be completed involving all of the electrical equipment associated with the Scott Street Substation. All of the protective relays were found to have discrepancies and we recommend verifying with the coordination study to determine if the values are correct or if these relays are in need of repair.

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Tel: (416)286-2444 Fax: (416)286-2445 E-mail: rondarto@look.ca

RONDAR INC.

Section 9

BUDGETARY QUOTATION
Scott Street Substation Upgrade

RONDAR INC.

September 25, 2006

Midland PUC
16984 Highway 12
P.O. Box 820
Midland, Ontario
L4R 4P4

Attention: **Mr. Wayne Dupuis**
Operations Manager

Subject **Scott Street Substation Upgrade**
Our Budgetary Quotation No. T-6989 Revised

Dear Sir:

In response to your request, we are pleased to submit our budgetary quotation to complete the work as itemized below.

Our quotation is based on preliminary discussions during our meeting on October 4, 2005.

Item #1 – Transformer Replacement
To provide the technical manpower, equipment, transportation and disposal services to remove the existing 3000kVA transformer, s/n 1-1028, and install a 5000kVA, s/n 02-1754, currently in the possession of Midland PUC.

Our Budgetary Quotation includes the following:

- Prep the substation for transformer removal.
- Transportation and lifting costs.
- Disposal of the insulating fluid.
- Disposal of the 3000kVA transformer.
- Installation of the 5000kVA transformer and associated connectors
- Removal of existing bus duct and installation of a cable duct rated 5kV, 1000A capacity mounted in cable tray.
- ESA Plan Approval and the first regular time hour charge of an ESA Site Inspector. Any additional regular time and any overtime charges will be billed as an extra.

Based On Regular Time (Budgetary).....$ 60,000.00

Qualifications

- Midland PUC is responsible for removal of asbestos from the substation enclosure prior to work commencing.

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Tel: (416) 286-2444 Fax: (416) 286-2445 E-mail: dbrown@rondar.com

RONDAR INC.

Item #2 – Secondary Switchgear Replacement

To provide the engineering services, technical manpower, material and equipment necessary to replace the existing 5kV switchgear with new 5kV Medium Voltage Metal Clad Switchgear with Vacuum Breakers.

Our Budgetary Quotation includes the following:

- Supply of four (4) cells of 5kV, 3000A switchgear.
- Supply of five (5) Vacuum draw-out vacuum circuit breakers including one (1) 2000A Main Breaker and four (4) 1200A Feeder Breakers.
- Supply and installation of one (1) set of three (3) 1/c 500MCM feeder cables encased in a concrete duct bank between one (1) breaker cell and the outdoor pole structure. Connection to the 5kV distribution lines to be completed by Midland PUC.

Based On Regular Time (Budgetary)..... $ 435,000.00

Qualifications

1. Midland PUC is responsible for installation of a larger access door into the substation building prior to work commencing.
2. Midland PUC to provide a lifting vehicle for removal of the old medium voltage switchgear and placement of the new medium voltage switchgear into the substation building.
3. Our quotation includes ESA Plan Approval and the first regular time hour charge of an ESA Site Inspector. Any additional regular time and any overtime charges will be billed as an extra.
4. The cost associated with drilling new cable duct holes into the existing cable pit is unknown and is not included with our quotation.

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RONDAR INC.

Item #3 – Relay Protection Upgrade

To supply the engineering services, technical manpower and material necessary to replace the existing induction style relays with microprocessor based protection devices.

Our proposal is to install four (4) Schweitzer Protection and Breaker Control Relay SEL -351S-5 on each of the feeder breakers. We have also included the Schweitzer communication processor SEL-2020 that would provide the necessary communication between the protection relays and your existing supervisory system. The communication processor would be necessary for remote operation.

Our quotation includes the supply of the following:

- Supply of one (1) coordination study, short circuit analysis, ground grid calculation and device analysis.
- Supply of one (1) freestanding NEMA 12 enclosure with one overhead light, front and rear door access.
- Supply of five (5) Schweitzer Protection and Breaker Control Relays SEL-351S-5, manual included with this proposal.
- Supply of one (1) Communication Processor SEL-2020, manual included with this proposal
- Drawings: Control and Protection wire schematics will be produced and supplied.
- Material necessary to connect the wiring between the switchgear and the protection relay panel.
- Relay panel to include semi flush-mounted test/isolation switches one (1) for current and one (1) for voltage per SEL 351S-5 relay.
- Provide on-site training of the functions and operation of the SEL 351S-5. Training will be completed during commissioning of the relay panel.
- ESA Plan Approval and the first regular time hour charge of an ESA Site Inspector. Any additional regular time and any overtime charges will be billed as an extra.

Based On Regular Time (Budgetary)..... $ 115,000.00

Qualifications

1. Our quotation does not include costs associated with connecting and commissioning of the remote operation and communication of the relays. As per my conversation with a service representative from Surveillance, the communication processor is adaptable to their system and they can provide system support for connection and start up.

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RONDAR INC.

Our quotation is based on completing Items 1, 2 & 3 at the same time.

Upon completion of our work, a commissioning report including our engineering studies, as built control drawings, wiring schedules and new equipment manuals will be submitted.

We thank you for the opportunity to quote and look forward to serving you in this regard. If you require any additional information or assistance, please do not hesitate to contact our office.

RONDAR INC.

Dan Brown, A.Sc.T.
Technical Service Representative

Terms and Conditions

Terms of payment are net 15 days. Interest will be charged on all overdue accounts at the rate of 2% per month (24% per annum). Price is net and firm for 30 days from the date of quotation. Hydro and Electrical Safety Authority fees are extra if applicable. Taxes are extra if applicable. Delays not related to Rondar would be charged as an extra. Additional labour required by the Customer and/or its Union, other than that quoted by Rondar, will be billed as an extra. Unless otherwise indicated, this work will be performed during normal working hours, 8:00 a.m. to 4:30 p.m., Monday to Friday. Other terms and conditions are attached.

20 Venture Drive, Unit 9 Scarborough, Ontario M1B 3R7
Tel: (416) 286-2444 Fax: (416) 286-2445 E-mail: dbrown@rondar.com

RONDAR INC.

TERMS AND CONDITIONS

THIS QUOTATION IS MADE SUBJECT TO THE FOLLOWING TERMS AND CONDITIONS WHICH MAY NOT BE VARIED EXCEPT BY WRITTEN INSTRUMENT SIGNED BY A DULY AUTHORIZED REPRESENTATIVE OF RONDAR INC. ('RONDAR').

1. **ACCEPTANCE:** This quotation is made subject to approval by **Rondar** of Purchaser's credit and, subject to such approval, is open for acceptance for a period of thirty (30) days unless otherwise specified within our proposal.

2. **PRICES, TAXES AND PAYMENTS:** The prices quoted are in Canadian Dollars and unless otherwise stated herein are exclusive of all taxes. In the cases where taxes (including Federal and Provincial Sales, use or other taxes), are included, any changes to the tax rate after the quotation are to the Purchaser's account. Prices quoted are based on rates for work performed during **Rondar's** normal business hours. Overtime work involves extra charges unless otherwise specified. **Rondar** shall be entitled to charge reasonable storage charges over the prices quoted where storage of repaired equipment results from any cause for which Purchaser is directly or indirectly responsible. Where any work is delayed as a result of any cause for which Purchaser is directly or indirectly responsible, the date for determining the date on which payment is due for the work shall be the date upon which **Rondar** advises Purchaser as to its ability to perform. **Rondar** may request payment in advance notwithstanding payment terms specified if in the opinion of **Rondar**, Purchaser's financial condition does not at any time warrant continuation of work. Any payments not made to **Rondar** when due shall be subject to a service charge of 2% per month (24% per annum) provided that the foregoing is not to be construed as permitting any extension of time for payment.

3. **COMPLETION OF WORK:** Any completion dates specified are subject to events of force majeure and the receipt from Purchaser of all information necessary to allow maintenance of **Rondar's** schedule.

4. **FORCE MAJEURE:** **Rondar** shall not be responsible or liable for any loss, damage, detention or delay caused by war, invasion, insurrection, riot, the order of any civil or military authority, or by fire, flood, weather or other acts of the elements, breakdown, lockouts, strikes or labour disputes, the failure of **Rondar's** supplier to meet their contractual obligations or any other cause beyond the reasonable control of **Rondar** including any default of Purchaser and the time for the performance by **Rondar** of any of its obligations shall be extended by an amount of time equal to the delay caused by any such event.

5. **INCLEMENT WEATHER:** **Rondar** may cancel any work scheduled where inclement weather is forecasted. If **Rondar** cancels and Purchaser wishes work to proceed, Purchaser shall be liable for charges relating to additional time to complete the work or for reasonable cancellation charges in the event work cannot proceed. Reasonable cancellation charges shall include travel charges and minimum of 4 hours per person charge.

6. **HYDRO DELAYS:** On disconnecting and reconnecting power source, any delay caused by Hydro, Purchaser shall be charged as an extra.

7. **WARRANTY:** **Rondar** warrants that the specific equipment or part serviced under this contract will not fail for a period of one (1) year from commencement of the servicing by **Rondar**. Provided that **Rondar** may notify Purchaser if in **Rondar's** opinion, the equipment cannot be adequately repaired or serviced and **Rondar** shall have no further obligation hereunder. **Rondar's** warranty remains in effect provided the equipment is properly maintained and operated in accordance with the manufacturer's and **Rondar's** maintenance instructions and that the equipment is not moved for any reasons whatsoever after the servicing. This warranty only applies to equipment failures that can be proven to be a direct result of the repair servicing performed by **Rondar**, i.e. failures caused by other events or reasons not directly related to **Rondar's** repair work are not covered by this warranty. Should the customer's equipment fail during **Rondar's** one (1) year warranty period, **Rondar** will refund to the customer, the portion of the contract price (less all taxes) associated with specific part of the equipment giving rise to the claim, provided that the customer immediately informs **Rondar** of said claim in writing. Under no circumstances will **Rondar** be liable for an amount exceeding the original contract price (less all taxes). This warranty expressly excludes failures caused by acts of God, acts of third parties and negligent acts of the Purchaser. A warranty refund to the Purchaser shall not renew nor extend the warranty. **Rondar** will not directly give nor cause to be implied this equipment warranty on any contacts that do not involve direct servicing of equipment by **Rondar** (engineering studies, laboratory work, and oil processing do not constitute direct servicing). The foregoing constitutes the only warranties of **Rondar** and there are no other warranties or conditions, expressed or implied, statutory or otherwise, relating to the work to be performed or to the parts or components to be supplied by **Rondar** under this quotation. This warranty is not transferable to a third party without the expressed written consent of a duly authorized representative of **Rondar**.

8. **LIMITATION OF LIABILITY:** Notwithstanding any other provisions herein contained or any applicable statutory provisions, **Rondar** shall not be liable to Purchaser or third parties for special consequential damages or damages for loss or use arising directly or indirectly from any breach of agreement resulting from the acceptance of this quotation, fundamental or otherwise, or from any tortuous acts or omissions of its employees or agents. The liability of **Rondar** with respect to any defective work or any part of the work which is subject to late completion shall not exceed the unit price of such defective or late work, as the case may be, and in no event, shall the total liability of **Rondar** exceed the total amount paid by Purchaser for the work performed hereunder.

9. **SCOPE OF WORK:** Obligations of **Rondar** are limited to the work specified in this quotation. **Rondar** shall not be liable for any failure of Purchaser to be specific nor for any inaccuracy in delineating the work. The definition of the scope of work is the sole responsibility of Purchaser.

10. **COMPLETE AGREEMENT:** If accepted within the time period above, the terms and conditions of this quotation shall constitute the entire agreement between Purchaser and **Rondar** with respect to the subject matter hereof. Such agreement shall not be amended except by written instrument signed by a duly authorized representative of **Rondar** and shall be governed by the laws of the Province of Ontario.

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