Undertaking # #9
EB-2008-0230

McMillan, Brian

From: Shawn Otal [shawn.otal@gmail.com]
Sent: November 10, 2008 11:55 AM
To: McMillan, Brian
Subject: Draft of my report
Attachments: Sudbury Hydro - Capex and O&M Review.doc

Hi Brian:

As promised attached please find draft 1 of my report. After you have had a chance to browse through it please give me a call and we can discuss it. After that I will finalize the report and also do one more edit on the document.

I was proposing to use the asset management document that I emailed to you previously as Appendix A.

Regards

Shawn

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EXECUTIVE SUMMARY

This report, prepared by METSCO Inc, provides an independent review of the proposed capital and O&M expenditure for the three year period from 2009 to 2011.

The proposed capital expenditure during each year consists of the following three components: expenditure for distribution system relocations to facilitate road widening or road realignment projects; expenditure for distribution system capacity upgrades or network exensions to facilitate connection of new services; and expenditure for renewal and replacement of distribution system assets at the end of their useful life.

Expenditures for line relocations as well as system extensions for connection of new services fall under the "non-discretionary" spending category. Based on historic spending level into these projects, the budgets proposed by Sudbury Hydro for fulfillment of these statutory commitments are reasonable.

For the past many years, Sudbury Hydro has not kept up the capital investments into asset renewal at the required level to optimally manage the risk of in-service asset failures. This has resulted in a disproportionately high percentage of the assets reaching beyond their mean life expectancy. In our opinion, Sudbury Hydro will need to ramp up the capital investments into asset renewal and replacement to a level of approximately $11 million annually, for the next 10 years or so, to clear the backlog of assets that are currently in service beyond their mean life expectancy.

We have independently reviewed the asset renewal projects proposed by Sudbury Hydro for implementation during the next 10 years and implementation of each of these projects is timely and in the best interest of rate payers. In order to prioritize the asset replacements beyond Year 2011, we recommend Sudbury Hydro to adopt a formal risk-based asset management strategy, by benchmarking the health and condition of all assets through the use of a system of health indices. Guidelines for development of health indices for overhead and underground lines are provided in Appendix A.

Due to the existing age and condition of assets, risk of in-service asset failure will remain high for the next 10 years. Sudbury Hydro is proposing to expand the scope and frequency of its preventative maintenance and asset condition monitoring programs to better manage the increased risk of in-service asset failure. A further increase in O&M funding is needed to provide for additional resources during the investment planning phase for prioritization of projects as well as during the implementation phase to provide improved cost controls and project management activities. Therefore, the proposed increase in O&M expenditure by Sudbury Hydro is justified.

1 INTRODUCTION

This report, prepared by METSCO Inc, provides an independent review of the proposed capital and operating and maintenance (O&M) expenditure for the three year period from 2009 to 2011, documented in a report prepared by Sudbury Hydro in support of its 2009 rate application, titled Capital Asset Management Report.

The proposed capital expenditure during each year consists of the following three components:

(a) expenditure for distribution system relocations to facilitate road widening or road realignment projects, required to fulfil Sudbury Hydro's commitments to applicable provincial statutes and municipal bylaws;

(b) expenditure for distribution system capacity upgrades or network exensions to facilitate connecting new services in compliance of Sudbury Hydro's regulatgory obligations; and

(c) expenditure for renewal and replacement of distribution system assets at the end of their useful life.

In addition to the above listed capital expenditures, an increase in operating and maintenance (O&M) expenditure is proposed by Sudbury Hydro to improve the scope and frequency of preventative maintenance, carry out asset management tasks and effectively manage the increased scope of capital investments.

The report is organized into five sections including this introductory section. Section 2 critiques the adequacy of overall capital expenditure proposed by Sudbury Hydro. Section 3 provides a review of the specific projects proposed under the asset renewal and replacement program. Proposed O&M expenditure is reviewed in Section 4. Report conclusions and recommendations are summarized in Section 5.

Detailed guidelines for implementation of an asset management strategy for overhead and underground lines are documented in Appendix A.

2 REVIEW OF OVERALL CAPEX PLAN

2.1 *Expenditure for Network Relocation*

To comply with its statutory obligations, Sudbury Hydro is required to relocate its overhead and underground facilities installed within the road right-of-way allowances within 90 days upon receiving a request from the appropriate municipal or provincial authorities. The costs for such line relocations are shared based on a legislated cost sharing formula. Based on prior years' experience and knowledge of the upcoming municipal road widening projects, the estimated value of the Sudbury Hydro's share of the costs is summarized in Exhibit 2.1.

Capital Expenditure for distribution network relocations requested by the municipal / provincial authorities during the year:	Estimated Cost to be borne by Sudbury Hydro
2009	$650,000
2010	$950,000
2011	$650,000

Exhibit 2.1 Capital Expenditure for Distribution Line Relocations

Since these are non-discretionary costs over which Sudbury hydro has no control, based on prior years' experience these budgetary estimates appear to be reasonable.

2.2 *Expenditure for New Services*

This is also non-discretionary expenditure, because in order to meet the "obligation to serve" within its franchised service area, Sudbury Hydro is obligated to expand the system capacity and provide network extensions to serve new customers, when they apply for a service and absorb the economically justified portion of the expenditure. Historic capital expenditure for release of new electrical connections is summarized in Exhibit 2.2 below:

Year	Expenditure
2001	$1,327,451
2002	$1,899,775
2003	$1,288,908
2004	$894,065[1]
2005	$3,611,392
2006	$2,323,562
2007	$1,610,613
Mean	**1,850,824**

Exhibit 2.2 Historic Capital Expenditure for New Services

As indicated in Exhibit 2.3, the planned expenditure for new services during the next 3 years is of the same order of magnitude as the previous seven years, and therefore, the magnitude of proposed expenditure for new services is reasonable.

Capital Expenditure for New Services	Forecast Amount
2009	$1,928,890
2010	$1,485,077
2011	$2,235,077
Mean	**$1,883,015**

[1] Expenditure during this year unusually low due to labour strike at Sudbury Hydro

Exhibit 2.3 Proposed Capital Expenditure for New Services

2.3 *Expenditure for Asset Renewal and Replacement*

The best-in-class asset management strategies, including the one proposed in BSI standard PAS-55, are based on managing the risk of in-service failure of assets at an optimal level by making on time and adequate investments into asset renewal and replacements. Depending on the consequences of the risk associated with in-service failure of a specific asset, it may make perfect sense to run some of the assets, such as small distribution transformers, to failure, while for other assets with a high consequence of in-service failure, such as poles, circuit breakers and power transformers, it is considered prudent to adopt a proactive approach and replace the assets when the probability of their failure exceeds an acceptable level.

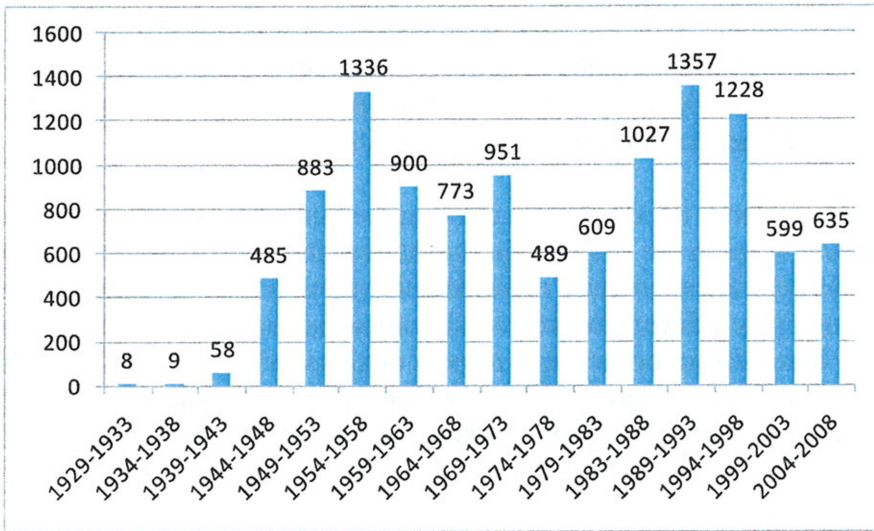
In either case, adequate funds need to be allocated in the budget for replacement and renewal of those assets projected to reach the end of their useful over the next three years. In order to accurately assess the capital expenditure requirements based on risk optimization approach, detailed asset demographic information and condition assessment surveys are required in respect of all major assets. Since full information in respect of all assets is not readily available, in order to establish the reasonableness of proposed expenditures, we have utilized all readily available information to establish an estimate of the assets expected to reach the end of their useful life over the next three years, as described below.

2.3.1 Overhead Distribution Lines:

The overhead lines at Sudbury Hydro consist of 44 kV sub-transmission lines supplying municipal substations (MS) and large industrial customer owned power transformers; 12 kV and 4 kV medium voltage lines fed from the municipal substations and supplying distribution transformers; and low voltage lines and services. Major assets installed on overhead lines consist of support structures, insulators, conductors, distribution transformers and disconnect switches and cutouts. Support structures for overhead lines mostly consist of wood poles, demographic information for which is available. Since in case of a majority of the existing overhead lines, all of the line components including insulators, conductors, disconnects and cutouts were installed at the time of the original line construction, the age of wood poles also represents with reasonable accuracy the age of the insulators, conductors, disconnect switches and cutouts.

Sudbury Hydro's inventory records indicate a total of 14,248 poles are currently in use. Out of these, 11,347 poles are owned by Sudbury Hydro and the remaining 2901 poles are owned by Bell and Hydro One and Sudbury Hydro leases a space on these. The demographic information for Sudbury Hydro owned poles is summarized in Exhibit 2.4. Wood species are predominately western red cedar and pine, but some of the older poles are native cedar. Information on quality and type of pole treatment with preservatives is not available.

For wood poles, the most critical degradation processes involve biological and environmental mechanisms such as fungal decay, wildlife damage and effects of weather. Fungi attack both external surfaces and the internal heartwood of wood poles. The process of fungal decay accelerates in the presence of fungus spores, moisture and oxygen. For this reason, the area of the pole most susceptible to fungal decay is at and around the ground line and this is also the area where highest strength is required. To reduce the rate of decay, wood poles are treated with preservatives before installation. Preservatives help keep out moisture and kill off fungal spores. Typically, preservative treated poles have a mean life of approximately 50 years, while the mean life of untreated poles, depending upon the environmental conditions, may be approximately 30 to 35 years. But because wood is a natural rather than engineered material, there are significant variations in fiber strength which result in relatively large deviations from the mean in pole's life expectancy.



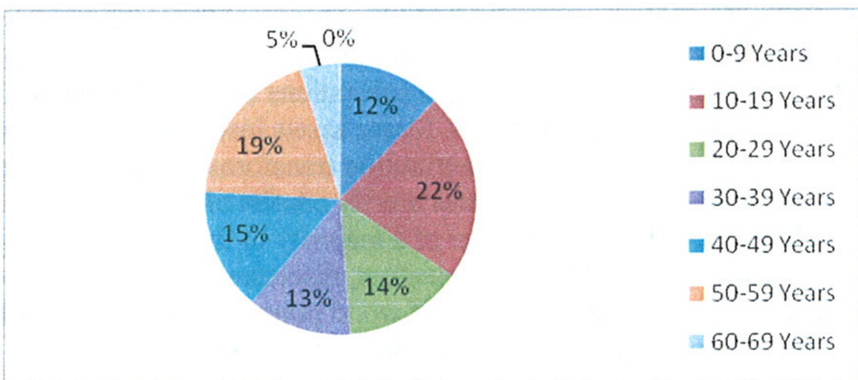


Exhibit 2.4 – Sudbury Hydro's Wood Pole Age Profile

In addition to fungal decay, some other sources of pole damage and degradation include rock and earth slides, snow slides and creep, ice or heavy snow drop off, random impact, i.e. motor vehicle accidents, vandalism, lightning, forest fires, and ineffective grounding which causes fires. While some forms of damage can be detected through visual inspections, internal decay usually requires in-situ testing of poles using non-destructive techniques and estimation of their remaining strength.

We propose Sudbury Hydro adopt a pole testing program to manage the aging fleet of wood poles to prevent in-service failures. Since the consequences of in-service pole failures include serious public safety hazards and can be extremely costly, when the remaining strength of a pole fails to provide adequate safety margins, it must be retired from service and replaced.

An examination of Exhibit 2.4 reveals at least 24% of the poles are older than 50 years and well beyond the mean life expectancy. An additional batch of poles, consisting of 15% of the overall population is currently between 40-50 years of age and if Sudbury Hydro were to embark on a 10 year plan for asset renewal these 15% poles will also reach past mean life expectancy and will need to be replaced over the next 10 years.

Asset Name	Total Installed	Assets currently older than mean Life Expectancy and Requiring replacement in the next 10 years		Per unit Replacement Cost	Total Replacement Cost
		%	#		
Distribution Transformers OH (#)	4178	20%	814.7	$4,836	$3,939,938
Distribution Poles (#)	12638	39%	4,928.8	$3,827	$18,862,594
Overhead wires 3 ph 44 kV (m)	105169	20%	20,508.0	$22	$451,175
Overhead 3 ph wires 12 kV, 4 kV (m)	412591	20%	80,455.2	$35	$2,815,934
Overhead Secondary Wire (m)	994768	20%	193,979.8	$19	$3,685,615
Gang operated switches 44 kV (#)	113	20%	22.0	$57,500	$1,267,013
Gang operated switches 12 kV (#)	369	20%	72.0	$12,650	$910,231
Disconnect Switches (Loc + Trans) (#)	10353	20%	2,018.8	$333	$672,272
Lower Bound of Capital Expenditure for renewal of Overhead Lines during next 10 years					**$32,604,771**

Exhibit 2.5 – Capital Expenditure Estimates for Overhead Line Renewal

Because of the unavailability of any other asset condition indicators, Exhibit 2.5 represents our estimate of the lower bound of capital investment requirements over the next 10 years for overhead lines, based on the following assumptions:

(a) Even under the most optimistic scenario, the mean life of distribution transformers does not exceed 50 years, and about half of the distribution transformers have been previously replaced.

(b) Assuming a very optimistic scenario, approximately 50% of the existing overhead conductors and disconnects are found in excellent condition and can be re-used when replacing poles.

(c) The per unit costs indicated in Exhibit 2.5 are in 2007 dollars and will require adjustment for inflation during the next 10 years.

To summarize, an annual capital investment of at least $3,260,000 is required for renewal and replacement of overhead line poles, distribution transformers, insulators, conductors and disconnect switches during each of the next ten years to manage the risk of in-service asset failures.

2.3.2 Municipal Substation Assets:

Municipal substation assets include power transformers; sub-transmission (44 kV) circuit switchers and disconnects; distribution (4 kV or 12 kV) switchgear: circuit breakers and reclosers; buildings and fences; ground grid electrodes; control batteries and chargers; and remote terminal units and supervisory control and data acquisition (SCADA) system. Not including land, the replacement cost of a typical distribution transformer is approximately $180,000. Power transformers and distribution switchgear are the two most expensive substation assets and even under the most optimistic scenario, mean life expectancy for these two pieces of equipment does not exceed a range of 40-50 years. The SCADA system requires ongoing software and hardware upgrades for which the mean life expectancy is of the order of 10 years.

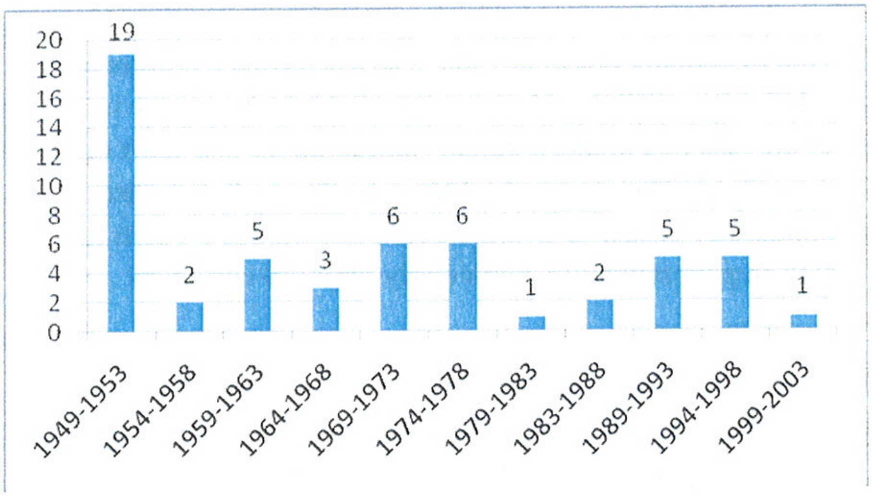
The most critical component in transformer aging consideration is the insulation system, which consists of mineral oil and paper. Transformer insulating oil consists of hydrocarbon compounds that degrade with time due to oxidation, resulting in formation of moisture, organic acids and sludge. The oil oxidation rate is a function of operating temperature. Increased acidity and moisture content in insulating oil causes accelerated degradation of insulation paper. Formation of sludge adversely impacts the cooling efficiency of transformer, resulting in higher operating temperatures and further increasing the rate of oxidation of both the oil and the paper. Oil analysis provides valuable information on health of the insulation system and is good indicator of remaining life. In case of old vintage switchgear, that often employs oil or magnetic air circuit breakers, un-availability of spare parts and increasing operating and maintenance costs often determine the end-of-life and replacement decisions.

Exhibit 2.6 shows the demographic information on Sudbury Hydro's power transformers, which is also indicative of the age profiles of other major assets installed in substations, i.e. switchgear, fences, ground electrodes and buildings. As indicated, over 58% of the station assets are either already past or approaching the mean life expectancy. Aging substation assets near the end of their useful life present a high risk of in-service failure and require frequent condition monitoring and preventative maintenance, which results in high operating and maintenance costs. In the absence of frequent preventative maintenance, equipment failures pose a risk for supply system security and potential catastrophic equipment failures also pose serious safety and environmental risks.

In our opinion, Exhibit 2.7 represents the lower bound of capital investment requirements over the next 10 years for substation assets.

2.3.3 Underground Distribution System Assets

The demographic information available on underground distribution systems is not complete. We do know underground distribution system has been in use in Sudbury for both commercial areas and residential areas for over 35 years. The renewal and replacement of underground cables in commercial areas has been on-going for several years, but very few cable circuits have been replaced thus far in the residential areas. Records indicate there are approximately 82 km of single-phase underground cable circuits and 25 km of three-phase underground cable circuits employed on the distribution system.



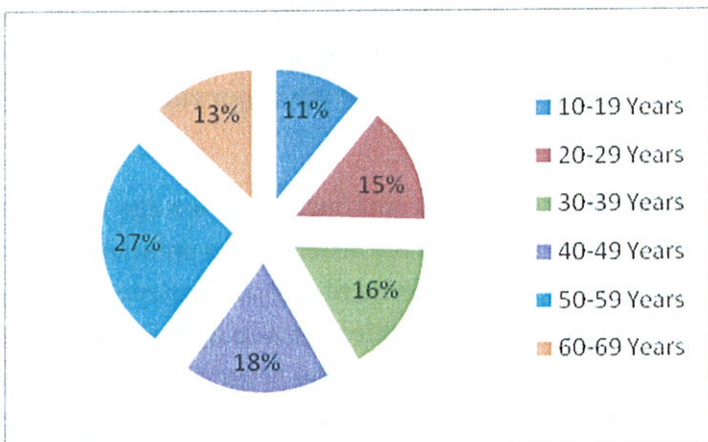


Exhibit 2.6 – Sudbury Hydro's MS Power Transformer's Age Profile

Asset Name	Total Installed	Assets currently older than mean Life Expectancy and Requiring replacement in the next 10 years		Per unit Replacement Cost	Total Replacement Cost
Substations	43	58%	24.9	1,800,000	44,892,000
SACADA System	1	50%	0.5	750,000	375,000
Lower Bound of Capital Expenditure for renewal of Substation equipment during the next 10 year period					45,267,000

Exhibit 2.7 – Capital Expenditure Estimates for Substation Assets Renewal

Underground subdivision construction in Sudbury began in 1960's, so a significant portion of the underground cables in residential subdivisions (URD cables) are approaching service age in excess of 35 years. The URD cables are installed in direct buried configurations and some of the early installations are in radial configurations. Direct buried cables not only result in higher repair costs upon failure, but the significantly longer time it takes to locate faulted sections and repair direct buried cables, also results in poor reliability, particularly for those customers supplied in radial configurations.

A majority of the URD cables circuits employ polymer insulation in form of cross-linked polyethylene (XLPE) which was introduced as an economic alternative to paper insulated lead covered (PILC) cables in early 1970's. The insulation system in XLPE cables consists of a semi-conducting sheath over the conductor, the insulation, another semi-conducting layer over the insulation, a metallic shield tape or concentric neutral. For the early generation of these cables, manufactured in the 1970's, presence of impurities in the insulation system and vulnerability to moisture ingress has made these cables susceptible to premature failures due to water treeing. Water treeing in XLPE cables of 1970's vintage are the major cause of excessive cable failures in most North American power companies.

As a large number of Sudbury Hydro's cables approach a service age in excess of 35 years, reliability is expected to deteriorate rapidly in the absence of a proactive cable replacement program. The pad-mounted distribution transformers and pad mounted switchgear, which were installed at the same time as the underground cables are also approaching the end of service life and would require a proactive replacement and renewal program. Older underground maintenance holes will need to be enlarged to comply with the safety regulations. In our opinion, Exhibit 2.8 represents the lower bound of capital investment requirements over the next 10 years for underground assets.

Asset Name	Total Installed	Assets currently older than mean Life Expectancy and Requiring replacement in the		Per unit Replacement Cost	Total Replacement Cost
Underground cable 44 kV	3370	20%	674.0	1,421	957,754
Underground Cable 3 ph	25004	20%	5,000.8	1,320	6,601,056
Underground Cable 1 ph	82411	40%	32,964.4	440	14,504,336
Underground Secondary Cable	973449	5%	48,672.5	30	1,460,174
Dist Transformers mini pads 1 ph	684	40%	273.6	9,760	2,670,336
Dist Transformers pad mounted 3 ph	537	20%	107.4	22,860	2,455,164
Dist Transformers U/G Vault	130	25%	32.5	18,560	603,200
Padmounted switches	60	25%	15.0	28,660	429,900
Junction Enclosure	56	25%	14.0	13,260	185,640
Underground maintenance holes	900	11%	99.0	10,000	990,000
SF 6 Switches	13	25%	3.3	35,780	116,285
Total Anticipated CAPEX for Asset Renewal over the next 10 years					**30,973,845**

Exhibit 2.8 – Capital Expenditure Estimates for Underground System Assets Renewal

2.3.4 Overall Capital Budget for Asset Renewal and Replacement

By summing up the capital budget needs for overhead lines, substations and underground distribution systems, presented in Sections 2.3.1, 2.3.2 and 2.3.3 we have arrived at the conclusion that the capital expenditure for equipment renewal and replacement will need to be ramped up to levels indicated in Exhibit 2.10, to maintain risk at an optimal level.

Overhead Line assets	$3,260,477
Muncipal Substion assets	$4,526,700
Underground Distribution assets	$3,097,384
Total annual Capex for asset renewal	**$10,884,562**

Exhibit 2.9 – Annual Capital Expenditure Requirements

In view of the analysis presented above, in our opinion Sudbury Hydro's proposal to gradually ramp up the capital expenditure for asset renewal over the next three years is justified and represents a responsible plan. The capital expenditure will need to be increased to the levels indicated in Exhibit 2.9 in subsequent years.

Capital Expenditure for New Services	Forecast Amount
2009	$5,330,088
2010	$6,617,598
2011	$6,994,020
Mean	**$6,313,902**

Exhibit 2.10 – Annual Capital Expenditure Requirements

3 Review of Specific Asset Renewal Projects

The specific projects proposed to be implemented over the next three years under the asset renewal program are briefly reviewed below:

(a) The first set of the asset renewal projects consists of emergency repairs, rehabilitation or replacement of an asset upon total or partial failure such as replacement of a failed distribution transformer, repairs to a piece of substation equipment, system betterment projects to remove operational bottlenecks or safety hazards; and asset replacement in response to regulatory directives, such as replacement of PCB containing transformers.

(b) The second set of projects is in form of voltage conversion projects, upgrading the voltage of distribution lines from 4 kV to 12 kV. A review of the specific projects proposed for implementation during the next three years reveals that projects have been prioritized to replace 4 kV overhead lines near the end of their useful life or replace old lines installed along the back-lot lines where they are difficult and costly to maintain due to poor access. These implementation of these voltage conversion projects, thus serves a dual purpose: they allow risk mitigation while at the same time contributing towards loss reduction through voltage upgrade.

(c) A number of projects are proposed to replace lines with small conductor sizes of #2 AWG and smaller. While overhead conductors employed on distribution lines rarely fail in service, experience of recent years indicates that smaller cross-section conductors have been experiencing frequent in-service failures. Live conductors snapping and falling on ground represent extreme risk to public and employee safety. These projects are therefore being implemented with the objective of improving public safety. They will also produce some additional benefits, including reduced line losses and reliability improvements.

(d) A number of projects are proposed to replace aging URD cables in residential subdivisions. The subdivisions for implementation of these projects have been selected based on recent reliability performance and to maximize reliability improvement benefits.

(e) Some projects include replacing porcelain insulators on overhead lines that have been experiencing high failures.

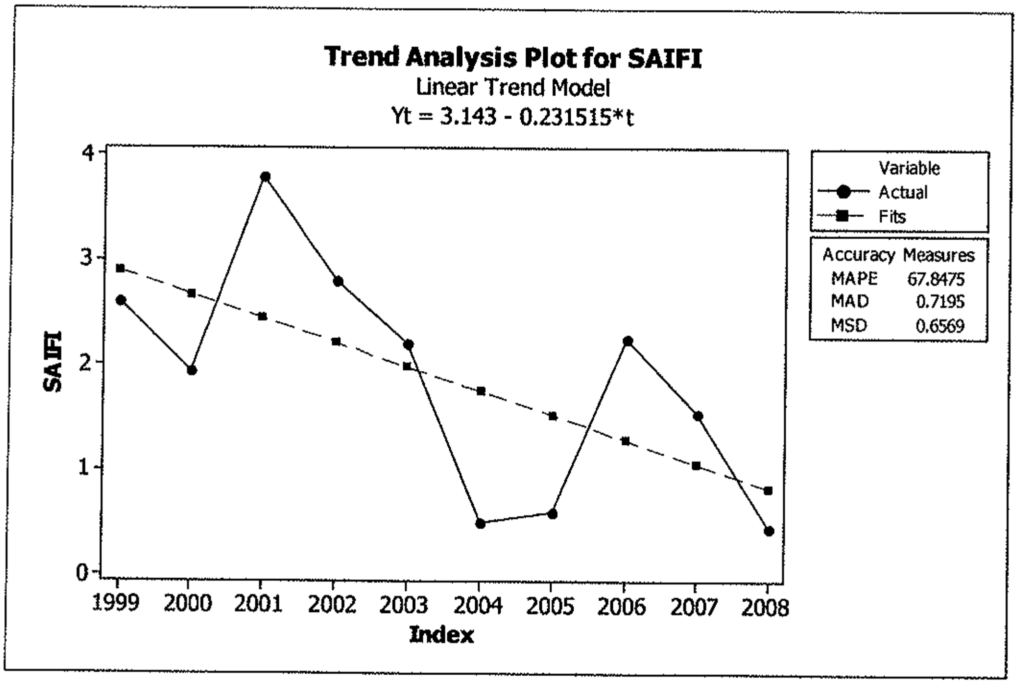
(f) Capital investments are proposed for rebuilding of a municipal station.

(g) Capital budget also includes SCADA upgrades and upgrade of as-built records to GIS mapping.

Based on our field inspections of the representative samples of projects proposed for implementation, the prioritization of projects is appropriate and follows the best asset management practices.

4 O&M PLAN

As indicated in Section 2, a significantly large proportion of the assets employed on Sudbury Hydro's overhead lines, substations and underground distribution system are approaching the end of asset's useful life. As the assets approach the end of their useful life, the scope and frequency of asset condition monitoring and preventative maintenance activities must be raised significantly to maintain risk of in-service failure within acceptable levels. Due to lack of adequate staff levels over the past many years, Sudbury Hydro has not been able to keep up with the required level of preventative maintenance.



The regression equation is
SAIFI = 466 - 0.232 Year

Predictor	Coef	SE Coef	T	P
Constant	465.7	199.9	2.33	0.048
Year	-0.23152	0.09977	-2.32	0.049

S = 0.906164 R-Sq = 40.2% R-Sq(adj) = 32.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	4.4219	4.4219	5.39	0.049
Residual Error	8	6.5691	0.8211		
Total	9	10.9910			

Exhibit 3.1: Regression Analysis of Reliability Indicator - SAIFI

While a regression analysis of System Average Interruption Frequency Index (SAIFI) over the last 10 years, shown in Exhibit 3.1, demonstrates an improving trend in supply system reliability, it is noteworthy that the linear regression function is not a very good fit for the data, as evidenced by low value of correlation coefficient - R^2 and the large deviations of the forecast from the mean. With the expected cyclical variations in weather, when adverse weather arrives in Sudbury for a few years in a row, reliability could get much worse due to the existing age and condition of assets, unless preventative maintenance activities are expanded in scope and frequency, and this is why additional funding is needed under O&M budgets.

Additional O&M funds are also needed for additional resources during the investment planning phase for prioritization of projects as well as during the implementation phase to provide improved cost controls and project management activities, as Sudbury Hydro ramps up its asset renewal and replacement program during the next 10 years. Asset management activities, which in the long run result in lower life cycle costs and improved asset performance, require additional resources in the short term to collect and document asset management data in GIS data base.

In view of the above, in our opinion, the requisition for additional O&M resources as indicated in Sudbury Hydro's Capital Asset Management report is reasonable.

5 CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis provided in Sections 2, 3 and 4, our conclusions and recommendations are summarized below:

(a) The three year capital budgets for non discretionary spending proposed by Sudbury Hydro to relocate its overhead and underground facilities at the request of municipal or provincial authorities are reasonable.

(b) Based on previous years' experience, the three year capital budgets for system extensions and capacity upgrades for connection of new services are also reasonable.

(c) For the past many years, Sudbury Hydro has not kept up the capital investments into asset renewal at the required level to optimally manage the risk of in-service asset failures. This has resulted in a disproportionately high percentage of the assets reaching beyond their mean life expectancy. In our opinion, Sudbury Hydro needs to ramp up the capital investments into asset renewal and replacement to a level of approximately $11 million annually, for the next 10 years or so, to clear the backlog of assets that are currently in service beyond their mean life expectancy.

(d) We have independently reviewed the asset renewal projects proposed by Sudbury Hydro for implementation during the next 10 years and implementation of each of these projects is timely. In order to prioritize the asset replacements beyond Year 2011, we recommend Sudbury Hydro to adopt a formal risk-based asset management strategy, by benchmarking the health and condition of all assets through the use of a system of health indices. Guidelines for development of health indices for overhead and underground lines are provided in Appendix A.

(e) Due to the existing age and condition of assets, risk of in-service asset failure will remain high for the next 10 years. Sudbury Hydro is proposing to expand the scope and frequency of its preventative maintenance and asset condition monitoring programs to better manage the increased risk of in-service asset failures. In our opinion, this is a prudent approach and the proposed increase in O&M expenditure for its implementation is justified.

Appendix A