Reference: 2.1 2024 Substation Refurbishment and Modernization

Q. Page 1. Newfoundland Power introduced its Substation Refurbishment and Modernization Plan as part or its 2007 Capital Budget application. Please file a copy of this plan for the record in this proceeding.

A. Attachment A contains the *Substation Strategic Plan* ("the Plan") as filed with the *2007 Capital Budget Application*. Newfoundland Power's *Substation Refurbishment and Modernization Plan* is an element of the Plan. The Plan changed the way substation capital projects were planned and executed at Newfoundland Power.

Report *2.1 2024 Substation Refurbishment and Modernization* filed with the *2024 Capital Budget Application* provides an update on Newfoundland Power's *Substation Refurbishment and Modernization Plan*.

ATTACHMENT A:

Substation Strategic Plan

Substation Strategic Plan

March 2006

Prepared by:
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SEAN LaCOUR
SIGNATURE
PROVINCE OF NEWFOUNDLAND

NEWFOUNDLAND POWER
A FORTIS COMPANY

Table of Contents

Page

1.0 Introduction

This report outlines a change in the way Newfoundland Power's ("the Company") substation capital projects are planned and executed. This change will help the Company realize productivity and reliability gains by organizing refurbishment and modernization projects on an individual substation basis. In addition, capital work will be coordinated as much as possible with major operating maintenance work, thereby minimizing service interruptions to customers.

In recent years, the Company's substation capital program has consisted of five projects: Rebuild Substations, Replacement and Standby Equipment, Protection and Monitoring Improvements, Additions Due to Load Growth and Feeder Remote Control. In 2007 and beyond, Newfoundland Power's substation capital budget will be organized into three projects as follows:

1. Substation Refurbishment and Modernization;
2. Replacements Due to In-Service Failures; and
3. Additions Due to Load Growth.

The revised approach is supported by a detailed review of the Company's substation assets that was recently undertaken. The review has identified Substation Refurbishment and Modernization capital projects in 80% of the Company's substations. These capital projects will be planned in conjunction with operating maintenance involving major equipment over a ten-year cycle. The Substation Refurbishment and Modernization capital projects are expected to require an average annual capital expenditure of approximately $4 million.

2.0 Background

2.1 Newfoundland Power's Substations

Newfoundland Power has 130 substations located throughout its operating territory. A small number of those substations connect generating plants to the electrical system. The remainder, which constitute the vast majority of the Company's substations, interconnect transmission lines and distribute electricity to customers via distribution feeders. The equipment in the substation controls the flow of that electrical energy to other parts of the electrical system, safely and at appropriate voltage levels. Appendix A is a description of a typical substation.

Figure 1 on the following page shows the location of the Company's transmission lines, substations and generating plants, as well as those of Newfoundland and Labrador Hydro on the island of Newfoundland. Substations are listed in the map legend as "Terminal Stations", and each substation is depicted on the map as a small black square labelled with the substation's three-letter designation.

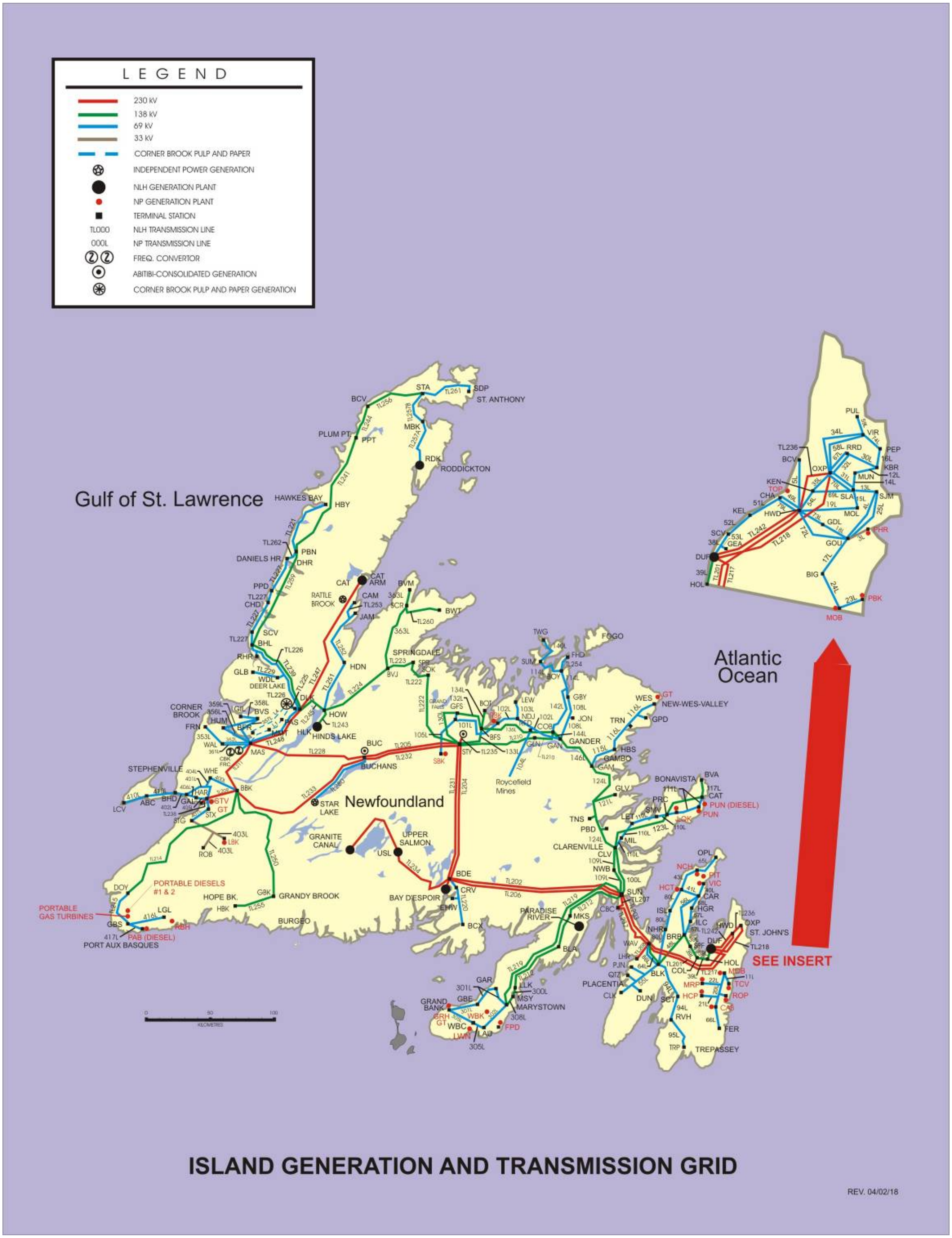
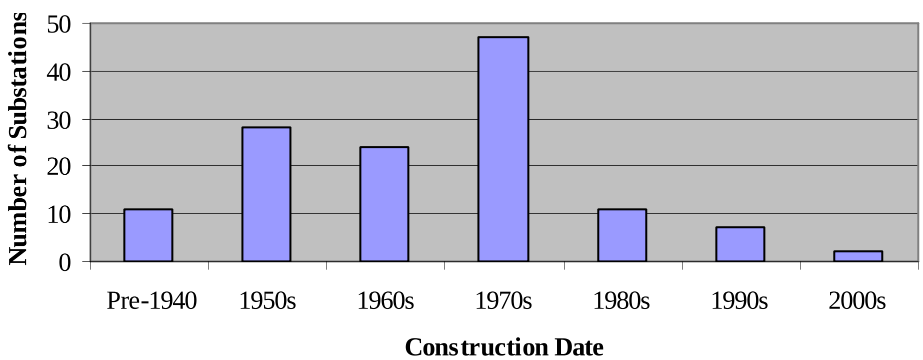

LEGEND
230 kV
138 kV
69 kV
33 kV
CORNER BROOK PULP AND PAPER
INDEPENDENT POWER GENERATION
NLH GENERATION PLANT
NP GENERATION PLANT
TERMINAL STATION
TL000 NLH TRANSMISSION LINE
000L NP TRANSMISSION LINE
FREQ. CONVERTOR
ABITIBI-CONSOLIDATED GENERATION
CORNER BROOK PULP AND PAPER GENERATION
Gulf of St. Lawrence
Atlantic Ocean
Newfoundland
ST. ANTHONY
RODDICKTON
HAWKES BAY
DANIELS HR.
CORNER BROOK
DEER LAKE
HINDS LAKE
STEPHENVILLE
BUCHANS
STAR LAKE
GRANITE CANAL
UPPER SALMON
BAY D'ESPOIR
GRANDY BROOK
HOPE BK.
BURGEO
PORTABLE DIESELS #1 & 2
PORTABLE GAS TURBINES
PAB (DIESEL)
PORT AUX BASQUES
SPRINGDALE
Roycefield Mines
FOGO
GANDER
GAMBO
NEW-WES-VALLEY
BONAVISTA
PUN (DIESEL)
CLARENVILLE
PARADISE RIVER
PLACENTIA
MARYSTOWN
GRAND BANK
ST. JOHN'S
TREPASSEY
SEE INSERT
ISLAND GENERATION AND TRANSMISSION GRID
REV. 04/02/18

Figure 1

2.2 Aging Substation Infrastructure

Nearly half of Newfoundland Power's substations are over 40 years old, with approximately one-third exceeding 50 years of age. The core infrastructure and major equipment in the Company's substations includes foundations, structures, grounding systems, fencing, power transformers, oil filled breakers, cables, potential transformers, control buildings, switchgear and protective relaying. With few exceptions, the core infrastructure and major equipment in the Company's substations has been in service since the substations were built. Chart 1 shows the age grouping of the Company's 130 substations.

Chart 1
Age of Substations



Typically, the requirement for refurbishment or replacement of substation equipment is minimal during the first 40 years in service. During this period, components will be replaced or refurbished if their condition warrants it. Consequently, the Company's substation capital refurbishment and replacement programs have tended to focus on specific equipment with a recent history of failure. Examples of this program-based approach include the insulator replacement programs of the 1990s and the lightning arrestor program which is currently being implemented. These programs have been successful in reducing the risk associated with specific substation equipment.

Beyond 40 years of age, the number of substation components requiring refurbishment or replacement tends to increase significantly. Civil infrastructure, including foundations and bus structures, reach the end of their useful lives and must be replaced. On the other hand, other major substation equipment, such as power transformers, can remain in service if the external components of the equipment such as gas relays are refurbished or replaced in a timely way.

2.3 Substation Maintenance Program

Because of the critical role they play in the power system, substations must be designed and maintained to provide a high degree of reliability. Unplanned outages to Newfoundland Power customers caused by substation problems have accounted for only 6% of total unplanned customer minutes of outage over the past 5 years. The three leading causes of substation outages have been failures of breakers and reclosers, failures of lightning arrestors and failures caused by birds and animals. These account for about 25%, 20% and 15%, respectively, of unplanned substation related customer minutes of outage**.**

While substation-based outages are infrequent, they affect a large number of customers (typically several thousands) when they do occur. It is therefore essential that substation outages be avoided where possible.

Newfoundland Power has an effective substation asset management and equipment maintenance program that follows industry best practices. The scheduling of maintenance on major substation equipment such as transformers and breakers is condition-based, relying on results from oil testing and other predictive techniques. Maintenance of substation yards, structures and auxiliary equipment usually follows inspection results. All remaining substation equipment is generally maintained on a time-based schedule.

The Company's predictive and preventive equipment maintenance programs are designed to minimize unexpected mechanical and electrical equipment failures. One of the major challenges presented by Newfoundland's harsh, salt-contaminated environment, however, is the prevention of premature failure of equipment due to corrosion. In the Company's experience, time-based maintenance is most effective when it comes to dealing with corrosion. The Company has found that a 10-year substation maintenance cycle is appropriate.

Many types of substation maintenance work can only be carried out when the substation is de-energized. When the nature or extent of the work could result in a lengthy outage, one of the Company's portable substations is deployed to carry the substation load. In some cases, particularly in urban areas where switching options are greater, the load can alternatively be transferred to other substations.

Whenever possible, the Company will coordinate all future maintenance work on individual substations so that it is carried out on a single occasion. This approach will be further coordinated with substation capital work as described in this report. The coordinated approach will minimize service interruptions to customers and will also take maximum advantage of the deployment of portable substations or the switching of loads to other substations, as the case may be.

2.4 A Modified Approach to Capital Work

In light of the large number of substations that are now in excess of 40 years of age, Newfoundland Power is modifying its approach to substation capital improvement. Following a detailed individual assessment of all of its substations, the Company has determined that an approach that focuses on the overall condition of individual substations will be more effective and efficient than the existing program-based approach.

Each substation has been assessed, with particular consideration given to the physical condition of core infrastructure and equipment. Based on these individual substation assessments, the Company has established priorities and developed a plan for the overall refurbishment and modernization of its substations that will coordinate with ongoing major equipment maintenance and replacement activities.

The substation plan will follow a 10-year cycle, coinciding with the maintenance cycle for major substation equipment. The objective is to complete the capital work at each substation at the same time as major operating maintenance work. This will improve the overall condition of individual substations, and will be more productive and less disruptive to the operation of the substation than having multiple jobs scheduled for individual substations over a period of time.

In between the planned capital and major operating maintenance work, regular substation inspections and equipment preventive maintenance will continue as usual. Additions and modifications due to load growth, as well as replacements due to in-service failures, will also continue on an as-required basis.

2.5 Benefits of the New Approach

For the most part, the Company's existing capital program has focused on programs that addressed issues identified with specific equipment and infrastructure. This has allowed the Company to address high priority reliability and safety issues affecting most of the Company's substations. Programs such as wholesale insulator replacements (because of high failure rates due to cement growth) and, more recently, the replacement of silicon carbide lightning arrestors (due to high failure rates from aging) are examples of focused programs that had immediate positive impacts on substation reliability.

The new approach will focus on coordinating substation major operating maintenance and substation capital work on a substation by substation basis to improve reliability and productivity. With this approach, 80% of the Company's substations will be refurbished and modernized on a priority basis over the 10-year planning period.

Capital projects will be planned in conjunction with major operating maintenance to realize improved productivity, with project planning and execution encompassing both capital and operating work. This is similar to the "blitz" approach to line work adopted by the Company in recent years where all deficiencies on a distribution line are addressed at the same time. This approach will be particularly beneficial when installation of a portable substation or offloading of the substation is required, as it will reduce the number of outages required to perform work on the substation.

Advanced planning and coordination of both capital and operating maintenance work will achieve the following benefits:

- Greater utilization of (and thus fewer overall) portable transformer set ups and substation offloading will reduce costs.
- Greater use of the "blitz" approach to execute work will increase worker productivity and efficiency, and will create savings by reducing overall travel time and accommodation expenses.
- A reduction in the number of smaller projects will reduce the total number of projects and associated project overheads such as job plans, safety and environmental management plans, protection plans, switching orders and work orders.
- There will be more effective use of project supervisors, who will manage more work in a shorter period of time.
- Fewer overall projects, portable installs and switching orders will result in fewer outages to customers.

3.0 Substation Refurbishment and Modernization Plan

The new 10-year substation refurbishment and modernization plan was developed following a detailed review of the assets in each of the Company's substations. Each substation was assessed based on a number of factors including physical condition, history of equipment maintenance and performance, equipment life expectancy, impact of failures on service to customers and requirements for modernizing substation protection and control.

The following is a high level overview, with reference to specific substation components, of the refurbishment and modernization work identified from the substation assessments.

3.1 Power Transformers

It has been the industry experience that power transformers often remain in service well beyond the manufacturer's estimate of life expectancy. It is not unusual to find units in service for well in excess of fifty years. Incidents of heavy loading and damage caused by external forces, such as lightning, resulting in premature failure are rare in Newfoundland Power's system. Good maintenance practices should therefore ensure that Newfoundland Power's units remain in service for a very long time.

The Company will continue with oil sampling and analysis to gauge the internal health of transformers and plan transformer replacements based upon this predictive style of maintenance. However, if a transformer fails unexpectedly, the Company will bypass it with the use of a portable transformer until a replacement unit can be installed.

Although power transformers are expected to remain in service for a long time, the associated monitoring and protection equipment, which is exposed to the climate, often requires earlier replacement. For example, to function effectively, transformer radiators are made of thinner metals. Although newer radiators are made of galvanized steel to prevent premature rust perforations and oil leaks, some older units will require replacement due to corrosion.

To ensure reliable operation, the auxiliary equipment used to monitor and protect power transformers must be replaced after 25 to 30 years in service. The condition of such auxiliary devices as gas relays, temperature and oil level gauges, pressure relief switches and associated piping, conduits, cabinets and wiring is determined from inspection and testing. All auxiliary equipment will be replaced at the same time during a scheduled maintenance overhaul of power transformers.

Sixty-eight of the Company's 190 transformers have tap changer mechanisms that adjust the transformer's output voltage. The older tap changer controllers contain discrete electronic components that age and deteriorate with time, causing the tap changer to fail to operate. Based on the Company's experience with failures of tap changer controllers they will be replaced when they approach 25 years of age. The newer technology tap changer mechanisms can be integrated with the Company's SCADA system, enabling remote control of those units replaced in substations that have remote control infrastructure in place.

3.2 Lightning Arrestors

The primary function of lightning arrestors is to protect power transformers. Until the early 1980s, silicon carbide lightning arrestors were standard. They are known to fail as they age due to water leaking into the arrestor through failed seals. The Company has experienced increasing failures of this type of lightning arrestor. There is no reliable way to test or monitor an arrestor to predict its failure. All remaining silicon carbide lightning arrestors will be replaced on a prioritized basis over the next 5 years. The majority of these replacements will require the use of a portable transformer, and will be coordinated with other capital work and transformer maintenance.

3.3 Bus Structures and Foundations

Bus structures are galvanized steel or wood pole structures that support the switches, insulators and conductors in a substation. Newfoundland Power has 118 wooden and 138 steel bus structures in service. Galvanized steel structures last longer than wood structures, and are essentially maintenance-free. They are also more physically stable than wood structures, making them more suited to ensuring isolating switches stay properly aligned, reducing maintenance. Steel structures do not require guying. This decreases the overall dimensions of the substation compared to designs employing guyed wooden structures. In future, Newfoundland Power will install only galvanized steel structures.

Existing steel structures are in generally good condition. The existing wooden bus structures range in age from five to over 60 years of age. Wooden structures over 50 years of age are showing signs of deterioration such as rotting, cracking and splitting. Some have deteriorated to the point where replacement of some or all of the structure is necessary.

Concrete foundations weather over time and begin to deteriorate. If left unchecked, the deterioration of foundations and footings can jeopardize the structural stability of substation equipment. The Company will repair or replace these as required in conjunction with planned substation work.

3.4 Buses and Insulators

The main problem with buses is the failure of supporting insulators. One of the most common modes of failure of porcelain insulators is cement growth. In the 1990s, the Company undertook a major program to replace substation insulators vulnerable to this mode of failure. Newer insulators are not failing due to cement growth. Overall, the insulators and buses in Newfoundland Power substations are in very good condition, and no major upgrading work is required.

3.5 Power Cables

Power cables in substations are used to transfer the output of the power transformer to the low-voltage bus. The majority of these cables are the original equipment installed when the substation was built. Experience has shown that power cable failures begin to occur when cables are about 35 years old. There is currently no accurate test to predict cable failure. Failure normally occurs in the termination at the end of the cable. Replacing cable terminations is difficult due to the cable's fabrication, location and made-to-measure installation. To ensure reliable operation of substation power cables, the Company will replace those that are more than 35 years old.

3.6 Protective Relaying

Protective relaying protects transmission lines, substation equipment and distribution feeder circuits. Most of the Company's substations were constructed with electro-mechanical relays. Electro-mechanical relays contain moving parts and are prone to failure as they age, wear and accumulate dirt and dust. In recent years, there has been ongoing replacement of distribution feeder protective relaying as part of the Company's Feeder Remote Control program. In addition, relaying associated with the St. John's transmission system has been replaced to improve fault-clearing times. However, much of the protective relaying equipment in Newfoundland Power's substations is the original electro-mechanical equipment.

The Company has also experienced failure in electronic components in older transmission line relays. The failures are due to the aging of components causing the relays to drift out of calibration. As recently as March 2006, the relay at Carbonear Substation for transmission line 56L failed to operate to clear a fault, resulting in customer outages. The Company's experience has been that as these older type relays approach 40 years of age they may fail to clear faults.

Failure of protective relaying can result in widespread outages and significant equipment damage and can jeopardize the safe operation of the electrical system. Older relays will be scheduled for replacement with modern protective relaying as part of substation refurbishment and modernization upgrading plans.

3.7 Switches

Substation switches provide isolation for equipment such as power transformers, breakers and reclosers. Switches that are operated infrequently have a tendency to seize due to deterioration of bushings, corrosion in operating mechanisms or misalignment of blades. Substation switches such as transformer isolating and bus tie switches are operated infrequently. Consequently, they are susceptible to failure.

The work required to address seized bushings and switch alignment problems cannot practically be undertaken while a switch is energized. As well, refurbishment of the switch is best undertaken in a maintenance shop environment. The Company's strategy for switches is to operate and maintain switches whenever opportunities and substation work permit, and to replace switches when they are more than 30 years old. Switches removed from the field will be refurbished at the electrical maintenance shop, or scrapped if deemed uneconomical to repair.

3.8 Buildings and Batteries

Many of the Company's substation buildings are of steel pre-engineered fabrication and are generally in good condition. However, the roofs of some buildings are more than 25 years old and are badly corroded. If left unchecked, corrosion can result in water entering a substation building and damaging protective equipment and controls. The Company will carry out substation building upgrading work such as roof replacement when other major work is planned for the substation.

Battery banks provide continuous power to substation protection and control equipment and have a normal life expectancy of 15 to 20 years. Testing will determine when the entire battery bank needs to be replaced.

3.9 Protection from Animals and Birds

Small animals and birds have caused significant substation outages. Most commonly, they cause short circuits in equipment such as reclosers, metering tanks and station service transformers, often severely damaging the equipment. The problem has been more prevalent in rural substations.

Insulated coverings, guards and leads can be effective in preventing damage and outages caused by small animals and birds. In future, Newfoundland Power will install the necessary protective covers and insulated leads in rural substations.

4.0 Substation Capital Budget Presentation

4.1 Modified Presentation

The revised approach to substation capital budget planning has prompted the Company to modify its presentation of the capital budget for substation work. In recent years, the Company's substation capital program has consisted of the following five major projects:

Rebuild Substations
The Rebuild Substations project provided for replacement of deteriorated substation infrastructure such as buses, structures, foundations, fencing, switches, lightning arrestors and other equipment, including replacement of PCB contaminated equipment.

Replacement and Standby Equipment
The Replacement and Standby Equipment project provided for the replacement of deteriorated or unreliable equipment on a planned basis and the replacement of equipment that actually failed in service also provided for the appropriate inventory levels of spare equipment for use during emergencies.

Protection and Monitoring Improvements
The Protection and Monitoring Improvements project provided for the upgrading of protective relaying equipment and control devices required to improve or maintain the protection and control of the electrical system to ensure a reliable supply of electricity.

Feeder Remote Control
Feeder Remote Control was a specific program to replace old protective relays and oil filled reclosers on distribution lines and to expand the remote control of the electrical system to realize productivity and reliability gains.

Additions Due to Load Growth
Additions Due to Load Growth provided for the upgrading of system and equipment capacity, as well as the installation of additional system capacity or new equipment to accommodate load growth and the connection of new customers on the system.

Commencing with the 2007 Capital Budget Application, the Rebuild Substations, Protection and Monitoring Improvements and Feeder Remote Control projects have been consolidated into a single project known as Substation Refurbishment and Modernization. All planned replacements of substation equipment under the new 10-year plan described in this report will be included in this project.

The Replacement and Standby Substation Equipment project is renamed the Replacements Due to In-Service Failures project. This project is ultimately driven by the need to replace failed equipment and equipment identified as being in imminent danger of failing.

The Additions Due to Load Growth project is unchanged.

4.2 2007 Substation Capital Program

Newfoundland Power's 2007 substation capital program is presented as three projects:

1. Substation Refurbishment and Modernization;
2. Replacements Due to In-Service Failures; and
3. Additions Due to Load Growth.

The Substation Refurbishment and Modernization project will address all planned work that has been identified based upon inspections and testing. The capital work will be coordinated with the ten-year cycle of major operating substation maintenance work and scheduled to maximize productivity.

In the first ten-year period, Substation Refurbishment and Modernization work will take place in 80% of the Company's substations and will require an average annual expenditure of approximately $4 million.

The Replacements Due to In-Service Failures and Additions Due to Load Growth projects permit the Company to respond to equipment failures and customer load growth, respectively. Replacements Due to In-Service Failures will be budgeted based primarily on historical budget data. Additions Due to Load Growth will be based on load forecasts and equipment ratings.

Appendix B shows the proposed ten-year substation plan and expenditures for Substation Refurbishment and Modernization. The plan will be revisited yearly as part of the preparation of the annual capital budget, and may change due to changing priorities as indicated by the most recent inspections, assessments and operating experience.

Appendix C contains a detailed review of the Substation Refurbishment and Modernization work required in 2007.

Appendix A

A Typical Substation

A Typical Substation

A typical distribution substation “steps down” electricity from the transmission network to the distribution network. Stepping down involves converting high voltage power, necessary to transport electricity over great distances at lower losses, to lower voltage power, capable of being used by residential and commercial customers.

Electricity enters a distribution substation via transmission lines. The electricity passes through a high voltage bus, disconnect switches and circuit breakers on the way to the step down power transformer. Circuit breakers monitor the electrical current and will break the circuit if they detect a problem thus protecting the electrical equipment from damage caused by an overload or a short circuit.

Switches allow the entire substation or separate distribution lines to be disconnected from the network when necessary. Switching can be planned, for example to perform maintenance, or unplanned, for example to isolate problems on the grid.

By far, the largest, most critical, and most expensive piece of equipment in a substation is the power transformer. The transformer converts high voltage power to low voltage power. Once the voltage has been lowered it passes through the voltage regulator and on to the distribution low voltage bus.

The voltage regulator ensures the power is maintained at a constant voltage level making the necessary adjustments as the customer loads vary throughout the day. The distribution low voltage bus, which is comprised of conductors and insulators, splits the power off into multiple directions for delivery to particular service areas by using distribution breakers or reclosers.

All the major components and high voltage buses are located outdoors. Equipment such as buses and switches are mounted on wooden or steel structures. Equipment such as transformers and voltage regulators are mounted on concrete foundations. Where outdoor space is restricted, some equipment, such as low voltage buses and some circuit breakers, is located inside substation buildings.

Substations also include many systems and devices such as grounding systems and telecommunications devices, to provide protection for equipment as well as remote control and monitoring of substations from a central location.

A key aspect of substation design is employee and public safety. Substations are surrounded by security fences with secured access for employees only. All equipment is grounded to ensure safe operation and can be isolated from the network for safety and maintenance reasons.

Figure 1 is a photograph of a typical substation. The red arrows depict the direction and flow of electricity through the substation. The major substation components have been numbered according to the legend.

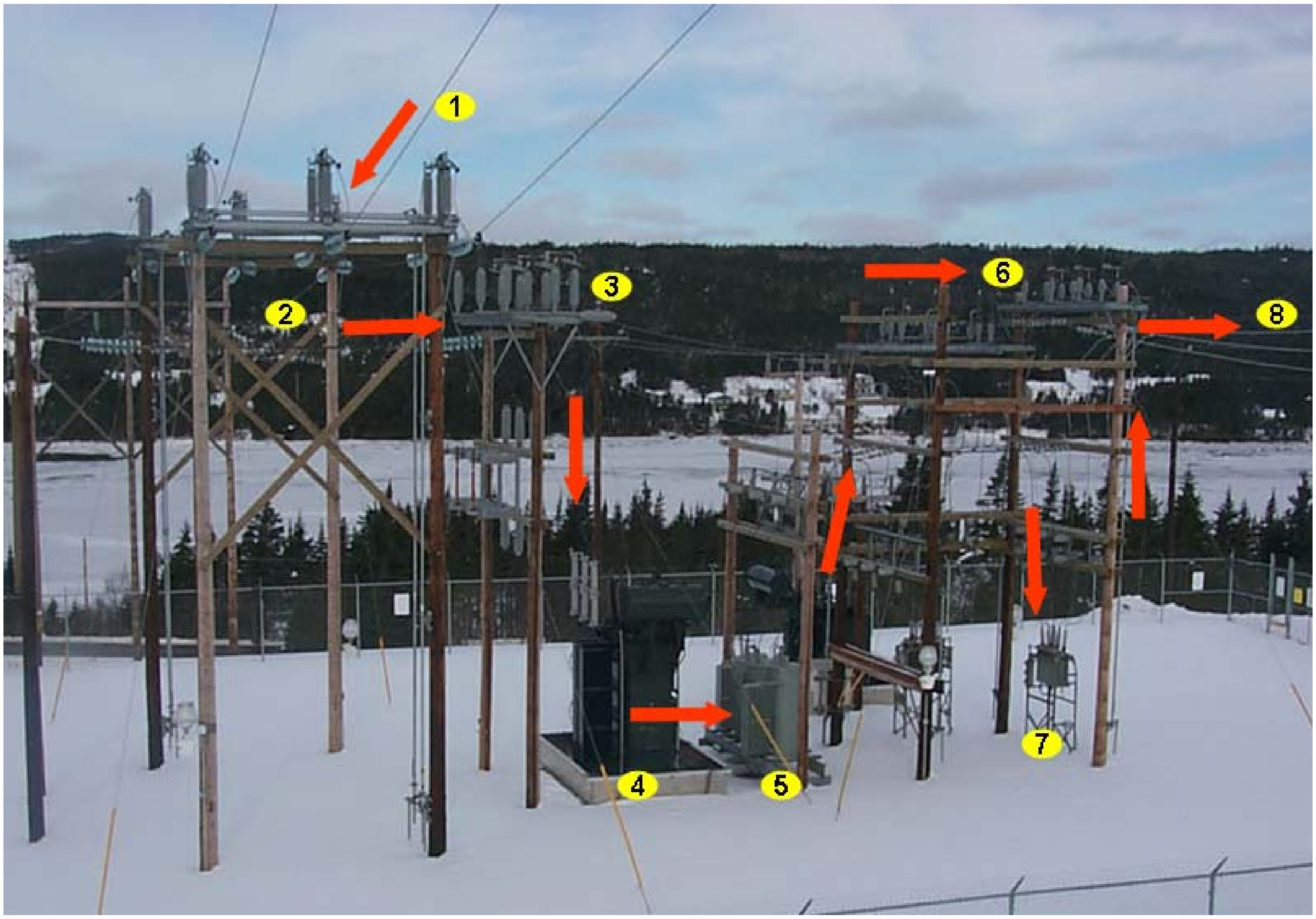


Figure 1

Legend

1	Transmission Line	5	Voltage Regulator
2	High Voltage Bus	6	Low Voltage Bus
3	Switch	7	Recloser
4	Power Transformer	8	Distribution Feeder

Appendix B

Ten-Year Substation Refurbishment and Modernization Plan

Ten-Year Substation Refurbishment and Modernization Capital Plan
($000s)

2007		2008		2009		2010		2011		2012		2013		2014		2015		2016	
SUB	**Cost**	**SUB**	**Cost**	**SUB**	**Cost**	**SUB**	**Cost**	**SUB**	**Cost**	**SUB**	**Cost**	**SUB**	**Cost**	**SUB**	**Cost**	**SUB**	**Cost**	**SUB**	**Cost**
BLK	231	CLV	476	ABC	99	CAR	464	BRB	770	GBE	71	LLK	596	CAT	574	SLA	306	BCV	411
CAR	26	BOT	538	BHD	228	GAL	396	BON	620	BLA	161	GBY	162	HUM	803	CAB	834	COL	277
CLV	26	FER	57	BOY	26	FRN	436	GIL	145	BVS	567	GPD	195	LEW	498	CHA	238	HOL	822
CLK	215	GAN	738	GFS	749	GLN	183	MAS	367	BIG	295	HWD	290	MIL	451	COB	1,058	ICV	507
GAL	46	BVJ	68	HCT	187	HGR	1,276	MKS	428	GAM	697	MOL	322	PBD	335	FPD	108	LAU	399
GAR	374	KEL	218	LET	105	HAR	159	NHR	423	HBS	165	NWB	633	PUL	304	HCP	77	PJN	15
GLV	209	KBR	654	NCH	428	JON	13	QTZ	24	ISL	114	PEP	389	SCV	546	MMT	389	RVH	472
GOU	174	LOK	178	P335	237	SPR	222	SCR	516	P135	377	SPF	553	SMV	937	PAS	536	SUM	1,135
GRB	11	LBK	12	P435	237	STX	123	TWG	165	ROB	170	SJM	185			PBK	77	WES	129
LLK	26	MOB	277	STV	239	VIR	223	WAL	345	SCT	81	TCV	247						
PUN	16	OXP	117	SUN	318	WAV	154	ROB	16	TBS	712								
RRD	312	ROP	388	FPD	7	BLA	17	SPF	57	TRP	880								
SBK	15	LEW	48	PJN	7	ISL	53	DLK	57	TRN	154								
SLA	509	MIL	48	PAB	182	P135	10	PAS	17	WBC	235								
		BRC	48	SLP	221	TRN	53	PBK	8	BFS	603								
				WES	7	PEP	49	ICV	55										
						SCV	7	LAU	17										
						SUM	16	WES	8										
						MMT	53	MRP	11										
						VIC	446	MGT	8										
								GBS	629										
Total	**2,190**		**3,865**		**3,277**		**4,353**		**4,686**		**5,282**		**3,572**		**4,448**		**3,623**		**4,167**

Notes: SUB: Substation - Refer to the Electrical System handbook for three letter substation designations.
P135, P335 and P435 are the designations for the portable substations.

Appendix C

2007 Substation Refurbishment and Modernization Projects

2007 Projects

Table 1 is a summary of the Substation Refurbishment and Modernization projects planned for 2007. A further $578,000 is budgeted for the Rattling Brook Substation Rebuild, which is clustered with the Rattling Brook Plant Refurbishment project in accordance with the Provisional Capital Budget Application Guidelines.

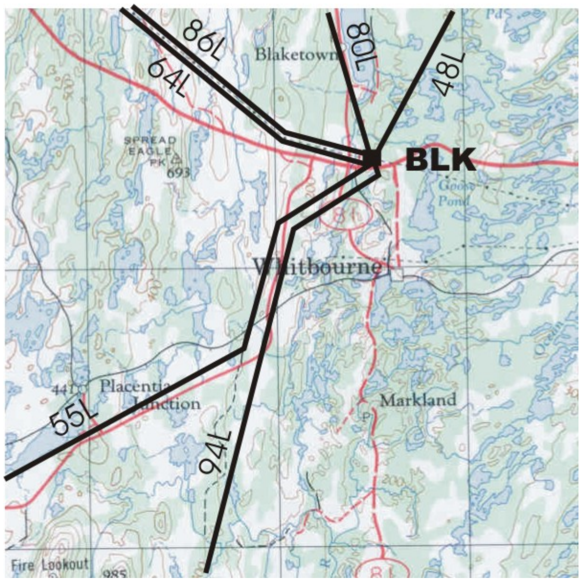
Table 1
2007 Substation Projects
(000s)

Substation	**Budget**
Blaketown (BLK)	$ 231
Carbonear (CAR)	26
Clarenville (CLV)	26
Clarkes Pond (CLK)	215
Gallant Street (GAL)	46
Garnish (GAR)	374
Glovertown (GLV)	209
Goulds (GOU)	174
Grand Beach (GRB)	11
Linton Lake (LLK)	26
Port Union (PUN)	16
Ridge Road (RRD)	312
Sandy Brook (SBK)	15
Stamps Lane (SLA)	509
Total	**$ 2,190**

The following pages outline the above projects as well as the ongoing lightning arrestor and tap changer projects.

1. Blaketown Substation ($231,000)

Blaketown substation was built in 1977 as a combined transmission and distribution substation. It contains a 138 kV to 66 kV, 42 MVA transformer (T3) and a 138 kV to 25 kV, 20 MVA transformer (T2). The 138 kV bus is energized via two 138 kV transmission lines, 64L from Western Avalon substation and 48L transmission line from Bay Roberts substation. The 66 kV bus has four transmission lines terminated on it. Line 55L is a radial transmission line to Clarkes Pond substation. Line 94L is a radial line to St. Catherines substation. Line 80L services New Harbour substation and line 86L is an in-feed from Western Avalon substation. The distribution part of the substation services approximately 2,600 customers in the Whitbourne and Blaketown areas through two 25 kV feeders.



Blaketown Substation Location

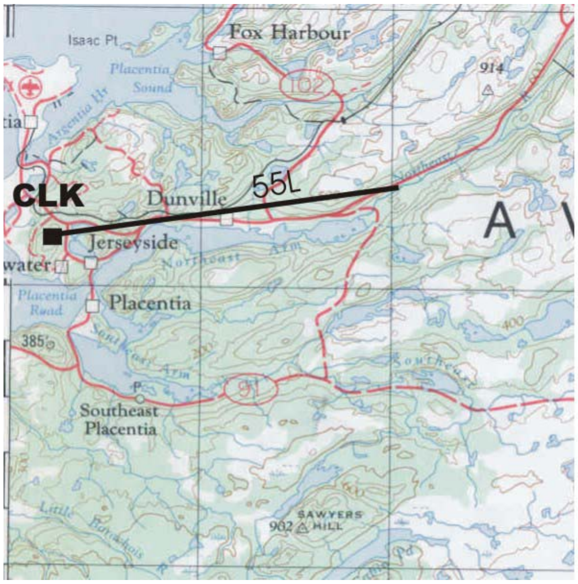
After reviewing maintenance records and conducting on-site engineering assessments it was determined that the 138 kV, 66 kV and 25 kV steel structures and concrete foundations are in good condition with no sign of deterioration. The 138 kV, 66 kV and 25 kV bus and insulators are also in good condition with no signs of deterioration.

T3 transformer is in good condition. T2 transformer has cooling radiator fin edges that are perforated due to rusting. The perforated fin edges have been patched as a temporary measure to prevent leaking but require replacement. The lightning arrestors on T2 and T3 transformers are silicon carbide and require replacement with metal oxide arrestors. The air break switch on T2 transformer is 30 years old and requires replacement. Protection against small animals should be installed on the 25 kV equipment and bus. A maintenance overhaul is required for the T2 and T3 power transformers in 2007 which will be completed at the same time as the required capital work.

Deteriorated radiator fin edges – Blaketown Substation

2. Clarkes Pond Substation ($215,000)

Clarkes Pond substation was built in 1976 as a distribution substation. It contains two 66 kV to 12.5 kV power transformers (T1 & T2). Each power transformer is rated for 7.5 MVA for a total station capacity of 15 MVA. The 66 kV bus is energized via a radial 66 kV transmission line 55L from Blaketown substation. The substation services approximately 2,500 customers in the Placentia/Argentia areas through three 12.5 kV feeders.



Clarkes Pond Substation Location

After reviewing maintenance records and conducting on-site engineering assessments, it was determined the 66 kV and 12.5 kV steel structures are in good condition with no sign of deterioration. Inspections of the concrete foundations show that there are two recloser and three bus structure concrete foundations that are crumbling and require replacement.

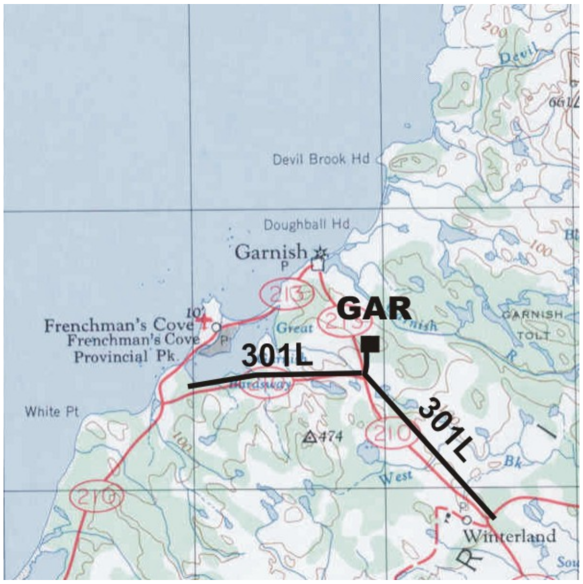
The two power transformers are in good condition with no obvious signs of deterioration. The tap changer controllers on T1 and T2 are twenty-nine and thirty years old respectively and require replacement. Small animal protection should be installed on the 12.5 kV equipment and bus. The Nulec reclosers were installed in 2002 and are capable of being remote controlled. The three feeders will be automated to allow remote control from the System Control Centre. A maintenance overhaul is required to be completed for both power transformers T1 and T2 in 2007 which will be completed at the same time as the required capital work.

Foundation damage at Clarkes Pond Substation

3. Garnish Substation ($374,000)

The 38 year old Garnish substation services approximately 430 customers. The substation is deteriorated and will be replaced with a new substation. All the insulators are old and prone to cement growth failure. The fence is deteriorated. Cross-arms are split and wood rot is present. Some cross-arms have been temporarily reinforced to prevent failure. Most of the concrete foundations are crumbling. The metering tank and other equipment are severely rusted. The transformer fans have to be replaced as their motor bearings are seized.

The new substation will be built adjacent to Highway 210, reducing overall cost and improving access for operational staff. The current substation required a high voltage bus structure. However, when transmission line 301L was rebuilt in 2003, it was constructed so that a high voltage bus structure would not be required for the new substation thereby reducing the capital and operating costs associated with this substation. Establishing this new site will also avoid rebuilding the transmission tap to the existing substation.



Garnish Substation Location

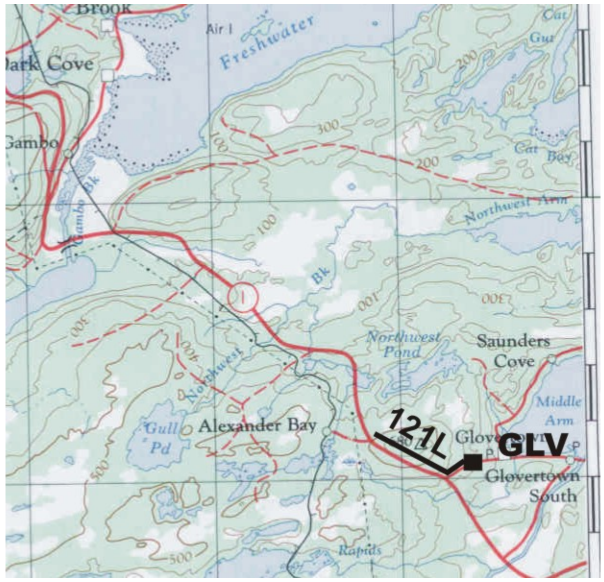
Cracked crossarm Garnish Substation

Corrosion damage Garnish Substation

Foundation damage Garnish Substation

4. Glovertown Substation ($209,000)

Glovertown substation was built in 1976 as a distribution substation. The power transformer (T1) is a 138 kV to 25 kV, 20 MVA unit. The 138 kV bus is energized via a tap from 124L transmission line which runs between Clarenville and Gambo substations. The substation services approximately 2,300 customers in the Glovertown area through two 25 kV feeders.



Glovertown Substation Location

After reviewing maintenance records and conducting on-site engineering assessments it was determined that the 138 kV and 25 kV wood pole structures and concrete foundations are in good condition with no sign of deterioration. The power transformer is in good condition with no signs of deterioration.

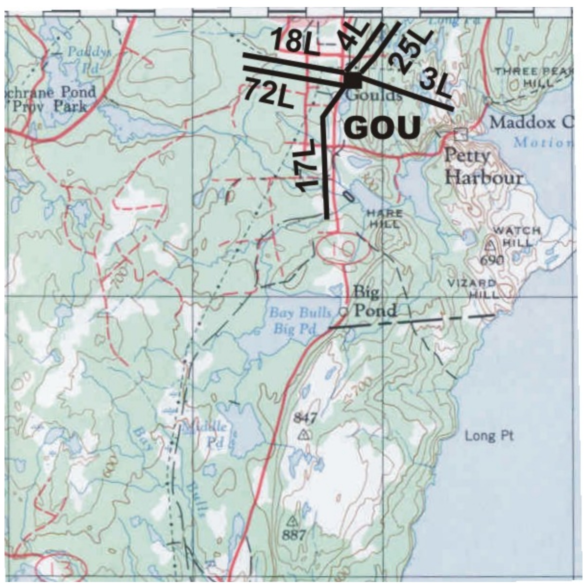
The lightning arrestors on T1 are silicon carbide and require replacement with metal oxide arrestors. The tap changer controller is thirty years old and should be replaced. Small animal protection will be installed on the 25 kV equipment and bus.

The Nulec reclosers in this substation were installed in 2002 and are capable of being remote controlled. The two feeders and the transformer tapchanger require automation to allow remote control from the System Control Centre. A maintenance overhaul is required to be completed on power transformer T1 in 2007 which will be completed at the same time as the required capital work.

5. Goulds Substation ($174,000)

Goulds substation was built in 1954 as a major 66 kV transmission switching substation and also as a 12.5 kV distribution substation. The substation contains two distribution power transformers (T2 & T3) with a combined capacity of 33 MVA. The substation directly services approximately 3,400 customers in the Goulds and Kilbride areas through three 12.5 kV feeders.

As a transmission substation there are five 66 kV transmission lines terminated in the substation. These are transmission lines 4L to St. John's Main substation, 17L to Big Pond substation, 18L to Glendale substation, 25L to St. John's Main substation and 72L to Hardwoods substation. As well there is a 66kV to 33 kV power transformer (T1) servicing 3L transmission line to Petty Harbour substation.



Goulds Substation Location

After reviewing maintenance records and conducting on-site engineering assessments it was determined that the 66 kV and 12.5 kV wood pole structures are in good condition and no issues are expected over the next ten years. The concrete foundations are in good condition with no signs of deterioration with the exception of T1 concrete foundation which must be replaced.

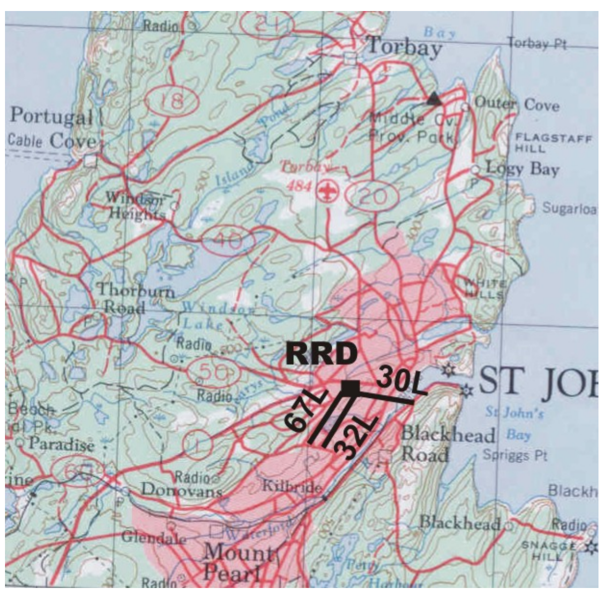
The power transformers are in good condition with no obvious signs of deterioration. The switches in the substation are in good condition with the exception of one 66 kV bus tie switch which is inoperable and currently bypassed. This switch must be replaced.

The radial line 17L to Big Pond substation requires a bypass switch to facilitate maintenance on the breaker. The 66 kV potential transformers are over 40 years old and showing signs of deterioration. These potential transformers are essential for providing protection for the transmission lines and equipment at Goulds substation and must be replaced to maintain reliability. A maintenance overhaul is required to be completed on the three power transformers in 2007 which will be completed at the same time as the required capital work.

Bus Tie Switch Bypassed Goulds Substation

6. Ridge Road Substation ($312,000)

Ridge Road substation was built in 1963 as a 66 kV transmission switching substation and as a 12.5 kV distribution substation. The substation contains three power transformers (T1, T2 & T3) with a combined capacity of 40 MVA at 12.5 kV and 2.2 MVA at 4.16 kV. The existing 4.16 kV section of the substation is being converted to 12.5 kV and the 4.16 kV power transformer (T1) will be retired in 2006. The substation directly services approximately 4,200 customers in the Higgins Line area of St. John’s through eight 12.5 kV metal clad switchgear feeders. In the substation there are three 66 kV transmission lines terminated in the high voltage bus. These are transmission lines 30L to King’s Bridge substation and 32L and 67L to Oxen Pond substation.



Ridge Road Substation Location

After reviewing maintenance records and conducting on-site engineering assessments it was determined the 66 kV steel structures and 12.5 kV metal clad switchgear are in good condition with no signs of deterioration.

The concrete foundations are in good condition with no signs of deterioration, with the exception of one 66 kV structure concrete foundation which must be refurbished.

The power transformers are in good condition with no obvious signs of deterioration. As a continuation of the feeder remote control program the eight 12.5 kV feeders will have relaying replaced and be automated to allow remote control from the System Control Centre. A maintenance overhaul is required to be completed on the two power transformers in 2007 which will be completed at the same time as the required capital work.

7. Stamps Lane Substation ($509,000)

Stamp's Lane substation was built in 1963 as a 66 kV transmission switching substation and as a 4.16 kV and a 12.5 kV distribution substation. The distribution substation contains four power transformers (T1, T2, T3 & T4) with a combined capacity of 50 MVA at 12.5 kV and 21 MVA at 4.16 kV. The substation directly services approximately 9,300 customers in the central area of St. John's through five 4.16 kV metal clad switchgear feeders and six 12.5 kV outdoor feeders. There are six 66 kV transmission lines terminated in the substation. These are transmission lines 13L to St. John's Main substation, 14L to Memorial substation, 15L to Molloy's Lane substation, 69L to Kenmount substation and 31L and 70L to Oxen Pond substation.

Ridge Road Substation Location

After reviewing maintenance records and conducting on-site engineering assessments it was determined that the 66 kV and 12.5 kV steel structures and 4.16 kV metal clad switchgear are in good condition with no signs of deterioration. Four 66 kV concrete structure foundations are in poor condition and require refurbishment. The remaining concrete foundations are in good condition with no signs of deterioration.

The power transformers are in good condition with no signs of deterioration. The 1971 power cables connecting transformer T2 show signs of compound leaking and require replacement. Eleven feeders will have relaying replaced and be automated to allow remote control from the System Control Centre. A maintenance overhaul is required to be completed on the power transformers in 2007 which will be completed at the same time as the required capital work.

8. Tap Changer Controllers ($124,000)

As discussed in the strategic plan, tap changer controllers have a service life of approximately 25 years. The older tap changer controllers contain discrete electronic components that age and deteriorate with time causing the tap changer to fail to operate. Regulation of the transformer tap is critical in maintaining the distribution feeder voltage within acceptable values.

Tap changer controllers will be replaced with SCADA operated tap changer controllers at the following substations:

- Carbonear Substation
- Clarenville Substation
- Gallants Substation
- Linton Lake Substation

9. Lightning Arrestors ($42,000)

As discussed in the strategic plan, lightning arrestors protect power transformers and other substation equipment. Silicon carbide lightning arrestors were installed on power transformers until the early 1980s. It has been Newfoundland Power’s experience that these arrestors fail as they age due to water leaking into the arrestor through failed seals. All remaining silicon carbide arrestors will be replaced on a prioritized basis within the next 5 years.

Silicon carbide lightning arrestors will be replaced in the following substations:

- Sandy Brook Substation
- Grand Beach Substation
- Port Union Substation