Q. [Account 355.3] – As it relates to Account 355.3 - Insulators, please provide the number and size of insulators; period during which each different type of insulator was installed, the reason for changing the type of insulator, and the number of each type of insulator retired by year for the past 10 years.

Data on insulators in service cannot be broken down by size. The approximate quantity in service by type is detailed in Table 1.

Table 1
Transmission Line Insulators

	Quantity
Clamp Top	16
Line Post	34,504
Pin Type	3,585
Polymer Line Post	157
Polymer Suspension	1,232
Station Post	67
Suspension	204,623
Polymer	286

The number of insulator retirements for the period 2001 – 2010 is detailed in Table 2.

Table 2
Transmission Insulator Retirements

	Clamp Top	**Line Post**	**Pin Type**	**Station Post**	**Suspension**
2001		21	953		9,533
2002	237	8	1,182		6,608
2003		1,329	509	32	7,929
2004		51	664		6,741
2005	154	172	120		10,558
2006		647	259		12,473
2007	52	385	160		8,962
2008	27	847	257	10	10,490
2009	12	488	1,202		4,542
2010		96	530		3,997

Insulators are replaced based on inspection results or as a result of failure. A program to replace faulty Canadian Ohio Brass and Canadian Porcelain insulators is still in place. This program represents the only significant change in the types of insulators used. A report was filed with the 2004 Capital budget application detailing the rationale behind this program. A copy of the report is provided in Attachment A.

Distribution Insulator Replacement Program
Newfoundland Power Inc.
June 2003

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Prepared By: Peter Feehan, P.Eng.

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Introduction

Premature failure of porcelain insulators due to cement growth is well recognized throughout the utility industry. Most Canadian utilities, including Newfoundland Power, have experienced significant insulator failures due to this phenomenon.

Newfoundland Power began to experience abnormal failures of porcelain insulation in the early 1980's. Suspension insulators fail by radial cracks, which are sometimes contained inside the metal cap and are not visible. The crack causes a current path between the metal cap and pin and shorts out the insulator. Pin type and pin cap type (2-Piece) insulators fail by circumferential cracks. Failure is usually mechanical; the top shears off the insulator causing the conductor to float clear of the structure.

Since the late 1980s the Company has replaced a significant number of defective insulators. The impact on reliability to the end of 2002 has been positive. The SAIFI and SAIDI statistics for 2002 for insulator-related outages were 0.29 and 0.43 respectively. This compares with a 10-year Company average of 0.37 and 0.54 respectively.

While progress has been made in reducing outages due to insulator failure on trunk sections of distribution lines, suspension and two-piece pin-type porcelain insulators are continuing to cause outages on feeder taps. Replacement of these insulators should be performed in conjunction with the Feeder Inspections and Feeder Improvement Projects. The cost of implementing this approach is estimated at approximately $500,000 in 2004. A similar amount is anticipated in each of the next five years as these insulators are identified for replacement during feeder inspections.

1.0 History and Mode of Insulator Failure

Porcelain insulators with cement have been used since the turn of the last century. The cement is used to hold sections of porcelain together and to hold the porcelain to the steel hardware.

Premature failure of porcelain insulators due to problems with the cement growth has occurred over many years. By the early 1960's the term "cement growth" had been used to categorize the problem. In 1976 Ontario Hydro began an investigation into the poor performance of its transmission lines. By the early 1980's Ontario Hydro had produced papers, which indicated cement growth as the most likely reason for insulator failures. Most Canadian utilities, including Newfoundland Power, have experienced insulator failures due to cement growth.

Cement growth is the most accepted theory for premature failure of porcelain insulators. The volume expansion of the cement occurs in the presence of moisture and is attributed to a chemical change in the cement that occurs with age. The expansion occurs over 10 or more years. As the cement expands it produces stress on the porcelain that fails in tension by cracking. Two manufacturers have been identified as the source of the cement growth problem in Canada, Canadian Porcelain (CP) and Canadian Ohio Brass (COB). Both companies went out of business many years ago. The most common porcelain suspension insulator remaining in NP's distribution system is the CP8080.

Newfoundland Power first identified the problem on the distribution system in the early 1980's when distribution suspension insulators[1] were causing outages. In the 1990's, transmission suspension insulators began causing outages. While transmission insulators were also failing in the 1980s, because there are many more units in an insulator string, outages did not occur until many insulators in the same string failed. Pin type insulators[2] have also been failing. 69 kV pin types experienced significant failures in the 1980's and 23 kV and 34.5 kV pin type insulators experienced increasing failures in the 1990's. Pin-type insulators used in substations to support the bus and switches have also experienced failures since the 1980's.

2.0 Recent Experience

Since the 1980's a significant number of distribution insulators have been replaced. A 1997 report entitled the "Distribution Insulator Replacement Program" identified and prioritized critical sections of feeders for testing and replacement of insulators. The report also established a five year time period to complete the identified work. This report was filed with the PUB on December 1, 1997 in response to Request for Information NLH-10(a).

The project began in earnest after 1997 when NP began its Distribution Insulator Replacement Program. The impact on reliability to the end of 2002 has been positive as

[1] Suspension insulators are insulators that are commonly stacked together in a string to provide the necessary gap between an energized conductor and a pole to prevent electricity from traveling from a conductor to a pole.
[2] Pin Top insulators are insulators that sit on top of a crossarm to support an energized conductor and prevent electricity from traveling from a conductor to a pole. These insulators are typically not stacked on top of each other.

Shown in Figure 1. The SAIFI and SAIDI statistics for 2002 for insulator-related outages were 0.29 and 0.43 respectively. This compares with a 10-year Company average of 0.37 and 0.54 respectively.

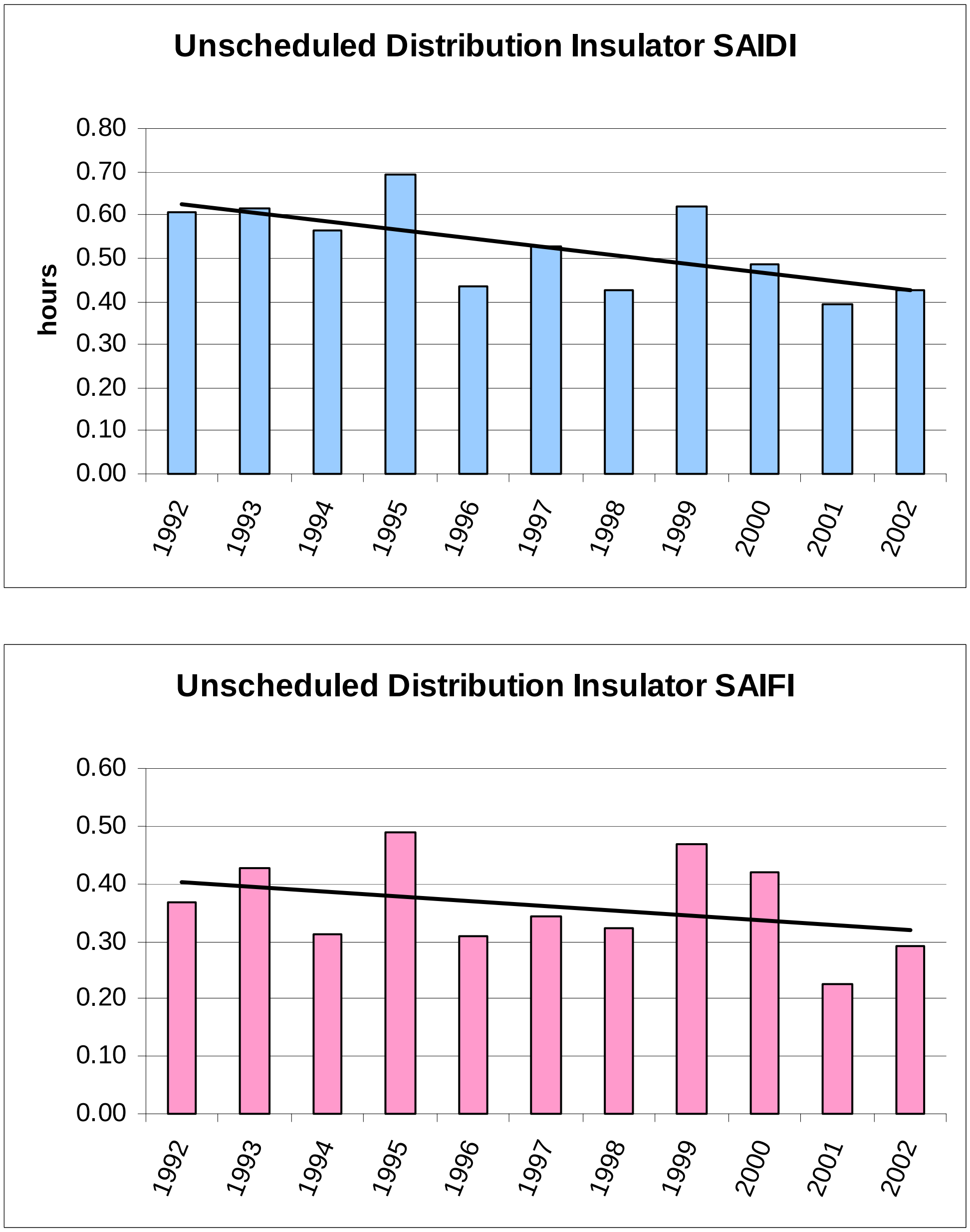

Figure 1: Insulator Related SAIFI & SAIDI

Considering the number of insulators changed out over the last five years and the overall improvement in SAIDI and SAIFI statistics related to distribution, a decreasing trend in the number of insulator related outages might be expected. Unfortunately this is not the case. As demonstrated in Figure 2, since 1992 there has not been any decrease in the number of insulator related outages. It seems likely that this is related to the fact that there are still a large number of CP8080 and 2-Piece insulators in the system on tap off lines. These are now five years older than they were when the Distribution Insulator Replacement Program started. As insulators age their failure rate goes up. Therefore, we have fewer insulators in the system but with a higher failure rate resulting in approximately the same number of outages in a year.

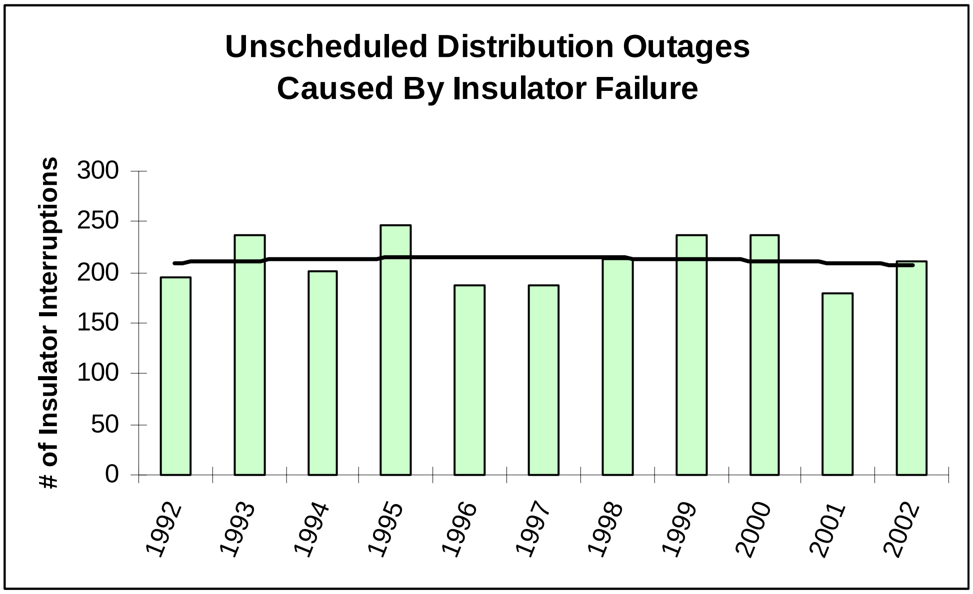

Figure 2: Number of Insulator Interruptions

The apparent inconsistency between the number of insulator outages and the SAIFI and SAIDI trends can be attributed to the focus the Company has been placing on replacing insulators on critical feeders and feeder trunks. An insulator failure on these sections of the distribution system impact more customers than do outages on feeder taps. As a result, while the number of insulator-related outages has remained the same, fewer customers are being impacted by the failures. This in turn results in a reduction in the average number of times a customer is impacted by an insulator outage as evidenced by the declining SAIFI statistic.

3.0 <u>Hazards of Faulty Insulators</u>

CP8080's and 2-Piece insulators have caused concern from an employee safety perspective. When working an a line containing insulators that are subject to the cement growth problems, caution is always required. If an insulator were to fail when a lineperson was working on an energized line, there is an increase in the risk of injury. As a result, there is additional diligence involved in working and repairing lines hot where these defective insulators are present. In certain situations, the presence of these insulators may result in the decision to complete the work through scheduled outages to customers to limit the hazard to employees. Failure of insulators also have the potential to create a public safety hazard if a failure results in the energized conductor becoming separated from the pole and falling to the ground.

4.0 <u>Testing vs. Replacement</u>

In the past an approach of testing CP8080 and 2-Piece insulators and replacing all or some based on the failure rate determined was considered to be a reasonable approach. Since

1999 a new approach has been followed that involves the complete change out of problem insulators without testing. It has been concluded that time spent testing insulators on the distribution system would be more effectively spent replacing insulators, since failure rates on these insulators remain abnormally high.

5.0 Future Work

The number of insulator related outages still remain unacceptable (an average of 216 per year for the last five years). The average outage duration experienced by customers is also still high at an average of 0.47 hours (28 minutes) per year over the last five years. The continued incidence of insulator failures have been confirmed by field staff who report that they are still seeing failures of two piece and CP8080 insulators. However in many areas staff have noted that these failures are becoming most common on feeder taps where the vast majority of remaining porcelain suspension and two-piece insulators remain.

Given the impact on reliability due to the continued high number of 2-piece and CP8080 failures and the hazards the insulators present to line workers, a continuation of a focused insulator replacement program is recommended.

This work should be completed in conjunction with the Feeder Inspections and Feeder Improvement Projects. Feeder inspections will be carried out on 20% of the feeders each year and these should identify locations where insulators should be changed out. This work should be budgeted for the following year.

Based on the 20% feeder inspection target, substantially all the problem insulators will have been replaced within the next five years

6.0 Cost of Insulator Replacement

In 2004, the Company plans on replacing 17,000 insulators, 11,000 in the Eastern Region and 6,000 in the Western Region.

The cost of changing these insulators is estimated at $500,000 in 2004. A similar amount is anticipated in each of the next five years as these insulators are identified for replacement during feeder inspections.

7.0 Recommendations

The following action is recommended with respect to the presence of CP8080 and 2-Piece insulators in the electrical system of Newfoundland Power:

> As part of the annual distribution feeder inspection program, identify all 2-piece and CP8080 insulator for replacement and replace them in the following year.