REFERENCE 3

NEWFOUNDLAND AND LABRADOR HYDRO

REPORT ON 1978/79 CLIMATOLOGICAL MONITORING PROGRAM

YEAR 2

PREPARED BY: Newfoundland and Labrador Hydro
Engineering & Construction Division
Transmission Line Design Group

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TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

1.0 SUMMARY

The climatological study which originated to select a route for the HVDC line from Gull Island was continued from June 1978 to May 1979 inclusive.

The Passive Ice Meter and Rosemount - Anemometer Programs were re-instituted without change, while five (5) additional sites were added to the Test Tower Program.

Also, Salt Contamination and Salt Corrosion Measurement Programs were instituted according to recommendations made in last year's report.

This report summarizes the findings of this year's study and recommends the program be continued in its entirety, subject to the following:-

- concentrated effort be made to correlate PIM observations with Rosemount records.
- establishment of PIM's in Long Range Mountains.
- co-ordinate with other utilities in Province to increase amount of data collected.
- remain in contact with the industry to keep abreast of latest developments in climate monitoring devices.
- addition of six (6) test tower sites, three (3) in Pinware Valley in Southern Labrador and three (3) in the Long Range Mountains.

2.0 OBJECTIVES

1. To outline the climatological program undertaken during the observation period June 1978 to May 1979 under Work Order Number 8015 and Work Order Number 9701.

2. To outline, in detail, new additions and expansions of the climatological program.

3. To summarize the data collected during the 1978/79 observation season.

3.0 INTRODUCTION

The first annual report on the weather monitoring program "Report on 1977/78 Weather Study" summarized several recommendations concerning continuation and expansion of the program. The Passive Ice Meter, Anemometer and Rosemount Ice Detector studies were to be continued with selective expansion as the need arose. The Test Tower monitoring was to be continued and the establishment of three (3) additional sites was recommended. It was also recommended that the Salt Contamination aspects of the study be re-introduced.

During the 1978/79 observation period, June 1978 to May 1979 inclusive, all of these recommendations were implemented and the data collected was tabulated and is summarized in this report.

4.0 DISCUSSION OF PROGRAM

4.1 PASSIVE ICE METER

The Passive Ice Meter monitoring program was re-activated without additions on October 15., 1978 and continued until May 15th., 1979 during which time monthly as well as daily observation reports were submitted from all sites.

A summation of the observed icing is tabulated in Appendix I - Summary of Passive Ice Meter Reports. Photograph I shows typical PIM installation.

4.2 ANEMOMETER

Monitoring of the four (4) established anemometer sites at Yankee Point, Hawkes Bay, Sunnyside and 4 Mile Pond - Holyrood continued throughout the June 1978 to May 1979 period. The recorder charts of wind speed and direction were analyzed and the abstracted information was summarized and is tabulated in Appendix II - Summary of Anemometer Data.

Photograph II shows the Anemometer at 4 Mile Pond - Holyrood after a wind and freezing rain storm. Similar conditions were documented at this site twice during the season, and a third case was reported by Newfoundland Telephone Company Personnel during which the anemometer was frozen inside solid ice. These icing conditions in conjunction with the high winds documented for this site helps us to understand why this anemometer has been severely damaged twice in the last two seasons with a resultant loss of valuable information. CEA presently has a research and development program underway for an ice-free anemometer but to-date the technology has not been perfected.

Problems with the recorder at Yankee Point caused a three month loss of information until spare parts could be obtained and repairs

4.2 ANEMOMETER (Cont'd)

undertaken. In an effort to avoid further prolonged outages, due to equipment failure, a spare anemometer, recorder and spare parts have been purchased.

4.3 ROSEMOUNT ICE DETECTOR

The Rosemount Ice Detector located at Yankee Point, Sunnyside and 4 Mile Pond - Holyrood were re-activated on October 15th., 1978 and remained in service until May 15th., 1979. The record of icing episodes abstracted from the recorder charts has been summarized and is tabulated in Appendix III - Summary of Rosemount Ice Detector Data.

Since the introduction of the climatological study it has been hoped to establish a correlation between the data automatically recorded by the Rosemount and the information recorded by a designated PIM observer. During the past season there has been three (3) occurrences of ice at 4 Mile Pond where actual ice measurements have been made and compared to the calculated value of ice based on the Rosemount records.

A major icing storm occurred at 4 Mile Pond on February 2nd, and 3rd., 1979 during which 110 icing signals were generated by the Rosemount in a twenty-one (21) hour, thirty-eight (38) minute period. An additional seven (7) signals occurred prior to February 9th., 1979, at which time a visit was made to the site, and up to 2.5" diameter of glaze ice was measured on a guy wire. See Photograph III. This compares with the calculated accumulation of 2.2" (110 X .02" = 2.2") of ice based on the Rosemount records.

On March 22nd., and 23rd., 1979 there were forty-four (44) icing signals generated by the Rosemount for a total calculated accumulation of .88" (44 x .02") of ice and during a site visit on March 23rd., 1979 approximately 1" of rime ice was observed.

4.3 ROSEMOUNT ICE DETECTOR (Cont'd)

On April 6th., 1979 1" to 2" of ice was the observed accumulation on the tower top after a storm during which sixty-four (64) icing signals were generated for a calculated accumulation of 1.28" (64 x .02" = 1.28") of ice.

In view of the fact that 4 Mile Pond experiences the most occurrences of ice of the three sites, it would be advisable to implement an all out effort in the coming season at this site to establish any correlation between the Rosemount data and the actual observed ice accumulation.

4.4 TEST TOWER SITES

It was a recommendation of the "Report on 1977/78 Weather Study" that three (3) additional test tower sites be installed along the twenty-eight (28) mile section over the ridge of the Long Range Mountains from Portland Creek to Main River. In 1978 these installations were completed as well as two (2) others on the eastern side of the Great Northern Peninsula, near the proposed route for the Cat Arm Development, to bring the total number of sites to fifteen (15). These sites were visited monthly from October 1978 to May 1979 with the exclusion of April 1979 and the data collected was tabulated and appears in Appendix IV - Summary of Test Tower Data. Refer to Figure I for locations of Test Tower Sites.

The purpose for the establishment of Site 2a in 1977 and then Site 2b in 1978 was to determine if the ice accumulation varied due to natural sheltering and difference in elevation. During the 1977/78 season it became apparent that Site 2a received icing which was only 1/3 as severe as Site 2 and similarily, in 1978/79, Site 2a received much smaller accumulations than Site 2. Refer to Appendix IV for test tower ice accumulation.

4.4 TEST TOWER SITES (Cont'd)

At Site 2b, during the 1978/79 season, the type of ice accumulations were quite similar to those at Site 2,however, less ice occurred at Site 2b which is further inland and at a lower elevation than Site 2.

These observations indicate that the amount and type of ice accumulation can vary greatly within a small region and hence, great care should be taken in routing any transmission line to ensure maximum benefit is derived from natural sheltering while staying at the lowest possible elevation.

Site 9 received one accumulation from the easterly direction, which deposited 3" diameter of glaze, and two other light accumulations. Site 10, at Main River, was ice free during each visit.

Sites on the eastern side of the Great Northern Peninsula, which had been subjected to large glaze deposits during the 1977/78 season, received massive accumulations of glaze again in 1978/79. In particular, Site 5, near Little Harbour Deep, received up to 30" diameter of glaze ice which caused severe damage to the Tower, see Photographs IV and V.

These large deposits of ice, which occurred in February 1979, also accumulated on the trees adjacent to Site 5 causing many of them to break off. See Photograph VI. This confirms earlier beliefs that this side of the Peninsula should be avoided as a possible HVDC transmission line route.

Any salt contamination experienced at the test tower sites would have an important role in establishing insulation requirements for the HVDC line. To check for salt contamination, ice samples were taken from accumulations on the towers and subjected to salinity tests. In every case the salinity of the samples, in g/l (of NaCl), was less than that of ordinary tap water which indicates an insignificant contamination level. See Appendix V - Table of Salinity Tests - Ice Samples.

4.4 TEST TOWER SITES (Cont'd)

Ice deposits differ in physical characteristics due to the varying climatic conditions which cause their formation. However, they can be classified under four (4) major headings with density being the most important feature since this determines the load imposed on a structure or wire by the accumulated ice. Densities are typically:[1]

Glaze	-	0.9 to 0.92 g/cm^3
Rime	-	0.3 to 0.9 g/cm^3
Wet Snow	-	0.3 to 0.8 g/cm^3
Hoar Frost	-	less than 0.3 g/cm^3

Many of the accumulations experienced in our study were glaze. Two (2) samples collected from 4 Mile Pond - Holyrood were tested and the density was determined to be 0.83 g/cm^3 and 0.85 g/cm^3.

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[1] Loading and Strength of Transmission Line Systems, Report No. A 77 230-6 IEEE Transmission and Distribution Committee of the IEEE Power Engineering Society.

4.5 SALT CONTAMINATION

The salt contamination program was set up to monitor natural contamination levels at various points along the Great Northern Peninsula and in Southern Labrador.

It is a modification of an IREQ program, commissioned in 1974 by Teshmont Consultants Limited, to monitor natural contamination levels and determine insulation requirements along the route of the proposed HVDC line associated with the Gull Island Development.

The original IREQ program consisted of three (3) sets of field measurements made simultaneously at each of a number of sites:

(1) Continuous measurement of leakage current over the surface of insulators.

(2) Recording the number of insulator string flashovers.

(3) Washdown of non-energized insulators to establish contamination levels at the site.

IREQ hoped that the correlation of these three (3) sets of measurements with meteorological data for the particular areas would establish a pattern which would determine insulation requirements in different line sections.

The Details of this study and results of same are documented in IREQ's Report No. IREQ-1416C. (Refer to this report for any information required on the IREQ study.)

The present program is a continuation of part three of the IREQ study, namely, the washdown of non-energized insulators to determine salt contamination levels at various points along the Great Northern Peninsula and in the vicinity of the Labrador straits crossing. In addition to providing further information relative to the HVDC routing, it is hoped that this program will provide information that will aid in the routing of any proposed transmission lines on the Great Northern Peninsula.

4.5 SALT CONTAMINATION (Cont'd)

There are basically two objectives of this program:

(1) To determine if there is a reduction in contamination levels as distance from the ocean increases.

(2) To determine if there is any change in contamination levels along the coast of the Great Northern Peninsula.

Refer to Figure I for a location map showing the Salt Contamination Test Sites.

On the Labrador side of the straits crossing two (2) IREQ sites have been refurbished, site L1 at Point Amoure, near the salt water, and Site L2 along the road to L'Anse Au Loup about 2.6 km inland.

On the Newfoundland side of the straits, in the Flowers Cove - Plum Point area, there are three (3) monitoring sites. One site has been reconstructed at the location of the original IREQ station at Yankee Point to monitor contamination levels at the straits crossing, and two (2) new sites have been constructed along the Roddickton Road about 6.5 km and 19 km from the salt water.

A little further south, in the Daniel's Harbour area, there are five (5) sites to monitor contamination levels. One is the original IREQ site located close to the salt water near the junction of the Great Northern Peninsula Highway and the road to the zinc mine. The other four sites are located along the zinc mine road at intervals up to 2.5 km inland.

Further south again, in the Sally's Cove area, there are three (3) monitoring sites. One is the original IREQ site at Sally's Cove, near the salt water, and two (2) new sites have been constructed along the road to the CNT transmitter at Green Point, 1.0 km and 1.4 km respectively, from the sea.

4.5 SALT CONTAMINATION (Cont'd)

It is anticipated that the above mentioned sites will provide the following information:

(1) Determine contamination levels at both sides of the straits crossing, and determine any reductions in levels moving inland from both sides of the crossing.

(2) To determine levels moving inland from the sea at Daniel's Harbour.

(3) To determine levels moving inland from the sea at Sally's Cove.

(4) To determine if a pattern of contamination exists moving north from Sally's Cove to Flowers Cove.

A brief description of the Salt Contamination Test Program is as follows:

The monitor visits every site at two-week intervals and collects insulators to be washed. These insulators are collected according to the schedules in Appendix VI. Each insulator is placed in a labelled plastic bag, replacement insulators are reinstalled at the site and the contaminated insulators are brought to a central location. Each insulator is then carefully washed in distilled water and measurements of water conductivity are sent to the St. John's office where they are analyzed by a computer and converted to equivalent salt deposit densities (in mg/cm^2) on the insulator surface.

The categories of salt contamination are as follows:[2]

Very Light - 0.01 to 0.025 mg/cm^2

Light - 0.025 to 0.05 mg/cm^2

Average - 0.05 to 0.10 mg/cm^2

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[2] "Pollution Performance of UHV Insulators", CIGRE SC. No. 33, in Cracow, September 1973.

4.5 SALT CONTAMINATION (Cont'd)

Heavy	-	0.10 to 0.2 mg/cm^2
Very Heavy	-	.20 to .40 mg/cm^2
Exceptional	-	.40 to .80 mg/cm^2

The program has been in operation since January of 1979 with the eight (8) stations at Daniel's Harbour and Sally's Cove and the two Labrador sites providing reliable information.

Due to operational difficulties, i.e. personnel and damaged insulators, no significant amount of useful information has been generated from the three sites at Flowers Cove to date.

Photograph VII shows the type of test site used on the Island while Photograph VIII shows the type of test site used in Labrador. The two (2) types of test sites were set up to provide different, but related, information.

As can be seen from the washing schedule for the Island sites in Appendix VI, insulators 2 and 3 in String A are done at each washing and the remaining insulators are washed according to a somewhat different pattern. It is hoped that the bi-monthly washing of the insulators in String A will establish peak contamination levels while the cyclic washing pattern of the other insulators, hopefully, will establish a pattern of contamination with respect to time.

Although a large volume of statistically weighted information is necessary to firmly establish patterns, Tables I and II in Appendix VII give an indication of the type of results obtained, to date, at the Daniel's Harbour and Sally's Cove sites.

The information shown in Tables I and II are for the String A insulators at these sites. A full washing cycle has not been completed, and since no conclusions can be drawn from the other insulators, no data will be presented for these insulators.

4.5 SALT CONTAMINATION (Cont'd)

As can be seen from Tables I and II, the sites at Sally's Cove and Daniel's Harbour show definite reductions in salt levels as one moves inland from the salt water. No attempt will be made to determine insulation requirements at this time due to the fact that results are not available for a year round program and it is felt that salt levels may vary from season to season. It is expected that the spring and fall levels will be highest due to seasonal winds and storms, with winter having the lightest levels due to ice cover on the salt water.

The two sites in Labrador, Site L1 and L2, were originally set up by IREQ to determine if contamination levels varied over the length of the insulator string. Due to the fact that those two sites were in existance at the time the present program was initiated, it was decided to refurbish and make use of them.

Again, although a large volume of statistically weighted data is necessary to firmly establish patterns, the results of the first washing cycle is presented in Table III, Appendix VII.

As can be seen from this Table, Site L1, which is closer to the sea than Site L2, shows higher contamination levels than Site L2. It would be premature to try to establish a pattern of contamination over the string based on one washing cycle, hence no attempt has been made to do so.

4.6 SALT CORROSION

Another problem related to salt contamination is corrosion of conductors, guy wire and hardware, resulting in shortened service life and increased maintenance cost of transmission lines.

To pinpoint areas of concern five (5) CLIMAT units (Classification of Industrial and Marine Atmosphere - See Photograph IX) have been installed at various points on the Great Northern Peninsula

4.6 SALT CORROSION (Cont'd)

and one (1) unit has been installed on the Avalon Isthmus. These units provide an indication of atmospheric corrosion levels, or corrosion indices. Based on these indices, recommendations can be made concerning the type of conductor and hardware protection to be provided in these areas.

Refer to the location map (Figure I) for the sites of the CLIMAT units. One (1) unit is at the Salt Contamination Test Site at Yankee Point, another is at the Daniel's Harbour Salt Contamination Test Site nearest the salt water, and three (3) are located along zinc mine road at Daniel's Harbour 1.6 km, 4 km, and 7.5 km from the salt water. The sixth unit is located on the Isthmus of Avalon, near Sunnyside, about .8 km from the sea.

A CLIMAT study was carried out by Teshmont in certain areas along the route of the HVDC line from Gull Island, and this study resulted in certain recommendations being made concerning protection of hardware and conductors. This program was conducted at eight (8) sites over a one year period, from September 1974 to October 1975. At the time of deferrment of the Gull Island Project, Teshmont recommended that the CLIMAT study be continued to see if previous results were typical.

The results of the present CLIMAT study for the first three (3) months (December 1978 - March 1979) are in line with those of the previous study and another set of results (March 1979 - May 1979) is pending.

While it is anticipated that this CLIMAT program will check any recommendations made as a result of that conducted for the HVDC line, the main purpose of re-instituting this program was to conduct it in conjunction with the salt contamination program and possibly establish a relationship to predict salt contamination levels based on indices produced by the CLIMAT program.

4.6 SALT CORROSION (Cont'd)

The results of the program to date are shown in Appendix VIII along with Alcan's recommendations. Included in this Appendix also, is a copy of a table compiled by Alcan giving general recommendation based on Marine Corrosion Indices.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The 1978/79 meteorological data collection program has been effective in providing necessary information needed to enhance transmission line design and routing.

The conclusions and recommendations of this report are as follows:

1. Insufficient information has been gathered to-date by the Passive Ice Meter Program to provide the statistically reliable data base necessary to establish an icing profile for the Province. Therefore, it is recommened the program be continued until adequate information is acquired.

2. The PIM Program should be expanded prior to the next observation season to include selected sites on the Long Range Mountains.

3. A correlation between the accumulation on a PIM and the number of operations of the Rosemount has not been established to-date. To this end a PIM should be installed at 4 Mile Pond and a remote monitoring system introduced between the Rosemount and the St. John's office to give an indication of operation so that PIM observations can be made in conjunction with Rosemount operation.

4. The Rosemount - Anemometer Program should be continued and an effort should be made to co-ordinate activities with other companies such as CBC, Newfoundland Telephone and Newfoundland Light & Power so as to avoid any duplication of efforts.

5. Contact should be maintained with industry (i.e. CEA, IREQ) to keep informed on the latest developments in climatological monitoring equipment.

6. Insufficient information has been collected to-date from the Test Tower Sites to confirm the HVDC routing in Southern Labrador and the Long Range Mountain Crossing area. Therefore, it is recommended that this Program be continued and additional Sites be established in the Pinware River Valley (Southern Labrador) and in the Long Range Mountains.

5.0 CONCLUSIONS AND RECOMMENDATIONS (Cont'd)

7. In the coming season further ice samples should be collected from the Test Tower Sites and checked for salinity and density.

8. Monitoring of the Test Tower Sites along the eastern side of the Great Northern Peninsula confirmed that this area is susceptable to massive glaze icing storms and hence should be eliminated as a possible HVDC line route.

9. The results of the Salt Contamination and Salt Corrosion Programs are in line with previously conducted studies, however, it is recommended that these programs be continued to complete the accumulation of at least one year's data.

Appendices

APPENDIX I

SUMMARY OF PASSIVE ICE METER REPORTS

SUMMARY OF PASSIVE ICE METER REPORTS

(1978 - 1979)

LOCATION	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY
Hawkes Bay	No Accum.	No Accum.	No Accum.	1.3 cm Glaze	No Accum.	No Accum.	No Accum.	No Accum.
Daniels Hr.	No Accum.	No Accum.	Trace Glaze	No Accum.	Trace Glaze	1.0 cm Glaze - 1 day	No Accum.	No Accum.
Gros Morne	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.
Stephenville	No Accum.	No Accum.	(Not Available At Present)					
Port Aux Basque	No Accum.	No Accum.	Trace Wet Snow	1.3 cm Glaze	0.3 cm Glaze	No Accum.	No Accum.	No Accum.
Burnt Pond	No Accum.	No Accum.	No Accum.	1.3 cm Glaze	No Accum.	Trace Rime	No Accum.	No Accum.
Buchans	No Accum.	No Accum.	No Accum.	Trace Glaze	No Accum.	0.6 cm Glaze	No Accum.	No Accum.
Deer Lake	No Accum.	Trace Glaze	No Accum.	(Not Available At Present)				
Hampden	No Accum.	Trace Wet Snow	Trace Glaze - 3 days	7.6-8.3 cm Glaze - 7 days Trace Glaze - 2 days	0.16 cm Glaze - 1 day Trace - 3 days	Trace to 0.95 cm Glaze - 5 days	No Accum.	No Accum.

NOTE: All measurements are diameter.

SUMMARY OF PASSIVE ICE METER REPORTS

(1978 - 1979)

LOCATION	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY
Wabush	0.1 cm Glaze - 2 days	Trace of Glaze	No Accum.	No Accum.	No Accum.	Trace to 0.2 cm Glaze - 2 days	No Accum.	No Accum.
Churchill Falls	Trace of Glaze	Trace of Glaze	No Accum.	Trace of Glaze	Trace of Glaze	1 cm on surface - 1 day	No Accum.	No Accum.
Goose Bay	Trace of Rime	Trace of Glaze 5-days	2 cm Frozen Snow	.5 cm Glaze - 1 day	Trace of Glaze	Trace of Glaze 3-days	No Accum.	No Accum.
Pointe Amour	No Accum.	No Accum.	Trace of Glaze & 0.9 cm Wet Snow	0.3 cm Glaze 0.6 cm Glaze - 2 days	No Accum.	0.3 cm Glaze	1.27 cm Glaze - 1 day	No Accum.
St. Anthony	No Accum.	1.0 cm Glaze	Trace of Glaze - 3 days .8 cm Rime 1 cm Glaze Trace Wet Snow	1.4-2 cm Rime - 3 days .5-1.0 cm Glaze - 2 days Trace Wet Snow	2.3 cm Rime - 2 days	Trace of Glaze	Trace of Rime - 2 days 2 cm Rime	No Accum.
Yankee Point	No Accum.	No Accum.	.6 cm Wet Snow	1.3 cm Glaze	.6-1.3 cm Wet Snow - 2 days	.6 cm Wet Snow	No Accum.	No Accum.
Plum Point	No Accum.	3 cm Wet Snow	Trace Rime	2 cm Rime - 5 days 2 cm Rime - 2 days	Trace Rime - 9 days	.3 - .4 cm Rime - 2 days	No Accum.	No Accum.

NOTE: All measurements are diameter.

SUMMARY OF PASSIVE ICE METER REPORTS

(1978 - 1979)

LOCATION	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY
Springdale	No Accum.	Trace Rime - 3 days 1 cm Rime	No Accum.	Trace Glaze - 3 days 2.2-3.2 cm Glaze - 7 days 1.3-2.5 cm Glaze - 2 days	Trace Wet Snow - 2 days	0.3 cm Glaze - 4 days	No Accum.	No Accum.
Stony Brook	No Accum.	Trace Glaze Trace Rime	Trace Glaze	0.5 cm Glaze	Trace Rime	0.2 cm Glaze	No Accum.	No Accum.
Gander	No Accum.	Trace to 0.5 cm Glaze - 3 days	Trace Glaze - 5 days	Trace Glaze - 6 days & .2 cm Glaze	Trace Glaze - 1 day	Trace to .3 cm Glaze - 3 days	Trace to .2 cm Glaze - 4 days	Trace of Glaze
Bay D'Espoir	No Accum.	No Accum.	No Accum.	No Accum.	0.5 cm Glaze	No Accum.	No Accum.	No Accum.
Sunnyside	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	0.1 cm Rime	No Accum.	No Accum.
St. Lawrence	No Accum.	No Accum.	Trace to 0.2 cm Wet Snow - 3 days 0.2 cm Glaze	Trace to 0.4 cm Wet Snow - 2 days Trace to 0.1 cm Glaze - 3 days	1.5 cm Rime - 1 day	No Accum.	No Accum.	No Accm

NOTE: All measurements are diameter.

SUMMARY OF PASSIVE ICE METER REPORTS

(1978 - 1979)

LOCATION	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY
"S" Turn	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.
Western Avalon	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.
Holyrood	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.	No Accum.
St. John's	No Accum.	No Accum.	0.1 cm Glaze - 2 days	0.1 to 2.5 cm Glaze - 6 days	0.6 cm Glaze	.2 to 1.2 cm Glaze - 4 days	0.8 to 1.2 cm Glaze - 2 days	No Accum.
Harbour Deep	No Accum.	No Accum.	No Accum.	No Accum.	1.3 cm Glaze - 1 day	No Accum.	No Accum.	No Accum.
Port Blandford	No Accum.	No Accum.	No Accum.	No Accum.	0.2 cm Glaze - 2 days	No Accum.	No Accum.	No Accum.

NOTE: All measurements are diameter.

APPENDIX II

SUMMARY OF ANEMOMETER DATA

ABSTRACT OF THE WIND

SUMMARY

HOLYROOD

	JUNE 78	JULY 78	AUG. 78	SEPT. 78	OCT. 78	NOV. 78	DEC. 78	JAN. 79	FEB. 79	MAR.79	APR.79	MAY 79
Total Mileage for Month			11,130	13,974	14,874	11,822	12,829	11,771			12,508	
Greatest Mileage in 24 Hrs.			626	889	991	936	1,001	1,058			952	
Greatest Mileage & Prevailing Dir. for 1 Hr.	OUT OF SERVICE		S-39	N-51	SW-59	S-60	SE-62	NW-60	OUT OF SERVICE		N-49	NOT AVAILABLE AT PRESENT
Date of Greatest Mileage for 1 Hr.			30th.	10th.	27th.	18th.	21st.	4th.			2nd.	
Average Speed for Month (mph)			16.3	20.0	20.9	21.6	20.4	20.0			17.5	
Longest Continued - Direction			SW	SW	SW	SW	W	NW			SE	
- Hours			35	45	46	31	53	38			49	
Prevailing Direction - By Mileage			SW	SW	NW	SW	W	NW			N	
- By Total Hrs.			SW	SW	SW	SW	W	NW			N	
Peak Gust (mph)			56	70	87	93	83	89			69	

NOTE: Instrument records in imperial units.

ABSTRACT OF THE WIND

SUMMARY

HAWKES BAY

	JUNE 78	JULY 78	AUG. 78	SEPT. 78	OCT. 78	NOV. 78	DEC. 78	JAN. 79	FEB. 79	MAR. 79	APR. 79	MAY 79
Total Mileage for Month	8,674		9,613	13,813	12,030	15,432	12,324	17,083	11,328	15,018	12,104	12,121
Greatest Mileage in 24 Hrs.	734		659	753	730	847	824	1,157	747	1,000	716	794
Greatest Mileage & Prevailing Dir. for 1 Hr.	SW-50	OUT OF SERVICE	SW-38	W-50	SW-48	SW-53	E-54	SW-54	SW-42	SW-56	SE-44	SW-46
Date of Greatest Mileage for 1 Hr.	10th. 12th.		31st.	29th.	31st.	18th.	18th.	3rd.	28th.	12th.	11th.	23rd.
Average Speed for Month (mph)	15.9		17.8	19.6	17.0	22.5	17.1	23.0	16.9	20.6	17.1	16.4
Longest Continued - Direction	SW		NW	SW	NW	NW	W	W	NW	NE	N	SW
- Hours	23		34	54	35	49	35	45	62	68	34	43
Prevailing Direction - By Mileage	SW		SW	SW	SW	NW	W	W	W	SW	N	SW
- By Total Hrs.	SW		SW	SW	SW	NW	W	E	W	SW	N	SW
Peak Gust (mph)	57		43	56	53	61	59	62	49	63	44	46

NOTE: Instrument records in imperial units.

ABSTRACT OF THE WIND

SUMMARY

YANKEE POINT

	JUNE 78	JULY 78	AUG. 78	SEPT. 78	OCT. 78	NOV. 78	DEC. 78	JAN. 79	FEB. 79	MAR.79	APR.79	MAY 79
Total Mileage for Month	5,766	6,189				10,854	7,780	11,562	7.855	10,860	6,561	
Greatest Mileage in 24 Hrs.	488	427				643	664	807	616	694	378	
Greatest Mileage & Prevailing Dir. for 1 Hr.	SW-26	NE-26				E-40	SE-42	NE-43	SW-30	NE-40	SW-27	
Date of Greatest Mileage for 1 Hr.	26th.	10th.				28th.	22nd.	16th.	13th.	12th.	18th.	
Average Speed for Month (mph)	8.5	10.2				17.2	14.6	15.7	12.5	14.6	10.1	
Longest Continued - Direction	NE	SW				SW	W	NE	N	NE	NE	
- Hours	50	55				36	35	178	65	90	59	
Prevailing Direction - By Mileage	SW	NE				SW	NE	NE	SW	NE	NE	
- By Total Hrs.	SW	NE				SW	NE	NE	SW	NE	NE	
Peak Gust (mph)	43	34				56	55	63	40	88	41	

OUT OF SERVICE

NOT AVAILABLE AT PRESENT

NOTE: Instrument records in imperial units.

ABSTRACT OF THE WIND

SUMMARY

SUNNYSIDE

	JUNE 78	JULY 78	AUG. 78	SEPT. 78	OCT. 78	NOV. 78	DEC. 78	JAN. 79	FEB. 79	MAR.79	APR.79	MAY 79
Total Mileage for Month	8,237	6,650	6,609	7,950	7,445	8,831	9,239	9,242	8,426	10,138	7,752	7,798
Greatest Mileage in 24 Hrs.	513	384	343	504	556	511	639	551	632	737	666	520
Greatest Mileage & Prevailing Dir. for 1 Hr.	SE-30	SE-22	SW-24	N-28	SW-30 W-30	SW-40 S-40	SE-32 W-32	SW-35	NE-35	S-45	N-35	SW-26
Date of Greatest Mileage for 1 Hr.	12th.	18th.	16th.	10th.	27th. 31st.	18th. 26th.	18th. 22nd.	3rd.	3rd.	12th.	2nd.	13th.
Average Speed for Month (mph)	11.4	9.2	8.9	11.1	10.1	12.3	12.4	12.5	12.7	13.6	10.8	10.5
Longest Continued - Direction - Hours	SE 118	SE 110	SW 56	SW 62	NE 36	W 41	NE 42	E 109	NE 62	SW 147	N 62	SW 142
Prevailing Direction - By Mileage - By Total Hrs.	SE SE	SE SE	SW SW	SW SW	SW SW	SW SW	NW W	SW NE	W W	SW SW	N NE	SW SW
Peak Gust (mph)	45	41	37	46	55	67	56	57	51	54		

NOTE: Instrument records in imperial units.

APPENDIX III

SUMMARY OF ROSEMOUNT ICE DETECTOR DATA

ROSEMOUNT ICE DETECTOR

YANKEE POINT

DATE	TIME	NO. OF ICING SIGNALS	CALCULATED ACCUMULATION (INCHES)
February 15/79	10:52 a.m.	1	0.02
February 17/79	4:08 a.m.	1	0.02
February 24/79	6:45 a.m.	1	0.02
February 28/79	4:33 p.m.- 8:40 p.m.	5	0.10
March 1/79	12:00 p.m.- 2:38 a.m.	12	0.24
March 1/79	9:58 p.m.	1	0.02
March 5/79	10:25 a.m.	1	0.02
March 5/79	7:30 p.m.	1	0.02
March 5/79	7:50 p.m.	1	0.02
March 7/79	11:58 p.m.	1	0.02
March 11/79	10:20 p.m.	1	0.02
March 14/79	7:05 p.m.- 9:40 p.m.	9	0.18
March 17/79	5:50 p.m.-11:12 p.m.	2	0.04
March 24/79	7:45 p.m.- 9:30 p.m.	2	0.04
March 31/79	1:25 p.m.- 8:25 p.m.	10	0.20
April 1/79	3:45 a.m.- 8:27 a.m.	2	0.04
April 8/79	6:27 a.m.	1	0.02
April 9/79	8:33 a.m.	1	0.02
April 11/79	12:40 a.m.	1	0.02
April 17/79	4:07 p.m.	1	0.02
April 18/79	1:55 a.m.- 6:17 a.m.	2	0.04

NOTE: Calculated accumulation = number of icing signals x 0.02".
Probe calibrated to detect 0.02" of ice.

ROSEMOUNT ICE DETECTOR

SUNNYSIDE

DATE	TIME	NO. OF ICING SIGNALS	CALCULATED ACCUMULATION (INCHES)
November 28/78	9:12 p.m.- 9:37 p.m.	2	0.04
November 29/78	12:43 a.m.- 2:07 a.m.	3	0.06
December 03/78	11:53 p.m.		
December 04/78	-12:10 a.m.	2	0.04
December 05/78	4:14 a.m.- 6:15 a.m.	3	0.06
December 19/78	4:13 p.m.	1	0.02
January 02/79	2:46 a.m.- 4:44 a.m.	5	0.10
January 14/79	9:13 p.m.		
January 15/79	- 1:40 a.m.	9	0.18
January 20/79	7:43 a.m.- 8:03 a.m.	2	0.04
January 21/79	12:35 a.m.- 1:05 a.m.	2	0.04
January 22/79	7:28 p.m.	1	0.02
February 26/79	10:29 p.m.		
February 27/79	- 6:57 a.m.	11	0.22
March 07/79	12:15 a.m.- 1:00 a.m.	2	0.04
March 17/79	12:30 p.m.- 1:55 p.m.	10	0.20
March 21/79	2:14 a.m.- 3:32 a.m.	3	0.06
March 30/79	9:50 p.m.		
March 31/79	- 2:15 a.m.	5	0.10
March 31/79	1:45 p.m.	1	0.02

NOTE: Calculated accumulation = number of icing signals x 0.02".
Probe calibrated to detect 0.02" of ice.

ROSEMOUNT ICE DETECTOR

4-MILE POND

DATE	TIME	NO. OF ICING SIGNALS	CALCULATED ACCUMULATION (INCHES)
October 31/78	10:28 a.m.	1	0.02
October 31/78	2:22 p.m.	3	0.06
November 05/78	11:52 a.m.	1	0.02
November 05/78	12:50 a.m.	1	0.02
November 06/78	9:27 a.m.	1	0.02
November 14/78	10:25 a.m.	1	0.02
November 21/78	4:40 p.m.	1	0.02
November 22/78	1:50 a.m.	1	0.02
November 23/78	4:37 p.m.- 4:57 p.m.	2	0.04
November 23/78	10:35 p.m.		
November 24/78	- 1:47 a.m.	12	0.24
November 25/78	5:30 a.m.		
November 25/78	- 9:35 a.m.	9	0.18
November 27/78	4:35 p.m.		
November 27/78	- 5:40 p.m.	11	0.22
November 27/78	6:50 p.m.	1	0.02
November 27/78	7:30 p.m.	2	0.04
November 28/78	1:50 p.m.	1	0.02
November 28/78	9:27 p.m.		
November 29/78	- 1:24 a.m.	22	0.44
November 29/78	11:45 a.m.	1	0.02
November 30/78	10:46 p.m.		
December 01/78	- 4:20 p.m.	12	0.24
December 05/78	2:37 a.m.- 5:34 a.m.	34	0.68
December 05/78	8:06 a.m.	1	0.02
December 05/78	8:45 a.m.	1	0.02
December 05/78	4:25 p.m.- 6:25 p.m.	5	0.10
December 14/78	4:15 p.m.- 5:28 p.m.	13	0.26
December 17/78	3:05 a.m.	1	0.02
December 17/78	11:45 a.m.	1	0.02
December 17/78	4:58 p.m.- 9:00 p.m.	20	0.40

NOTE: Calculated Accumulation = number of icing signals x 0.02".
Probe calibrated to detect 0.02" of ice.

ROSEMOUNT ICE DETECTOR

4-MILE POND (CONT'D)

DATE	TIME	NO. OF ICING SIGNALS	CALCULATED ACCUMULATION (INCHES)
December 18/78	1:37 a.m.- 2:58 a.m.	12	0.24
December 19/78	10:33 a.m.-12:30 p.m.	3	0.06
December 19/78	6:05 p.m.	1	0.02
December 21/78	10:27 p.m.		
December 22/78	-12:15 a.m.	27	0.54
December 25/78	8:05 a.m.	1	0.02
December 25/78	9:05 a.m.	1	0.02
December 25/78	4:35 p.m.	1	0.02
December 25/78	6:15 p.m.	1	0.02
December 26/78	4:45 p.m.		
December 27/78	- 8:23 p.m.	64	1.28
December 28/78	12:50 p.m.- 2:40 a.m.	5	0.10
December 28/78	4:58 a.m.		
December 29/78	- 1:10 a.m.	61	1.22
December 29/78	3:40 a.m.- 6:00 a.m.	6	0.12
December 30/78	2:05 a.m.-10:23 a.m.	14	0.28
December 30/78	3:05 p.m.- 6:13 p.m.	11	0.22
December 30/78	8:13 p.m.		
January 01/79	- 7:23 a.m.	153	3.06
January 02/79	4:00 a.m.-10:13 a.m.	20	0.40
January 04/79	12:00 p.m.	1	0.02
January 05/79	12:40 p.m.- 2:57 p.m.	5	0.10
January 07/79	11:53 p.m.		
January 08/79	- 9:35 a.m.	42	0.84
January 10/79	11:20 a.m.	1	0.02
January 14/79	9:00 p.m.		
January 15/79	- 2:20 a.m.	36	0.72
January 19/79	5:05 p.m.		
January 21/79	- 9:00 a.m.	79	1.58
January 22/79	2:01 p.m.- 8:20 p.m.	11	0.22
January 22/79	11:50 p.m.		
January 23/79	-10:02 a.m.	91	1.82

ROSEMOUNT ICE DETECTOR

4-MILE POND (CONT'D)

DATE	TIME	NO. OF ICING SIGNALS	CALCULATED ACCUMULATION (INCHES)
January 24/79	1:55 a.m.- 4:43 p.m.	66	1.32
January 25/79	12:40 a.m.- 5:28 p.m.	5	0.10
January 31/79	6:50 a.m.- 1:47 p.m.	20	0.40
January 31/79	5:35 p.m.		
February 01/79	- 1:15 a.m.	25	0.50
February 02/79	4:12 p.m.		
February 03/79	- 1:50 p.m.	110	2.20
February 03/79	9:16 p.m.	1	0.02
February 05/79	1:04 a.m.- 8:25 a.m.	4	0.08
February 08/79	11:50 a.m.-12:50 p.m.	2	0.04
February 15/79	11:12 a.m.	1	0.02
February 23/79	3:20 a.m.	1	0.02
February 24/79	4:58 a.m.	1	0.02
February 25/79	6:43 a.m.	1	0.02
February 25/79	1:30 p.m.- 7:45 p.m.	10	0.20
February 26/79	1:42 a.m.- 9:44 a.m.	10	0.20
February 26/79	7:08 p.m.		
February 27/79	- 2:18 a.m.	92	1.84
March 01/79	1:52 p.m.	1	0.02
March 01/79	9:23 p.m.-11:23 p.m.	3	0.06
March 03/79	10:08 a.m.-11:15 a.m.	4	0.08
March 09/79	4:35 p.m.-10:55 p.m.	19	0.38
March 10/79	1:58 a.m.	1	0.02
March 10/79	6:29 a.m.- 9:20 a.m.	5	0.10
March 11/79	10:17 p.m.-11:15 p.m.	7	0.14
March 12/79	1:00 p.m.	1	0.02
March 14/79	7:20 a.m.- 7:40 a.m.	2	0.04
March 16/79	9:50 p.m.-10:15 p.m.	2	0.04
March 17/79	1:43 a.m.	1	0.02
March 17/79	7:30 a.m.-11:28 a.m.	22	0.44

ROSEMOUNT ICE DETECTOR

4-MILE POND (CONT'D)

DATE	TIME	NO. OF ICING SIGNALS	CALCULATED ACCUMULATION (INCHES)
March 17/79	3:56 p.m.- 5:37 p.m.	19	0.38
March 18/79	8:28 a.m.- 8:55 a.m.	2	0.04
March 19/79	3:28 a.m.- 4:48 a.m.	10	0.20
March 19/79	6:28 a.m.-11:10 a.m.	59	1.18
March 19/79	7:45 p.m.		
March 20/79	-12:40 a.m.	33	0.66
March 21/79	2:35 a.m.- 1:50 p.m.	50	1.00
March 21/79	9:35 p.m.-10:35 p.m.	3	0.06
March 22/79	3:35 a.m.		
March 23/79	- 6:20 a.m.	44	0.88
March 25/79	11:11 p.m.	1	0.02
March 30/79	3:28 a.m.		
March 31/79	-11:47 a.m.	77	1.54
March 31/79	6:20 p.m.- 8:11 p.m.	4	0.08
March 31/79	11:47 p.m.		
April 01/79	- 5:58 a.m.	9	0.18
April 01/79	11:15 p.m.		
April 02/79	- 1:47 a.m.	3	0.06
April 05/79	7:45 a.m.	1	0.02
April 05/79	7:05 p.m.		
April 06/79	- 5:33 a.m.	64	1.28
April 07/79	5:40 a.m.- 8:20 a.m.	21	0.42
April 08/79	2:20 p.m.	1	0.02
April 08/79	7:58 p.m.- 9:12 p.m.	3	0.06
April 09/79	5:25 p.m.- 9:40 p.m.	20	0.40
April 09/79	11:45 p.m.		
April 10/79	-12:38 a.m.	2	0.04
April 10/79	7:07 p.m.		
April 11/79	- 5:14 a.m.	51	1.02
April 13/79	1:02 p.m.	1	0.02
April 16/79	10:45 a.m.-12:40 p.m.	2	0.04

ROSEMOUNT ICE DETECTOR

4-MILE POND (CONT'D)

DATE	TIME	NO. OF ICING SIGNALS	CALCULATED ACCUMULATION (INCHES)
April 18/79	10:03 p.m.		
April 19/79	- 7:55 a.m.	43	0.86
April 19/79	10:35 p.m.		
April 20/79	-10:50 a.m.	10	0.20
April 20/79	11:36 p.m.		
April 21/79	- 3:50 a.m.	3	0.06
April 21/79	8:58 a.m.	1	0.02
April 22/79	10:30 p.m.		
April 23/79	- 3:12 a.m.	11	0.22
April 23/79	7:00 a.m.	1	0.02
April 23/79	10:36 p.m.		
April 24/79	- 1:15 p.m.	137	2.74
April 24/79	8:06 p.m.	1	0.02
May 03/79	9:46 p.m.		
May 04/79	- 6:25 a.m.	24	0.48
May 06/79	10:00 p.m.-12:00 p.m.	10	0.20
May 07/79	4:36 a.m.-11:39 a.m.	6	0.12
May 08/79	6:00 a.m.- 8:40 a.m.	7	0.14
May 08/79	1:13 p.m.	1	0.02
May 08/79	8:13 p.m.		
May 10/79	- 7:49 a.m.	195	3.90
May 12/79	4:47 a.m.- 7:24 a.m.	7	0.14

115

APPENDIX IV

SUMMARY OF TEST TOWER DATA

TABLE OF DATA

SITE # 1 SHEFFIELD LAKE

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C.	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
10-11-78	69+	West	+1	Bare	-
15-12-78	14	West	-2	1" Pennant of Soft Rime on East Side of Tower and Guy.	East
17-01-79	21-32	Northwest	-20	Bare	-
16-02-79	14-23	West	-20	Glaze at 5' level of Tower Leg 2" wide and 2½" thick. Tower Top encased with 6" to 8" of Glaze covered by Snow.	East
26-03-79	23	West	7	Bare	-
10-05-79	9-10	Southwest	2	Bare	-

TABLE OF DATA

SITE # 2 PORTLAND CREEK

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C.	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
09-11-78	18-29	Southwest	0	Bare	-
14-12-78	32-44	Southeast	-10	Three massive accumulations of Rime. Hard Rime from NE; medium density Rime from SW; soft Rime from W. Tower completely encased, guys had total accumulation of 12" - 14" hard Rime covered by soft Rime. Soft Rime on 2" rods estimated at 2½' wide and formed into a wing shape.	Northeast Southwest West
18-01-79	Calm	-	-22	3" Pennant of soft Rime formed on guys and tower at 5' level. Accumulation increased towards tower top.	East
12-02-79	29	West	-25	Tower completely encased at top in 12" to 14" of Rime; 12" on rods; Rime 5" wide and 2" thick on guys.	Northwest North
26-03-79	32	South	7	Bare	-
09-05-79	9-10	North	4	Bare	-

TABLE OF DATA

SITE # 2a PORTLAND CREEK

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C.	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
09-11-78	18-29	Southwest	0	Bare	-
14-12-78	23-28	Southeast	-10	1/2" hard Rime from NE covered by soft Rime from SW at 5' level of tower leg. 1/4" hard Rime on guys covered by 1/4" soft Rime.	Northeast Southwest
18-01-79	Calm	-	-22	Remanents of Glaze formed by east wind; approximately 1/4" pennant.	East
21-02-79	14	West-Southwest	-14	Glaze 2" to 2½" thick and 2" to 2½" wide formed on NE tower face.	Northeast
26-03-79	16	South	6	Bare	-
09-05-79	5-7	Northeast	4	Bare	-

TABLE OF DATA

SITE # 2b PORTLAND CREEK

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C.	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
09-11-78	44-52	Southwest	0	Thin coat of Glaze on guys and tower formed by SW wind.	Southwest
14-12-78	26-31	South	-11	Large accumulation of soft Rime from W over 1" hard Rime from SW; Tower completely encased; 10" thick pennant on guys.	West Southwest
18-01-79	5	West	-22	Approximately 1" Pennant of Rime on Tower Leg, 3/4" on guys covered by 2" soft Rime.	West
21-02-79	15-16	West-Southwest	-14	Tower encased in snow over Rime over Glaze approximately 10" thick at tower top; 6" to 7" of Rime pennant on guys.	North Northeast
26-02-79	25	South	6	Bare	-
09-05-79	9-10	North	4	Bare	-

TABLE OF DATA

SITE # 3 - HILLS OF ST. JOHN

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
07-11-78	3	Northwest	1	Bare	-
13-12-78	29-40	Southwest	-12	Combination of 1" of soft rime over 2¼" hard rime on 5' level of tower leg. 2" to 3" hard rime on guys covered by soft rime.	Northeast Southwest
18-01-79	12	Southwest	-20	Bare	-
12-02-79	32-35	West	-30	Massive accumulation of glaze formed from the east. Glaze 7" thick and 4" wide at 5' level of tower leg. Pennant glaze on guys 5" wide and 2" deep.	East
26-03-79	23	Southwest-West	8	Bare	-
09-05-79	Calm	-	4	Bare	-

TABLE OF DATA

SITE # 4 L'Anse AU LOUP

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
07-11-78	18-22	Northwest	0	Approximately 3/8" rime from the north over 1/4" glaze from the west collected at 5' level of tower leg.	West North
12-12-78	31-32	Northwest	-18	Approximately 2"-2½" glaze in pennant form at tower top.	North
18-01-79	Calm	-	-20	1½" pennant hard rime on tower leg and 2" on rods.	South
14-02-79	2	South	-26	Slight coat of glaze on tower covered by hard rime 4" wide and 7" thick. 8" to 10" hard rime on rods.	Northeast
26-03-79	17	South	0	Bare	-

TABLE OF DATA

SITE # 4a L'Anse AU LOUP

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
07-11-78	14	North-Northwest	0	Slight trace of glaze.	West-Northwest
12-12-78	17	Northwest	-18	3/8" to 1/2" glaze pennant on tower face.	North
18-01-79	Calm	-	-20	3/4" hard rime pennant on tower face and guys.	South
14-02-79	17	South	-26	Glaze on tower leg measuring 2" x 2½".	Northeast
26-03-79	20	South	2	Bare	-

TABLE OF DATA

SITE # 5 LITTLE HARBOUR DEEP

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
10-11-78	69+	Northwest	-6	Bare	-
15-12-78	12-35	South	-3	1/2" pennant hard rime on tower leg. 1/4" pennant soft rime on guys.	West East
14-02-79	6	West	-20	Massive accumulation glaze on tower and guys. Approximately 30" thick on tower and 12" thick by 40" wide between guys and ground. Severe damage to tower.	East-Northeast
26-03-79	23	East	5	Bare	-
09-05-79	5-7	North-Northeast	4	Bare	-

TABLE OF DATA

SITE # 6 EAST OF BLUE MOUNTAIN

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
07-11-78	7	Northwest	0	Bare	-
14-12-78	12	East	-9	2" soft rime from the west over 1/2" hard rime from east. 1/4" hard rime covered by 3" soft rime on guys.	East West
18-01-79	Calm	-	-20	Slight trace of hoar frost.	-
12-02-79	52	West	-27	Massive accumulation of glaze. Glaze on tower measured 10" to 12" thick and 1½' wide. Glaze 9" diameter on guy.	Southeast
26-03-79	3	South	8	Bare	-
09-05-79	7-9	East	7	Bare	-

TABLE OF DATA

SITE # 7 TORRENT RIVER - HAWKES BAY

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
07-11-78	12-14	North	2	Bare	-
13-12-78	31-35	Southwest West	-11	Three accumulations from different directions: 3"-4" of rime (west) over 1/4" glaze (southwest) over 1/4" glaze (east). 3"-3½" (soft rime over glaze) on guys.	West Southwest East
18-01-79	6	West	-20	Trace of Hoar frost on tower leg.	-
12-02-79	48-52	West Northwest	-30	Slight accumulation of soft rime over 1/4" glaze.	Northwest
26-02-79	30	South	8	Bare	-
09-05-79	12-13	East	10	Bare	-

TABLE OF DATA

SITE # 8 HOOPING HARBOUR

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
07-11-78	14-18	Northwest West	0	Bare	-
18-01-79	5	West	-20	1/8" glaze on tower leg.	Southeast
14-02-79	17-23	West	-19	Massive accumulation of glaze. Glaze 5½" thick and 6"-7" wide at 5' level of tower leg. 1" to 2" diameter glaze on guys. Ice 3" to 4" in diameter fallen to ground from guys.	Northeast
26-03-79	25	East	2	Bare	-

TABLE OF DATA

SITE # 9 28-MILE SECTION

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
08-11-78	Calm	-	0	Bare	-
15-12-78	12	Southwest	-2	1/4" pennant of hard rime on tower and guys.	-
18-01-79	Calm	-	-20	1" glaze pennant formed at the 5' level of tower leg. 3/4" pennant on guys.	Southwest
16-02-79	2-6	West	-24	Glaze at 5' level of tower leg measured 3½" wide by 3" thick. Glaze on guys 2½" thick by 4" wide.	East
26-03-79	7	East	6	Bare	-
09-05-79	5-7	North	4	Bare	-

TABLE OF DATA

SITE # 10 MAIN RIVER

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
08-11-78	Calm	-	4	Bare	-
15-12-78	8-10	Southwest	-1	Bare	-
18-01-79	Calm	-	-22	Bare	-
16-02-79	12-14	West	-20	Bare	-
26-03-79	2	West	6	Bare	-
09-05-79	5	North	4	Bare	-

TABLE OF DATA

SITE # 11 CAT ARM

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
08-11-78				Installation	
15-12-78	13	Southwest	-2	Pennant of hard rime on tower leg 1½" thick and 1/4" wide.	Northeast
01-79				Not visited.	
14-02-79	9-14	West	-21	Hugh deposits of glaze. NE tower face completely encased in glaze 15" wide by 24" thick. Pennant formed on lower guy and anchor attachment measured 41" across. Small twigs measured 44" across.	Northeast
26-03-79	17	East	5	Bare	-
09-05-79	7-9	North Northwest	4	Bare	-

TABLE OF DATA

SITE # 12 CAT ARM

DATE	WIND SPEED (MPH)	WIND DIR. (TRUE)	TEMP. °C	ACCUMULATION NOTED	DIRECTION OF ACCUMULATION
08-11-78				Installation	
15-12-78	25	Southwest	-2	Slight accumulation of soft rime over hard rime 1/2" thick and 1" wide at 5' level of tower leg. 1/4" pennant soft rime on guys.	East
01-79				Not visited.	
14-02-79	16	West	-20	Hugh accumulation of glaze. Samples from tower leg measured 15" thick by 25" wide. 6" diameter glaze on guys.	East to Northeast
26-03-79	17	East	5	Bare	-
09-05-79	7-9	North Northwest	4	Bare	-

APPENDIX V

TABLE OF SALINITY TESTS - ICE SAMPLES

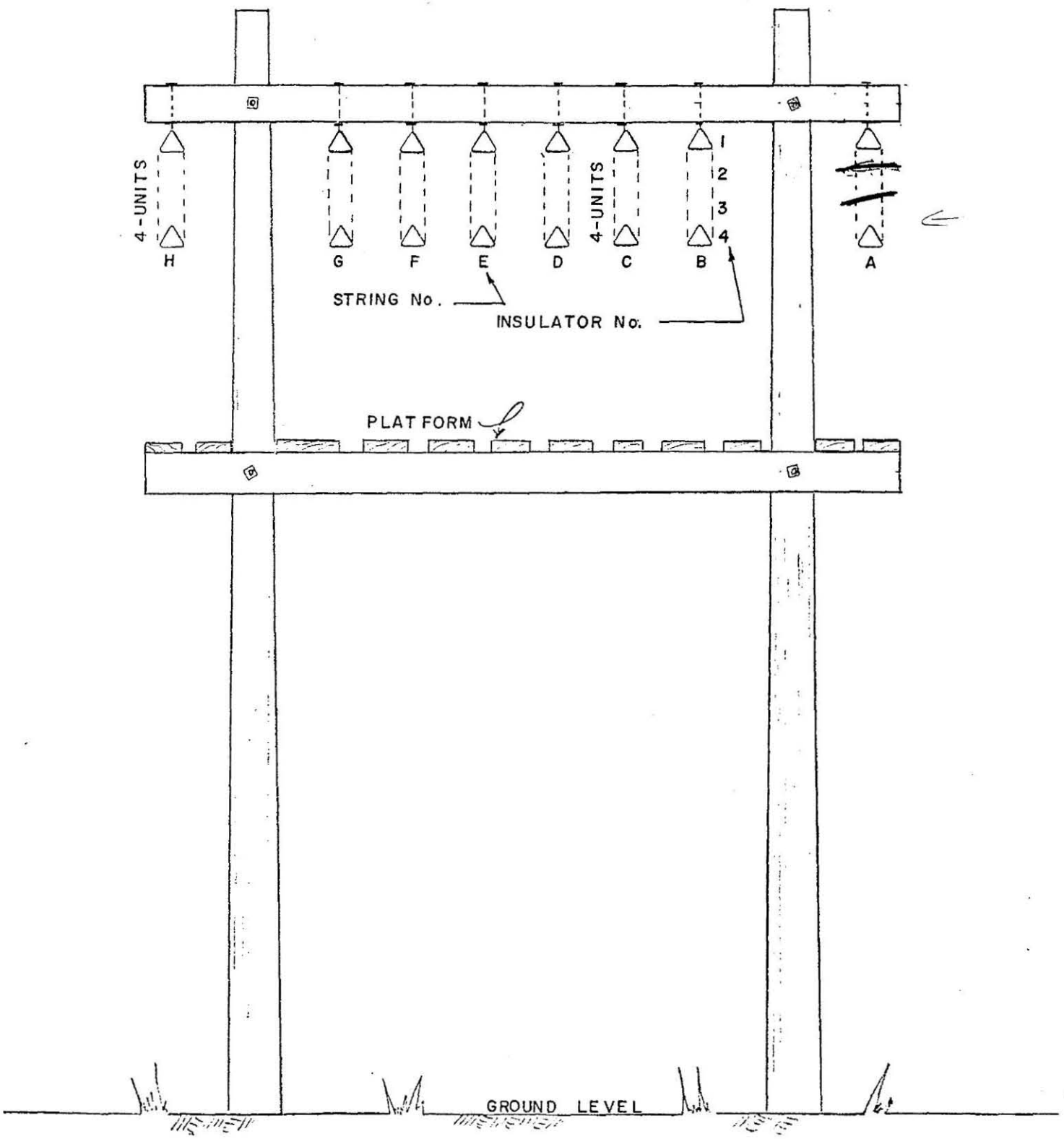
SALINITY TEST RESULTS

SITE NO.	SALINITY g/l (NaCl)
1	0.0045
2	0.0041
2a	No Sample
2b	No Sample
3	0.0160
4	0.0110
4a	0.0060
5	0.0063
6	0.0028
7	0.0043
8	0.0169
9	0.0080
10	No Sample
11	0.0032
12	0.0020
Tap Water	0.0195
Distilled Water	0.001

APPENDIX VI

WASHING SCHEDULES

TEST STATIONS - ISLAND

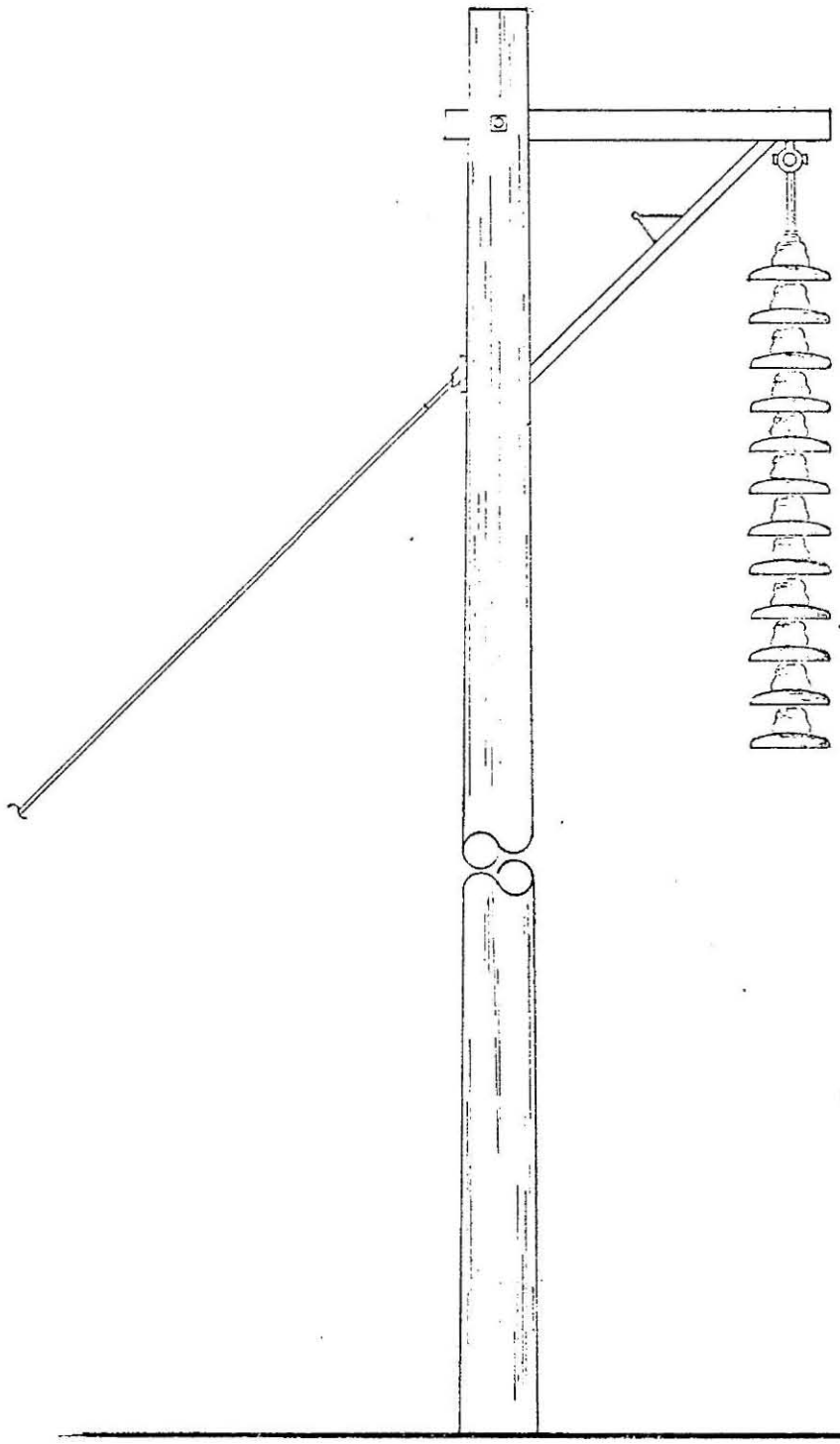


WASHING SCHEDULE

Sites at Flowers Cove, Daniel's Harbour and Sally's Cove

Washdown #	String #	Insulator #
1	B	1,2
2	B	3,4
3	C	1,2
4	C	3,4
5	D	1,2
.	.	
.	.	
13	H	1,2
14	H	3,4

In addition, String A Insulators 2 and 3 to be washed at each scheduled washdown.



TEST STATIONS

L'ANSE-AU-LOUP & POINTE AMOUR

For sites where one string of twelve insulators will be washed.
(Sites L'Anse - Au - Loup and Point Amour)

Washdown #	Insulator #
1	1,7
2	2,8
3	3,9
4	4,10
5	5,11
6	6,12

Washings will be at two week intervals. When cycles are completed they are started again.

APPENDIX VII

SALT CONTAMINATION TEST RESULTS

TABLE I

SALT CONTAMINATION TEST RESULTS, SALLY'S COVE SITES

STRING A INSULATOR 2

SITE NO.	SALT DEPOSIT DENSITY (mg/cm^2)	DISTANCE FROM SEA (km)	LEVEL OF CONTAMINATION
11	0.022940	At Seashore	Light
10	0.013250	1	Light
9	0.005340	1.4	Very Light

STRING A INSULATOR 3

SITE NO.	SALT DEPOSIT DENSITY (mg/cm^2)	DISTANCE FROM SEA (km)	LEVEL OF CONTAMINATION
11	0.022770	At Seashore	Light
10	0.009080	1	Very Light
9	0.005730	1.4	Very Light

TABLE II

SALT CONTAMINATION TEST RESULTS, DANIEL'S HARBOUR SITES

STRING A INSULATOR 2

SITE NO.	SALT DEPOSIT DENSITY (mg/cm^2)	DISTANCE FROM SEA (km)	LEVEL OF CONTAMINATION
4	0.020895	At Seashore	Light
5	0.007330	0.5	Very Light
6	0.003927	1.5	Very Light
7	0.003770	2.15	Very Light
8	0.003650	2.5	Very Light

STRING A INSULATOR 3

SITE NO.	SALT DEPOSIT DENSITY (mg/cm^2)	DISTANCE FROM SEA (km)	LEVEL OF CONTAMINATION
4	0.019047	At Seashore	Light
5	0.007702	0.5	Very Light
6	0.005720	1.5	Very Light
7	0.003642	2.15	Very Light
8	0.003340	2.5	Very Light

TABLE III

SALT CONTAMINATION TEST RESULTS, LABRADOR SITES

SITE L1 - POINTE AMOUR (at seashore)		SITE L2 - LANSE AU LOUP (2.6 km inland)	
INSULATOR #	SALT DEPOSIT DENSITY (mg/cm^2)	INSULATOR #	SALT DEPOSIT DENSITY (mg/cm^2)
1	0.009880	1	0.004210
2	0.008170	2	0.006360
3	0.013060	3	0.004210
4	0.011480	4	0.006150
5	0.006240	5	0.002120
6	0.013390	6	0.009940
7	0.003680	7	0.003680
8	0.007660	8	0.006680
9	0.009770	9	0.004920
10	0.007920	10	0.005270
11	0.003950	11	0.001970
12	0.008690	12	0.005460

APPENDIX VIII

ALCAN REPORT ON CLIMAT UNITS, EXPOSURE PERIOD DECEMBER 1978 - MARCH 1979

Aluminum Company of Canada, Ltd
Research Centre, Kingston

ALCAN

Mail Address: Box 8400, Kingston, Ontario, Canada K7L 4Z4. Telephone: 613/549-4500. Cable: ALCANLAB

18 April 1979

Lower Churchill Development Corp.
c/o Mr. W. C. Squires
P. O. Box 9100
St. John's, Newfoundland
A1A 2X8

Dear Sir:

With reference to your Purchase Order No. 28702 we are sending you the initial CLIMAT data from Newfoundland. Table 1 summarizes the data.

TABLE 1

CLIMAT data from Newfoundland
(Exposure period Dec. 78-Mar. 79)

Distance from sea	Site	Al-Plastic Index (Al: A.C.I.)	Al-Fe Index (M.C.I.)
150 m (500 ft)	1.6 km (1 mile) from Daniels Hr.	0.17	12.8
800 m (0.5 mile)	800 m (0.5 mile) from Flowers Cove	0.08	3.9
800 m (0.5 mile)	1.6 km (1 mile) from Sunnyside	0.07	4.6
1.6 km (1 mile)	4.5 km (2.8 miles) from Daniels Hr.	0.10	3.8
4.0 km (2.5 mile)	7 km (4.3 mile) from Daniels Hr.	0.11	3.1
7.5 km (4.7 mile)	10.5 km (6.5 mile) from Daniels Hr.	0.06	1.6

These data show that at 150 m from the sea, marine corrosivity reached "Severe" level, at 800 m - 4.0 km it was 'Moderate" and at the distance of 7.5 km from the sea it was "Negligible".

..... 2

The present data are in line with previous results and therefore for conductors our recommendations are as follows:

1) Labrador and Central Newfoundland, over 8 km (5 miles) from the sea.

   No special protection for conductors.
   Standard galvanized hardware, with zinc coating of 0.025 mm (0.001 in.)

2) a) Labrador and Central Newfoundland, from 4 to 8 km (2.5 to 5 miles) from the sea.
   b) Northern Peninsula and the main part of the Avalon Peninsula, over 4 km (2.5 miles) from the sea.

   No special protection for all-aluminium conductors.
   Grease protection for ACSR core wires.
   Standard galvanized hardware (as above).

3) All coastal areas, up to 4 km (2.5 miles) inland, and the region of the Avalon Peninsula, directly between Placentia and Trinity bays.

   Grease protection for cores and inner aluminium layers for all conductors, both all-aluminium and ACSR. Hardware may be galvanized steel, provided the zinc coating is 0.05 mm (0.002 in.) thick.

Table 2, Recommendations for Power Lines Based on CLIMAT Data, is attached for your complete information.

Yours truly,

V. Hron

V. Hron

VH:ak
Attach.

Copies to: Alcan Canada Products Limited: Montreal
c/o Mr. G. K. Carroll

Alcan Canada Products Limited: Toronto
c/o Mr. J. D. Many

TABLE 2

RECOMMENDATIONS FOR POWER LINES BASED ON CLIMAT DATA

Marine Corrosivity Index	Classification	Significance	General Remarks	Conductors (see Notes)	Line Hardware
<2	Negligible	Average habitable area	No precautions	Use any type of conductor.	Standard galvanized steel hardware is adequate where the galvanizing is 0.001 in. (0.025 mm) thick.
2 - 5	Moderate	Seaside	Guard against galvanic attack	If ACSR, use greased cores.	
5.1-10	Moderately severe	Seaside and exposed	Guard against galvanic attack and moisture in crevices	If ACSR, use greased cores. If all-aluminium construction, or ACSR/AW or ACSR/AZ, and if wire size is below 2.5 mm, use grease on inner wires.	Galvanized steel hardware with a galvanized coating of 0.002 in. (0.05 mm) thick should be used.
10.1-20	Severe	Very exposed	Eliminate chance of galvanic attack and crevice attack from moisture in crevices.	Avoid small sizes of ACSR (6/1) and those with only one layer of aluminium wires. Use grease in all conductors. Use wire sizes above 2.5 mm.	Here aluminium or stainless steel hardware should be used, since galvanized steel hardware, even with a galvanized coating of 0.002 in. (0.05 mm) will have a limited life.
>20	Very severe	Wind-swept, sand-swept & very exposed	Same as above, but also allow for some pitting	Avoid using ACSR or ACSR/AZ. Use grease in all conductors. Use wire sizes above 3 mm.	

Note (1): The choice of conductors can be made from:

All-Aluminium Constructions

ASC Aluminium Stranded Conductor
AASC Aluminium Alloy Stranded Conductor
ACAR Aluminium Stranded Conductor, Alloy core.

Steel Reinforced Constructions

ACSR/AW or AWAC Aluminium Conductor, Alumoweld Steel core.
ACSR/AZ Aluminium Conductor, Aluminized Steel core.
ACSR Aluminium Conductor, Galvanized Steel core.

Note (2): Two types of grease protection are entailed; for the "moderate" and "moderately severe" classifications only the core wires are greased, but for the "severe" and "very severe" classifications all interstices in the conductor are filled with grease.

Photographs

PHOTOGRAPHS

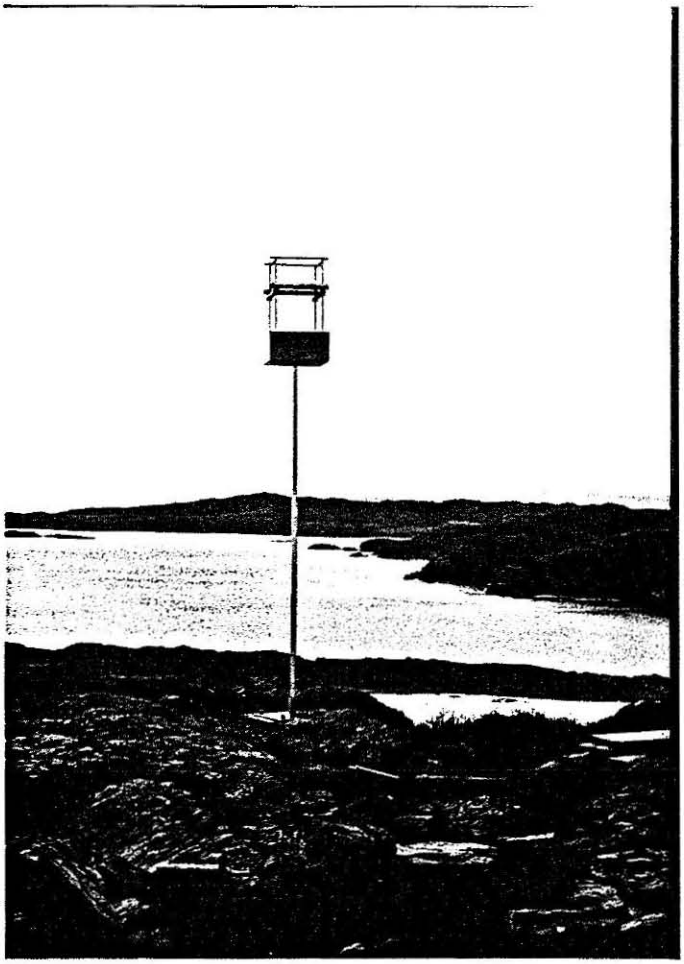


PHOTO I - Passive Ice Meter

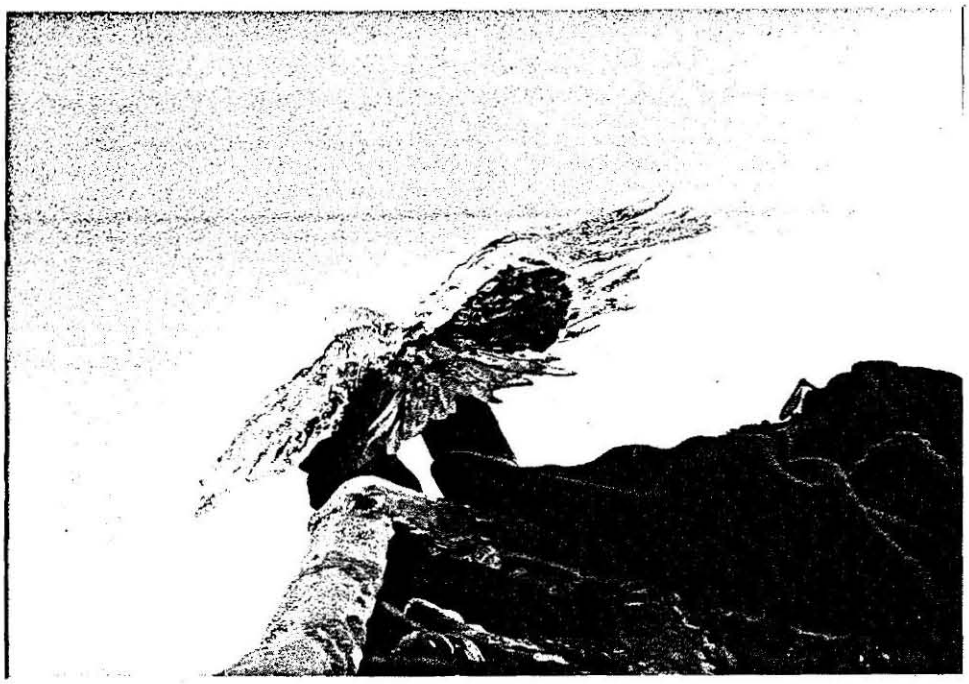


PHOTO II - Anemometer

PHOTO III - 2.5" Glaze on Guy Wire

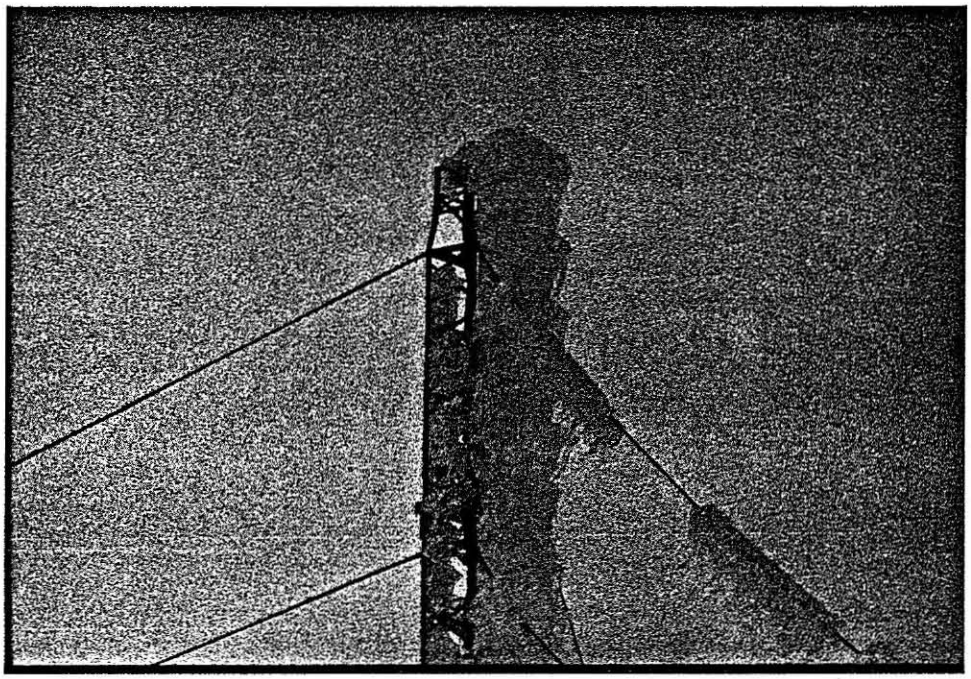


PHOTO I.V - Icing at Site 5

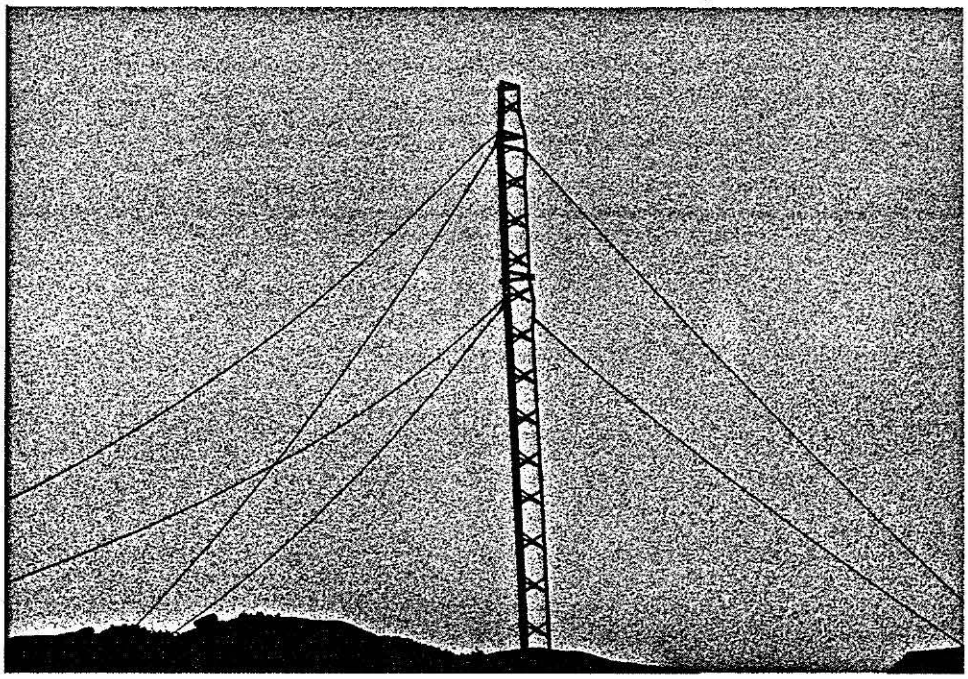


PHOTO V - Tower Damage Due to Ice

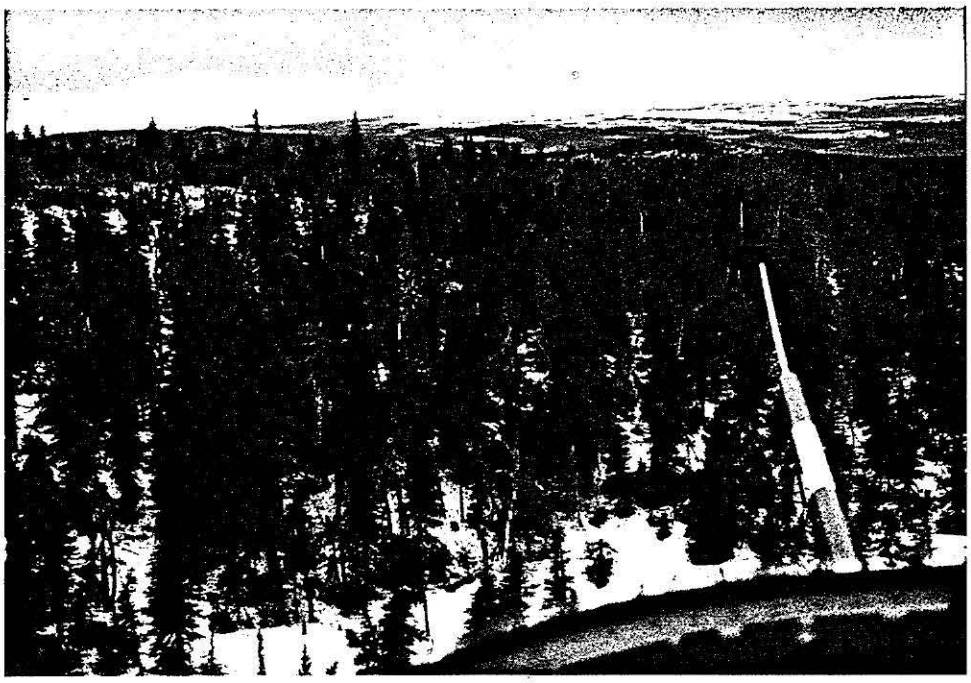
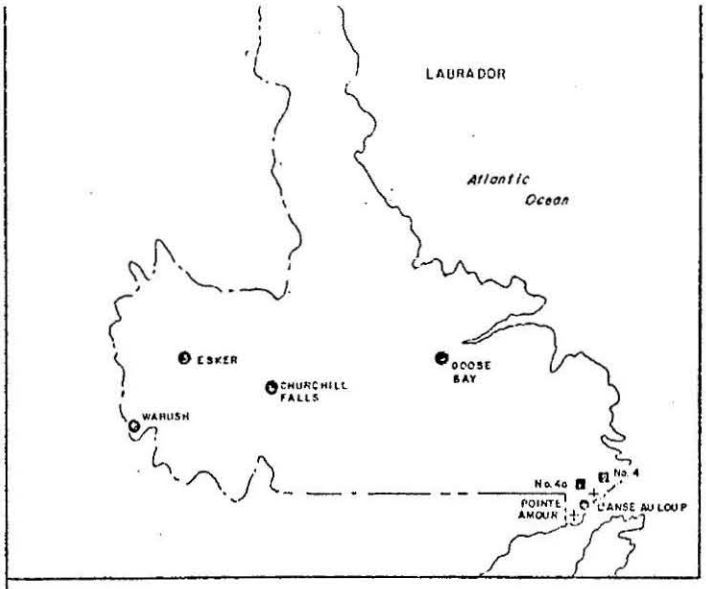


PHOTO VI - Forest Damage Due to Ice and Wind

FIGURES



LEGEND

- TEST TOWER SITES
- PASSIVE ICE METER SITE
- ROSEMOUNT-ANEMOMETER SITE
- CLIMAT UNIT LOCATION
- SALT CONTAMINATION TEST SITE