NP - General Rate Application - 2008
Information - # 17
Filed: Oct. 26, 2007 Board Secretary: CB

Reference Only

Report to the Board of Commissioners of Public Utilities on the Technical Performance of Newfoundland Light & Power Co. Limited

George Baker, July 1991

JUL 22 1991

Hiltz and Seamone COMPANY LIMITED

CONSULTING ENGINEERS AND SUPERVISORS

Telephone (902) 678-2774
FAX (902) 678-6990

536 Main Street
Kentville, Nova Scotia
B4N 1L3

July 16, 1991

COMMISSIONERS ON PUBLIC UTILITIES
JUL 22 1991
ST. JOHN'S NEWFOUNDLAND

Mr. R. E. Good
Chairperson
Board of Commissioners of Public Utilities
P. O. Box 9188
St. John's, Newfoundland
A1A 2X9

Dear Mr. Good:

With this letter, I submit for the consideration of the Board my report on the technical performance of Newfoundland Light & Power Co. Limited.

I acknowledge with pleasure and appreciation the splendid co-operation provided by the Company in my investigations and am equally pleased to be able to report that all its operations falling within my terms of reference are characterized by high standards of service and exceptional cost efficiency.

Six copies of the report are enclosed. If the document is acceptable to the Board and you wish more copies, I shall be glad to provide them.

Should it be necessary or desirable from the Board's point of view that I testify on the subject matter of my report, I shall of course be available to do so, but would appreciate as much advance notice as possible in order to avoid the possibility of conflict with other commitments.

Yours respectfully,

George Baker

G. C. Baker, P. Eng.

GCB/db

Encl.

REPORT ON THE TECHNICAL PERFORMANCE

OF NEWFOUNDLAND LIGHT & POWER

CO. LIMITED

Prepared for the

Board of Commissioners of Public Utilities

Newfoundland and Labrador

By

G. C. Baker, P. Eng.

July 1991

TABLE OF CONTENTS

Section		Page
1.	Foreword	1
2.	System Planning and the NP/NLH Interface	2
3.	Hydro Generation	3
4.	Other Generation	4
5.	Transmission	5
6.	Distribution	6
7.	Discussion	10
8.	Conclusions and Recommendations	11

REPORT ON THE TECHNICAL PERFORMANCE

OF NEWFOUNDLAND LIGHT & POWER

By G. C. Baker

1. Foreword

The work covered by this report, comprising a review of technical performance, was undertaken by G. C. Baker (the Consultant) pursuant to instructions received from the Public Utilities Commission of the Province of Newfoundland, hereinafter sometimes referred to as the Commission.

The technology employed by electric utilities is relatively standardized and differences from utility to utility usually occur in response to differences in service area, energy resources available or similar circumstances beyond the control of utility management. For this reason, the present review has focussed on operating methods and on the economic efficiency of technical operations, rather than on the nature of the technology employed.

The basic approach has been to measure economic efficiency by comparisons with other utilities deemed to be operating under similar circumstances.

The reader should be aware of the fact that utility performance is influenced by many factors unique to each utility and that it is almost impossible to remove completely the data distortions which occur due to variations in accounting treatment and nomenclature. Results of the comparisons made in this report should therefore be regarded as general indications rather than precise measurements of performance.

Technical operations have been taken broadly to mean generation, transmission and distribution, and to exclude administration as such. However, administrative costs allocated to these functions have been included in some cases in order to facilitate comparisons.

In addition, the review has included dispatching, system planning and the interface between Newfoundland Light & Power (NP) and Newfoundland and Labrador Hydro (NLH).

The Consultant wishes to acknowledge the complete co-operation of NP in this review. A great deal of information was provided, both in response to written questions and during a meeting held at St. John's June 12, 1991 with executives responsible for corporate policies and technical operations.

No attempt has been made to include in this report all the detailed information provided to the Consultant. Significant points have been summarized.

2. System Planning and the NP/NLH Interface

Planning criteria regarding reliability, voltage stability and loading used by NP are typical of those used by most utilities and decisions are properly based on the principles of economic choice.

In addition to changes required for load growth and enhanced reliability, NP planning reviews possibilities for additional small hydro plants and upgrading of present plants. Thermal generation options investigated include co-generation and garbage burning.

However, the evaluation of options often depends on long-run costs and in this respect accurate planning decisions by NP must rely on projections for the NLH system.

At present NLH is uncertain as to the nature of its future generation expansion, for reasons to be covered in a subsequent report by the Consultant on that utility. In the absence of specific information from NLH, NP is using its own estimates of NLH generation expansion and long-run marginal cost.

In the Consultant's opinion, both utilities should use a common set of assumptions, even if the only assumptions possible at present are of the type: A with probability X% and B with probability (100 - X)%.

In fact, the utilities have a joint planning committee which meets about four times per year and some joint studies are in progress.

NP is investigating DSM as a planning option, but has not yet determined the economic potential of DSM in its service territory. In selecting DSM options, NP would apply the criterion of no disbenefit to non-participating customers (sometimes referred to as the no losers criterion or fourth California criterion).

The Consultant observes that NP is somewhat behind most other Canadian utilities in its consideration of DSM; that the economic potential of DSM depends to a high degree on future costs of both capacity and energy, and that given the present situation in Newfoundland with respect to generation expansion plans, it would be difficult or impossible to make intelligent decisions on many types of DSM programs.

The energy-only rate under which NP purchases from NLH has some implications for both planning and operations. From a planning perspective, the portion of total purchase cost due to demand can be determined from NLH cost allocation studies. This at least provides a figure for the embedded cost of demand. However, from an operations point of view, peak shaving does not achieve any cost reductions in the short term, whereas energy savings are immediately rewarded.

The Consultant understands that the Commission has directed NLH to report on the implications of its rate form, and has therefore not pursued the matter further in his investigations.

3. Hydro Generation

NP owns and operates 22 hydraulic generating stations with a total capacity of 87.1 MW. Nearly all of these stations have sufficient storage to supply firm capacity to the system and the storages are operated to ensure that such capacity is available at peak hours as agreed with Newfoundland & Labrador Hydro. Two of the stations have three units and five others have two units, making 31 units in all. Unit sizes range from .35 to 11.9 MW. Energy output is 417.8 GWh per year under average hydrologic conditions.

The capacity and output of these stations are small compared to NP's 1990 system peak of 1,073.6 MW and estimated energy requirement of 4,464 GWh. The hydro system output is nevertheless of economic importance to NP, costing about 1.28¢/KWh (1988), including all operating, maintenance and depreciation costs, but excluding return on investment.

NP's 1988 cost of service study shows the cost of hydro operation and maintenance at $2.217 millions. An indication of the economic efficiency implied by such costs is obtained by comparing the cost of operating Nova Scotia Power Corporation's (NSPC's) hydro system, excluding the 200 MW Wreck Cove generating station.

With this exclusion, the two systems are quite similar in character. The NSPC system comprises 51 units, all within the size range of NP units. Nearly all the NSPC stations and all the NP stations operate unattended under remote control. Maintenance functions are centralized in both cases. The profile of unit ages is similar, with in-service dates spanning most of this century except during the period when oil at $1 per barrel discouraged investment in any other form of generation.

There are also some differences. The NP system has a slightly higher proportion of plants with storage, and a somewhat greater geographic dispersion, both of which would imply slightly higher inherent cost.

Analysis of NSPC operating and maintenance costs for 1989/90 indicates that they can be quite well represented by:

	$ 35,000	per unit year.
plus	$ 5,000	per MW (normal O & M).
plus	$ 11,700	per MW (major maintenance)
plus	$136,000	per station year (manned operation).

Applying this data to the NP hydro system would indicate costs as follows:

		$(000's)
31 units x $35,000	=	1,085
87.1 MW x $16,700	=	1,454.6
Total	=	2,539.6
Correction for inflation:		
2539.6 x .041 x 1.25	=	(130.2)
Corrected total	=	2,409.4
NP's 1988 cost	=	2,217

Year-to-year costs of maintaining a hydro system can be expected to fluctuate due to varying requirements for major maintenance. Thus a single-year comparison is of limited probative value. Also, differences in accounting practices may affect the reported direct costs. The Consultant is of the opinion that the above NSPC data reflects more supervisory costs than the NP data.

NP's operating strategy is to maximize energy production, subject to maintenance of firm capacity at the designated peak periods. Units are therefore normally run at their points of maximum efficiency.

Routine maintenance includes visual inspection at intervals of about two weeks. A preventive maintenance program is being developed. Permanent maintenance staff is kept to a minimum and augmented for heavy maintenance tasks, usually performed during the summer.

Based on the foregoing information, the Consultant is of the opinion that NP operates its hydro system in a technically adequate and cost-efficient manner.

4. Other Generation

In addition to its hydro plants, NP's generation facilities include a 30 MW steam plant at St. John's, gas turbines at Greenhill, Salt Pond and Grand Bay, diesels at St. John's, Salt Pond, Gander, Port Union and Port aux Basques, and a wind turbine in the St. John's region. The gas turbine capacity is 47 MW and the diesel capacity is 14.5 MW.

None of this capacity can produce energy at costs competitive with NLH supply, but it is nevertheless used and useful as a component of the total Island system reserve capacity.

The steam plant consists of a 10 MW unit with steam conditions 400 psi and 735^{0} F and a 20 MW unit with steam conditions 900 psi and 900^{0} F. The units were originally fired with Bunker C oil but No. 2 oil is now used in order to avoid environmental problems.

The high heat rates of these units (about 12,000 Btu per KWh for the larger unit), and the consequently high fuel cost, limits them to a reserve role. Units are operated when requested by NLH. Because the Island load peaks in winter, the plants are not likely to be required at other seasons. NP therefore economizes on manpower by using operating staff for hydro maintenance during the warmer months.

The gas turbines are used when called up by NLH and when that happens, NLH pays the cost of fuel used. During the most recent peak (January 8, 1991), NP's gas turbines supplied 25.8 MW. One of the gas turbines is a mobile 7.5 MW unit which can be deployed in emergencies.

Diesels are located mainly in areas which were at one time isolated. These are now limited to reserve or emergency use. NLH credits NP for its full hydro capacity, and deems the NP diesels to be a backup for such capacity. If NP were not able to provide the full 87.1 MW of hydro capacity when required by NLH, it would be expected to make up any shortfall by putting diesels on line. Two 750 KW diesels are mobile and intended for emergency use. One 2.5 MW unit is for start-up of the steam plant.

NP's only wind turbine is a 0.4 MW machine located on Bell Island. It was an experiment, intended to determine whether this technology would be of practical use under Newfoundland climatic conditions. The venture was subsidized by a grant from Energy, Mines & Resources Canada to the extent required to reduce the prospective cost of wind energy to a competitive level.

NP states that the experiment was not a success due to mechanical design shortcomings of the unit supplied. The Consultant notes that the wind climate at the site is good enough to make wind power potentially interesting; that a history of mechanical trouble has been experienced by other Canadian utilities who experimented with wind contemporaneously with NP; that equipment reliability has been improving in recent years, but that wind energy is not likely to be competitive except where the alternative is thermal generation and environmental impact mitigation costs are high.

The Consultant is of the opinion that NP's other generation is being put to the best use possible under the circumstances.

5. Transmission

NLH supplies what may be described as backbone transmission for the Island and delivers power and energy to NP at transmission voltage at 26 locations. Nevertheless, due to the size of its service areas, NP requires a substantial transmission system, both for delivering power to its distribution systems and for reliability of service.

Total length of transmission lines is 2,092 km, of which 643 km is operated at 138 KV and most of the remainder at 66 KV.

Transmission loss is 1.96% of input on peak and 1.04% of annual energy supplied, based on an analysis of 1989 losses. Energy used by the utility is included with energy sold.

These loss ratios are very low compared to most transmission systems. Without doubt, a contributing circumstance is that delivery by NLH is made at a large number of points so that both the amount of power transmitted and the transmission distances are relatively short for most NP lines. However, all the power and energy handled by the transmission system must be transformed at least once. A single transformation would impose about 1% loss on peak and 0.5% on average use, depending on power factor, load factor and the ratio of peak load to transformer capacity. It is therefore evident that loss in transmission lines is very small.

Transmission problems experienced by NP include damage due to icing (approximately $3 millions in 1984 and $0.4 millions in 1990) and insulators which have become prone to failure after a number of years in service. NP uses closer-than-normal pole spacing in critical areas to minimize damage from the severe icing conditions which tend to be characteristic of Newfoundland's winter climate. All insulators of the type prone to failure (COB 36000) are being replaced in a 5-year program.

Transmission line inspections are scheduled at a frequency which depends on age of the line, with a twice-per-year minimum. Of these, one is a foot-patrol and the other is a climbing inspection.

Transmission operating and maintenance staffing level is 10 man-years per year, or about one person per 240 km of line.

The Consultant considers that NP's transmission system is energetically efficient, and that it is operated and maintained in a cost-effective manner.

6. Distribution

NP operates about 7,230 km of distribution lines serving more than 192,000 customers. Primary distribution voltages are 4.16, 12.5 and 25 KV and standard secondary voltages are 120/240 V single phase, 120/208 V and 347/600 V three phase. The total capacity of distribution transformers in service is about 1,531 MVA.

An indicator of the functional efficiency of a distribution system is the level of line losses it incurs. For 1989, distribution loss was 4.46% of energy supplied and 8.55% on peak. Distribution losses for NP, NSPC and New Brunswick Power (NBP) are compared in the following table, in which figures are percent of energy delivered and utility use is included as loss:

DISTRIBUTION LOSS

		NP	NSPC	NBP
Annual line loss	%	4.92	10.20	6.45
Peak loss	%	9.79	18.00	14.24

The loss factors of the three utilities compared above are affected by special circumstances. Both NP and NSPC serve urban areas (Halifax and St. John's) which contain 35 to 50% of all customers served, while the largest urban area in NB (Saint John) is served by a distributing utility. Ribbon development and farming areas, both relatively difficult to serve efficiently, comprise a considerable part of the NSPC system, whereas in the Consultant's opinion NP non-urban customers tend to be grouped in small communities; which may in many cases be remote, but are nevertheless concentrated. After making due allowance for such differences, the NP distribution system appears to the Consultant to attain an unusual level of energetic efficiency.

The Consultant notes that NP limits its capital investment in distribution transformers and minimizes core losses by loading transformers at 110% of rated capacity on installation and leaving them in service up to a limit of 200% of rating for cold pickup of waiting loads. Also, for reasons of operational efficiency NP standardizes on just three sizes of wiring in its distribution system. This probably results in higher than normal conductor ampacities and lower line losses, both average and peak.

Reliability of service is to a large extent, but not totally, a function of distribution system quality. In the following table, standard reliability indices for NP are compared to those for all utilities reporting data to the Canadian Electrical Association.

	Year	SAIFI	SAIDI	CAIDI
NP	1987	4.05	6.32	1.56
	1988	5.78	9.59	1.66
	1989	3.80	5.20	1.37
NP	Average	4.54	7.04	1.53
CEA	1987	3.45	5.15	1.49
	1988	4.35	6.42	1.48
	1989	3.61	4.32	1.20
CEA	Average	3.80	5.30	1.39

SAIFI - System Average Interruption Frequency Index. (Total customer interruptions divided by total number of customers served.)

SAIDI - System Average Interruption Duration Index. (Total customer-hours of interruptions divided by total number of customers served.)

CAIDI - Customer Average Interruption Duration Index. (Total customer-hours of interruptions divided by total number of interruptions.)

The comparison shows that NP's system reliability is somewhat lower than the average for Canadian utilities. The causes are indicated in the following table:

CUSTOMER INTERRUPTIONS, PERCENT OF TOTAL

	NUMBER		HOURS	
CAUSE	NLP	ALL CEA	NLP	ALL CEA
Unknown/other	6.9	7.9	5.3	7.2
Scheduled outage	7.7	25.3	8.3	17.9
Loss of supply	48.3	22.7	51.3	16.1
Tree contact	1.8	6.5	2.2	12.2
Lightning	0.5	6.3	0.7	9.8
Defective equipment	22.9	18.4	20.2	20.0
Adverse weather	6.8	4.0	8.2	8.2
Adverse environment	1.2	1.0	1.2	1.0
Human element	2.3	2.3	1.2	1.8
Foreign interference	1.6	5.6	1.4	5.8
	100.0	100.0	100.0	100.0

It is evident that loss of supply is the dominant cause of interruptions and interruption duration in the NP system, accounting for about half of the total in each case. This contrasts with the CEA averages in which loss of supply accounts for 22.7% of interruptions and 16.1% of interruption time. There are other differences but with the exception of scheduled outages, they are not significant.

Loss of supply is in general beyond the control of NP*. If outages from this cause were reduced to CEA average levels, the NP interruption indices would compare very favourably, as shown in the following table:

ADJUSTED 3-YEAR AVERAGE INDICES

	SAIFI	SAIDI	CAIDI
NLP (adjusted)	3.38	4.56	.99
CEA	3.80	5.30	1.39

---

*Reliability of supply is to a very large extent the responsibility of Newfoundland and Labrador Hydro (NLH). The fact that the Island supply is somewhat less reliable than that of CEA utilities in general is not, however, a reflection on the performance of that utility. The reasons will be dealt with in a subsequent report by the Consultant, but relate principally to the isolation of the Island electrical system as a whole.

In summary, the data shows that the reliability of the NP system itself is significantly above the CEA average. This may well be a consequence of NP's practice of overbuilding (using closer pole spacing and higher safety factors) in areas most likely to be affected by severe icing. Also, the result may reflect the fact that management incentives are targeted in part on reliability enhancement.

As a measure of economic efficiency, distribution costs were examined in relation to class non-coincident loads on the distribution system and the number of distribution customers served.

Cost of service data was used for inter-utility comparisons. The available data had some obvious imperfections. NP's last cost of service study was for 1988 (actual). NB Power's only available study was for 1988/89 (actual) and NSPC's 1990/91 prospective study was used. In addition, differences in accounting treatment were evident, both in the definition of direct vs. overhead costs and in the definition of O&M vs. customer costs.

No indexing was attempted to remove differences in study vintage because inflationary increases are at least partly offset by growth in loads and customer numbers. To minimize accounting differences, comparisons were limited to overall distribution costs. The results are as follows:

COMPARISON OF DISTRIBUTION COSTS

	NP	NSPC	NBP
Total cost including distribution O & M, service, depreciation & overheads, but excluding return ($000's):	42,087	75,104	73,594
Cost in $/customer-year	231.45	193.17	283.06
Cost in $/primary NC KW	38.53	48.32	46.20

The figures show NP's costs to be lowest on a per-KW base and second-lowest on a per-customer base. NP classifies a larger proportion of distribution cost as customer service than NSPC and has significantly lower distribution O & M costs. This may be due at least in part to differences in accounting treatment and nomenclature.

NP's distribution O & M staffing is about one employee per 1,500 customers; a very modest level.

NP has a number of corporate objectives, including provision of "reliable electric service at least reasonable cost." The progress to be made toward attainment of these objectives is defined by specific goals for each year. A 1991 goal is to expand what NP calls the "organizational effectiveness process" to all departments and regions.

This process is perhaps best described as operations research. The consultant saw several results of operations research during a visit to the utility, including, for example, facilities and procedures to avoid bottlenecks and lost time in issuing distribution materials to line crews. Other improvements made as a result of operations research were described.

Based on all the information obtained, the Consultant believes that the NP distribution system is efficiently operated and that corporate policy toward increasing efficiency is aggressive and effective.

7. Discussion

NP cost data used in this review was taken mainly from the Utility's 1988 (actual) cost of service study. This choice was made because (1) the Consultant has found that cost of service data is the result of a disciplined and generally standardized process and is less likely to be misinterpreted than data taken directly from accounting records, and (2) because the 1988 study was the latest actual NP study available.

The use of 1988 data raises the question whether the Consultant's conclusions are still valid or whether more recent costs would paint a different picture. To examine this question, data from NP's 1990 annual report has been used to trace cost trends on a broad-brush basis over the last five years of record. The results, stated in dollars per MWh of sales, are as follows:

TREND OF NP EXPENSE

($/MWh of sales)

	1986	1987	1988	1989	1990
Operating expenses	52.09	53.34	52.27	51.51	51.83
Finance charges	4.54	4.61	4.78	4.42	4.81
Depreciation	4.85	4.95	5.10	5.25	5.68
Taxes	4.27	3.18	3.48	2.62	3.47
Earnings & Other	5.98	5.34	5.86	5.53	6.42
Total	71.73	71.42	71.49	69.33	72.21

It is evident from the figures that after allowing for system growth, NP's costs in current dollars were to all intents and purposes constant over the five-year period. Most utilities of which the Consultant has knowledge have been able to keep their cost increases at or a little below the rate of inflation. Therefore, comparisons on a 1990 basis would have shown NP in a little better light than the actual comparisons.

The fact that NP has been able to offset completely the effects of inflation supports the Consultant's conclusions as to the efficiency of NP's technical operations.

8. Conclusions and Recommendations

As a result of this review, it is the Consultant's opinion that NP technical operations are conducted in a technically adequate and cost-effective manner. This opinion is based on the analysis of comparative data; on a review of operating methods and problems; on NP's corporate goals and objectives; on the incentive programs adopted by the utility and on the attitude of management to many details of utility operations discussed during the review. No contrary indications came to the Consultant's notice.

In certain respects the electrical system in the Island is one and indivisible. This is true in most areas of system planning and with regard to economic dispatch of Island generation. Planning decisions mediate future costs and economic dispatch is important in the minimization of current costs. Consequently, the review included an examination of the interface between the two utilities.

A considerable degree of co-operation exists between the utilities in system planning. The co-operation is in the Consultant's opinion similar to or perhaps more extensive than that between Maritime utilities under the aegis of the Council of Maritime Premiers. However, it may not be complete in all respects. The Consultant recommends that the Commission should require each utility to file, at the time of its next rate application, a report containing (1) the Utility's appraisal of the effectiveness of present joint planning procedures, and (2) suggestions or recommendations for improving the effectiveness of joint planning.

The Consultant considers that economic dispatch is to all intents and purposes controlled by NLH and that no inefficiencies are introduced by the existence of the utility interface.

The Consultant notes that the Commission contemplates a review of the NLH energy-only rate, and submits his opinion that the rate form is of potential importance in that it may force certain short-term responses by NP. The rate form should be such that the responses tend to optimize the social benefit.