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AN ASSESSMENT OF HYDRO-QUÉBEC'S SECURITY OF SUPPLY IN ACCORDANCE WITH THEIR ENERGY RELIABILITY CRITERIA

A Special Report
Prepared for
Régie de l'Énergie
Montréal, Québec

by
Gene Biggerstaff
Nicholas A. Dodge
Richard L. Mittelstadt

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EXECUTIVE SUMMARY

Régie de l'énergie (La Régie) has solicited the services of three consultants from the United States to analyze the data provided to La Régie on a confidential basis by Hydro-Québec in order to ascertain whether the actual low levels of runoff affect the safety of supply of Québec consumers and whether the situation needs to be mitigated by resorting to exceptional measures.

Specifically, the consultants were tasked to accomplish the following:

a. Ascertain that Hydro-Québec can insure adequate energy capability to meet both domestic and firm export sales in excessively low runoff scenarios in accordance with energy reliability criteria established in 1991.

b. Analyze the adequacy of supply considering a worst case scenario of low runoff over a two-year period and shorter or longer periods.

c. Recommend a reporting program for La Régie to be put in place to insure that appropriate measures will be undertaken to meet energy demand adequately and comply with the energy reliability criteria in the future.

In the 1980's Hydro-Québec used an energy reliability standard based on the four consecutive driest years of record. Among the shortcomings of the approach was that it did not account for the random nature of water inflows or the possible variations in demand. It also did not establish the risk of load shedding or the costs and benefits of various energy reserve levels.

In 1991 a new method of assessing energy reliability was introduced. This method simulates on a stochastic basis the anticipated operation of the Hydro-Québec system over the full range of expected supply and demand conditions. Such a method enables Hydro-Québec to establish the risk of load shedding, and thus determine a desirable energy reserve level in view of these load shedding probabilities and the costs associated with various reserve levels

Specifically, Hydro-Québec is required to maintain sufficient energy reserves to insure that the system loss-of-load expectancy will not exceed 0.35 TWh/year and that firm loads will be met in 98 percent of all expected combinations of streamflows and energy demands. Meeting this criteria would require that, in some flow conditions, the system's hydro and nuclear generation would have to be supplemented by "exceptional measures," which might include terminating non-firm sales, running higher-cost thermal generation, and purchasing energy from neighboring utilities.

Hydro-Québec's methodology develops estimates of the adverse flow sequences that will be exceeded 98 percent of the time. These adverse or "worst-case" flow sequences, which have a probability of occurrence of only two percent, are developed for periods ranging from one to seven years.

The consultants performed a monthly study using data provided by Hydro-Québec to determine the storage remaining in the reservoir system at key points during the period 1 November 1998 through 1 May 2002. The purpose was to determine if firm loads could be met under the 98 percent exceedence (or "worst-case") inflows, given the actual reservoir content on 1 November 1998 and the fact that the system could not be drafted below the 10 TWh minimum allowable level on 1 May in any year. Both two- and three-year adverse streamflow sequences were examined.

The resulting reservoir conditions are summarized in the following table. For purposes of comparison, operation under average and correlated inflow conditions were also examined. Correlated streamflows represent the most likely sequence that would occur given the inflow experience of the past several years. Corresponding estimates provided by Hydro-Québec are also presented for two of the scenarios.

	2-Year Worst Case Inflows, TWh		3-Year Worst Case	Aver-Age Inflows	Correlated Inflows TWh	
	Calcu-Lated	Hydro-Québec	Calcu-Lated	Calcu-Lated	Calcu-lated	Hydro-Québec
1 Nov 1998 Levels	78	78	78	78	78	78
1 May 1999 Levels	[redacted]					
1 Nov 1999 Levels						
1 May 2000 Levels						
1 Nov 2000 Levels						
1 May 2001 Levels						
1 Nov 2001 Levels						
1 May 2002 Levels						

Both the consultants' and Hydro-Québec's analyses of the two-year worst case scenario confirmed that the system could meet these criteria providing Hydro-Québec supplement their hydro and nuclear generation with exceptional measures. This includes implementing some of these measures starting in November of the current operating year. If the current series of low runoff years continues, as much as [redacted] of exceptional measures may be required in succeeding years.

These measures, in combination with the available generation from the hydro system and the Gentilly nuclear plant, will make it possible to keep the reservoir system at or above its 10 TWh minimum level through 2002, even if low inflows continue to occur. [redacted]

[redacted]

[redacted]

With three consecutive years of average water conditions, the reservoirs were able to regai[redacted] of reserves between 1 May 1999 and 1 May 2002. This was while carrying out some non-firm sales in all three years. Even so, the reservoirs would only reach th[redacted] level on 1 November 2001, well below the desirable 70 percent full mark.

The following table demonstrates that, in two of the next three years, the available supply under average water conditions will be at least 5 TWh over the forecasted firm load requirements, thus indicating that Hydro-Québec has effectively built its system with 5 TWh of excess energy. This margin will insure that the 0.35 TWh/year loss-of-load exceedence criteria will be met.

Year	Supply Avge Wtr TWh	Total Load TWh	Non-Firm Load TWh	Firm Load TWh	Margin Over Load TWh
1999	189.0	188.9	[redacted]	[redacted]	[redacted]
2000	189.6	189.1	[redacted]	[redacted]	[redacted]
2001	190.2	189.8	[redacted]	[redacted]	[redacted]

While the consultants agree that Hydro-Québec is capable of providing an adequate supply to meet firm energy loads within its established reliability criteria through the spring of 2002, they offer several comments and suggestions.

- The method used by Hydro-Québec to develop its energy reliability criteria is analogous to methods widely used throughout the electric utility industry to determine capacity reliability. The consultants commend Hydro-Québec on the implementation of this model, but strongly urge that a demand variation component be included with the supply variations shown above to avoid over-estimating system reliability. Since these criteria are based on the relationship between supply, demand and costs, La Régie should recommend that Hydro-Québec continually update those factors.

- Based on available hydrologic records, the 98 percent criterion for supply variations is considered reasonable and appropriate.

- It should be noted, however, that the supply variations developed using the reliability model are based on 1943-1997 streamflow records. The decisions Hydro-Québec makes in planning its current operations, as well as additions to its supply base, are highly dependent on the characteristics of this limited hydrologic record, which is undoubtedly embedded in its reservoir operation models as well. Because of the sensitivity of these models to the streamflow characteristics, La Régie should recommend that Hydro-Québec retain a

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consultant to determine if extension of their hydrologic database is warranted. This consultant should be expert in drought hydrology and capable of evaluating the consequences of the apparent trend toward more extremes in meteorological activity.

- The characteristics of the Hydro-Québec reservoir system dictate that multi-year sequences of low flows should be considered in their planning, and as noted above, Hydro-Québec does develop these numbers with their probabilistic model. For purposes of planning they should continue to look at the consequences of low-flow periods of at least four years. However, given that for the next few years, supply at average runoff will exceed firm sales requirements, a two-year low flow period is satisfactory for analyzing whether they can meet firm loads between now and 2002.

- The consultants deem it essential that a monthly monitoring and follow up program be established immediately to give sufficient assurance to La Régie that the reservoir system is being operated in accordance with the reliability criteria and that the exceptional measures considered essential to meet these criteria are being implemented as needed. Some specific suggestions on accomplishing this are outlined in Chapter 5.

- To insure that the general public is well informed of the issues relating to water reserves management and to the adequacy of such reserves in meeting energy requirements, Hydro-Québec should prepare and distribute a public information brochure explaining the principles of operation of their power system, and in particular the hydropower system.

Some observations on the impact of non-firm sales energy reserves are also warranted. As shown in the preceding table, non-firm sales are forecasted to total [redacted] during the 1999-2001 period under average water conditions. After reaching a level of 15.1 TWh in 1995, non-firm sales were reduced as a consequence of continued below average streamflow. During 1995-1997 Hydro-Québec experienced a cumulative supply shortfall[2] of 53.5 TWh due to low water inflows, while total sales outside Québec during that period totaled about 58 TWh, including non-firm surplus sales of about 30 TWh. These figures are tabulated below, along with the revenues associated with the outside sales:

Year	Hydro Shortfall TWh	External Sales, TWh			External Sales - Million $		
		Firm	Surplus	Total	Firm	Surplus	Total
1995	28.5	8.9	15.1	23.9	283	354	637
1996	14.5	9.5	9.4	18.9	337	251	588
1997	10.5	9.4	5.9	15.2	400	196	596
Total	53.5	27.8	30.2	58.0	1,020	801	1,821

On 1 November 1997, the hydro reservoirs were 52 percent full, with about 90 TWh in storage. Assuming that no surplus sales had been made during the 1995-1997 period, the reservoir levels

[2] Compared to average water conditions.

[redacted]

on 1 November 1997 would have been at 120 TWh, or about 70 percent full. However, without the surplus sales Hydro-Québec's revenues would have decreased by $0.8 billion during the period.

In summary, our main conclusions and recommendations are as follows:

1. Hydro-Québec has effectively built its system such that the available supply under average water conditions will be at least 5 TWh over the forecasted firm load requirements, and that the loss-of-load expectancy does not exceed 0,35 TWh/year.

2. Hydro-Québec is capable of providing an adequate supply to meet firm energy loads within its established reliability criteria through the spring of 2002. However, this will require that they supplement their normal hydro and thermal generation with exceptional measures, which could include terminating non-firm sales, running higher-cost thermal generation, and purchasing energy from neighboring utilities.

3. As to verifying compliance to the energy reliability criteria, the consultants strongly urge that a demand variation component be included with the supply variations shown above to avoid over-estimating system reliability. In addition, since these criteria are based on the relationship between supply, demand and costs, La Régie should recommend that Hydro-Québec continually update those factors.

4. The consultants recommend that La Régie ensures that Hydro-Québec retain a consultant familiar with drought hydrology and the potential impact of the recent trend toward more extremes in meteorological activity to determine if extension of Hydro-Québec's hydrologic data base is warranted.

5. The consultants deem it essential that a monthly monitoring and follow up program be established immediately to give sufficient assurance to La Régie that the reservoir system is being operated in accordance with the reliability criteria and that extraordinary measures considered essential to meet this criteria are being implemented as needed.

6. Finally, the consultants recommend that La Régie ensures that Hydro-Québec issue a public information brochure, explaining the principles of operation of their power system, and in particular the hydropower system.

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CHAPTER 1: INTRODUCTION

1.1 Scope of work.

Régie de l'énergie (La Régie) has solicited the services of three consultants from the United States to analyze the data provided to La Régie on a confidential basis by Hydro-Québec in order to ascertain whether the actual low levels of runoff affect the safety of supply of Québec consumers, and whether the situation needs to be mitigated by resorting to exceptional measures.

Based on the above concerns, La Régie entered into an agreement on December 3, 1998 with the consultants who were to accomplish the following:

a. Ascertain that Hydro-Québec can insure adequate energy capability to meet both domestic and firm export sales in excessively low runoff scenarios in accordance with energy reliability criteria established in 1991.

b. Analyze the adequacy of supply considering a worst case scenario of low runoff over a two-year period and shorter or longer periods.

c. Recommend a reporting program for La Régie to be put in place to insure that appropriate measures will be undertaken to meet energy demand adequately and comply with the energy reliability criteria in the future.

The analysis in these tasks will be limited to energy considerations only and will not address the issue of capacity adequacy.

1.2 The Hydro-Québec Hydroelectric System.

The Hydro-Québec hydroelectric system is the second largest in North America, almost matching the Columbia River hydro system. For comparison the installed hydro peaking capability and expected annual energy from hydro for the two systems are as follows:

	Columbia[3]	Hydro-Québec
Hydro peak capability	39,164 MW	36,000 MW
Hydro energy capability	189.4 TWh	180 TWh

Ninety seven percent of Hydro-Québec's energy is provided by hydro, with the remainder coming primarily from the Gentilly 2 nuclear plant. In the Columbia River System, which includes some Canadian resources, the hydro energy capability is much less, meeting only 50-60 percent of system firm requirements. The character of both systems is that electrical loads are at

[3] Based on median water conditions. Includes B.C. Hydro and West Kootenay Power & Light resources on the Columbia and Kootenay Rivers. Source: *Northwest Power Pool Operating Program for 1996-97*, page B-3.

a maximum in winter months when natural flows are lowest. Therefore storage must be released during the winter to meet loads. During the summer freshet, excess water not needed to meet load is stored for the following drawdown season.

Storage energy reserves are as follows:

	Columbia	Hydro-Québec
Annual reservoirs	--	60 TWh
Cyclic reservoirs	--	111 TWh
Total	518 TWh	171 TWh

Existing interconnections link Hydro-Québec to power grids in Ontario, New Brunswick, and the U.S., making it possible to sell electricity to neighboring systems and to import electricity as well. Hydro-Québec's export capability of 7,543 MW is greater than its import capability of 4,195 MW.[4]

Of the total storage energy reserves of 171 TWh, 147.7 TWh resides in three subsystems: Manicougan, La Grande, and Churchill Falls. A unique characteristic of the Hydro-Québec system is the long transmission distances between the generation sites and the load center. From the La Grande complex, power is delivered to the load center 1,000 km to the south by five 735 kV AC lines and one 450 kV DC line. The DC line extends to the Boston area. Length of the Churchill Falls transmission lines is about 1,300 km. A map of the Hydro-Québec system is shown in Appendix A.

1.3 Organization of This Report

This report is divided into 5 chapters plus Appendices A through D.

Chapter 1 is the Introduction; it discusses the scope of the study and provides a very brief description of the Hydro-Quebec system.

Chapter 2 describes Hydro-Québec's energy reliability criteria and the data provided by Hydro-Quebec to evaluate the adequacy of energy supply during the next several years.

Chapter 3 summarizes the energy supply studies for the1999-2002 period that were performed by the consultants.

Chapter 4 is an in-depth review of Hydro-Quebec's energy reliability criteria. The factors which were considered by Hydro-Quebec in developing its current criteria were critiqued.

Chapter 5 is the consultants response to item c of the scope of this study, and outlines a reporting program for La Régie to be put in place to insure that appropriate measures will be undertaken to

[4] Source: Hydro-Québec data provided to the consultants by La Régie on 16 December 1998.

[redacted]

meet energy demand and comply with the energy reliability criteria.

Appendix A is a map of the Hydro-Québec system. Appendix B contains the monthly worksheets used to determine reservoir storage at the end of the drawdown season under various inflow conditions for the operating years 1999 through 2002. Appendix C describes the model used to develop the probability of meeting demand values described in Section 4-3b. Appendix D is the sample reservoir condition report for the Northwest Power Pool.

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CHAPTER 2: BASIS FOR ANALYSIS

2.1 Current Status of Hydro-Québec Reservoir System

a. **Total Storage Capacity.** The Hydro-Québec reservoir system currently has a maximum usable storage capacity of 171 TWh. This capacity is considered to be the system's energy reserve.

b. **Seasonal Reserve Capacity.** Of the 171 TWh, 35 percent is allocated to provide the normal seasonal regulation: i.e., water which is stored in the peak runoff months of May through August to augment natural flows in the high demand, low runoff months of November though April. The amount of storage actually used in a given year for this purpose varies, but it is typically in the 45-50 TWh range.

c. **Multi-Year Reserve Capacity.** The remaining storage is carry-over storage, which is used to supplement the natural runoff in years of lower than average runoff or in a series of years with low runoff. The bulk of this storage is concentrated in three reservoirs:[5]

Joey Smallwood Reservoir at Churchill Falls	26.1 TWh total storage[6]
Caniapiscau Reservoir in the La Grande Complex	88.7 TWh total storage[6]
Daniel Johnson Reservoir in the Manicouagan complex	32.9 TWh total storage[6]

d. **Seasonal Operating Cycle.** The typical operating year is divided into two periods: the winter drawdown season and the summer refill season. Reservoirs are normally at their maximum elevation on about 1 November. About this time the weather begins to turn cold, natural flow drops off, and electrical loads increase, resulting in the progressive draft of seasonal storage that continues until about the end of April. In May, the snowmelt runoff begins and continues into July. Electrical loads also drop off. During the summer months snowmelt runoff is augmented by rainfall runoff, which may continue into October.

e. **Planned Normal Range of Reservoir Operation.** Because of the wide range in runoff from year to year, the optimal 1 November level of the reservoir system has been established at about 70 percent of its total capacity.[7] This allows space for capture of additional water should runoff for the following year[8] be well above average. This extra stored energy would be sold as market conditions permit and the reservoir system restored to its normal operating range.

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[5] Table 3 of *Bilan d'utilisation des ressources hydriques*, Janvier à juin 1998.

[6] Includes seasonal as well as multi-year storage

[7] This level could be lower if the system is forecasted to produce surplus energy that is in excess of that required to meet firm demands and also satisfy the energy reliability criteria. This surplus can act as an additional reserve, thus making it possible to lower the optimum level of the reservoirs without incurring additional risks.

[8] or series of years

[redacted]

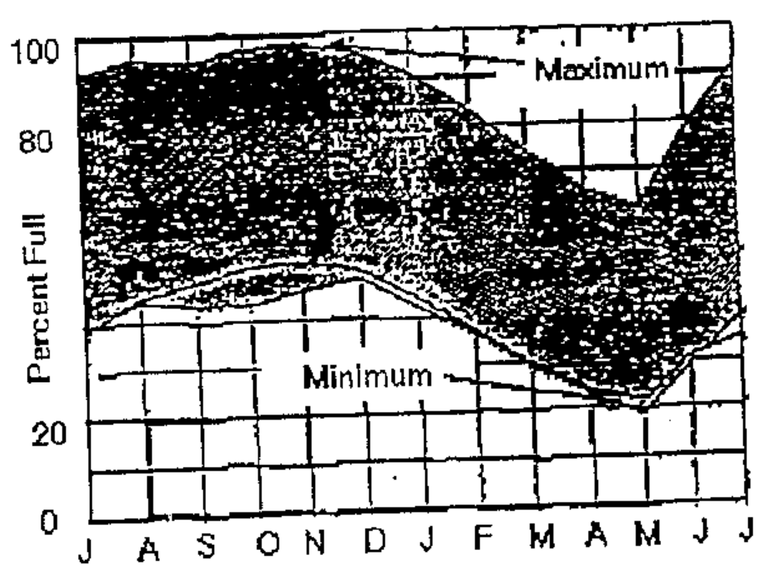
In years of low runoff, water must be drafted from multi-year storage to supplement natural inflow. Because of the large amount of multi-year storage in the system, several years of low runoff can be accommodated before the reservoir system is drawn down to an unacceptable level.

Another reason Hydro-Québec sometimes drafts multi-year storage is to make financially attractive secondary energy sales. However, while financial factors are taken into consideration, just how far to draft into the multi-year reserve is ultimately based on hydrologic risk. If the reservoirs are allowed to draft too far, a succeeding drought year may cause the system to go empty,[9] and exceptional measures must then be taken to meet firm loads (by terminating non-firm sales, and making purchases from neighboring utilities, and running high-cost generation). In the extreme case, shedding of load may even be required.

Hydro-Québec has two major tools to help guide the use of the multi-year energy reserves. The first is an economic model. The consultants were not given detailed information about this model, but it is understood that this model determines the relative value of storage at different levels, based on current and forecasted values for sales and the cost of exceptional measures. This model is used to develop operating guidelines for water reserves management.

The second tool is their new energy reliability criteria, which were adopted in 1991, following a serious situation that developed in the late 1980's as a result of a multi-year drought combined with unexpectedly high load growth. These criteria, which will be discussed in more detail later, are designed to insure that loads will be met in 98 percent of the expected runoff and load

Figure 1
Évolution du stock énergétique



[9] That is, may reach the 10 TWh 1 May minimum

[redacted]

conditions. In years of low runoff, this would be accomplished by drafting from the multi-year storage or by resorting to exceptional measures.

Through experience, Hydro-Québec has also established a minimum system storage of about 10 TWh on 1 May. This allows some reserve to meet loads if snowmelt runoff is delayed until later than normal and to accommodate variations in runoff pattern among the different river basins.

Figure 1[9] shows an envelope encompassing the expected range of reservoir operation by month given streamflow conditions that occurred during the period 1967 through 1998. It can be seen that the reservoir system would never have been drafted below 20 percent full on 1 May.

f. Range of Operation in Recent Years. During the present decade, 1992 was the last year in which runoff was well above average. 1994 was close to average, but the remaining years since 1992 have been well below average.

Figure 2[10] and the following table[11] describe the reservoir system operation from 1992 to the present. The Total Supply values in the table include thermal generation (primarily from the Gentilly nuclear plant) and deliveries received under contract as well as hydroelectric generation. However, Total Supply does not include the drafting of reserves from the reservoir system. Note on Figure 2 that the [Total] Supply at Average Runoff increases between 1992 and 1997 due to additions to the generating system.

Year	Total Supply TWh	Firm Sales TWh	Surplus Sales TWh	Total Sales TWh	Net Gain Or Loss TWh	1 May Storage Content	1 Nov Storage Content
1992	185	163	2	165	20	27%	79%
1993	162	166	5	171	-11	41%	69%
1994	185	167	11	178	7	34%	70%
1995	162	170	16	186	-24	41%	55%
1996	176	173	10	183	-7	27%	51%
1997	180	176	6	182	-2	21%	52%
1998	172	NA	NA	NA	NA	22%	45%

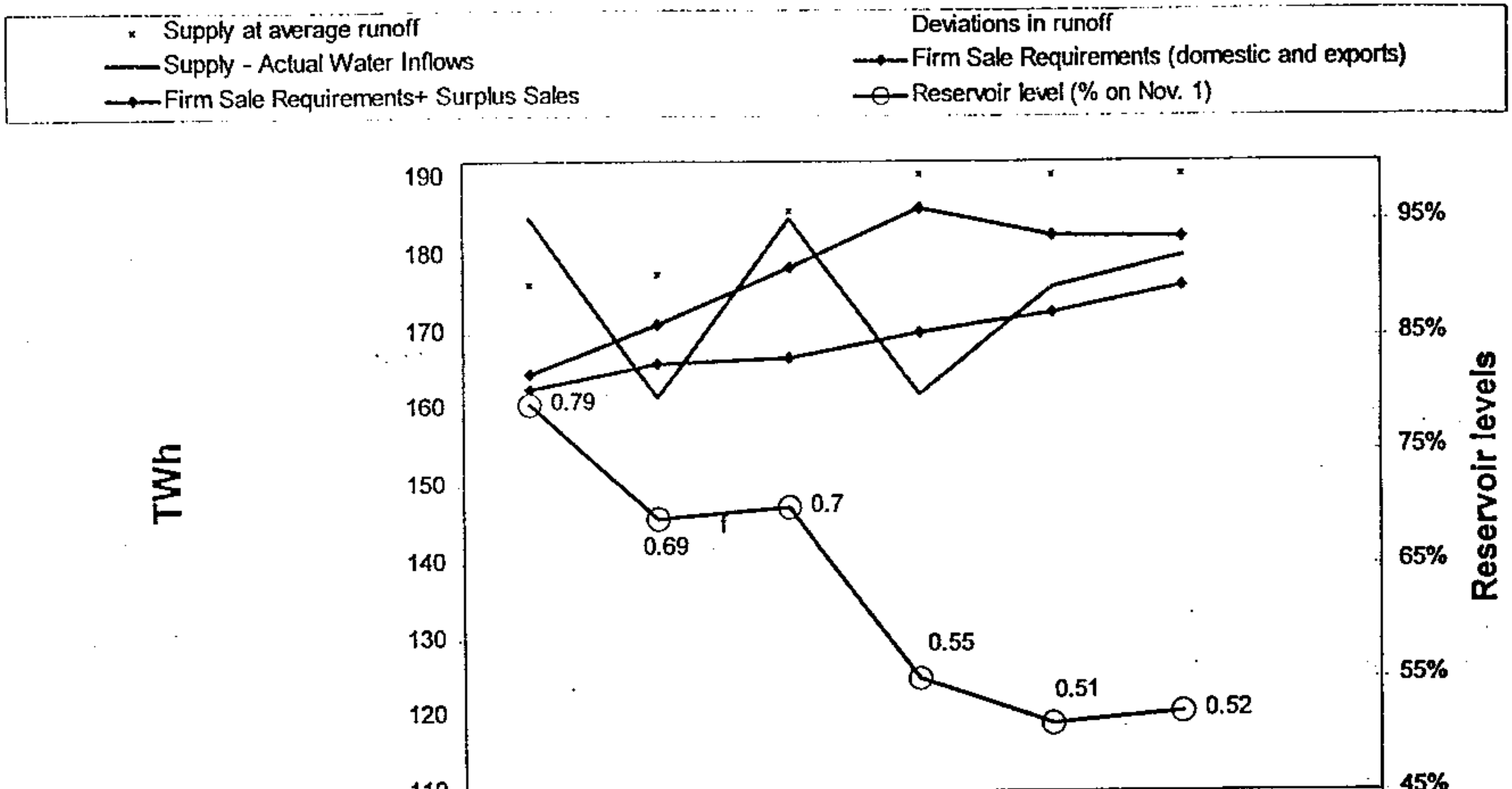
In 1992, the total supply was above average (runoff was 8.5 TWh above average and the resulting total supply was 20 TWh above total sales), and this permitted refilling the reservoir system to 79 percent full on 1 November. The following year the total runoff was 16 TWh below average and the total supply was 11 TWh below total sales, resulting in the reservoirs

9 From *Bilan d'utilisation des ressources hydriques*, Janvier à juin 1998

10 The figure *Supply, Sales and Reservoir levels* provided by La Régie as part of their briefing giving an overview of Hydro-Québec and its supply system. Note that both sets of Supply values in the figure include thermal, deliveries under agreements, and (in 1992) exceptional measures in addition to hydroelectric generation.

11 Supply, sales values, and 1 Nov storage content values from Figure 2, and 1 May storage content values from page 9 of *General Description of Hydro-Québec's System*

Figure 2
Supply, Sale Requirements & Reservoir Levels



	1992	1993	1994	1995	1996	1997	1998
Supply at average runoff	176.2	177.6	185.7	190.4	190.4	190.4	
Deviations in runoff	8.5	-16.1	-1	-28.5	-14.5	-10.5	
Supply - Actual Water Inflows	184.7	161.5	184.7	161.9	175.9	179.9	
Firm Sale Requirements (domestic and exports)	162.7	166.1	166.8	169.9	172.6	176	
Firm Sale Requirements+ Surplus Sales	164.7	171	178.4	186	182.6	182.3	
Reservoir level (% on Nov. 1)	0.79	0.69	0.7	0.55	0.51	0.52	

[redacted]

[redacted]

being 10 percent lower on 1 November 1993. However, at 69 percent, this level was still close to the desired storage level of 70 percent at that date. The 1994 runoff was close to average[12] and total supply was 18 TWh greater than firm sales. This permitted 11 TWh of non-firm sales as well as a slight gain in reservoir storage.

The next year (1995) was the first in the current series of low flow years, with runoff being 28.5 TWh below average and the total supply 8 TWh below firm requirements. Nevertheless, 16 TWh of non-firm sales were effected, so that reservoir storage dropped to 55 percent at the end of the runoff season. Inflow in 1996 was 14.5 TWh below average but the total supply was 3 TWh above firm sales. Ten TWh of non-firm energy was sold, and 1 November reservoir content dropped to 51 percent. In 1997, runoff was 10.5 TWh below average, but the total supply was 4 TWh above firm requirements. Non-firm sales were reduced to 6 TWh, and the 1 November reservoir content remained about the same at 52 percent.

Complete data was not available for 1998, but inflow was 18.4 TWh below normal, and reservoir storage at the end of the runoff season had dropped to 45 percent.

2.2 Description of Reliability Criteria

Hydro-Québec's current energy reliability criteria, which were established in 1991, require that sufficient energy reserves will be provided to insure that the loss-of-load-expectancy will not exceed 0.35 TWh/year. The implementation of these criteria implies that, based on past runoff and base loads patterns, firm energy loads will be met in 98 percent of all likely combinations of runoff and loads.

a. Criteria prior to 1991. Prior to the drought of the late 1980's, Hydro-Québec's reservoir planning was based on recurrence of the most adverse sequence of streamflows that occurred during the historical streamflow period beginning in 1942. The "critical period" was found to be the four-year period 1960-63. During this period, generation would have a cumulative shortfall of 100 TWh, compared to average generation (which was then 173 TWh annually).[13]

b. Problems with this criterion. The drought of the late 1980's demonstrated that this criterion was not satisfactory. During the seven-year period 1984-90, five years were below average (three far below average) and the remaining two were about average. This produced a cumulative shortfall of 97 TWh compared to average streamflows. In addition, load growth was higher than expected, the cumulative over-run being 76 TWh above forecasted loads. When added together, the cumulative energy deficit would have been 173 TWh had not Hydro-Québec had a temporary surplus of generating capability at the time.

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[12] Note that while 185 TWh was 8.5 TWh above average runoff in 1992, the same value was only average in 1994 because generation from average runoff had increased due to system additions.

[13] Hydro-Québec, *Impact of the Revision of the Capacity and Energy Reliability*, 1992, page 13.

[redacted]

It became apparent that there were two major problems with the old criteria:

- it was not based on risk, so it was not possible to assess the economic impact of different levels of energy reserve.

- it did not consider the potential variations in future power demand compared to the most likely projected load

c. The 98 percent confidence criterion. To overcome these problems, Hydro-Québec developed a probabilistic approach to account for variations in both supply (streamflow) and demand. Operation of the Hydro-Québec system was simulated under a wide range of combinations of loads and streamflow in order to develop a probability distribution of energy surpluses and deficits (compared to average streamflow and expected loads).

Economic studies were also performed, and it was determined that a reasonable level of protection would be to insure that enough energy resources would be available to meet firm loads 98 percent of the time. It was established that the single-year runoff that would be exceeded 98 percent of the time was 39 TWh less than the average hydro system generation of 180 TWh. The cumulative shortfalls for four different time periods based on the 98 percent exceedence criterion are as follows:

For one year	-39 TWh
For two consecutive years	-64 TWh
For three consecutive years	-87 TWh
For four consecutive years	-107 TWh

Note that these values are from Hydro-Québec's most recent analysis and are lower than those presented in their 1992 report.[14]

d. The Excess Energy Reserve. According to their 1992 study,[15] Hydro-Québec had, in addition to its base hydroelectric and non-hydro[16] resources, 12 TWh of "exceptional measures" which could be used to meet shortfalls in periods of extreme drought. These include measures such as purchases, running high-cost thermal generation, and buying back firm contracts

In their analysis of the base or "reference" system under projected 1995 loads, they found that, with the 12 TWh of exceptional measures included, the system would have a load-shedding expectation of about 0.8 TWh per year. This could be reduced to the 0.35 TWh/year target by an additional "excess energy reserve." This could be obtained by further development of the hydro system and/or providing additional thermal capacity, which would be used only in the event of low runoff.

[14] See also Section 4.1.

[15] Hydro-Québec, *Impact of the Revision of the Capacity and Energy Reliability*, 1992, pages 19-22.

[16] Primarily the Gentilly nuclear plant but also including some exchange agreements and Independent Power Producers..

Taking into account that Hydro-Québec's present energy reserve capacity is limited to 171 TWh, page 6 of the *Energy Reliability Criteria* handout indicates that Hydro-Québec is currently planning to provide excess energy of 5 TWh/year. When this criterion is respected, the load loss expectancy is 0.35 TWh/year. The excess energy criterion is met if the total supply under average water conditions exceeds firm load by 5 TWh/year.

An analysis of the development plans from 1992 to 1996 suggests that the scheduling of LaGrande Phase II projects, namely LaForge 1, Brisay, LaGrande 1 and LaForge 2, was aimed at providing the excess energy required to meet the new reliability criteria.

2.3 Export Sales

Hydro-Québec currently exports a substantial amount of energy to utilities in both the northeastern United States and adjacent Canadian provinces. These exports fall into three categories:

- long-term firm exports:
- short-term firm exports:
- non-firm exports:

Most of the long-term export contracts were negotiated during the commissioning of the LaGrande Phase I projects, which provided excess capacity for a number of years. These contracts will be expiring in the next few years as Québec provincial loads absorb this generation.

Short-term firm export contracts are of shorter duration and are intended to secure income from energy which is temporarily surplus due to new generating facilities coming on line or to a large supply of excess water in storage. These contracts may be of a year or more in duration or for only a period of months.

Non-firm sales are sales of energy that is temporarily surplus to the Hydro-Québec system. This is primarily energy resulting from periods of moderate to high runoff. Because this energy is of an unpredictable and intermittent nature, it must be sold on the spot market as it becomes available. Because of the large amount of storage in the Hydro-Québec system, there is usually some capability to store this energy temporarily in the reservoirs. This gives the utility some flexibility in marketing the power at the best possible price. However, it may sometimes be necessary to produce it as rapidly as possible to bring the reservoirs down to their normal operating range.

2.4 Load-Resource Data Provided by Hydro-Québec

The evaluation of whether Hydro-Québec is meeting its reliability criteria is based primarily on data provided by Hydro-Québec to La Régie and which was shared with the consultants on a confidential basis on 4 December 1998.

a. Scenarios. Data was provided for three main scenarios: average water, worst case, and correlated flows:

- **Average water** assumes that each year will have inflows equal to the average of the 55-year period 1943-97
- **Worst case** is a two-year sequence of flows that is exceeded by 98 percent of the probable combinations of streamflow, as determined from a stochastic simulation using the 55-year streamflow database. This is not actually the true worst case because there is a two percent probability that there will be a more adverse combination of flows. However, this is the "worst-case" scenario adopted by Hydro-Québec for system planning purposes and to comply with its energy reliability criteria.
- **Correlated flows** is the most likely sequence of flows that will occur given the actual flow sequence that has occurred prior to November 1998. It is based on an analysis of the correlation of succeeding runoff volumes for the 55 historical years.

A fourth scenario was also provided, representing the three-year "worst-case" sequence that was exceeded 98 percent of the time. This was derived in the same manner as the two-year "worst-case" scenario.

b. Monthly Demand: Hydro-Québec provided estimates of the monthly demand between November 1998 and May 2002.

c. Initial Reservoir Content: As per confidential information provided by Hydro-Québec on November 6, 1998, the water levels of the hydroelectric reservoirs had reached 45 percent of their total capacity, or 78 TWh on 1 November 1998, the end of the 1998 refill period.

d. Monthly Supplies: Hydro-Québec provided a forecast of the monthly supplies for each of the four runoff scenarios.

The [redacted] inflow for the period November 1998-April 1999 is common to all scenarios because, as was pointed out by Hydro-Québec in meetings with La Régie, water inflows during this period are typically very low and show little variation from one year to the next. The inflow remains about the same for the November-April period during subsequent years.

The inflow for the May-October period varies among the four scenarios. The average annual values are considered to be the base, and as shown on page 13, they increase slightly with time. This is due to some small additions to the hydro system and the independent power produces (IPPs), which are offset slightly by variations in output of the nuclear plant due to the maintenance schedule.

[redacted]

The shortfall values for the worst-case and correlated inflow scenarios for 1999 and 2000 were from Table 1 of Hydro-Québec's letter dated 6 November 1998. The 23 TWh shortfall value for the 2001 worst-case scenario was taken from page 6 of the translation of the Hydro-Québec document entitled *Energy Reliability Criteria*. The 2001 value for the correlated inflow scenario was provided in Hydro-Québec's runoff forecasts. The annual inflow values used for each of the four scenarios are as follows:

	Aver-age Water	Corre-lated Shortfall	Corre-lated Inflow	Worst Case Shortfall	2-year Worst Case	3-year Worst Case
1999	180	-8	171	-39	141	141
2001	180	-3	177	-25	155	155
2002	180	0	180	-23	180	157

e. **Monthly Exceptional Measures:** Hydro-Québec estimates tha[redacted]of exceptional measures will be required between November 1998 and May of 1999. The monthly distribution of these measures during this period will depend on economics, but have been assumed to be divided equally among the six months. Similarly, values for the periods from May 1999 through April 2001 were obtained from Hydro-Québec's letter dated 13 November 1998 for the worst-case, correlated, and average runoff scenarios.

The values for the worst-case are estimated at [redacted] in both 1999-2000 and 2000-2001. For the 3-year worst-case scenario in the same period, [redacted] of exceptional measures would be needed.

Hydro-Québec estimates that [redacted] of measures would required for the 1999-2000 and 2000-2001 time periods under average water conditions.

The specific measures are discussed further in Section 4.4.

[redacted]

CHAPTER 3: ANALYSIS OF HYDRO-QUÉBEC'S RELIABILITY CRITERIA

3.1 Analysis of the 98 Percent Reliability Criterion

A monthly analysis was performed using the data provided by Hydro-Québec to determine the storage remaining in the reservoir system at key points during the period 1 November 1998 through 1 May 2002. The purpose was to determine if firm loads could be met under the 98 percent exceedence (or "worst-case") inflows, given the actual reservoir content on 1 November 1998 and the fact that the system could not be drafted below the 10 TWh minimum allowable level on 1 May in any year. Both two and three-year adverse streamflow sequences were examined.

The resulting reservoir conditions are summarized in the following table. For purposes of comparison, operation under average and correlated inflow conditions were also examined. Correlated streamflows represent the most likely sequence that would occur given the inflow experience of the past several years. Corresponding estimates provided by Hydro-Québec are also presented for two of the scenarios.

	2-Year Worst Case Inflows, TWh		3-Year Worst Case	Average Inflows	Correlated Inflows TWh	
	Calculated	Hydro-Québec	Calculated	Calculated	Calculated	Hydro-Québec
1 Nov 1998 Levels	78	78	78	78	78	78
1 May 1999 Levels	[redacted]					
1 Nov 1999 Levels	[redacted]					
1 May 2000 Levels	[redacted]					
1 Nov 2000 Levels	[redacted]					
1 May 2001 Levels	[redacted]					
1 Nov 2001 Levels	[redacted]					
1 May 2002 Levels	[redacted]					

Both the consultants' and Hydro-Québec's analyses of the two-year worst case scenario confirmed that the system could meet these criteria providing Hydro-Québec supplemented their hydro and nuclear generation with exceptional measures. This includes implementing some of these measures starting in November of the current operating year. If the current series of low runoff years continues, as much as [redacted] of exceptional measures may be required in succeeding years.

These measures, in combination with the available generation from the hydro system and the

[redacted]

Gentilly nuclear plant, will make it possible to keep the reservoir system at or above its 10 TWh minimum level through 2002, even if low inflows continue to occur. [redacted]

With three consecutive years of average water conditions, the reservoirs were able to regain [redacted] of reserves between 1 May 1999 and 1 May 2002. This was while carrying out some non-firm sales in all three years. Even so, the reservoirs would only reach the [redacted] level on 1 November 2001, well below the desirable 70 percent full mark.

The exceptional measures required in each year in the worst-case scenarios would be as follows:

	May-Dec	Jan-Apr	Total
1999-2000	[redacted]		
2000-2001			
2001-2002			

The detailed monthly calculations are shown in Appendix B.

3.2 Analysis of the Excess Energy Reserve

The energy criteria also imply that in the long run the loss-of-load expectancy will be 0.35 TWh per year. This level of reliability can be obtained only if all the proper measures are put in place, which means among other things, that Hydro-Québec's system should be planned and built to supply, at average runoff, 5 TWh over total firm demand requirements. The following table[18] demonstrates that for the next three years, the available supply will be at least 5 TWh over the forecasted requirements, thus indicating that Hydro-Québec has effectively built its system with 5 TWh of excess energy.

Year	Supply, Average Water TWh	Total Load TWh	Non-Firm Load TWh	Firm Load TWh	Margin Over Load TWh
1999	189.0	188.9	[redacted]		
2000	189.6	189.1			
2001	190.2	189.8			

[redacted]

[18] Hydro-Québec data provided to consultants by La Régie via spreadsheet on 17 December 1998.

[redacted]

CHAPTER 4: REVIEW OF HYDRO-QUÉBEC'S ENERGY RELIABILITY CRITERIA

4.1 Description of the Energy Reliability Criteria

In a predominately hydroelectric power system such as Hydro-Québec, reliability criteria must be based on energy as well as capacity considerations.[19] Such criteria must reflect both the probability of load shedding with various energy levels (considering variations in both supply and demand) and the economic consequences of such load shedding.

In the 1980's Hydro-Québec used an energy reliability standard based on the four consecutive driest years of record. Among the shortcomings of this approach was that it did not account for the random nature of water inflows or the possible variations in demand. It also did not establish the risk of load shedding or the costs and benefits of various energy reserve levels.

In 1991 a new method of assessing energy reliability was introduced. This method simulates on a stochastic basis the anticipated operation of the Hydro-Québec system over the expected range of supply and demand conditions. Such a method enables Hydro-Québec to establish the risk of load shedding, and thus establish a desirable energy reserve level in view of these load shedding probabilities and the costs associated with various reserve levels.

According to information made available to the consultants,[20] Hydro-Québec's model has established that the variation of supply will, for 98 percent of the time, be less than:

- one year	39 TWh
- 2 years	64 TWh cumulative
- 3 years	87 TWh cumulative
- 4 years	107 TWh cumulative

When these energy criteria were initially established, Hydro-Québec estimated that the one-year combined variation of supply and demand would be 43 TWh, of which 4 TWh was due to variation in demand. The absence of any variation due to demand in the current figures seems to indicate that Hydro-Québec has a high level of confidence in its current load forecasts.

Based on these studies and methodology, Hydro-Québec has established energy reliability criteria such that its system will be capable of coping with the combined demand and supply uncertainties which have a probability of occurrence of 98 percent of the time. Providing that planned excess energy is introduced to the system, respecting the above criteria will result in a loss-of-load-expectancy of 0.35 TWh per year. The amount of the planned excess energy was

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[19] rather than on capacity alone, as would be the case with thermal-based power systems.

[20] La Régie staff material entitled *Reliability Criteria for Hydro-Québec*"

[redacted]

3.3[21] TWh when the criteria were originally implemented, but it is now 5 TWh according to information provided to the consultants.

4.2 Comments on Specific Aspects of the Energy Reliability Criteria

a. Adequacy of the Hydrological Record. The consultants are not aware of the exact hydrological period used by Hydro-Québec in its 1991 evaluations. However, while the mean annual hydro generation for the period 1943-1997 is lower than for the periods 1943-89 or 1943-1991,[22] there is little significant difference among the flow periods in the hydro variations from the mean, which for 98 percent of the time during each of the periods would be less than the figures shown below:

	TWh		
	1943-89	1943-91	1943-97
- one year	39	39	39
- 2 years	64	65	64
- 3 years	85	87	87
- 4 years	101	104	103

Whether this statement would be true for considerably longer flow records is, or course, unknown. While a 50-year plus period of record has traditionally been considered adequate for hydropower analysis, the increasing volatility of hydrologic and meteorological phenomena in recent years might be a compelling argument to consider extending the record. Even before the El Nino-generated phenomena of the past few years, the meteorological literature suggested that weather patterns were reverting from an extended period[23] of relatively consistent conditions into the more normal long-term scenario of wider extremes.[24] This is supported by the fact that, in the latter part of this century, long periods of drought have been experienced in some parts of the world, and in others, there have been record-breaking floods.

The decisions Hydro-Québec makes in planning its current operations, as well as additions to its supply base, are highly dependent on the characteristics of the limited hydrologic record embedded in its reliability and its reservoir operation models. For this reason, Hydro-Québec would be well served by retaining a consultant familiar with drought hydrology and the potential impact of the recent trend toward more extremes in meteorological activity, to determine if

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[21] This planned excess energy was to have been provided by hydro resources installed <u>after</u> the completion of La Grande Phase II. To date only the La Forge 1 station, with an annual output of about 1.6 TWh has been installed subsequent to the La Grande Phase II facilities.

[22] This conclusion and the following table are based on review of a chart entitled *Écarts Énergétiques des Apports, 1943-1997*, which shows hydro variations from a 180 TWh mean during the 1943-1997 period. The tabular figures would be slightly different if the actual data forming the basis for that chart had been used to calculate the means and standard deviations.

[23] Since the early 1900's.

[24] Specific references will be provided at a later date.

[redacted]

extension of Hydro-Québec's hydrologic data base is warranted.

b. Use of Stochastic Versus Deterministic Streamflow Records. From Hydro-Québec's description of its energy reliability methodology, it appears that the annual supply in its simulation model was randomly selected from the population of available supplies. Whether the two, three, and four-year supply figures were derived from these one-year selections, or whether each two, three and four-year figure represents contiguous years, was not reported, although the variations used correspond to the two standard deviation figures computed from actual supply data for contiguous years. It is likely that the two, three, and four-year variations would be greater if determined stochastically[25] It should be noted that, to the degree that statistical correlation exists between annual streamflows, the hydrologic phenomena would not be a purely stochastic phenomena.

c. Use of 0.35 TWh/year as the Appropriate Load Shedding Expectancy Value. This value was chosen when Hydro-Québec developed its new energy reliability criteria. Based on the generation system that would exist following completion of the La Grande Phase II facilities and estimated 1995 loads, it was determined that the loss-of-load-expectancy was 0.8 TWh/year. Adding various amounts of hydro energy surplus reduced this figure to lower levels. During periods of high runoff the surplus hydro energy could be sold, while under low runoff conditions it could be used to reduce the use of exceptional measures or to reduce load shedding.

The choice of the 0.35 TWh/year figure, resulting from the addition of 3.3 TWh of hydro surplus energy, was apparently based on economic considerations, and is subject to change. Under more recent load and supply conditions, Hydro-Québec has determined that a hydro energy excess of 5 TWh is necessary to maintain the 0.35 TWh/year loss-of-load-expectancy. In its original analysis, Hydro-Québec indicated that there were potential advantages to using higher energy reliability standards, such as 0.1 or 0.2 TWh/year, and that additional studies would be performed to determine whether such higher standards were feasible. Given that both load and supply relationships and cost factors have changed since the 0.35 load-shedding expectancy criterion was developed, Hydro-Québec should replicate its original studies with updated supply, demand and cost data to determine if this figure is still appropriate.

d. Selection of a Two-Year Critical Period for Planning and Operational Studies. As noted above, Hydro-Québec presented data in their 1992 report[26] showing the energy shortfall compared to average water for as many as seven consecutive years. However, the Hydro-Québec data provided to the consultants in December, 1998, showed a current analysis for only the two-year period, although sufficient data was also provided to evaluate a three-year period.

In evaluating reservoir system firm yield, it is usually found that the larger the amount of storage compared to runoff, the longer the duration of the critical period.[27] For example, in the Columbia

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[25] This statement is based on the fact that under actual conditions, 39 TWh variations did not occur in two or more consecutive years; in the stochastic model, such a sequence could occur

[26] Hydro-Québec, *Impact of the Revision of the Capacity and Energy Reliability Criteria*, 1992 (unofficial translation into English by La Régie).

[27] The critical period is the sequence of streamflows that is most adverse from the standpoint of both flows and

River system, the ratio of storage to runoff is only about 0.25, and the critical period has varied from one to four years, depending on the nature of the current demands on the system. When power was the primary driving function, the critical period shifted between a two-year and a four-year sequence. Now that the annual requirements of migratory fish have taken on increased importance, the critical period is reverting to a one-year sequence. By way of comparison, the mainstream Missouri River reservoirs have a storage ratio of about two and a critical period of seven years.

In the Hydro-Québec system, the storage ratios for the three major river systems are 1.1 for the La Grande, 1.5 for the Manicouagan, and 0.7 for the Churchill, which comes to a combined ratio of just over one. This would suggest a multi-year critical period, and this is confirmed by the fact that Hydro-Québec used the four-year period 1960-63 in their operational planning until the early 1990's.

The characteristics of their reservoir system dictate that they should still consider multi-year sequences of low flows in their planning, and as has been noted, Hydro-Québec does develop these numbers with their probabilistic model. For purposes of planning they should continue to look at the consequences of low-flow periods of at least four years.[28] However, given that for the next few years supply at average runoff will exceed firm sales requirements, the two-year period is satisfactory for purposes of analyzing whether they can meet firm loads between now and 2002.

It must be remembered that the first year in the "worst-case" scenario begins in May of 1999.[29] The drawdown through the winter of 1998-99 is the result of the current year's shortfall of 18 TWh. The 39 TWh shortfall[30] during the first year of the "worst-case" scenario causes the reservoir to become [redacted] The data provided by Hydro-Québec demonstrates that, with the reservoir system at [redacted] on 1 May 2000 and the second-year shortfall of 25 TWh, the system can still meet firm loads in that year by implementing [redacted] exceptional measures.[32] Note that the reservoir system would again be drafted to [redacted] by 1 May 2001.

In the third year, the shortfall would be only 23 TWh, and firm loads could once again be met if [redacted] of exceptional measures were available. The shortfall for a fourth year would be even less, so firm loads could once again be met providing that [redacted] exceptional measures were available. The consequences of an adverse sequence of flows longer than two years would not be failure to meet firms loads, but the financial impact of having to rely extensively on high-cost exceptional measures in order to meet those firm loads.

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demand in the historical streamflow record.being examined.

[28] The exact length of the low-flow sequence that should be used could depend on the recommendations of the drought probability analysis proposed in the preceding section, should Hydro-Québec choose to undertake it.

[29] See Section 3.1 of this report.

[30] Compared to average runoff

[redacted]

[32] See Section 3.1 of this report.

[redacted]

In reality the exceptional measures required in the third and following years would probably be much less than computed in a three or four year drought study. As part of its ongoing planning process, Hydro-Quebec identifies various options which can be brought into service by the beginning of the third year, thereby lessening or eliminating the need for exceptional measures. These options include additional partial diversions, gas turbines designed for high utilization factors, or increased import capability. Economic considerations would be taken into account in choosing the best options.

e. Selection of the 98 Percent Exceedence Criterion. The 98 percent exceedence criterion used by Hydro-Québec means that 98 percent of the time the annual hydro energy would be 141 TWh (180 TWh average - 39 TWh variation) or greater in the first year. Conversely, it would be equal to or less than 141 TWh two percent of the time.

A review of the variations from 1943-1997 average hydro energy indicates that these variations have a roughly Gaussian (normal or bell shaped) distribution, with about 95 percent of the variations during any one year period falling within +/- 39 TWh of the average, during any two year period falling within +/- 64 TWh, and so on. Thus, Hydro-Québec's 98 percent criterion is effectively a two standard deviation criterion, with a two percent chance of annual hydro energy of 141 TWh or less and a two percent chance of 219 TWh or more. Using a three standard deviation (or 99 percent criterion) would result in using a worst case annual energy variation of about 58 TWh for one year and 96 TWh for two years. Such variations are much more extreme than have occurred during the historical records and, in the opinion of the consultants, would be unreasonable. The present 98 percent criterion is therefore considered reasonable and appropriate.

f. Treatment of Demand Variations. As noted, the currently reported variations of supply which will be exceeded two percent of the time do not actually include any variations due to demand. Assuming a 68 percent chance that the actual demands in 2000-2002 would be within one percent of Hydro-Québec's forecast,[33] the demand variation which would be exceeded two percent of the time would be about 2 TWh in each of those years. This demand variation would increase to about 4 TWh in each of those years if there were a 68 percent chance that the actual demands would be within two percent of the forecasts. Given that it is unrealistic to assume that any forecast is not subject to variation,[34] the exclusion of a demand variation component from the one, two, three and four-year figures shown in Section 4.1 will result in over-estimating system reliability.

4.3 Operation at Lower Reservoir Levels to Expedite External Sales

a. Relationship Between Reservoir Levels and External Sales. Except for two years, the period since 1984 has been characterized by low streamflow in the Hydro-Québec system.

[33] As shown in the *Hydro-Québec Strategic Plan: 1998-2002*, pp. 13 and 28

[34] One of the reasons Hydro-Québec's four-year drought criteria was abandoned in 1991 was that it did not consider potential variations in demand. See Section 2.2 of this report

[redacted]

During the early years of this period, however, the available supply on the system was greater than firm demand, enabling Hydro-Québec to sell large amounts of surplus energy. These sales stopped by the end of the 1980s. In 1992 streamflow was above average and surplus sales were resumed. After reaching a level of 15.1 TWh in 1995, surplus sales were again reduced as the period of below average streamflow resumed.

During the 1995-97 period Hydro-Québec experienced low water inflows with a cumulative shortfall of 53.5 TWh. During the same period total sales outside Québec totaled about 58 TWh, including non-firm surplus sales of about 30 TWh. These figures are tabulated below, along with the revenues associated with the outside sales:[35]

Year	Hydro Shortfall TWh	External Sales - TWh			External Sales - Million $		
		Firm	Surplus	Total	Firm	Surplus	Total
1995	28.5	8.9	15.1	23.9	283	354	637
1996	14.5	9.5	9.4	18.9	337	251	588
1997	10.5	9.4	5.9	15.2	400	196	596
Total	53.5	27.8	30.2	58.0	1020	801	1821

On 1 November 1997, the hydro reservoirs were 52 percent full, with about 90 TWh in storage. Assuming that no surplus sales had been made during the 1995-1997 period, the reservoir levels on 1 November 1997 would have been at 120 TWh, or about 70 percent full. However, without the surplus sales Hydro-Québec's revenues would have decreased by $0.8 billion during the period. Given that Hydro-Québec's total net income during the period was $1.7 billion, a reduction of almost one-half of its net income during this period could have seriously affected Hydro-Québec's ability to freeze rates on 1 May 1998.

b. Impact of Lower Reservoir Levels on the Risk of Load Shedding. As discussed earlier, the Hydro-Québec system is planned to protect against a supply deficit of 64 TWh during a two-year critical period. For example, with a firm demand of 170 TWh in the first year of the two year critical period, a demand growth of 1.5 percent in the second year, and no use of exceptional measures, the Hydro-Québec system must have about 35 TWh in storage on 1 May to be 98 percent sure of supplying the demand. If the firm demand increases to 180 TWh, however, either the probability of supplying this demand drops to 96 percent, the beginning storage must increase to 55 TWh, or exceptional measures must be utilized.[36]

During successive two-year periods beginning with 1993, and with the 1 May storage at the levels described in Chapter 2, the probability of meeting demands during the 1993-94 period was almost 100 percent; during 1994-95, 99.8 percent; during 1995-96, 99.9 percent; and during

[35] Hydro-Québec, *Annual Report: 1997*, page 68.

[36] See Appendix C, Part 2

[redacted]

1996-97, 98.6 percent.[37] Even with the current low reservoir levels, Hydro-Québec's chances of meeting currently estimated demands (which include a considerable amount of non-firm sales) during the next several years are 98 percent under worse case conditions assuming that the exceptional measures it anticipates using are actually implemented.[38]

c. Impact of Lower Reservoir Levels on Production Efficiency. The Hydro-Québec reservoir system has been operating in the lower half of its operating range during much of the 1990's, due in part to low inflows and in part to its non-firm sales strategies. It should be pointed out that operating continuously in this range results in forgoing a significant portion of the system's energy potential at the storage projects themselves. Operating in the bottom half of the reservoir means an energy loss due to a lower generating head. Furthermore, turbines are typically designed to operate most efficiently at the heads that would occur in the middle to upper portion of the reservoir's operating range. While all of this is presumably accounted for in the economic model which drives Hydro-Quebec's day-by-day sales strategy, a policy that leads to prolonged operation in an inefficient operating range needs to be carefully monitored.

4.4 Exceptional Measures Available to Hydro-Québec Under Adverse Conditions

a. Measures Available When the Energy Reliability Criteria Were Developed. When the energy reliability criteria were developed in the early 1990's, Hydro-Québec had two broad measures to deal with adverse energy conditions. The first of these measures, water reserves, consisted of a seasonal reserve and a multi-year reserve, which have been described in Chapter 2 of this report. In years of very high demands or very low runoff, these water reserves may be inadequate to meet energy needs. In those situations, the other measures available to Hydro-Québec would be utilized. Hydro-Québec identified these "exceptional measures" as

- purchasing energy from neighboring systems;
- operating the Tracy station on a continuous basis;
- buying back commercial, institutional and industrial dual energy contracts.

These measures, based on then-existing contracts, import transmission capacity, and available energy, had a total annual capacity of about 12 TWh.

b. Exceptional Measures Currently Available. The exceptional measures now available, about [redacted] exclusive of the reduction of non-firm sales, are slightly greater than those available in the early 1990's due to an increase in purchased power availability. The following table summarizes the individual measures expected to be available to Hydro-Québec in calendar years 1991, 2000, and 2001.[39]

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[37] See Appendix C, Part 3

[38] See Appendix C, Part 1

[39] From the table *Available Measures: 1999-2001*, provided to La Régie by Hydro-Québec

[redacted]

Measure, in order of Availability, TWh[40]	1999	2000	2001	Total
[redacted]				
Total	18.0	24.0	23.0	65.0

In discussing its exceptional measures, Hydro-Québec has indicated that additional on-peak purchases could be made but that these are very expensive and are only sought on a basis limited to the quantities required to meet the energy reliability criteria. Hydro-Québec also includes the reduction of non-firm sales as an exceptional measure. This inclusion is appropriate given that these same sales are also included in its demand estimates.

A potential energy source, which Hydro-Québec does not consider, is its gas turbine generating units, which have a present installed capacity of about 791 MW. Hydro-Québec's arguments for not considering the gas turbine units are (a) that they are expensive to operate, and (b) after 10,000 hours operation a unit would have to be completely replaced. It is the consultants' understanding that many gas turbine units (such as those at pipeline compressor stations) are designed for continuous operation and that 10,000 hours operation requires a major overhaul, not complete replacement of the unit. The potential output of these units is in the order of 3 to 4 TWh/year. While the four units at Hydro-Québec's nuclear station may be unavailable due to the need to provide shutdown or "black-start" power at that plant, the high cost of operating the other gas turbines should not be a limiting factor when the alternative may be the interruption of firm power.

c. **Transmission Limitations.** Hydro-Québec's transmission interconnections permit export of up to 7,543 MW, but its import capabilities are limited to 4,195 MW. A recent change in these transfer capabilities has permitted a significant increase in Hydro-Québec's ability to both sell and buy energy.

Because Hydro-Québec's major generating facilities are located long distances from its load centers, at the end of radial lines, voltage swings exceed NERC standards, so that Hydro-Québec cannot be synchronized with its neighboring systems. Interconnections with these systems consist of either AC to DC to AC converter stations or, in the case of the Boston intertie, a DC

[redacted]

[redacted]

line. Power transfers with Ontario are handled either by isolating part the Ontario system and attaching it to the Hydro-Québec grid, or by isolating a Hydro-Québec generating facility and attaching it to the Ontario system. In either case, opportunities for purchases from Ontario are currently limited.

While part of Hydro-Québec's import limitations might be overcome by modifying conversion equipment, it is the consultants' understanding that the major limiting factors are related to commercial and reliability problems.

One way around the transmission constraints would be to purchase energy on the U.S. spot market to meet its firm sales obligations in the U.S. The net result would be to reduce Hydro-Québec's firm exports.[43] However, this could be considered as a possible exceptional measure only to the extent that Hydro-Québec still has firm contracts with U.S. customers.

4.5 Recommendations Regarding Hydro-Québec's Energy Reliability Criteria

The method currently used by Hydro-Québec to develop its energy reliability criteria is analogous to methods widely used throughout the electric utility industry to determine capacity reliability. The consultants commend Hydro-Québec on the implementation of this model. Throughout this chapter, however, comments were made regarding both input parameters to the model and the final criteria. These comments are summarized herein.

a. Demand Variations. Both supply and demand variations should be considered by Hydro-Québec in determining its ability to provide reliable service. It is unrealistic, even for short-term forecasts, to assume no possible variation in forecast demands.

b. Streamflow period. Hydro-Québec would be well served by retaining a consultant familiar with drought hydrology and the potential impact of the recent trend toward more extremes in meteorological activity, to determine if extension of Hydro-Québec's hydrologic data base is warranted. Such longer periods might change estimates of average hydro output and possible variations from the average. They might also affect correlation relationships.

c. Use of a 0.35 TWh/year criterion. This criterion was based on the demand, supply and cost relationships existing in the early 1990s. It should periodically be updated to reflect current relationships among these factors. The cost data used to develop reliability criteria usually would reflect the financial costs to the utility. Considering Hydro-Québec's role in the Québec economy and its status as a government agency, this cost data should reflect all the costs - financial and social - associated with providing reliable electric service.

d. Exceptional measures. In considering reliability, the purchased power component of exceptional measures should reflect what could be purchased regardless of cost, unless such costs exceed the total socio-economic costs of extended power outages.

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[43] Hydro-Quebec evidently already takes advantage of such opportunities.

[redacted]

e. Operation of Reservoirs at Lower Levels. As noted by Hydro-Québec, the operation of their reservoir system is based on a combination of engineering and business judgments. The lowering of reservoir levels to engage in export sales results in either a measurable decrease in system reliability or the possible increased use of exceptional measures. The financial risks associated with such an export sales policy should proportionally accrue to those parties benefiting from the policy.

[redacted]

CHAPTER 5. MONITORING AND FOLLOW-UP OF HYDRO-QUÉBEC HYDROELECTRIC SYSTEM.

5.1 Introduction

The National Assembly Bill #50 chapter III paragraph 31(2) states that Régie de l'Énergie has the exclusive responsibility to monitor the operations of Hydro-Québec or of natural gas distributors to ascertain that consumers are adequately supplied and are charged fair and reasonable rates. This chapter describes a plan for monitoring Hydro-Québec's reservoir operation.

5.2 The Current Situation

Based on current projected worst case deficits from natural stream flows of 39 TWh next year (May 1999-April 2000) and 25 TWh in year 2000 (May 2000-April 2001), the goal for reservoir reserves should be to retain no less than [redacted] at the end of the present draw-down season (1 May 1999).

As discussed earlier, the following exceptional measures have been proposed by Hydro-Québec to insure that its energy reliability criteria are satisfied:

[redacted]

These measures will be called upon in a priority order based on increasing cost.

For the period starting in November 1998 and ending in May 1999, Hydro-Québec will have to call upon [redacted] of exceptional measures to meet its energy reliability criteria. The exceptional measures required in 1999-2000 and 2000-2001 are listed in Section 3.1.

The consultants feel that the priority of exceptional measures as suggested by Hydro-Québec is appropriate.

To be able to anticipate future actions based on anticipated snowmelt runoff, Hydro-Québec will conduct, in February through April and in conjunction with outside partners, a series of "snow campaigns" intended to measure the snow accumulation.

Operational planning will consider the following:

[redacted]

- current water and snowpack conditions

- the water reserves must be at a minimum of [redacted] in May 1999 to allow Hydro-Québec to meet its energy reliability criteria and guarantee the supply to the committed demand if extreme low runoff conditions occur, such as a deficit of 64 TWh over two consecutive years (May 1999-April 2001)

- until the next snowmelt runoff begins in May or June 1999, Hydro-Québec must resort to exceptional measures during this period estimated to be [redacted] based on current supply and demand forecasts

5.3 The Proposed Monitoring Program

It is deemed essential that a monthly monitoring and follow-up program be established immediately with Hydro-Québec to give sufficient assurance to La Régie that the exceptional measures considered essential to meet the energy reliability criteria are being implemented.

The following table specifies the monthly forecasts pertaining to supply, demand, and the resulting level of resort to exceptional measures throughout the period November 1998-May 1999 (all values in TWh).

	Nov	Dec	Jan	Feb	Mar	Apr
Supply	15.0	10.0	[redacted]			
Demand	17.0	19.0				
Reserves	76.5	68.0				
Exceptional measures	0.5	0.5				

Each month, starting in January 1999, Hydro-Québec should provide to La Régie updated information on actual and forecasted supply, demand, and reserves, and the results of the actions taken to implement the exceptional measures. Hydro-Québec should also make available the snow accumulation data gathered through the snow surveys, as well as their estimate of the snowmelt runoff.

Based on real demand and supply, adjustments to the exceptional measures program for the remaining period will be agreed upon between Hydro-Québec and La Régie. At the end of this period (1 May 1999) and depending on the actual snowmelt runoff situation, a similar follow-up monitoring program may need to be conducted if water conditions continue to be serious.

Following is an outline of the proposed annual monitoring program for future years:

- At the start of each drawdown season (1 November), Hydro-Québec should present their projected reservoir operation for the coming year, given their expected loads and the amount of water available in storage

[redacted]

- Hydro-Québec should present plans for how they would operate their reservoirs in the two succeeding years if the adverse sequence of runoff defined by their energy reserve criteria should occur. These plans would include projections of what exceptional measures would be implemented if such were required. They should identify the resources connected with their exceptional measures.

- Hydro-Québec should also show planned non-firm sales and demonstrate that these sales would not adversely impact their energy reserves.

- Following the annual November presentation, monthly follow-up would be required only if water situation is serious enough to oblige Hydro-Québec to resort to exceptional measures to meet it's energy reliability criteria. However, Hydro-Québec should provide brief reservoir status report to La Régie on a monthly basis.

- This data could also be summarized into a series of bands showing month-by-month the range of elevations where economic studies show it is appropriate for HQ to market non-firm energy, to terminate non-firm sales, to make economic purchases when they are available, and to implement exceptional measures. This is shown conceptually on the following graph.

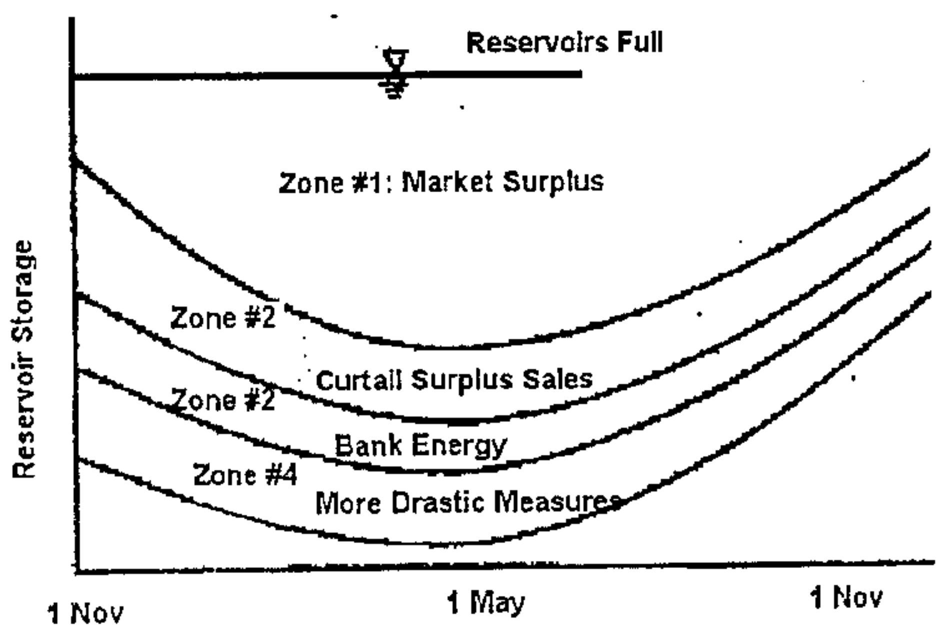

Figure 1
Reservoir System Storage Zones

- Zone #1 represents reservoir operation when runoff is sufficient to market non-firm energy. When the reservoir system enters zone #2, sale of non-firm energy would be curtailed. In zone #3, opportunities for energy banking through exchanges or economic purchases should be seized. In zone #4, the remaining exceptional measures should be implemented. (note that the shape of the curves are for illustrative purposes only)

- An improved volume-of-runoff forecast, which incorporates snow data transmitted by automatic recording gages, can be made as early as January and in subsequent months. These forecasts then may allow surplus sales to begin earlier in the year with no jeopardy to firm energy load requirements.

The consultants agree that the data supplied to the La Régie by Hydro-Québec lacks information pertaining to the raw volume-of-runoff data. The data La Régie currently receives has already been converted to equivalent TWh.

The consultants suggest an alternative model for consideration that has been successfully used in the Pacific Northwest for over 25 years. Although the alternative model suggested uses energy as its primary parameter, and is thus similar to the data currently reported by Hydro-Québec, it is superior in that it includes a running accounting of the system condition on a weekly basis. Included are (a) actual reservoir system status compared to the first-year critical rule curve, and (b) the rule curves based on forecasted runoff. In the Columbia River System, secondary sales are proscribed if the system is forecasted to be not full by July 31. A sample report is attached as Appendix D.[44]

5.4 Public Information Brochure

In order to insure that the general public is well informed on the issues relating to water reserves management and to their adequacy in meeting the energy requirements, Hydro-Québec should also prepare a public information brochure explaining the principles of operation of their power system, and in particular their hydropower system. *The Columbia River System: The Inside Story*[45] is an example of the type of information that could be provided.

Key elements would be

- a description of how the reservoir system is operated to carry over excess runoff in the spring and summer to meet loads in the low-flow heavy-demand winter months, and

- a description of how that water is carried over from high rúnoff years to low runoff years, or from one low runoff years to other low runoff years.

Hydro-Québec's strategy of selling non-firm energy in periods of adequate runoff in order to

[44] Note that energy values in Appendix D are specified in average megawatts or megawatt-months instead of the more usual MWh or TWh.
[45] Published jointly by the Bonneville Power Administration, the U.S. Corps of Engineers, and the U.S. Bureau of Reclamation.

generate additional income should also be explained, in general terms.

Emphasis should be placed on the fact that runoff varies markedly from year to year, which causes wide variations year-to-year in both reservoir elevation and income from non-firm sales. This is an inherent characteristic of a hydro-dominated power system, and the public should not get alarmed when this occurs, as long as a strategy for protecting against periods of low flow has been established.

Hydro-Québec's energy reserve criteria should be explained to show how the utility is actively protecting against periods of drought. The report should describe by example the exceptional measures that are available and how they would be implemented if necessary.

The fact that it is not economically feasible to protect against all possible conditions should be pointed out, as well as what measures would be implemented if a sequence of flows that is worse than that defined by the criteria should occur.

The brochure should also describe how sales income from different classes of sales (domestic firm, firm exports, and non-firm) all contribute to Hydro-Québec's financial picture, and how this income can vary from year to year depending on streamflows. Include a discussion of the impact of non-firm sales and periods of low runoff on rates.

Finally, it should describe the role of the La Régie in monitoring Hydro-Québec's operation to insure that the utility is operating in the best interest of the public.

Hydro-Québec's 1992 report *Follow-up of Development Plan: 1990-1992, Horizon 1999: Specific Report - Runoff* would be a good starting point for such a brochure. Equally important to the preparation of the brochure is its widespread distribution to the media, libraries, and educational institutions, as well as to all other interested groups and individuals.

[redacted]

APPENDICES

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Appendix A	Map of Hydro-Québec System	A-1
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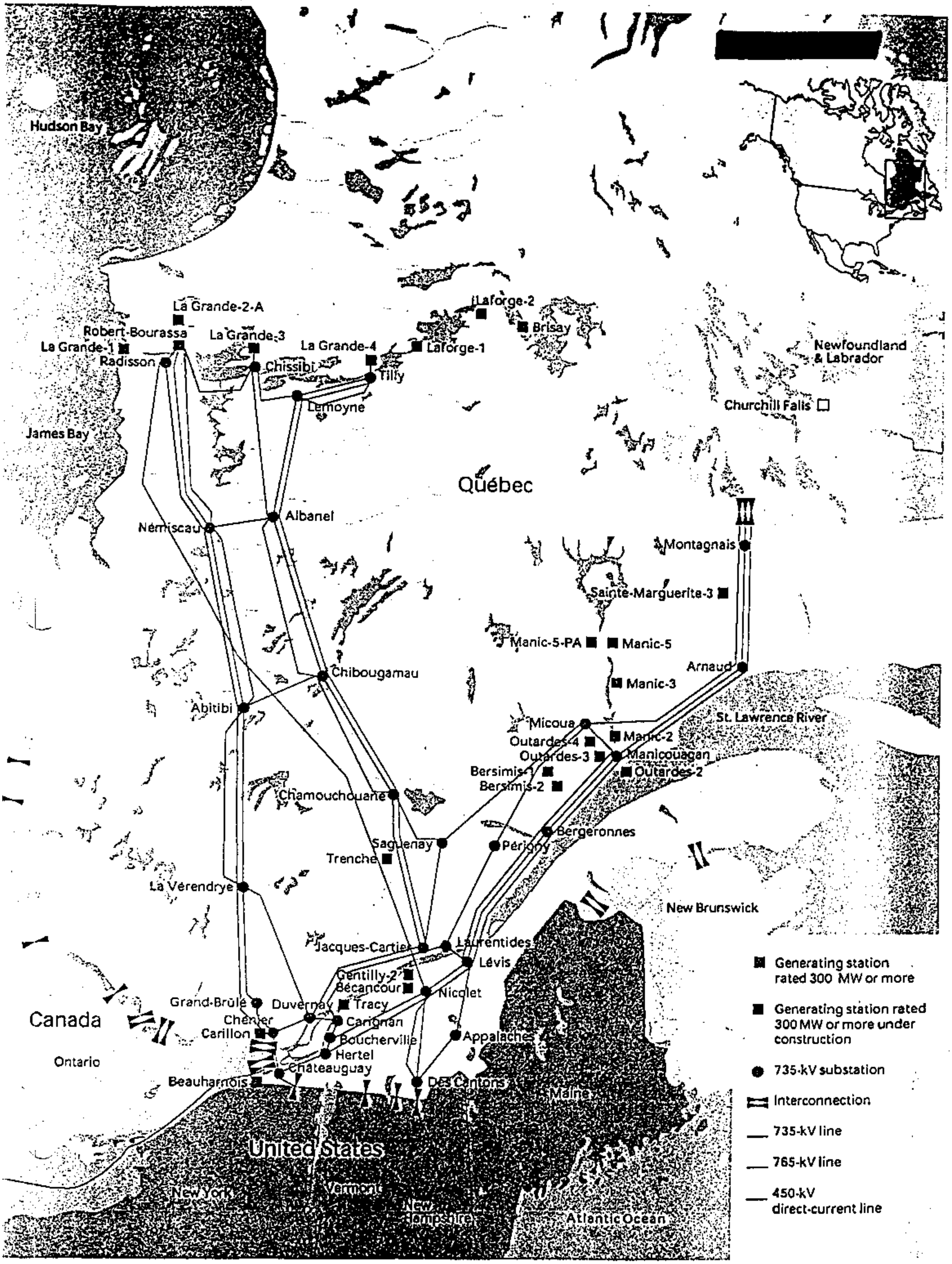
Appendix C	Probability Spreadsheets Referred to in Section 4-3b	C-1
Appendix D	Reservoir Status Report for Northwest Power Pool	D-1

18 December 1995


[redacted]
Hudson Bay
James Bay
La Grande-2-A
Robert-Bourassa
La Grande-1
Radisson
La Grande-3
Chissibi
La Grande-4
Tilly
Lemoyne
Laforge-2
Brisay
Laforge-1
Newfoundland & Labrador
Churchill Falls
Québec
Nemiscau
Albanel
Montagnais
Sainte-Marguerite-3
Manic-5-PA
Manic-5
Arnaud
Manic-3
Chibougamau
Abitibi
St. Lawrence River
Micoua
Manic-2
Outardes-4
Outardes-3
Manicouagan
Outardes-2
Bersimis-1
Bersimis-2
Chamouchouane
Bergeronnes
Saguenay
Périgny
Trenche
La Vérendrye
New Brunswick
Jacques-Cartier
Laurentides
Lévis
Gentilly-2
Bécancour
Nicolet
Grand-Brûlé
Duvernay
Tracy
Chénier
Carignan
Carillon
Boucherville
Hertel
Appalaches
Châteauguay
Beauharnois
Des Cantons
Canada
Ontario
Maine
United States
New York
Vermont
New Hampshire
Atlantic Ocean
Generating station rated 300 MW or more
Generating station rated 300 MW or more under construction
735-kV substation
Interconnection
735-kV line
765-kV line
450-kV direct-current line

[redacted]

APPENDIX B
USE OF RESERVOIR STORAGE: 11/1998-4/2002
CASE 1: TWO-YEAR WORST CASE FLOWS

		Starting Storage TWh	Inflow TWh	Demand TWh	Extraord. Measures TWh	EOM Storage TWh	Change in Storage TWh
1998	Oct	--	--	--	--	78.0	--
	Nov	78.0	14.5	16.5	0.5	76.5	-1.5
	Dec	76.5	10.1	19.3	0.5	67.8	-8.7
1999	Jan	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Feb	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Mar	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Apr	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	May	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Jun	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Jul	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Aug	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Sep	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Oct	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Nov	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Dec	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2000	Jan	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Feb	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Mar	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Apr	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	May	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Jun	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Jul	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Aug	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Sep	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Oct	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Nov	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Dec	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2001	Jan	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Feb	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Mar	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Apr	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	May	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Jun	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Jul	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Aug	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Sep	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Oct	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Nov	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Dec	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2002	Jan	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Feb	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Mar	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Apr	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
CY 1999	Totals	[redacted]	[redacted]	188.9	[redacted]	[redacted]	[redacted]
CY 2000	Totals	[redacted]	[redacted]	189.1	[redacted]	[redacted]	[redacted]
CY 2001	Totals	[redacted]	[redacted]	189.8	[redacted]	[redacted]	[redacted]
5/99-4/00	Totals	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
5/00-4/01	Totals	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
5/01-4/02	Totals	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

APPENDIX B
USE OF RESERVOIR STORAGE: 11/1998-4/2002
CASE 2: THREE-YEAR WORST CASE FLOWS

		Starting Storage TWh	Inflow TWh	Demand TWh	Extraord. Measures TWh	EOM Storage TWh	Change in Storage TWh
1998	Oct	--	--	--	--	78.0	--
	Nov	78.0	14.5	16.5	0.5	76.5	-1.5
	Dec	76.5	10.1	19.3	0.5	67.8	-8.7
1999	Jan	[redacted]					
	Feb	[redacted]					
	Mar	[redacted]					
	Apr	[redacted]					
	May	[redacted]					
	Jun	[redacted]					
	Jul	[redacted]					
	Aug	[redacted]					
	Sep	[redacted]					
	Oct	[redacted]					
	Nov	[redacted]					
	Dec	[redacted]					
2000	Jan	[redacted]					
	Feb	[redacted]					
	Mar	[redacted]					
	Apr	[redacted]					
	May	[redacted]					
	Jun	[redacted]					
	Jul	[redacted]					
	Aug	[redacted]					
	Sep	[redacted]					
	Oct	[redacted]					
	Nov	[redacted]					
	Dec	[redacted]					
2001	Jan	[redacted]					
	Feb	[redacted]					
	Mar	[redacted]					
	Apr	[redacted]					
	May	[redacted]					
	Jun	[redacted]					
	Jul	[redacted]					
	Aug	[redacted]					
	Sep	[redacted]					
	Oct	[redacted]					
	Nov	[redacted]					
	Dec	[redacted]					
2002	Jan	[redacted]					
	Feb	[redacted]					
	Mar	[redacted]					
	Apr	[redacted]					
CY 1999	Totals	[redacted]		188.9	[redacted]		
CY 2000	Totals	[redacted]		189.1	[redacted]		
CY 2001	Totals	[redacted]		189.8	[redacted]		
5/99-4/00	Totals	[redacted]					
5/00-4/01	Totals	[redacted]					
5/01-4/02	Totals	[redacted]					

[redacted]

APPENDIX B
USE OF RESERVOIR STORAGE: 11/1998-4/2002
CASE 3: AVERAGE FLOWS

		Starting Storage TWh	Inflow TWh	Demand TWh	Extraord. Measures TWh	EOM Storage TWh	Change in Storage TWh
1998	Oct	--	--	--	--	78.0	--
	Nov	78.0	14.5	16.5	0.5	76.5	-1.5
	Dec	76.5	10.1	19.3	0.5	67.8	-8.7
1999	Jan	[redacted]					
	Feb						
	Mar						
	Apr						
	May						
	Jun						
	Jul						
	Aug						
	Sep						
	Oct						
	Nov						
	Dec						
2000	Jan						
	Feb						
	Mar						
	Apr						
	May						
	Jun						
	Jul						
	Aug						
	Sep						
	Oct						
	Nov						
	Dec						
2001	Jan						
	Feb						
	Mar						
	Apr						
	May						
	Jun						
	Jul						
	Aug						
	Sep						
	Oct						
	Nov						
	Dec						
2002	Jan						
	Feb						
	Mar						
	Apr						
CY 1999	Totals	[redacted]	[redacted]	188.9	[redacted]	[redacted]	[redacted]
CY 2000	Totals	[redacted]	[redacted]	189.1	[redacted]	[redacted]	[redacted]
CY 2001	Totals	[redacted]	[redacted]	189.8	[redacted]	[redacted]	[redacted]
5/99-4/00	Totals	[redacted]					
5/00-4/01	Totals						
5/01-4/02	Totals						

31 December 1998

[redacted]

APPENDIX B
USE OF RESERVOIR STORAGE: 11/1998 - 4/2002
CASE 4: CORRELATED INFLOWS

		Starting Storage TWh	Inflow TWh	Demand TWh	Extraord. Measures TWh	EOM Storage TWh	Change in Storage TWh
1998	Oct	--	--	--	--	78.0	--
	Nov	78.0	14.5	16.5	0.5	76.5	-1.5
	Dec	76.5	10.1	19.3	0.5	67.8	-8.7
1999	Jan	[redacted]					
	Feb	[redacted]					
	Mar	[redacted]					
	Apr	[redacted]					
	May	[redacted]					
	Jun	[redacted]					
	Jul	[redacted]					
	Aug	[redacted]					
	Sep	[redacted]					
	Oct	[redacted]					
	Nov	[redacted]					
	Dec	[redacted]					
2000	Jan	[redacted]					
	Feb	[redacted]					
	Mar	[redacted]					
	Apr	[redacted]					
	May	[redacted]					
	Jun	[redacted]					
	Jul	[redacted]					
	Aug	[redacted]					
	Sep	[redacted]					
	Oct	[redacted]					
	Nov	[redacted]					
	Dec	[redacted]					
2001	Jan	[redacted]					
	Feb	[redacted]					
	Mar	[redacted]					
	Apr	[redacted]					
	May	[redacted]					
	Jun	[redacted]					
	Jul	[redacted]					
	Aug	[redacted]					
	Sep	[redacted]					
	Oct	[redacted]					
	Nov	[redacted]					
	Dec	[redacted]					
2002	Jan	[redacted]					
	Feb	[redacted]					
	Mar	[redacted]					
	Apr	[redacted]					
CY 1999	Totals	[redacted]		188.9	[redacted]		
CY 2000	Totals	[redacted]		189.1	[redacted]		
CY 2001	Totals	[redacted]		189.8	[redacted]		
5/99-4/00	Totals	[redacted]					
5/00-4/01	Totals	[redacted]					
5/01-4/02	Totals	[redacted]					

[redacted]

APPENDIX C: PART 1

PROBABILITY OF AN ENERGY SHORTAGE FOR THE HYDRO-QUEBEC SYSTEM FOR THE PERIOD MAY 1999 - APRIL 2001

1. The demand figures used by HQ are total requirements, i.e., firm sales within Quebec, firm sales outside Quebec, non-firm sales outside Quebec, deliveries per agreement, and transmission losses.
2. The exceptional measures contemplated by HQ include purchases, operation of the Tracy oil-fired plant, and reduction in non-firm sales.
3. The beginning storage level on May 1, 1999 was based on actual storage levels as of November 1, 1998 and estimated demands and supply until May 1, 1999.

All figures except for probability values are in TWH.

Year	Month	Demand	Hydro	Thermal	Exceptional Measures	Ending Storage
1999	May	[redacted]				
	Jun					
	Jul					
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
2000	Jan					
	Feb					
	Mar					
	Apr					
	May					
	Jun					
	Jul					
	Aug					
	Sep					
	Oct					
	Nov					
	Dec					
2001	Jan					
	Feb					
	Mar					
	Apr					

[redacted]

PROBABILITY OF AN ENERGY SHORTAGE FOR THE HYDRO-QUEBEC SYSTEM FOR THE PERIOD MAY 1999 - APRIL 2001
(continued)

Beginning Storage - May 1, 1999	[redacted]
Ending Storage - Apr 30, 2001	
Reservoir Drawdown	
Total Demand - May 1999 - April 2001	
Total Supply - May 1999 - April 2001	
Thermal and other	[redacted]
Exceptional measures	
Hydro available	
Hydro needed[1]	
Hydro variation from normal which would allow Hydro-Quebec to meet demand	65
Probability of a hydro variation equal to or greater than the "allowed" variation	0.02

[1] Hydro-Quebec's "needed" hydro equals total demand less supply available from drawdown, thermal and other, and exceptional measures. Demand could have been met if the variation had been 65 TWh during the two year period, rather than the 64 TWh which is part of the energy reliability criteria. The probability of a 65 TWh variation or more is .021.

[redacted]

APPENDIX C: PART 2

PROBABILITY OF ENERGY SHORTAGE DURING 2 YEAR CRITICAL PERIOD AS A FUNCTION OF BEGINNING STORAGE AND TOTAL DEMAND

Note: All values in TWH except the probability figures

Demand - First year	170	170	170	170	170	170
Demand - Second year (Yr 1 x 1.015)	173	173	173	173	173	173
Hydro supply - First year	141	141	141	141	141	141
Hydro supply - Second year	155	155	155	155	155	155
Thermal and other supply - First year	12	12	12	12	12	12
Thermal and other supply - Second year	12	12	12	12	12	12
Desired minimum storage	10	10	10	10	10	10
Beginning year storage	25	30	35	40	45	50
Maximum drawdown	15	20	25	30	35	40
Total demand - two years	343	343	343	343	343	343
Total supply - two years						
Thermal and other	24	24	24	24	24	24
Hydro "needed"[2]	304	299	294	289	284	279
Variation from average two year hydro supply associated with hydro "needed"	56	61	66	71	76	81
Probability of a two year variation equal to or greater than the variation shown	.040	.028	.020	.013	.009	.006

[2] See definition of hydro "needed" in footnote on page C-2.

[redacted]

PROBABILITY OF ENERGY SHORTAGE DURING 2 YEAR CRITICAL PERIOD AS A FUNCTION OF BEGINNING STORAGE AND TOTAL DEMAND
(continued)

Note: All values in TWH except the probability figures

Demand - First year	180	180	180	180	180	180
Demand - Second year (Yr 1 x 1.015)	183	183	183	183	183	183
Hydro supply - First year	141	141	141	141	141	141
Hydro supply - Second year	155	155	155	155	155	155
Thermal and other supply - First year	12	12	12	12	12	12
Thermal and other supply - Second year	12	12	12	12	12	12
Desired minimum storage	10	10	10	10	10	10
Beginning year storage	35	40	45	50	55	60
Maximum drawdown	25	30	35	40	45	50
Total demand - two years	363	363	363	363	363	363
Total supply - two years						
Thermal and other	24	24	24	24	24	24
Hydro "needed"[3]	314	309	304	299	294	289
Variation from average two year hydro supply associated with hydro "needed"	46	51	56	61	66	71
Probability of a two year variation equal to or greater than the variation shown	.075	.055	.040	.028	.020	.013

[3] See definition of hydro "needed" in footnote on page C-2.

[redacted]

APPENDIX C: PART 3

PROBABILITY OF ENERGY SHORTAGES FOR THE TWO YEAR PERIODS SHOWN BASED ON APPROXIMATE MAY 1 STORAGE AND ESTIMATED FIRM DEMAND

Note: All values in TWh except the probability figures

	1993-94	1994-95	1995-96	1996-97
Demand - First year	165.7	168.0	170.8	173.3
Demand - Second year	168.0	170.8	173.4	176.4
Hydro supply - First year	141	141	141	141
Hydro supply - Second year	155	155	155	155
Thermal and other supply - First year	12	12	12	12
Thermal and other supply - Second year	12	12	12	12
Desired minimum storage	10	10	10	10
Beginning year storage	70	58	70	46
Maximum drawdown	60	48	60	36
Total demand - two years	334	339	344	350
Total supply - two years				
Thermal and other	24	24	24	24
Hydro "needed"[4]	250	267	260	290
Variation from average two year hydro supply associated with hydro "needed"	110	93	100	70
Probability of a two year variation equal to or greater than the variation shown	0.000	0.002	0.001	0.014

Notes:

1. Assumed annual firm demand = total energy requirements for the year - short term sales. The result is slightly high, since the losses associated with the short-term sales were not considered.
2. May 1 reservoir storage in percent from "General Description of the Hydro-Quebec System"
3. With the beginning storage each year, compute the maximum permissible drawdown. The two-year demand minus the permissible drawdown minus thermal equals the needed hydro. This "needed" hydro was subtracted from 360 TWH to arrive at a two-year variation. Given a standard deviation of about 32 TWH, for each two year period the number of standard deviations was computed and the probability of a variation of this magnitude computed. For example, in the years 1993-94 a variation of 110 TWH or more would have been required for the minimum storage level of 10 TWH to have been reached. This variation is equal to 3.44 standard deviations; the probability of such a variation approaches zero.

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[4] See definition of hydro "needed" in footnote on page C-2.

[redacted]

NORTHWEST POWER POOL

26 SW SALMON STREET, SUITE 400
PORTLAND, OREGON 97204
PHONE 503-464-2801 FAX 503-464-2819

June 25, 1998

OPERATING COMMITTEE

Paul Adams
Darrel VanCoevering
Ken Johnson
Hank LuBean
Alan Dunn
Damon McCauley
Roger Nelson
Greg Lange
Vern Porter
LeRoy Patterson
Tarcy Lee
Frank Afranji
Mike Hunter
Mike Sinowitz
Carolyn Bonari
Keith Morisette
Stan Gordeyko
Terry Kent
Randy Cloward
Rick Spyker

B. C. Hydro & Power Authority
Bonneville Power Administration
Chelan County PUD #1
Douglas County PUD #1
Edmonton Power
Enron Power Marketing, Inc.
Eugene Water & Electric Board
Grant County PUD #2
Idaho Power Company
Montana Power Company
PacifiCorp
Portland General Electric Company
Puget Sound Energy
Seattle City Light
Sierra Pacific Power Company
Tacoma City Light
TransAlta Utilities Corporation
U. S. Bureau of Reclamation
Washington Water Power Company
West Kootenay Power

OPERATING NOTES

The Pool weighted average temperature for the week ending Wednesday, May 20, 1998 was 53.1°F. This is 1.9° below Normal and 1.3° below the previous week.

Compared with the previous week, the Pool energy load of 36,389 MW increased 29 MW; and the Pool non-coincidental peak load of 42,367 MW decreased 19 MW. For the month of May, area energy and peak loads are 104% and 97% of the Pool forecast.

The reservoir data for May 27 is the latest available and is attached.

Only one copy of the Operating Notes is being sent to each Operating Committee member.

Deborah Martinez

Attachments
cc: Bob Eastman, CASSO
Cindy Henriksen, U.S. Corps of Engineers
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[redacted]

NORTHWEST POWER POOL
SUMMARY OF COORDINATED OPERATION
Week Ending Wednesday, May 20, 1998

6/24/98

UTILITY	Area Load (1)	Borderline & Other Load	System Load (2)	Natural Flow	Storage Draft	Total Area Hydro	Thermal	Misc. Resources	Net Area Intch.	Control Error
ENERGY - Avg. MW										
B C Hydro	5610.0	38.4	5648.4	8939.6	-5104.2	3835.4	379.4	321.2	-1084.0	
BPA - USCE - USBR	5411.3	675.6	6086.9	22846.5	-10618.5	12228.0	69.1	62.2	6948.0	
Chelan PUD	401.4	0.0	401.4	875.6	-386.4	489.2			87.8	
Douglas PUD	139.3	-15.4	123.9	413.2	-186.9	226.3			87.0	
Edmonton Power	730.0	0.0	730.0			0.0	1242.4		512.4	
Eugene	283.9	2.4	286.3	154.9	-51.8	103.1		35.7	-145.1	
Grant PUD	307.6	31.5	339.1	2045.1	-1664.2	380.9		5.5	78.8	
Idaho	1532.1	-165.3	1366.8	1567.1	8.0	1575.1	391.4	119.8	554.2	
Montana	991.2	-65.8	925.4	627.2	-73.6	553.6	558.5	84.1	205.0	
PacifiCorp	6836.4	-1423.3	5413.1	1707.4	-626.1	1081.3	5024.3	141.0	-589.8	
Portland G E	2123.7	36.7	2162.4	1338.3	-592.6	745.7	185.4	31.4	-1161.2	
Puget Power	2405.0	-44.6	2360.4	2123.4	-996.2	1127.2	542.3	146.3	-589.2	
Seattle	1023.4	24.7	1048.1	1199.1	-334.6	864.5	24.5	141.1	6.7	
Sierra Pacific	1097.3	-107.2	990.1	8.6		8.6	558.9	118.3	-411.5	
Tacoma	602.0	0.0	602.0	426.3	-217.8	210.5	45.2	37.9	-308.4	
TransAlta - AP - CMH	4754.5	-33.3	4721.2	180.5		180.5	3878.7	10.0	-685.3	
Washington	1674.1	-800.0	874.1	1329.7	-510.9	818.8	215.3	76.8	-563.2	
West Kootenay	465.3	5.4	470.7	645.0		645.0			179.7	
TOTAL POOL	36388.5	-1838.2	34550.3	46429.5	-21355.8	25073.7	13115.4	1321.3	3121.9*	

* Includes 3121.6 MW Interchange with adjacent Areas and Pools.

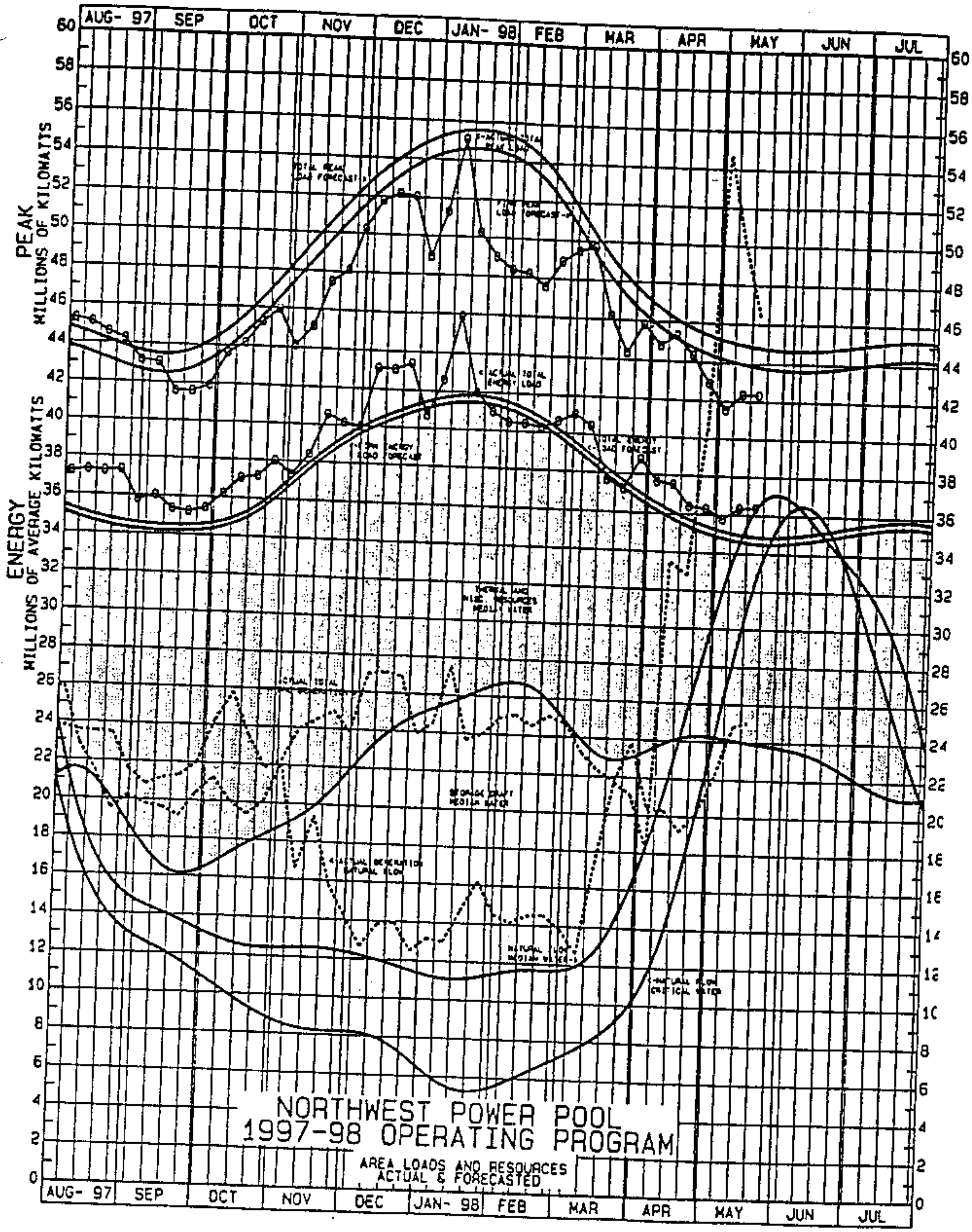
UTILITY	Area Load (1)	Borderline & Other Load	System Load (2)	Natural Flow	Storage Draft	Total Area Hydro	Thermal	Misc. Resources	Net Area Intch.	Control Error
PEAK (Non-Coincidental) - MW										
B C Hydro	6631.0	35.0	6666.0	5486.0		5486.0	297.0	249.0	-599.0	0
BPA - USCE - USBR	6426.0	755.0	7181.0	14643.0		14643.0	65.0	77.0	8359.0	3
Chelan PUD	392.0	0.0	392.0	380.0		380.0			-12.0	0
Douglas PUD	168.0	-16.0	152.0	283.0		283.0			115.0	-3
Edmonton Power	910.0	0.0	910.0			0.0	1382.0		472.0	
Eugene	362.0	3.0	365.0	158.0		158.0		36.0	-168.0	
Grant PUD	344.0	37.0	381.0	507.0		507.0		6.0	169.0	+10
Idaho	1764.0	-135.0	1629.0	1679.0		1679.0	451.0	112.0	478.0	2
Montana	1131.0	-74.0	1057.0	558.0		558.0	522.0	89.0	38.0	-6
PacifiCorp	7922.0	-1533.0	6389.0	1248.0		1248.0	5202.0	107.0	-1365.0	-37
Portland G E	2627.0	37.0	2664.0	961.0		961.0	291.0	13.0	-1362.0	7
Puget Power	3055.0	-45.0	3010.0	1146.0		1146.0	582.0	133.0	-1194.0	-17
Seattle	1249.0	28.0	1277.0	884.0		884.0	15.0	140.0	-210.0	-75
Sierra Pacific	1215.0	-105.0	1110.0	9.0		9.0	692.0	114.0	-400.0	4
Tacoma	746.0	5.0	751.0	332.0		332.0	52.0	40.0	-322.0	-5
TransAlta - AP - CMH	4983.0	-40.0	4943.0	325.0		325.0	4278.0	10.0	-370.0	-11
Washington	1884.0	-819.0	1065.0	950.0		950.0	359.0	76.0	-499.0	5
West Kootenay	558.0	6.0	564.0	648.0		648.0			90.0	
TOTAL POOL	42367.0	-1861.0	40506.0	30197.0	0.0	30197.0	14188.0	1202.0	3220.0*	

* Includes 3644.0 MW Interchange with adjacent Areas and Pools.

(1) A utility's total load within the confines of its interconnections. This could include borderline loads of other utilities in the utility's load area.

(2) Net load of a utility system, including all losses and imports, but excluding deliveries to other utilities in the Pool and outside the Pool; system load equals area load plus or minus borderline loads.

[redacted]



PEAK
MILLIONS OF KILOWATTS
ENERGY
MILLIONS OF AVERAGE KILOWATTS
AUG- 97
SEP
OCT
NOV
DEC
JAN- 98
FEB
MAR
APR
MAY
JUN
JUL
NORTHWEST POWER POOL
1997-98 OPERATING PROGRAM
AREA LOADS AND RESOURCES
ACTUAL & FORECASTED

[redacted]

NORTHWEST POWER POOL
COINCIDENTAL OPERATING RESERVE 6/25/98
HE 1100 PAST -- Monday, May 18, 1998

Utility	Spinning Reserve	Ready Reserve	Interruptible Scheduled	Interruptible Load	Total
BCHA	3573	635	0	0	4208
BPA	2085	1747	0	0	3832
CHPD	-9	44	0	49	84
DOPD	21	0	0	0	21
EP**	0	0	0	0	0
EWEB	8	0	0	0	8
GCPD	-2	23	0	0	21
IPC	111	0	50	0	161
MPC	241	1	25	0	267
PACE	77	0	371	0	448
PACW	478	15	0	0	493
PGE	97	137	0	0	234
PSPL	43	72	0	0	115
SCL	856	174	0	0	1030
SPP	79	117	0	0	196
TCL	195	279	0	0	474
TAUC	304	175	0	0	479
WWPC	74	126	-125	0	75
WKPL	43	0	0	0	43
TOTAL POOL	8274	3545	321*	49	12189

Total Pool Load (Coincidental) 37305

Total Scheduled NonPool Transfers (+ = Out) 4509

* A net of 321 Mw Interruptible was scheduled outside the Pool

** Reserves for EP are included in the TAUC data.

[redacted]

NORTHWEST POWER POOL
FUEL DATA
Week Ending Wednesday, May 20, 1998

1000 BARRELS OF OIL MILLION CUBIC FEET OF GAS

Utility	In Storage	Amount	Cumulative Bum From 8/01/97
Idaho	Oil	0.0	0.0
Washington	"	0.0	0.0
Puget Power	"	69.2	9.9
PacifiCorp	"	0.0	0.0
Port G E	"	NA	NA
B C Hydro	"	17.0	0.0
Sierra	"	176.9	18.4
Edmonton	"	0.0	0.0
	Total Oil	263.1	28.3
Washington	Gas	-	1664.2
Puget Power	"	-	2178.9
PacifiCorp	"	-	0.0
Port G E	"	-	NA
B C Hydro	"	-	9628.7
Sierra	"	-	23814.6
Edmonton	"	-	30936.6
	Total Gas		68223.0

1000 TONS OF COAL NUMBER OF DAYS IN CORE

Plant	Coal in Storage: No. of Days @ Norm. Bum Rate	Cumulative Burn From 8/01/97
Corette	12	332.9
Colstrip	24	8142.4
Carbon		530.7
Dave Johnston		3258.2
Hunter		3355.9
Huntington		2298.0
Naughton		2235.3
Wyodak		1177.0
Cholla		0.0
Bridger		6955.4
Centralia		4693.2
Boardman		NA
Sundance	35	8202.9
Wabamun	9	2382.4
Keephills	16	3123.7
Valmy	22	1147.3
Genesee	39	3120.8
Total Coal		50956.1

WNP-2		
Fuel left in core	0.0	
Fuel remaining until coastdown	0.0	241.1

[redacted]

STORAGE RESERVOIRS DATA
Week Ending Wednesday, May 27, 1998

Reservoir	Full	Rule Curve	ECC	Actual	Feet Draft From Full
American Falls	4354.5	(Irrigation Control)	0.0	4354.2	0.3
Amer. F. - MW-Mos.	0.0			0.0	
Bear Lake	5923.6	(Irrigation Control)	0.0	5921.2	2.5
Hebgen	6534.9	6534.9	6534.9	6532.3	2.6
Madison Gauge	9.5	9.5	9.5	9.5	
Canyon Ferry	3797.0	3797.0	3797.0	3790.5	6.5
Hungry Horse	3560.0	3529.3	3546.9	3547.9	12.1
Flathead	2893.0	2889.1	2889.1	2891.8	1.2
Noxon	2331.0	2326.2	2326.2	2327.6	3.4
Pend Oreille	2062.5	2057.7	2057.7	2062.2	0.3
Libby	2459.0	2434.9	2434.9	2431.8	27.3
Duncan	1892.0	1816.5	1834.7	1839.7	52.3
Kootenay	1745.3	1744.6	1745.4	1747.9	-2.6
Mica	2475.0	2403.9	2404.0	2415.9	59.1
Arrow Lakes	1444.0	1393.2	1416.5	1426.4	17.6
Coeur d'Alene	2128.0	2129.6	2129.6	2128.3	-0.3
Long Lake	1536.0	1535.0	1535.0	1535.4	0.6
Grand Coulee	1290.0	1280.1	1280.0	1284.9	5.1
Chelan	1100.0	1087.7	1088.7	1097.2	2.8
Brownlee	2077.0	2069.6	2069.6	2076.8	0.2
Dworshak	1600.0	1594.7	1594.7	1598.5	1.5
Upper Baker	724.0	717.6	717.6	719.6	4.4
Lower Baker	438.0	422.0	422.0	423.8	14.2
White	543.0	540.4	540.4	542.7	0.3
Ross	1602.5	1519.1	1566.0	1566.1	36.4
Alder	1207.0	1166.6	1207.0	1200.6	6.4
Cushman	738.0	642.4	727.4	734.3	3.7
Mossyrock	778.5	673.9	776.4	768.8	9.7
Swift	1000.0	913.3	998.7	998.5	1.5
Yale	490.0	472.3	489.0	487.5	2.5
Merwin	239.6	231.6	239.6	235.6	4.0
Klamath	4143.3	4142.2	4142.7	4143.1	0.2
Lemolo	4148.5	4142.4	4142.4	4147.6	0.9
Timothy	3190.0	3156.9	3184.3	3191.5	-1.5
Round Butte	1945.0	1923.8	1944.9	1944.6	0.4
Hills Creek	1541.0	1540.2	1540.2	1541.3	-0.3
Green Peter	1010.0	1009.4	1009.4	1010.7	-0.7
Foster	637.0	634.1	634.1	636.8	0.2
Cougar	1690.0	1688.4	1688.4	1690.7	-0.7
Detroit	1563.0	1563.0	1563.0	1563.5	-0.5
ookout Point	926.0	924.4	924.4	926.7	-0.7
Bridge River	2136.0	2136.0	2136.0	2089.7	46.3
Peace River	2205.0	2200.0	2200.0	2183.8	21.2

ERRATUM

Please note the following changes to the report titled « An Assessment of Hydro-Québec's Security of Supply in Accordance with their Energy Reliability Criteria » ("the Report") :

1. At Page 7 of the Report, the 3rd paragraph, which reads as follows:

> "Existing interconnections link Hydro-Québec to power grids in Ontario, New Brunswick, and the U.S., making it possible to sell electricity to neighboring systems and to import electricity as well. Hydro-Québec's export capability of 7,543 MW is greater than its import capability of 4,195 MW.[4]"

is replaced by the following paragraph:

> "Existing interconnections link Hydro-Québec to power grids in Ontario, New Brunswick, and the U.S., making it possible to sell electricity to neighboring systems and to import electricity as well. Hydro-Québec's export capability, which may vary between 5000 and 6000 MW, ~~7,543 MW~~ is greater than its import capability of approximately 4,195 MW.[4]"

2. At Page 13 of the Report, Section 2.2, Subsection a, which reads as follows:

> "**a. Criteria prior to 1991.** Prior to the drought of the late 1980's, Hydro-Québec's reservoir planning was based on recurrence of the most adverse sequence of streamflows that occurred during the historical streamflow period beginning in 1942. The "critical period" was found to be the four-year period 1960-1963. During this period, generation would have a cumulative shortfall of 100 TWh, compared to average generation (which was then 173 TWh annually).[13]"

is replaced by the following paragraph:

> "**a. Criteria prior to 1991.** Prior to the drought of the late 1980's, Hydro-Québec's reservoir planning was based on recurrence of the most adverse sequence of streamflows that occurred during the historical streamflow period beginning in 1942. The "critical period" was found to be the four-year period 1960-1963. During this period, generation would have a cumulative shortfall of 100 TWh, compared to average generation (which was ~~then~~ 173 TWh ~~annually~~).[13]"

3. At Page 14 of the Report, Subsection d, which reads as follows:

> "**d. The Excess Energy Reserve.** According to their 1992 study,[15] Hydro-Québec had, in addition to its base hydroelectric and non-hydro[16] resources, 12 TWh of "exceptional measures" which could be used to meet shortfalls in periods of extreme drought. These include measures such as purchases, running high-cost thermal generation, and buying back firm contracts."

is replaced by the following paragraph:

> "**d. The Excess Energy Reserve.** According to their 1992 study,[15] Hydro-Québec had, in addition to its base hydroelectric and non-hydro[16] resources, 12 TWh of "exceptional measures" which could be used to meet shortfalls in periods of extreme drought. These include measures such as purchases, running high-cost thermal generation, and buying back ~~firm contracts~~ commercial, institutional and industrial dual energy contracts."

4. At Page 27 of the Report, Subsection c, which reads as follows:

> "**c. Transmission Limitations.** Hydro-Québec's transmission interconnections permit export of up to 7,543 MW, but its import capabilities are limited to 4,195 MW. A recent change in these transfer capabilities has permitted a significant increase in Hydro-Québec' ability to both sell and buy energy."

is replaced by the following paragraph:

> "**c. Transmission Limitations.** Hydro-Québec's transmission interconnections permit export of ~~up to 7,543 MW~~ approximately 5,000 to 6,000 MW, but its import capabilities are limited to approximately 4,195 MW. A recent change in these transfer capabilities has permitted a significant increase in Hydro-Québec' ability to both sell and buy energy."

MANDAT VISANT LA SÉCURITÉ DES APPROVISIONNEMENTS

Contexte :

En vertu de sa Loi, la Régie de l'énergie a compétence exclusive pour surveiller les opérations d'Hydro-Québec afin de s'assurer que les consommateurs québécois aient des approvisionnements suffisants. Environ 97% de la production d'Hydro-Québec provient d'installations hydro-électriques, dont la moitié sont pourvues de réservoirs annuels ou multi-annuels. Le Québec connaît une période de sècheresse depuis le début des années 1990, et certaines inquiétudes ont été soulevées quant à la gestion des réserves hydrauliques.

La Régie de l'énergie a décidé en août dernier de procéder à un examen de l'état des réserves hydrauliques afin d'établir si la sécurité des approvisionnement est assurée à court et à moyen terme tout en respectant des critères de fiabilité établis. La Régie a obtenu des informations déposées de façon confidentielle par Hydro-Québec concernant les prévisions de l'offre, de la demande et de l'évolution des réserves hydrauliques selon des scénarios prédeterminés. La Régie souhaite à présent faire appel à deux experts externes afin de lui permettre de conclure sur l'état de la sécurité des approvisionnement à court et à moyen terme et d'élaborer un programme de suivi efficace.

Étendue du mandat : À partir des données fournies par la Régie, produire et présenter à la Régie un rapport contenant une analyse des faits et ses conclusions relativement :

a. à la suffisance des approvisionnements jusqu'en 2002,
b. au respect des critères de fiabilité en énergie, et
c. au programme de suivi que la Régie devra établir afin de s'assurer que les mesures adéquates sont entreprises par Hydro-Québec.

De plus, sur demande de la Régie, les experts devront demeurer disponibles pour témoigner en audience publique sur le contenu de leur rapport, à l'exception des données confidentielles qui ne pourront être dévoilées.

Échéance : Le 11 décembre 1998.

Support offert : La Régie s'engage à fournir toutes les données requises par les experts dans l'exécution de leur mandat.

Exigences particulières : Les experts seront tenus de respecter une entente de confidentialité qui leur sera soumise avec le mandat. Cette entente précisera que les données qui fournies par la Régie pour l'exécution du mandat et qui seront identifiées comme étant confidentielles ne pourront être dévoilées, en aucun cas, pour la durée déterminée par la Régie.

WATER RESOURCES ASSESSMENT MANDATE – DESCRIPTION AND SCOPE

Context :

The Province of Quebec's energy board, the *Régie de l'énergie* (« Régie »), pursuant to its Act, has the exclusive jurisdiction to monitor the operations of Hydro-Québec to ascertain that Quebec consumers are adequately supplied in energy. Approximately 97% of Hydro-Québec's production is from hydroelectric facilities, half of which are equipped with multi-annual reservoirs. Since 1990, the Province of Quebec has been through a relatively dry period, and a certain uneasiness regarding Hydro-Québec's water resources management has been noted.

The Régie decided last August to proceed with the assessment of the water resources situation in Quebec in order to establish whether the adequacy of energy supply is ensured in the short and medium term, and whether established energy reliability criteria have been respected. The Régie has obtained confidential information from Hydro-Québec regarding supply and demand forecasts as well as hydraulic reserve forecasts according to predetermined scenarios. The Régie wishes to retain two external experts in order to complete its assessement of the adequacy of supply in the short and medium term and to design an efficient reporting program.

Scope of the mandate : Based on data provided by the Régie, produce and present a report to the Régie which would include both an analysis of the data and conclusions in relation to :

a. the adequacy of energy supply until 2002,
b. whether the existing reliability criteria have been met, and
c. the reporting program which the Régie should put in place in order to ensure that appropriate measures have been taken by Hydro-Québec to meet the demand adequately.

In addition, upon request by the Régie, the experts should remain available to testify on the scope of their report in the course of a public hearing, except for information relating to confidential data which cannot be disclosed.

Due Date : 11 December 1998.

Available Ressources : The Régie undertakes to provide the data required by the experts to execute their mandate.

Other Requirements : The experts will be bound to a Confidentiality Agreement which will be provided along with the mandate. This agreement will indicate that the data provided by the Régie for the execution of the mandate and which will be identified as being confidential cannot, in any case, be disclosed until such time determined by the Régie.