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# ENGINEERING HISTORY PAPER #34

# "An Engineering Career in the Hydro-Electric Industry"

**by Leonard A. Bateman**
(previously published as EIC Working Paper 22/2004 – Jul 2004)

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EIC HISTORY AND ARCHIVES

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Abstract

Leonard Bateman is now in his mid-80s and is still serving engineering and the engineering profession. This Working Paper provides the 'first person' story of his long and varied career, from the pre-graduation years in Winnipeg, through distinguished service in the hydro-electric industry in Manitoba, to international post-retirement consulting and the presidency of the Canadian Society for Senior Engineers. Over the years, he developed many fruitful and useful contacts in the hydro-electric network business outside Canada, presented papers to national and international conferences, and took a leading role in the advancement and management of the technology used within his industry. This Paper also has three appendices, two of which provide basic information on the hydro-electric industry in Manitoba, while the third lists a selection of the papers the author has presented and published. A map precedes the Appendices.

About the Working Paper Series

In June 1995 the Council of the Engineering Institute of Canada agreed that Working Papers on topics related to its history and development, to the history and development of other institutions serving the engineering profession in Canada, and to engineering generally should be published from time to time.

These Papers have limited initial distribution, but a supply is maintained by the EIC History & Archives Committee for distribution on request. They are listed and summarized in the History & Archives section of the EIC's website (www.eic-ici.ca), and electronic copies may be obtained through this same source. The individual Papers may also be published later, in whole or in part, in other vehicles, but this cannot be done without the expressed permission of the Institute. The series is presently administered by the Publications Sub-Committee of the main Committee in co-operation with the executive director of the Institute.

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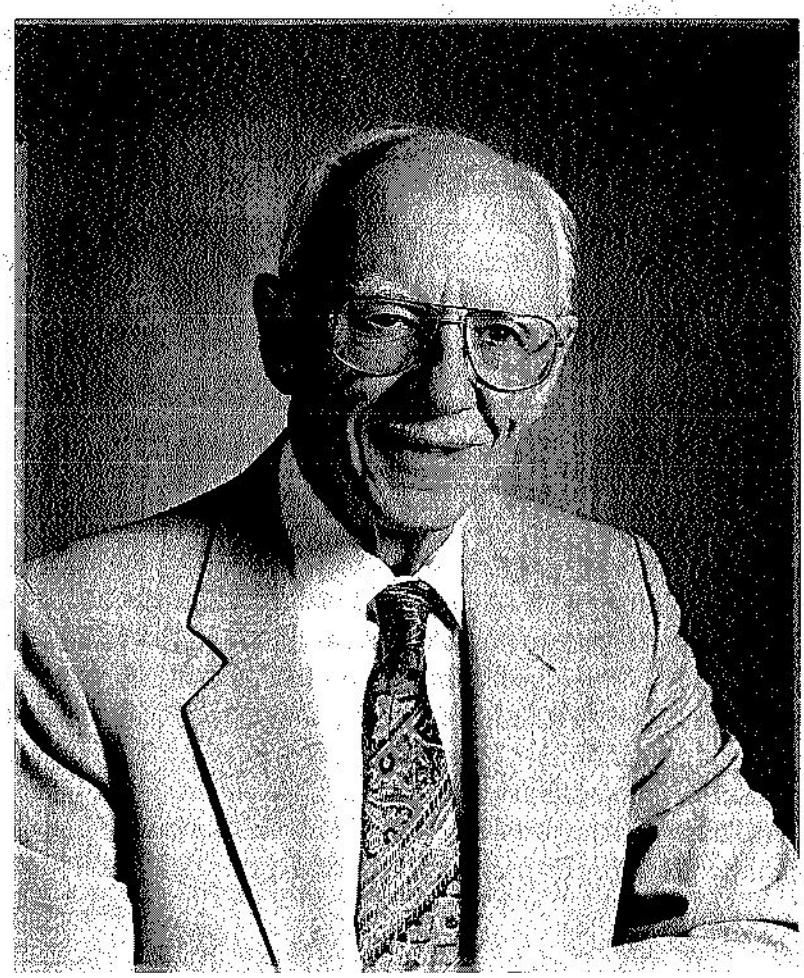
*The editors of this present Working Paper were Peter R. Hart and Andrew H. Wilson*

About the Author

Len Bateman was born in Winnipeg in 1919 and was educated there. His intention was to graduate in mining but, after his second year at the University of Manitoba, he switched to electrical engineering, graduating in 1942. He joined Winnipeg Hydro, working in its engineering office. He also enrolled for a master's degree, which he received in 1948. In 1952 he was named general superintendent in charge of production for Winnipeg Hydro. Late in 1956 he joined the staff of the Manitoba Hydro Electric Board to establish its planning department. Following the reorganization of the electrical power industry in the province in 1961, he was appointed one of five directors of the newly created Manitoba Hydro. His particular task was the organization of the production

division, which was responsible for the operation of the system, including direct responsibility for all generation and transmission. He also had responsibility for the design and operation of the system's communications. From then on, he was deeply involved in hydro developments in northern Manitoba. Len rose through the ranks of Hydro, becoming chairman and CEO in late 1972. On his retirement in January 1979 he became a consultant with an international practice and actively undertook work in this capacity until 1992. He served as an adjunct professor at the University of Manitoba in the 1980s, and is presently semi-retired. He was also the last chairman of the Life Members' Organization of the Engineering Institute of Canada and the first president of its successor, the Canadian Society for Senior Engineers, an EIC member society, stepping down from this latter position in May 2004.

Len Bateman has been elected a senior life member of the Institute of Electrical and Electronic Engineers and a Fellow and life member of the Engineering Institute of Canada. He is a past president of the Canadian Electrical Association, vice-president of the Canadian Nuclear Association, and chairman of the Canadian National Committee of CIGRE *(Conseil International des Grands Réseaux Électriques)*. He was awarded the Gold Medal of the Canadian Council of Professional Engineers in 1994, honorary life membership in the Association of Professional Engineers and Geoscientists of Manitoba in 2001, the Queen's Golden Jubilee Medal in 2003, and the Order of Manitoba, also in 2003.



## The Pre-GraduationYears

I was born in Winnipeg on January 14, 1919, educated in the public school system, and graduated from Grade XI with a high school leaving certificate in 1935. The Great Depression still dominated these times, so I decided to obtain some credits towards university entrance by taking advantage of the public school system's partial Grade XII program, which offered instruction in modern history, English and mathematics. However, this left plenty of time for other pursuits. For example, our teacher - Mr. C. A. E. Hensley - had built a photography laboratory with his own equipment, which he encouraged a few of us to use. I found this activity rewarding since my father had introduced me to film development at a very early age.

For me, this partial Grade XII program ended early in the year, as I was one of two students from Kelvin High School chosen for a career with the Royal Bank of Canada - at a starting salary of $400 a year. While this was not my idea of a job, I did last about five months in it. I then worked in a variety of jobs, including farming, harvesting, mining and surveying. It was while working with a surveyor that I became interested in the mineral claims we were surveying and in mining engineering. So, instead of playing poker with the 'gang' in the evenings, I helped the surveyor to do the computations. When this job was over, and in spite of having had no previous experience, I applied for a prospector's licence and staked some claims of my own. I carried the samples out on my back, through the muskeg, to have them analysed. During that winter, 1936-37, I worked on the CNR bridge and building gang.

All of these jobs pointed me in the direction of more education. The principal deficiencies in my academic background leading to the entrance qualifications for engineering were in physics, chemistry and a foreign language. To overcome these, I enrolled in the Collegiate Department of United College, now the University of Winnipeg, in the fall of 1937. At that time, I was set on becoming a mining engineer and attending McGill University after the second year at the University of Manitoba. For the foreign language, I chose German. This program kept me very busy.

It was a tough year, but I was successful - in spite of the dean having sent my father a letter after the October exams to say that, in view of my sub-par performance, he should withdraw me from the course and save his money! Since I was paying my own way, he simply handed me the letter without saying a word. Needless to say, I stopped hanging around with my friends, who were not in school, and got down to some serious studying. The dean's comments on the December exam were much more encouraging. By the end of the year, I had the highest marks in the chemistry class. But life was not all work. I participated successfully in long-distance cycling and in college extra-curricular activities such as the Drama Club. This Club's performance of the play *The Bishop's Candlesticks*, in which I played the bishop, was particularly memorable. The girl who made me up before each performance, Eileen Campbell, became my date at school dances and for several years afterwards. We were married in August 1943, after a six-year courtship.

My first year engineering courses at the University of Manitoba (UofM) began in September 1938 and were taken in the old Broadway Buildings in downtown Winnipeg. For the second year, we were

located at the University's Fort Garry Campus. For two years, I took special lectures in physical chemistry on Saturday mornings, as required for entrance to the mining course at McGill. I qualified for McGill with good marks, but several things happened to change my plans. First, World War II had started just as we began second year, but engineering students were advised to proceed with their education before joining up. Second, I had worked underground at Madsen Red Lake Gold Mine during the summer of 1940 and decided that mining was not really the career for me. For these, as well as financial reasons, I dropped the idea of going to McGill. Instead, I enrolled in electrical engineering at UofM - one of the three branches then offered.

Since it was wartime, students were enrolled in the Canadian Officers' Training Corps, and were assured of a commission on graduation. We were given regular military training along with our studies and were to spend the summer of 1941 training at Camp Shilo, east of Brandon. However, within a day of arrival there, we were subjected to a strict medical examination, which I failed because of a heart murmur resulting from having had rheumatic fever as a child. I was sent home. While heartbroken at this development, I was assured by the doctor that the country badly needed my services as an engineer to help with the war effort. So instead of military training, I was accepted by the city of Winnipeg's Pointe du Bois Power Plant to work there as a mechanical helper. This provided me with useful practical experience, and a promotion to electrical helper, which was especially useful for my chosen field.

In the fall of 1941 I returned to the University for my final year, during which I was involved in publishing *The Slide Rule*, the official yearbook of the UofM student engineering body. As it happened, the editor, along with many others in our class who were exempt from writing final exams, left to enter the service of their choice in March 1942, leaving me responsible for seeing the yearbook into print, which I did. However, to accommodate those leaving early, the Ceremony of the Iron Ring, or the Kipling Ritual as it was usually called, was held early in March. It was at this Ceremony that I was asked by the assistant chief engineer of Winnipeg Hydro, Herbert L. Briggs, if I would join the engineering office of the company after graduation. I accepted, and by doing so turned down an earlier offer of employment from the Canadian General Electric Company. And so began my long association with electrical engineering in public utilities in Manitoba.

## Winnipeg Hydro and Further Education[1]

My early years at Winnipeg Hydro, as the only electrical engineer not in management, were busy ones. I was involved in the design of water heater control programs to enable the utility to switch the water heater load off over the noon and evening peaks. Occasionally, we had to run the Amy Street thermal plant, with a capacity of 11 megawatts, to meet the peak demand in winter months. I was also involved in the design of the second half of the Slave Falls Generating Station, for which Hydro received permission from the Wartime Prices and Control Board to order the required steel in late

[1] Appendices 1 and 2 describe briefly the development of the corporate components of the electrical supply industry in Manitoba and some of its units. In addition, readers may wish to refer to WP 13/2003 *The Manitoba Electrical Museum and Education Centre* by Lindsay Ingram, dated March 2003.

1944.

One of my most interesting projects was designing the generator characteristics to ensure that they could energise the 138 kV transmission system, which was an integral part of the expansion of the Slave Falls plant. This was the first such system in Manitoba, and was chosen so that, in the event of a loss of transmission capacity from Pointe du Bois, the line between the two stations could re-route the power to Winnipeg.

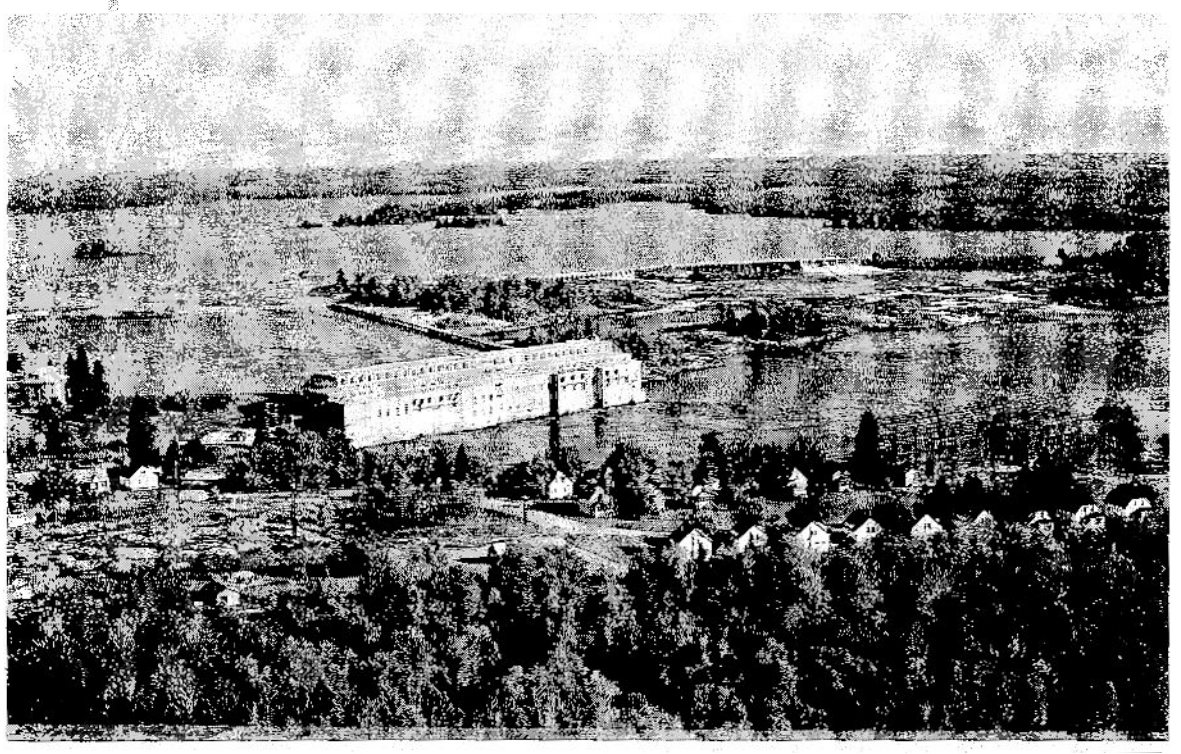
I also designed the autotransformer station at Pointe du Bois to connect with the Slave Falls transmission system and the new step-down autotransformer station in Winnipeg at the Scotland Avenue Terminal, which connected the 138 kV lines to the existing 69 kV network. All of this made for a heavy workload. Fortunately, when the war was over and we received some additional engineering help, I was able to concentrate on the Slave Falls expansion and the Pointe du Bois connection. It was all very valuable experience in design, specification writing and the supervision of construction. In those days, the managements of small utilities did not use consulting engineers, so I had to take full responsibility for my own designs.

Along with this engineering work, Mr. Briggs involved me at technical society meetings, such as those of the Engineering Institute of Canada, which I had joined in 1941 as a student member, by asking me to thank guest speakers. I was also presenting papers to the Electrical Section of the Winnipeg Branch of the Institute and became part of its management committee. Even so, I realized that I had limitations in non-engineering skills and enrolled in a university evening course in public speaking and in weekend courses in accounting and management. Later, I chaired the Business Development Committee of the Junior Chamber of Commerce.

I also realized quite quickly that there was much more to an engineering education than was included in a bachelor's degree course. So, in 1944, I enrolled as the only student in the electrical engineering master's program at UofM. When lectures occurred during working hours, I was given time off to attend, providing that it was made up after hours. I saw this as a very fair arrangement and, later in my career, at Manitoba Hydro, allowed my engineering staff to do the same. In 1948, after four very intense years of study and of full-time work designing and planning ways 'to keep the lights on' during the war years and after, I received an MSc degree from the University. My thesis was titled, *A Mathematical Investigation of the Relative Importance of Mutual Impedance in Short Circuit Calculations for Transmission Networks.*

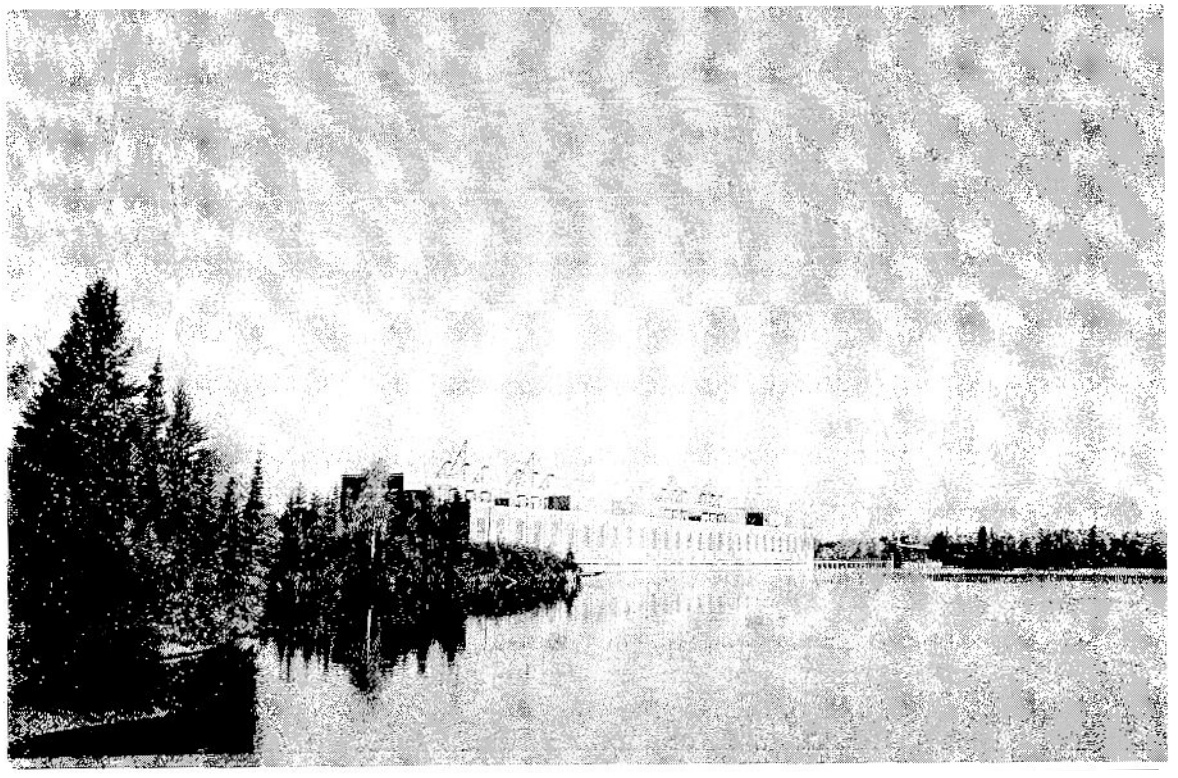
In 1948, I also joined the Association of Professional Engineers of Manitoba (APEM), later serving on its Council and as its president in 1958.

During the early postwar years, I was part of the Winnipeg Hydro team involved with the expansion of the supply of electric power in Manitoba. Especially as a result of the farm electrification program, growth in consumption in the province was very significant. Neither the private supplier, the Winnipeg Electric Company (WEC), nor its public competitor, Winnipeg Hydro, would accept responsibility for building the next generating station - at Pine Falls on the Winnipeg River - without



Pointe du Bois Generating Station: the oldest hydro plant on the Winnipeg River

Slave Falls Generating Station: downstream from Pointe du Bois



adequate guarantees from the provincial government. So the government itself undertook to build it through the Department of Natural Resources. Donald M. Stephens was deputy minister of the Department and became responsible for the project. However, with such rapid growth in demand and the difficulties involved in reaching agreement with the province, Winnipeg Hydro undertook, on its own initiative, to expand the Amy Street thermal plant by adding two new units of 15 and 25 MW to ensure that the city would not experience brownouts during periods of heavy demand in winter.

In the meantime, the government had been trying to reorganize the supply industry in the province. Plan C, as it was called, would have given Winnipeg Hydro responsibility for all distribution in the Greater Winnipeg area, and the Manitoba Power Commission, a Crown agency created in 1919 to deliver power to rural areas, would supply the rest of the province. The government also planned to create a new agency to be responsible for all power *generation* and, consequently, Hydro would be required to give up its two plants at Pointe du Bois and Slave Falls. However, these proposals did not meet with the approval of the Winnipeg city electorate. So the government created a new organization, the Manitoba Hydro Electric Board (MHEB) in 1951, with responsibility for providing for the *future* power requirements of the province. Don Stephens was named the first chairman of this Board.

Meanwhile, the first expansion at the Pine Falls station was already underway and was barely meeting the increasing power requirements resulting from the farm electrification program. Also, the new MHEB purchased the stock of the Winnipeg Electric Company - Winnipeg Hydro's private sector competitor - thereby obtaining the Seven Sisters and Great Falls plants on the Winnipeg River. The private company had been supplying power to the Manitoba Power Commission for distribution in the rural areas. Talks now got underway between the Board and the city of Winnipeg to eliminate competition within and outside the city. The proposal was for the Board to give its newly acquired customers in the city to the publicly owned utility and have the city give its customers outside the city to the Power Commission.

These talks consumed a great deal of time between 1948 and 1956 and involved the Hydro team of which I was a member. At the engineering level, we discussed how to interconnect the two operating systems to make them into a single one. Tests were conducted and the result was an interconnection that worked, involving some adjustments to the transformers at the various terminals. From an engineering point of view, the engineers from the two utilities worked to ensure that, if either of them got into serious difficulties, the other could provide the means to 'keep the lights on.'

One of my closest colleagues during these talks was Lindsay Hovey, who was the senior electrical engineer with WEC and, after the takeover, became assistant to the Board chairman and took charge of planning for the growth of the system. Although my senior by quite a few years, we co-operated closely on such matters as transformer design and on the mutual assistance procedures just mentioned. Fortunately, these were never needed. This co-operation facilitated our subsequent discussions on the interconnection of the two electrical systems.

Meanwhile, in 1948 I had been promoted to operating engineer, with responsibility for the operation and maintenance of the Winnipeg Hydro electrical system. In 1952 I was promoted again and was named general superintendent in charge of production for Hydro. This position made me responsible not only for the operation of the system, but also for all personnel in the operating and maintenance departments, and it was in this position that I participated in the talks mentioned above.

While the engineering staff of Hydro was unable to handle all the work that was included in the budget, I felt very strongly that fire protection for the equipment in the power plants should be provided. It was there, for example, that large quantities of transformer oil constituted a hazard I was not prepared to live with. The result was that, in addition to all my other duties, I undertook to plan, design and construct approved fire protection systems for the two Hydro plants. They were not quite finished when I left Winnipeg Hydro in late 1956.

But before then, as general superintendent I was also responsible for taking over the personnel and properties of WEC and transferring Winnipeg Hydro properties outside the city to the Manitoba Power Commission. The substations involved in supplying the Winnipeg Transit Company were also part of this arrangement. WEC had owned the transit facility, but the newly created MHEB gave it to the city of Winnipeg to be operated as a separate entity. Since Winnipeg Hydro supplied the DC power to run the trolley buses, it was necessary to compute the cost of maintaining these facilities. But once these one-time tasks were completed, things settled down in a more normal fashion.

While I was very busy around this time, combining my job with membership of the Council of APEM, I took the opportunity to look to the future. As I saw it, Winnipeg Hydro was a utility with little opportunity to grow except in the distribution business, and this was confined within the boundaries of the city of Winnipeg as they were in 1955. I felt the need, strongly, to seek a more challenging position in my field - and actively sought one.

In the fall of 1956, I read an advertisement, inserted in a local newspaper by the MHEB, for a systems planning engineer. The position and its requirements appeared to offer the kind of challenge I was seeking, and it was located in Winnipeg. I went to see Lindsay Hovey, by then a senior engineer with the Board, who told me that it intended to do its own planning in the future, rather than use consultants. The successful applicant would be working with him to organize a new planning department - something Hovey said I could easily do. He took me to see the chairman, Don Stephens, and left me with him. At the end of our meeting, Mr. Stephens offered me the job, provided my departure from Winnipeg Hydro could be amicably arranged with its senior management. I agreed to take responsibility for this. I also discussed the move with my wife, since it meant giving up certain fringe benefits that had been accumulating to my advantage and that of my family as a city employee. Appropriate arrangements were duly made and my resignation from Winnipeg Hydro became effective on 30 November 1956, by which time I had wound up my outstanding obligations.

## Manitoba Hydro Electric Board

The Board's offices were on the 10th and 11th floors of the Electric Railway Chambers in downtown Winnipeg. Mine was on the 10th, some distance from Lindsay Hovey, to whom I reported. He was a fine engineer and taught me a great deal, but preferred to leave administrative details to me while he concentrated on technical matters. We would occasionally travel together on Board business. We went, for example, to the General Electric Company in Schenectady, New York, to do expansion studies on its analogue AC network calculator. One aspect of this study involved interconnecting the combined Manitoba system with that of the northwest region of Ontario, also an isolated system. This eventually became the first interconnection between Manitoba and an adjacent utility I was involved with all the interconnections that occurred during my subsequent career with Manitoba Hydro. I should comment that the demands of such projects more than justified my having acquired a master's degree! On another occasion, I travelled to Vancouver on APEM business, with Don Stephens' approval, and while there mixed Board and Council business. Mr. Stephens had urged me to take a few extra days to become acquainted with the planning personnel of BC Hydro, as a result of which a valuable relationship was begun which served both utilities well in the years to come.

My appointment to the position of systems planning engineer, with a close relationship to Chairman Stephens through his deputy, Mr. Hovey, meant that special tasks were often referred to me by either of these gentlemen. Soon after I arrived at the Board's offices, I was given a copy of the capital budget by the Mr. Stephens and asked to review it. It had been put together by the engineering design division and I had not been party to its development or the need for the projects included in it. At the same time, planning as a function was in its very early stages at the Board. I found this to be a sensitive task because of the possibilities for conflict with the people in the division. But I think I asked enough intelligent questions to satisfy the chairman without alienating the division! Nevertheless, I felt there was a strained feeling between engineering people and the planning department that I was beginning to put together.

In doing this, I chose not to hire senior engineers, opting instead for recent graduates who were eager to learn and to accept new challenges. These young engineers took their assignment direction from me. One of them was Roy Billington, to whom I assigned reliability studies and who later became internationally known in this field. If any of them were experiencing problems and came for help, I always made time for them. If I could not provide the answer myself, I was able to consult engineers in other utilities across the continent, contacts that were the result of my participation in technical societies, through writing papers and attending technical meetings. To know who was working on the leading edge of a particular subject was extremely valuable.

Once my staff had mastered the fundamentals of planning, it was a relatively simple matter to apply them to the requirements of our electrical system. Each project was then priced for budget purposes by the engineering division. Unfortunately, this failed to remove all of the tensions that had developed between the two divisions. But in later years, when I had responsibility for all engineering functions, I was able to transfer people between divisions so that they would come to appreciate the work done by others. This proved to be successful in reducing the tensions.

One interesting job I had around this time was to investigate the possible interconnection of the Manitoba system with the one in Saskatchewan operated by the Saskatchewan Power Corporation (SPC). Working with an SPC colleague, William Reid, we were able to convince our respective utilities that economies were to be gained through an interconnection, such as between Brandon and Estevan. Initially, this would be done at 138 kV, but it would be designed for 230 kV operation when the conditions warranted. I undertook to draft an agreement for review by SPC, after an initial review by the MHEB manager who was presenting the proposal to our Board. The Board's vice-chairman, Donald A. Thompson, a partner in a leading Winnipeg law firm, also reviewed it. It was from him I learned that "in any legal document, you should say what you mean and mean what you say!" Needless to say, I was very explicit in any later legal document I drafted. It was also pleasing on some of these occasions to be asked which lawyer did the draft! In any event, SPC found little to question in the one I did for them, and it laid the foundations for several interconnections between Manitoba and Saskatchewan.

In 1950, a flood of major proportions occurred on the Red River and affected the city of Winnipeg very seriously: it came close to being evacuated. This prompted the provincial government to develop some short-term protection measures, such as the building of dykes and pumping stations to pump out the sewers and prevent back-up flooding. In 1955, the government appointed a Lakes Winnipeg and Manitoba Flood Control Board to study ways and means to alleviate the adverse effects of possible future flooding, not only for the city of Winnipeg, but also for the lakes as well. I was appointed by Chairman Stephens to work with the Flood Control Board on the Lake Winnipeg flooding and on future hydroelectric power developments in Manitoba. There was great public pressure to control the flooding of this lake since the damage in 1950 had been severe. It is interesting that the Board concluded that control of Lake Winnipeg was feasible, but was too expensive until some of the proposed power developments on the Nelson River in the north could occur to help share the costs.

My work with the Flood Control Board gave me the opportunity to identify and assess several bright and well qualified engineers who might work with me in the future. One of them was a German engineer, Karl Renger, with whom I later did some very interesting work on the Grand Rapids project and the Nelson River development. Another was Edward Kuiper, the chief engineer of the Board, who later joined the Faculty of Engineering at the University of Manitoba as a professor of hydraulics. He was a graduate of the University of Delft in Holland and earned his master's degree at the Massachusetts Institute of Technology. He later worked with me on a part-time basis on planning studies to determine the most economic way to develop the future growth of Manitoba's hydro-electric system.

During the late 1950s and the 1960s, I wrote and presented some interesting papers on the development of the power potential of the north, several of which are included in Appendix 3.

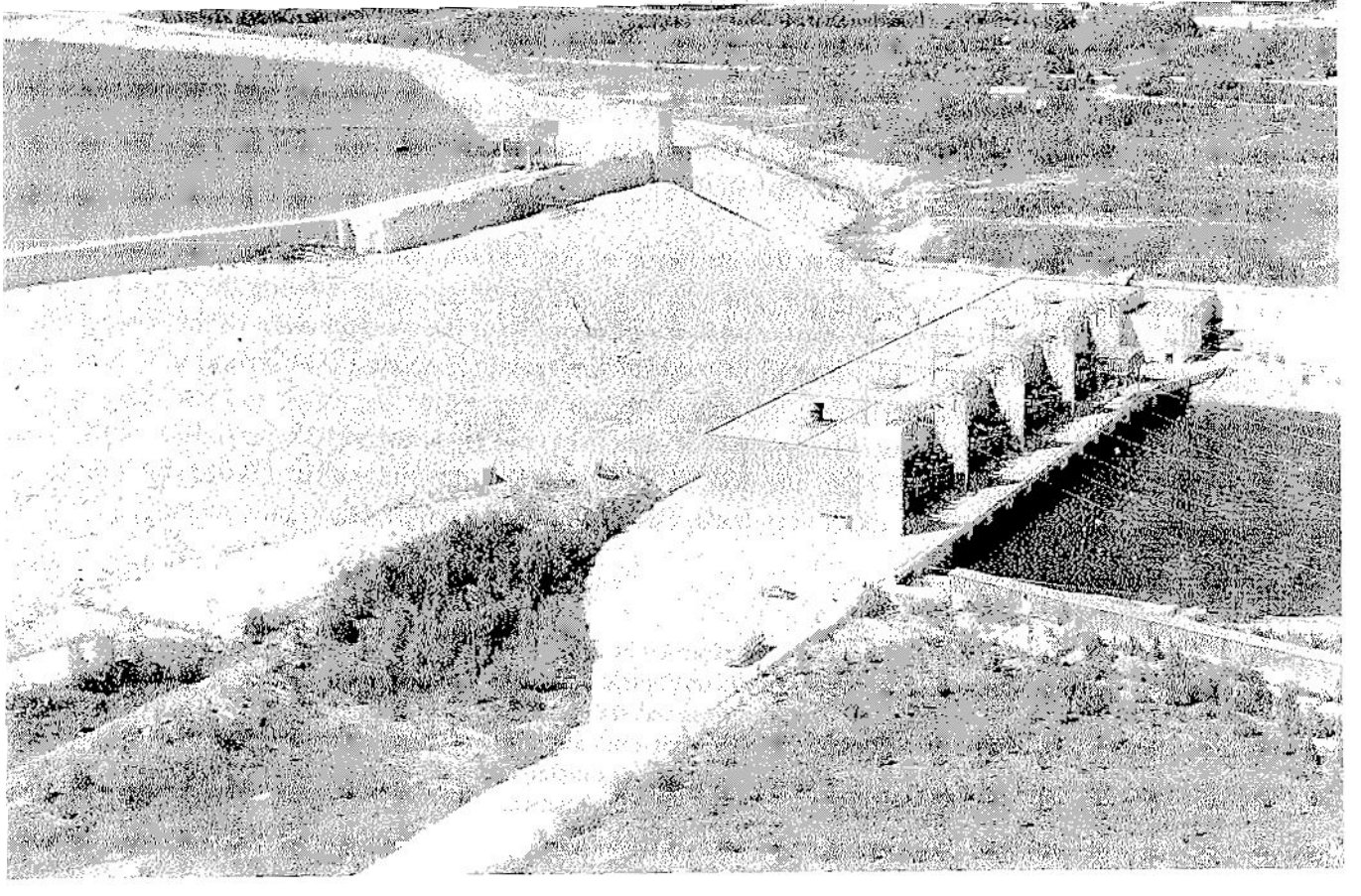
In January 1960, I was sent to the Banff School of Advanced Management for a six-week course. This helped me prepare for what lay ahead.

## Manitoba Hydro

In April 1961, I was appointed one of the five staff directors of the newly created Manitoba Hydro (MH), whose evolution has been described more fully in Appendix 1. In particular, I was asked to head up its production, operation and communication activities, with the title of director of production. This provided me with a new challenge, a seat on the Executive Committee, and occasional appearances before the Board of Directors. So began the process of integrating Manitoba's Power Commission and Hydro Electric Board, with attendant discussions on staff and functions. The new organization had come into being on 1 April 1961.

During the next few years, I managed to effect a good number of improvements to the older plants at Great Falls and Seven Sisters, which made the job of maintaining the equipment easier for the staff. But one of my new areas of responsibility was communication. It involved the design as well as the operation and maintenance of Hydro's communication system. For example, one of the challenges of keeping staff in remote northern communities was to provide them with some of the amenities found in the more populated regions, such as television. I found a way to do this for the staff at Grand Rapids with TV, the gift Hydro had received from New Brunswick Power for services we had rendered to it in the development of its own power system. We were able to raise a tower on

Grand Rapids Generating Station: where the Saskatchewan River empties into Lake Winnipeg



the highest point adjacent to the Grand Rapids community, pick up the signal from Baldy Mountain, the highest point in Manitoba, located in Duck Mountains Provincial Park, and cable it to the community. So the staff had TV - even though it was limited to one station!

In 1963 studies began involving the federal government and Hydro on ways and means to develop the Nelson River. The results were announced in 1966. They involved Manitoba in developing the Kettle Rapids site on the Nelson, the diversion of the Churchill River into the Nelson, and the control of Lake Winnipeg for the storage of water for the Nelson plants.

The federal government undertook to finance and build the HVDC transmission system from Kettle to Winnipeg, using Atomic Energy of Canada Ltd. (AECL). The government provided a low interest loan repayable by Manitoba Hydro when the load could support the payments. It was explained to me by AECL president Lorne Gray that his company had been chosen because it was the only federal agency that could spend money fast enough to suit the project! AECL and MH, together, hired the Teshmont consortium of consultants in Winnipeg to design and build the line[2].

This HVDC line required a reliable communication circuit and I suggested that it should be ready well ahead of the line to prove its reliability. I received the required approval for this from AECL. This circuit was also the ideal vehicle to bring TV to the north, and I negotiated the arrangement with the Manitoba Telephone System that it would provide the necessary additional equipment for the use of the towers for their commercial purposes. But this was not entirely to the liking of AECL!

I took my production supervisory staff to the Kettle site before any work was done so that they could assess the future needs of our organization regarding staff and equipment. I also kept myself informed on the progress of the studies and the work. Progress was reviewed frequently at meetings of AECL, who had set up an operation in Winnipeg, the consultants and Hydro. This triumvirate had to reach agreement on all of the important steps in the design and construction of the line.

It became evident early in 1967 that the building of the HVDC line was falling behind. The consultants blamed Manitoba Hydro for creating unnecessary delays in reviewing their work. The chief engineer of Hydro, Thomas E. Storey, asked me to take over the management of the project on Hydro's behalf. But I felt that, if I did, authority within our orgnization would be fractured if, among several parts of it, one part was doing the planning and other parts the rest of the job. This was changed in May 1967 when I became director of planning with responsibilities for liaison with the consultants and AECL on the HVDC line and for all planning functions within Hydro. This really was a major challenge, and I worked very hard. I encouraged the engineers to take more

[2] The firm, Teshmont Consultants Inc., was formed in 1966 to provide engineering and project management services for the Nelson River Transmission Project in Manitoba. These services included initial feasibility studies, detailed engineering design, electrical and structural design, construction supervision and commissioning of the two +&- 450 kV HVDC transmission lines and the converter stations at Radisson in the north and Dorsey at the southern terminus. The line length was approximately 900 km. Since that time, the firm has provided services to a number of major power projects in North America.

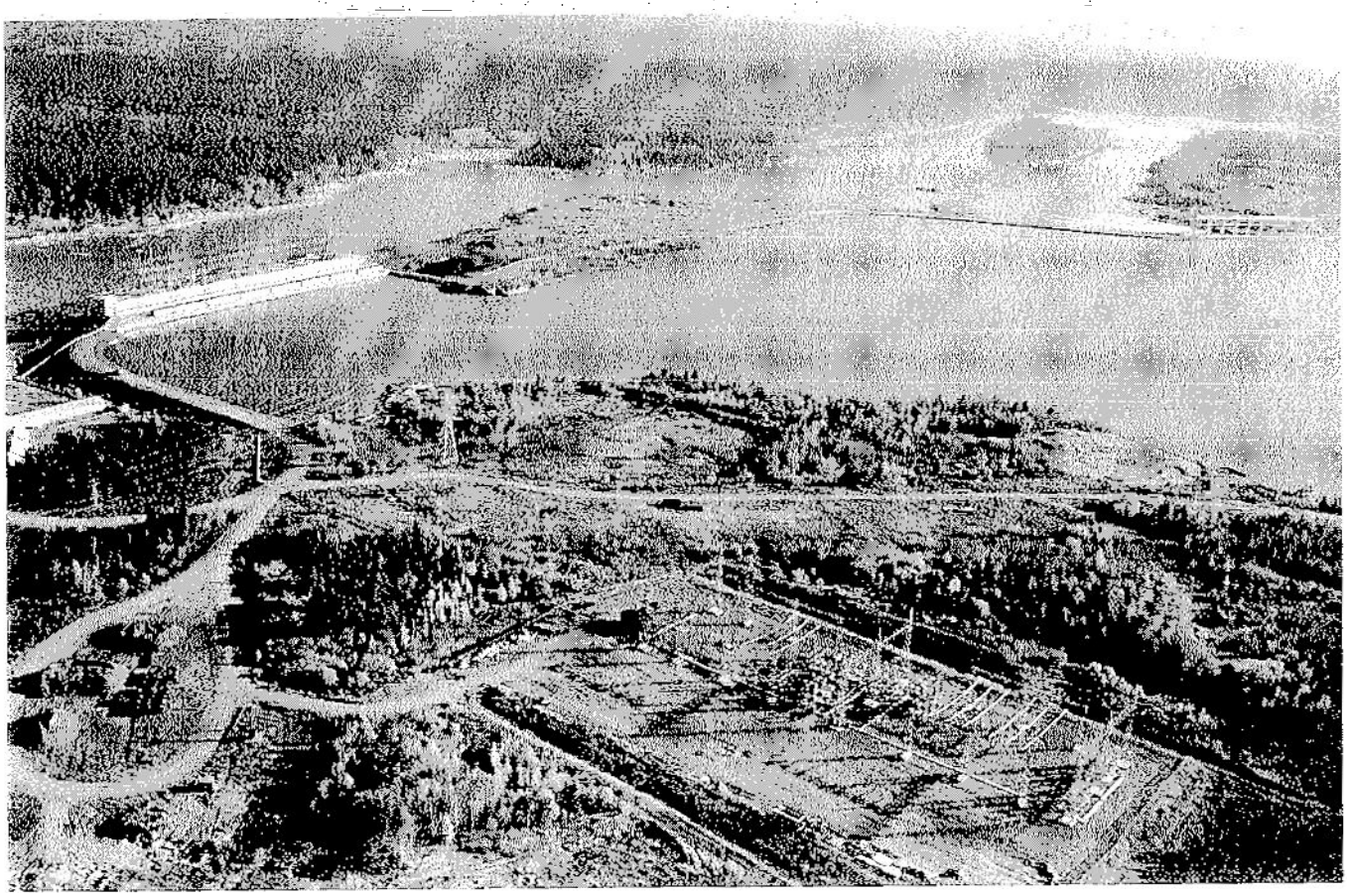
responsibility and so, by delegating, was able to to get the job back on track and to satisfy the consultants.

The schedule for the HVDC line to meet the load forecast for Manitoba Hydro was tight. So I negotiated the first interconnection agreement with three American utilities in Minnesota: Northern States Power of Minneapolis, Minnkota of Grand Forks and Ottertail Power of Otter Falls. They agreed to provide the 90 MW needed to maintain an adequate margin in our system generation, and we were able to purchase the shortfall for the 1970 winter load period.

The public hearings for this first interconnection with the U.S. tie-line were held before the National Energy Board (NEB) in Winnipeg. I made the presentation on behalf of Manitoba Hydro and carried the arguments through to a successful conclusion. To get some idea of what to expect at such hearings, I had attended part of an earlier hearing that BC Hydro was having before the NEB, and this obviously helped me in Winnipeg. Ted Beddard assisted me in this work, but it still surprised me that the general manager of Hydro, William D. Fallis, let me lead on my first appearance before the Board. This tie-line has been very profitable and paid for itself in a very few years.

The Kettle Generating Station had one unit finished in 1970, but the HVDC equipment was not. The

Kelsey Generating Station: the first plant built on the Nelson River (see Appendix 1)



lines were physically ready to receive power, so we devised a scheme to use part of both lines as a three phase AC line and connected a shunt reactor at Grand Rapids to hold the voltage down to manageable levels by drawing lagging current. We then got some of the power from the first unit into the 230 kV system. This was a bonus and improved our security for 1970 with additional energy as well as additional capacity. The following year the longest DC line in the world to carry firm power was put into service. But this new technology was not without growing pains. There was cause for worry, but the system worked after some significant adjustments were made. It is now one of the most successful DC line projects in service anywhere.

The decision had been made to put six units in at Kettle, and this was a big increment for the Manitoba system. I negotiated two new 230 kV interconnections with Ontario Hydro to permit them to buy some of the surplus Kettle power. This permitted faster installation of the remaining units, with associated savings. I also initiated discussions with MPL of Duluth, Minnesota, for a second interconnection to the U.S. market. This company had seen how profitable the first one had been and was anxious to participate.

I presented a paper at the World Energy Conference in Moscow in 1968. This was my first trip overseas and I used the opportunity to visit some installations that were of interest to Manitoba Hydro. The only thing that marred the trip was the invasion of Czechoslovakia by Russia, which occurred during the conference. We cancelled the post-conference tour in Russia and headed home.

In 1969 there was a change of government in Manitoba and the plan to develop the Nelson River and to divert the Churchill River was the subject of much political debate. The government appointed an outside consultant, David Cass-Beggs, to review the proposal. Soon after this, the chairman of Manitoba Hydro, Mr. Fallis, took sick leave and retired. The new government appointed Mr. Cass-Beggs to replace him. I was asked by the new chairman to lead a task force to review all aspects of the Churchill diversion, which I undertook in addition to my normal planning division work. The subsequent report became embroiled in political controversy, and the government accepted Mr. Cass-Beggs' recommendation to divert the Churchill, with a lower flow and other conditions.

These major projects, negotiations and public hearings kept me very busy. In 1970 I was promoted to assistant chief engineer, a newly created position that would prepare me for the position of chief engineer when Tom Storey retired in 1971. However, on his retirement, I was named general manager of engineering, with responsibility for all divisions relating to engineering and the operation of the utility.

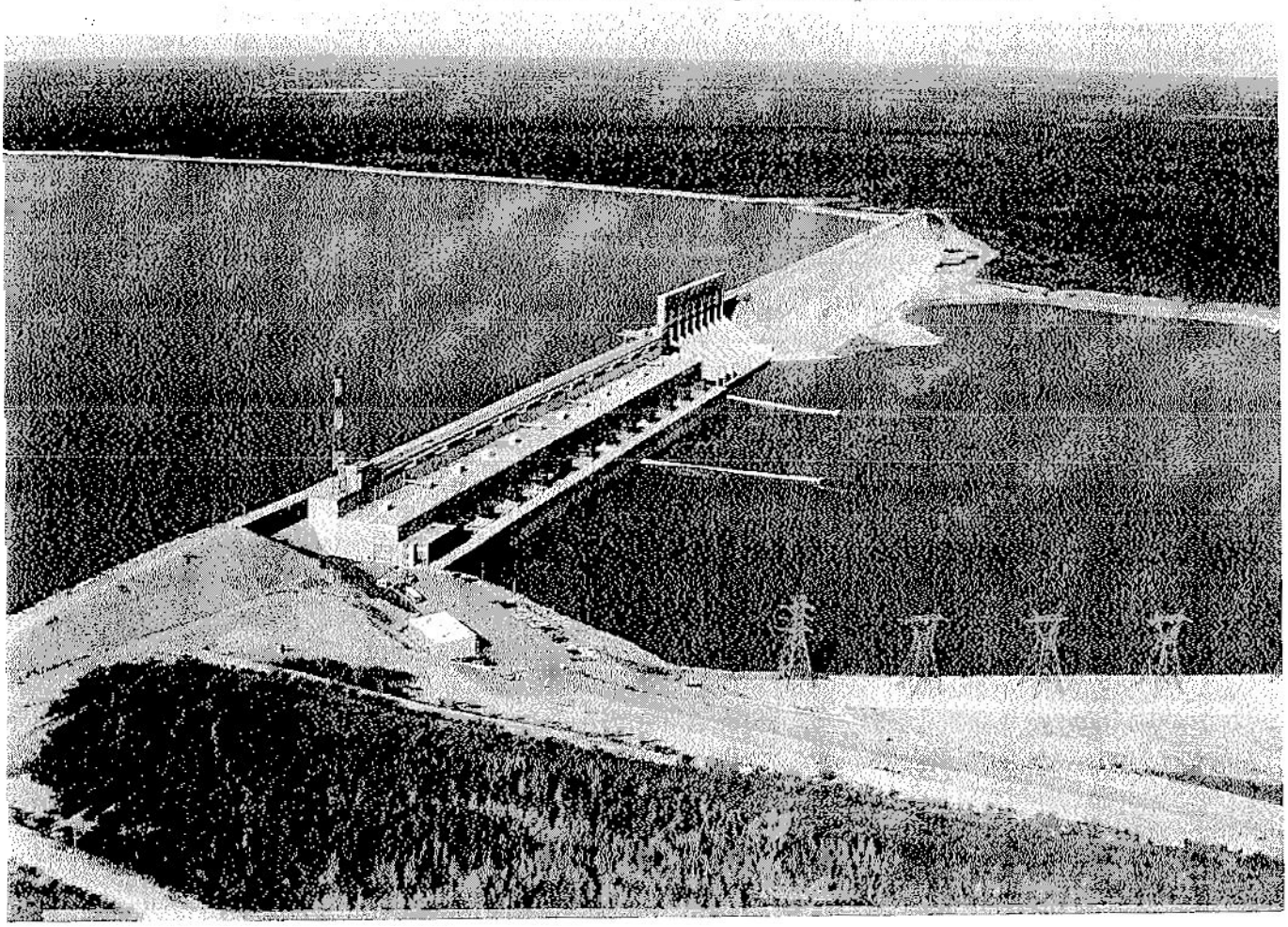
## Chairman of Manitoba Hydro

Late in 1972, Mr. Cass-Beggs resigned as chairman of Manitoba Hydro. In November, Premier Schreyer asked me to accept the position of chairman and chief executive officer, which I did effectively on 16 December. As I was a career engineer with the utility, it was a proud and exciting opportunity for me, and one that was embraced with pride by many of the 3600 staff members as a 'home grown' CEO had been selected.

I was the fourth chairman of the utility and the last to hold the combined positions. Now, in 2004, the chairmanship is a political appointment, on a part-time basis. The president is the full-time chief executive officer. This is actually a better governance structure. Despite the declaration that my own appointment was non-political, I found it difficult to remain neutral when appearing before a standing committee of the Legislative Assembly, when the Opposition was attacking Manitoba Hydro! I defended the staff of Hydro during these annual hearings, which were well reported by the press, and did this because I had confidence in the capable team I was privileged to lead for six years, during the largest construction program and largest capital expansion in the utility's history.

Completion of the 1224 MW Kettle Rapids station and the Bi-Pole 1 HVDC transmission line was proceeding, as was the finishing of the second large station of 1020 MW on the Nelson River at Long Spruce and the regulation of Lake Winnipeg. The latter included some major dredging contracts, one of which was to cut a two-mile (3.2 km) channel out of Lake Winnipeg, and another was an eight-mile (12.8 km) channel from Playgreen Lake to Kiskittogisu Lake. There was also a major channel excavated to get the Churchill River into the Nelson River by way of a series of lakes and rivers. Contracts were also let for an extension of the HVDC lines to the Limestone station and for the construction of a new HVDC terminal at Henday, adjacent to Limestone. All of these

Kettle Rapids Generating Station: which first produced power in 1970



contracts suffered from the severe inflation that occurred as a result of the Arab oil embargo in the 1970s, which required tough negotiations between the contractors and Hydro staff and which I was called upon occasionally to mediate. These large capital expenditures also required significant borrowing which, in turn, meant that more revenues were required to cover the cost of the interest. So it became necessary to institute major rate increases, although this was a common problem among power utilities at this time.

The basic premise for the development of the Nelson River was that it would be less costly than the alternative - thermal plants burning coal. I felt very strongly that the development of our natural water resources was better than importing coal, and was also much better from the environmental perspective since it did not contribute to the carbon dioxide problem that was, and is still, of great concern. Time has proven this premise correct and, today, Manitoba Hydro has the lowest 'per kWhr' rates in the country.

In selecting the equipment for Bi-Pole 2, I recommended the use of water-cooled thyristors for the first time in a DC line application. This later became the normal cooling method for this type of European-made equipment. Its performance has been outstanding and has surpassed the most conservative estimates for failure rates. It is very satisfying for an engineer to have the opportunity to step out ahead into new territory. Sometimes this does cause problems, but these can usually be solved and the ultimate result is progress. When things work out satisfactorily the first time, such as happened with the thyristors for Bi-Pole 2, it is a time to rejoice and feel proud!

There were many notable things that I could record that occurred while I was chairman of Hydro, but I will mention only a few. For example, I was asked by the federal Department of Trade and Commerce to participate in a trade mission to China during August and September 1973. I was the senior power utility officer in the delegation, which included representatives from associated industries and consulting firms, in addition to two federal officials. We spent a few days in Hong Kong and more than two weeks in China, assessing the status of its electrical power industry and systems. This provided opportunities for Canadian firms to seek assignments in China. The resulting departmental report outlined our findings and made 15 recommendations.

I returned from the China trip at a late hour on September 18 and left Winnipeg almost immediately with Premier Schreyer and the deputy minister of the provincial Department of Finance on a bond-selling trip to Boston, Hartford, New York, Chicago, Los Angeles and San Francisco. The trip was successful in raising funds by the sale of bonds to finance the Hydro construction program. Some of the financiers I met during it came later to Manitoba to tour the construction activities in the north.

I also had another trip to Russia. It was part of a pioneering experience for Hydro, and happened this way. Part of the construction program for the regulation of water levels in Lake Winnipeg was a spillway structure that had to be built at the strategic point in the river that would make use of the regulated outflow from the lake. The site was called Jenpeg. The logistics of building it were such that the power plant that would eventually be built at this site could be added during the construction of the spillway, with an overall saving in the project cost as well as in the number of spillway gates

that would be required. The Nelson River has many potential power sites, not all of which could produce power at the same unit cost. If Jenpeg had not been associated with the regulating structure, it would not have been built ahead of more economical sites. To match the power-use curve, it was necessary to increase the flow out of Lake Winnipeg in the late fall and winter. The head at the regulating structure would decrease as the flow was increased, due to the distance and channels from Lake Winnipeg, some 70 miles (110 km) upstream. This would require a variable pitch turbine blade. A Kaplan unit at the low head of the Jenpeg site would have been very costly, but the bulb turbine - which the French had pioneered - would be natural for this site. The Jenpeg installation, however, would be the first in North America. Tenders were called and, much to our surprise, Russia offered by far the lowest bid. Hydro's concern was, "Could they make such a unit?" Along with some of Hydro's engineering staff, I visited their manufacturing facilities in Leningrad (now, again, St. Petersburg) and found the Russian company was a sub-contractor for Nypric, a turbine manufacturer in France, who had also bid on the bulb turbines. We were very impressed by the skills the Russians appeared to have. They also offered a great deal of stainless steel in the design of the units, and the price was very favourable. The staff recommended the purchase of these units and, because I had seen their capabilities at first hand, I was able to help Hydro's Board reach a favourable decision. The installation was a success and considerable savings were realized in the construction of both the plant and spillway structures. In some years, all of the water that passes through the Jenpeg channel down the Nelson River produces energy[3]

The high rates of load growth experienced during the early 1970s slowed and one of the most difficult decisions that I led the Hydro Board to make was to stop the construction of the Limestone Generating Station in 1977. (Construction was resumed some six years later but, by that time, I was a private consultant and no longer in the chair at Hydro.) The curtailing of the generation program and the associated additional transmission of energy from the north was a worry to me. This included the reliability of the DC system, which was carrying a very large percentage of Hydro's firm load. If this system should fail, the province would be mostly in the dark until the lines could be restored. So I discussed the possibility of a high capacity interconnection with Northern States Power (NSP) of Minneapolis. A letter of intent was signed by both parties covering the installation of such an interconnection, should the results of our studies prove the economic value of it to both utilities. The key to the interconnection was the diversity of loads. NSP peaked in the summer, while Manitoba Hydro peaked in the winter. Hydro undertook to sell 500 Megawatts in the summer and to purchase the same amount in the winter. One of the most important aspects of this interconnection agreement was the ability of Manitoba Hydro to buy back as much energy as it sold, and this would be valuable in times of drought or failure of the transmission system from the north. Construction of the 500kV line to Minneapolis began in 1978 and was completed two years later.

[3] The author has noted that later, in the mid-1980s, while doing some work at the office of Preece Cardew in Brighton, England (see page 17), he reviewed a draft of the book *Power System Economics* by T. W. Berrie, a member of this firm. He noted Mr. Berrie's interest in Jenpeg and concurred with his view that, when developing multiple sites on any river for power production, the lowest cost site is not necessarily the best overall economic choice, due to a number of factors.

(My concern for the loss of high voltage lines was put to the test in 1997, long after I had left Hydro, when a wind shear just north of Dorsey, the southern terminal of the lines, took out 19 towers in the very early hours one morning. From an exporting mode, Manitoba Hydro instantly became an importer, but the public did not experience any loss of power, although they were asked to conserve it during the next few days while a temporary connection was put in place. The line to Minneapolis proved to be a valuable back-up, as well as a means to sell surplus energy to the U.S. Market, with financial benefits to the people of Manitoba!)

These kinds of technical experiences were the most rewarding, but there were other problems that brought me satisfaction. One such occurred when, during negotiations, Manitoba Hydro and the International Brotherhood of Electrical Workers (IBEW) requested the services of a mediator to resolve differences between them in order to reach an agreement without a strike. I always felt that management should be fair in dealing with staff, and this helped to reach the desired settlement.

The challenge of running a large utility also brought its share of administrative matters. For example, Hydro negotiated the transfer of the last area of the province - with the exception of Winnipeg's inner city, served by Winnipeg Hydro until it was purchased by it in 2002 - not served by Manitoba Hydro. This was the town of Flin Flon, which was served by the Hudson Bay Mining and Smelting Company (HBMS) from its Island Falls plant on the Churchill River in Saskatchewan. This transfer would also improve the reliability of the local system and provide some back-up for Hydro's diesel generating plant at nearby The Pas. The negotiation actually began not long after I joined Hydro in 1961. The chairman, Don Stephens, asked me to go to Flin Flon to discuss the possible interconnection of their isolated system to Hydro. Although relations with the Company were cordial, nothing was decided at this time. The issue re-surfaced in 1972, when I became chairman. I took the general manager, John Arnason, to Toronto with me for discussions with senior people at HBMS headquarters. The company was interested since, among other things, it needed extra power for its smelter. Arnason represented Hydro in the discussions that followed, which resulted in the proposed interconnection being approved by both parties.

On another level, several isolated diesel generating stations serving the First Nations were retired when the areas they covered were connected to the Hydro transmission system.

Hydro developed - after discussions that included the Board - a new, simple yet dignified logo which, on hindsight, has become a well-recognized symbol of the utility since it was introduced in 1975, during my 'watch.'

In addition to serving as chairman of Manitoba Hydro, the provincial government appointed me a member of the Manitoba Water Commission. This organization had all sorts of problems with drainage, flooding, erosion, and so on, referred to it. I used Manitoba Hydro experts to help me provide some worthwhile suggestions for their solution.

I have said that my appointment as chairman of Manitoba Hydro was non-political.. Yet I sometimes had difficulty avoiding political situations. Consequently, when a change of government took place

in the province in late1977, my tenure was shortened and I was replaced in January 1979. But as I look back on these years from the vantage point of more than 25 years of private consulting practice, I still have an interest in the utility I was able to mould so that it could better serve the citizens of the province. Like most Manitobans, I am proud of Hydro.

## Retirement....and Consulting

After retiring from Manitoba Hydro I turned to consulting, as many engineers do these days, to provide interest and income. I was immediately asked to go to Brazil on an assignment and negotiated a very good contract for my services over the next few years. I saw a lot of Brazil while I was associated with IESA, the consulting firm, which was then engaged on the construction of the largest hydro plant in the world at that time, Itaipu.

Initially, I called my own company Bateman Consulting Services but, in view of the volume of work I was doing, I followed my accountant's advice and incorporated it in August 1979 as Bateman and Associates Limited, through which I occasionally work today.

I was offered many other assignments from manufacturing and other companies, but turned down those in less appealing countries. I was also retained by International Engineering of San Francisco, a division of Morrison Knudsen, and by Preece Cardew of Brighton, England. During the 1980s, as I continued to consult in various parts of the world, I also participated in, and presented papers to, the World Energy Conferences. In the 1980s I served three terms of three years as a adjunct professor in the University of Manitoba's Department of Electrical and Computer Engineering. In 1987 I was asked by Hydro Québec to chair an international advisory committee dealing with the planning, design and operation of the DC line from its northern generation point at James Bay to a point near Boston. This assignment concluded in 1992. Thereafter, I did not aggressively seek new work and only took on jobs that held special interest.

## Professional and Technical Organizations

As mentioned earlier in this paper, I joined the Engineering Institute of Canada (EIC) as a student member in 1941. After joining Winnipeg Hydro in 1942, I became involved with the Electrical Section of the Winnipeg Branch, presented papers to it, and became its secretary and later chairman. I also served in the early 1960s as vice-president for the Western Region, after which I found my duties at Manitoba Hydro precluded further participation. I became a Fellow of the Institute in 1974 and a life member in 1984. I joined the Executive Committee of the Life Members' Organization (LMO) in 1985, taking the chair in 1999. The LMO became a member society of the Institute in September 2002. Its name was formally changed in May 2003 to the Canadian Society for Senior Engineers (CSSE), of which I became the founding president.

I joined the Association of Professional Engineers of Manitoba APEM - now APEGM, with Geoscientists added - in 1948. In 1952 I was elected to its Council. This coincided with increasing responsibilities at Winnipeg Hydro, so I was very busy! One of the advantages, however, was that

Don Stephens, the founding Chair of MHEB, was also a Council member, and I got to know him well. In 1958, I was elected president of APEM, but this was my last year on Council as I wanted to concentrate on my career. I did, however, serve on several committees, and was made an honorary life member in 2002.

My interest in technical societies - and the presentation of papers to them - became international. In 1968 I was named Canadian representative on the CIGRE *(Conseil International des Grands Réseaux Électriques)* Study Committee No.14, which covered DC links. This prestigious position gave me (and Manitoba Hydro) access to the leaders in the world of DC transmission. I attended and participated in the 1970 conference in Paris and in those that followed. In 1975 I was elected its chairman. I had invited this committee to meet in Winnipeg in the spring of 1976, and this was the largest gathering of highly skilled technical people in DC transmission to meet up until that time. I chaired the committee meeting and the symposium that was arranged in conjunction with it. This was the first such 'joint' meeting that CIGRE had held, and there was some criticism as a result. However, a special meeting was held in Rome in 1979, which I attended, and which established criteria for symposiums - patterned after the event I had staged in Winnipeg! What had happened, apparently, was that - as a relative newcomer to the organization - I was not familiar with 'the rules.' I had imagined that an accompanying symposium would be a worthwhile event. History has proven me right. In September 1976, and again in 1978, I presided over the Study Committee meeting and symposium in Paris, which was attended by close to 2000.

My chairmanship of Study Committee No.14 was the first time a Canadian had been elected to chair one if CIGRE's prestigious committees. It gave me a seat on its Technical Committee, which included the chairs of all 20 of its committees. In 1979, I had also been elected to chair the Canadian National Committee (CNC) of CIGRE, which gave me a seat on the Administrative Council along with the representatives of 44 other member countries. I realized that this Council had never met in North America and sought support to invite its members to Winnipeg. This came unanimously from the CNC members. Invitations were issued for the Council to meet here in 1983. It was a very successful meeting with arrangements that included a reception by the Governor General, the Rt. Hon. Edward Schreyer, at Lower Fort Garry, which dates from the late 1820s, followed by a dinner cruise through the locks to Winnipeg. I still hear favourable comments on this meeting. Even so, the Council has not met again in North America. Through CIGRE, I made many good engineering friends from many parts of the world.

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**Credits**

Credit for the power plant photographs used in the text of this paper, and for the map that precedes the Appendices, belongs to Manitoba Hydro.

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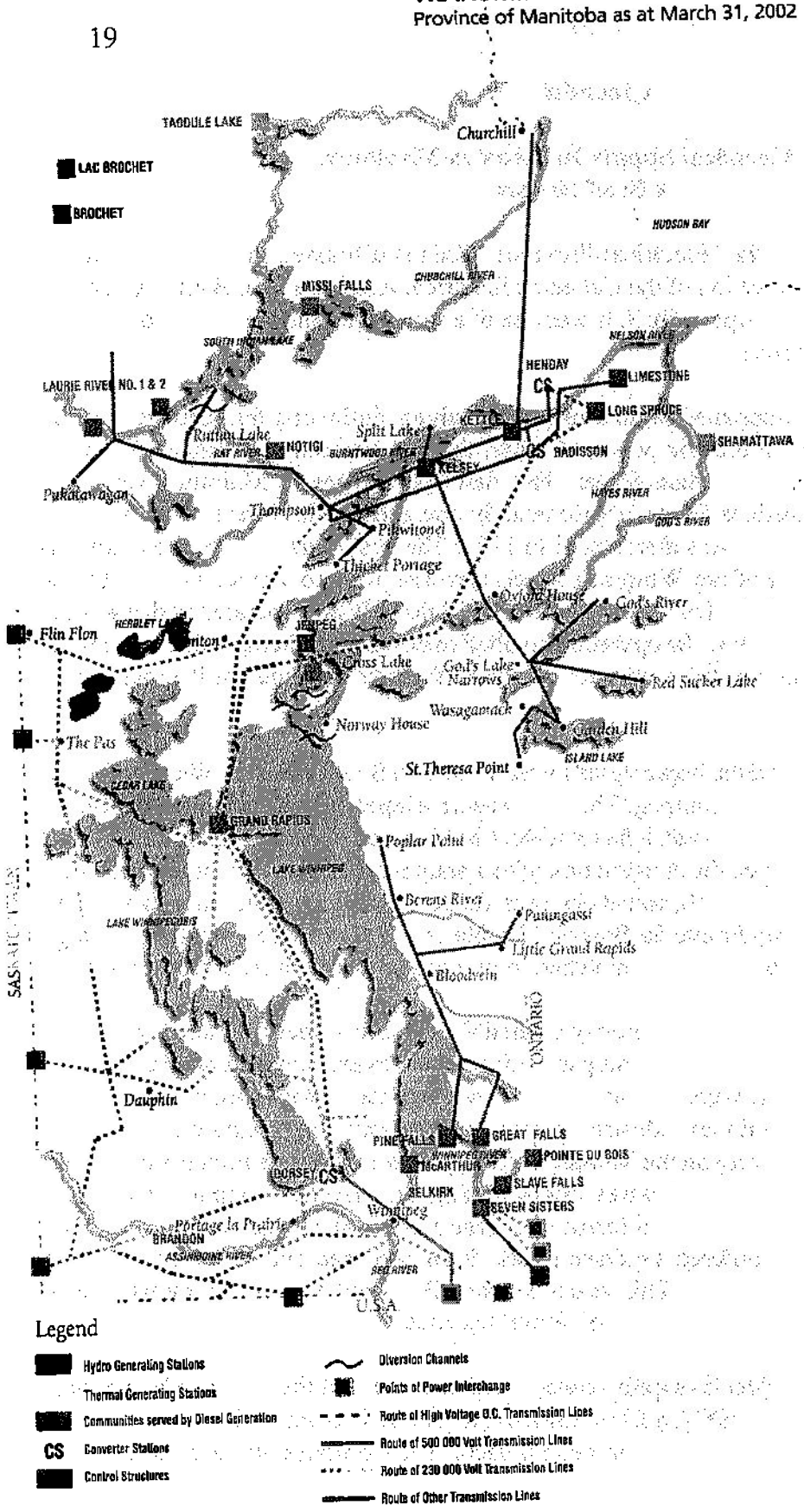
# POWER SOURCES AND HIGH VOLTAGE TRANSMISSION

Province of Manitoba as at March 31, 2002




## SOURCE OF ELECTRICAL ENERGY GENERATED AND IMPORTED

For the year ended March 31, 2002

### Nelson River 79.15%

| | |
|---|---|
| Billion kW.h generated | 27.0 |
| Limestone | 25.83% |
| Kettle | 24.61% |
| Long Spruce | 20.39% |
| Kelsey | 5.29% |
| Jenpeg | 3.03% |

### Winnipeg River 13.41%

| | |
|---|---|
| Billion kW.h generated | 4.6 |
| **Manitoba Hydro** | |
| Seven Sisters | 3.74% |
| Great Falls | 3.00% |
| Pine Falls | 2.07% |
| McArthur Falls | 1.35% |
| **Winnipeg Hydro** | |
| Pointe du Bois | 1.76% |
| Slave Falls | 1.49% |

### Saskatchewan River 1.61%

| | |
|---|---|
| Billion kW.h generated | 0.5 |
| Grand Rapids | 1.61% |

### Laurie River 0.15%

| | |
|---|---|
| Laurie River #1 | 0.07% |
| Laurie River #2 | 0.08% |

### Thermal and Imports 5.69%

| | |
|---|---|
| **Thermal –** | |
| Billion kW.h generated | 0.5 |
| Brandon | 0.95% |
| Selkirk | 0.46% |
| **Imports (Scheduled) –** | |
| Billion kW.h imported | 1.5 |
| Imports | 4.28% |

## Appendix 1

## The Electrical Supply Industry in Manitoba: A Brief History

Manitoba is often referred to as the 'Electrical Province.' This is discussed in some detail in the paper I presented to the annual meeting of the Canadian Electrical Association in Banff, Alberta, in 1974, and is the first one listed in Appendix 3. It was one of a series presented annually to the CEA by a provincial electrical executive.

In 1882, the first street lights illuminated Main Street in Winnipeg. Following this, private industry supplied the growing demand for electric power. A small thermal generating station was built in 1885 on Assiniboine Avenue, near Main Street. The first hydro plant in Manitoba went into operation in 1900 on the Minnedosa River, approximately one and one-half miles from where it flows into the Assiniboine River. It was dismantled in 1924. The first large scale hydro plant was at Pinawa, on a by-pass channel of the Winnipeg River, and was put into service in 1906 by the Winnipeg Electric Company (WEC). This plant was rated at 22,000 kW and operated with a 46-foot (14 m) head. It was dismantled in 1961. Its operation resulted in power rates being reduced from the prevailing 20 cents to 10 cents per kilowatt-hour - which the city aldermen still thought was excessive!

Alderman John Cockburn acquired the water rights for the Pointe du Bois site on the Winnipeg River and transferred these to the city of Winnipeg. This site was developed into what is now the oldest plant still operating on the Winnipeg River. It has a 46-foot head and a rated capacity of 72,000 kW. The public referendum that approved the construction of this plant promised power for the consumer at three cents per kW hour for the first 50, and at one cent for consumption greater than this. When the first power was delivered from Pointe du Bois on October 16, 1911, a real scramble took place to connect customers. Needless to say, WEC matched these rates to maintain its customer base.

The industrial load was coveted by both the newly created City Hydro - later re-named Winnipeg Hydro - and the private Winnipeg Electric Company. Injunctions to prevent raiding each other's customers were common, but these were only available on working days. It was not uncommon for Winnipeg Hydro to build a line into an industrial customer in the city, beginning on a Saturday morning, and connecting the customer on the Monday morning. This raiding resulted in parts of the city becoming unsightly, with poles and wires criss-crossing the streets to supply customers. Eventually, saner minds prevailed and, as a result of a case that went all the way to the Privy Council, WEC and Hydro were ordered to share poles. Each pole had space for primary and secondary cross arms for both utilities. This situation prevailed until the power industry was rationalized in 1955 and competition in the city of Winnipeg ended.

The Government of Manitoba decided to supply power to the rural areas of the province by creating the Manitoba Power Commission (MPC) in 1919. Initially, it supplied power to the municipalities which, in turn, sold it to their residents and commercial users. The Commission purchased power

from Winnipeg Hydro, beginning in 1919, but switched to the private company in 1931 because it had reserved 30 MW of power from the Seven Sisters site at the time the government granted the water rights there to WEC. Also in 1931, the government passed legislation that gave the Commission the right to deliver power to ultimate users, by-passing the municipalities, although these still provided power for such uses as street lighting.

Beginning in 1919, the Manitoba electrical supply industry included three utilities: Winnipeg Electric Company, which was investor owned; Winnipeg Hydro, which was municipally owned; and the Manitoba Power Commission, which was provincially owned. Some 30 years later, this changed.

Following World War II, the government undertook a farm electrification program. Neither WEC nor Hydro could guarantee to supply electricity to the Commission to meet this growing load. Consequently, the government created the Manitoba Hydro Electric Board (MHEB) and proceeded to develop the Pine Falls generating station on the Winnipeg River to meet the anticipated load.

The first members of the Board were appointed in 1951 and, in 1953, it purchased the Winnipeg Electric Company. Discussions on the rationalization of the industry were also begun with the city of Winnipeg and the Manitoba Power Commission. These discussions resulted in an agreement in 1955 whereby Winnipeg Hydro gave up its distribution loads outside the city boundary to the Commission. The Board gave the WEC's distribution load within the city to Winnipeg Hydro and ouside of it to the Commission. The 1955 city boundary remained the service area for Winnipeg Hydro for the next six years in spite of the amalgamation of adjacent municipalities with the city of Winnipeg. In 1961, the provincial government revised the Manitoba Hydro Electric Board Act and joined the Board with the Power Commission to form a single supply agency, which became known as Manitoba Hydro (MH). This arrangement continued until 2002, when the Board bought the Winnipeg Hydro system. One utility then covered all the electrical needs of the province.

The load growth that began with the farm electrification program continued well into the 1970s. By 1955, it had led to the full development of the hydro potential of the Winnipeg River. Two thermal coal fired generating stations were built at Brandon and Selkirk to help meet the need for power. They were followed in 1965 by the development of the Grand Rapids station on the Saskatchewan River, where it empties into Lake Winnipeg. It provided the largest head in Manitoba, at 120 feet (37 m), and the largest Kaplan turbines in North America were installed in it. Also around this time, the Kelsey station was built by MHEB on the Nelson River to supply power to INCO's new mine at Thompson. It was originally isolated, but was later connected to the Manitoba Grid. The first large plant on the Nelson was at the Kettle Rapids site, built for service in 1970, followed by Long Spruce and Limestone. The capabitities of these plants are given in Appendix 2.

Interconnections with adjacent provinces and states in the U.S. began in 1956. The first - to Northwestern Ontario - was an isolated system. In 1960, another was added to Saskatchewan, between Brandon and Estevan. In 1970, the first interconnection with the United States was completed. It was followed, by 1980, by other interconnections to Ontario and to Minnesota, using

a 500 kV line to Minneapolis. I participated in the discussions and agreements on all of the interconnections that were placed in service between Manitoba Hydro and the adjacent provinces and states from 1960 up until the Minneapolis tie line, which was begun before I retired from Hydro but was not completed until 1980.

Finally, I should mention that Public Affairs at Manitoba Hydro (PO Box 815, Winnipeg MB R3C 2P4) has published a number of pamphlets and booklets describing its present components.

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## Appendix 2

## Electrical Supply Units in Manitoba: Generating Stations and Capabilities

**Interconnected Capabilities:**

| *Station* | *Location* | *Number Of Units* | *Winter Capability (kW)* |
|---|---|---|---|
| Manitoba Hydro: | | | |
| Hydraulic - | | | |
| Great Falls | Winnipeg River | 6 | 130,000 |
| Seven Sisters | Winnipeg River | 6 | 154,000 |
| Pine Falls | Winnipeg River | 6 | 87,000 |
| McArthur Falls | Winnipeg River | 8 | 54,000 |
| Grand Rapids | Saskatchewan River | 4 | 472,000 |
| Kelsay | Nelson River | 7 | 211,000 |
| Kettle | Nelson River | 12 | 1,228,100 |
| Jenpeg | Nelson River | 6 | 97,600 |
| Long Spruce | Nelson River | 10 | 1,007,700 |
| Limestone | Nelson River | 10 | 1,347,100 |
| Laurie River (2) | Laurie River | 3 | 10,800 |
| Winnipeg Hydro: | | | |
| Hydraulic - | | | |
| Pointe du Bois | Winnipeg River | 16 | 75,600 |
| Slave Falls | Winnipeg River | 8 | 67,400 |
| Manitoba Hydro: | | | |
| Thermal - | | | |
| Brandon | | 1 | 97,500 |
| Selkirk | | 2 | 135,200 |
| **Total Interconnected:** | | | 5,175,000 |
| **Isolated Capabilities:** | | | |
| Manitoba Hydro: | | | |
| Four Diesel GS - | | | 9,615 |
| **Total Generating Capability:** | | | **5,184,615** |

## Appendix 3

### Partial List of Published Papers by Leonard A. Bateman

1. *The Manitoba Electrical Utilities Story*, presented to the Canadian Electrical Association, Banff, Alberta, June 1974

2. *Future Generation & Major Transmission for Manitoba's Power Requirements*, presented at the meeting of the Engineering Institute of Canada's (EIC's) Winnipeg Branch Electrical Section, March 1959

3. *Long Range Hydro Planning for Manitoba*, presented at the 74th EIC Annual General Meeting, Winnipeg, May 1960

4. *Speed Regulation Tests on a Hydro Station Supplying an Isolated Load*, with L. M. Hovey, presented at the Winter general meeting of the American Institute of Electrical Engineers, New York, December 1961

5. *Forward Planning Studies Involving the Economic Full Supply Level of Grand Rapids Generating Station of Manitoba Hydro*, with K. Renger, presented at the EIC Annual General Meeting, Montreal 1962

6. *On Interconnections*, presented at the Spring Meeting of the Canadian Electrical Association, Vancouver, March 1965

7. *Manitoba's DC Transmission System*, presented at the Area Power Conference, Minneapolis, November 1967

8. *The +&- 450 kV Direct Transmission System for the Nelson River Project*, with L. S. Butler and R. W. Haywood, presented at the CIGRE International Conference on Large High Tension Electric Systems, Paris, France, June 1968

9. *Manitoba's Power Resources*, presented at the World Power Conference, Seventh Plenary Sesssion, Moscow, August 1968

10. *Nelson River DC Transmission Project*, with R. W. Haywood and R. F. Brooks, presented at the IEEE-EHV Symposium, Montréal, October 1968

11. *Energy Transport Requirements in the Future Nuclear-Electric Age*, with W. J. Tishinski, presented at the World Energy Conference, Ninth Plenary Session, Detroit, October 1974

12. *The Story of the Nelson River*, presented to the EIC Congress, Winnipeg, October, 1975

13. *The Integrated Powerhouse*, with H. R. Hopper, presented at the EIC Congress, Halifax, October 1976

14. *The Challenge of Economic Development of Canada's Low Head Hydro Potential*, with others, presented at the World Energy Conference, New Delhi, India, September 1983

15. *A Reflection on Past Decisions, AC or DC Transmission for Nelson River and Churchill Falls*, presented at the Fourth International Conference on AC & DC Power Transmission, Institution of Electrical Engineers, London, England, September 1985

16. *Canadian Pioneer Development in HV Electric Transmission*, presented at the Canadian Engineering Centennial Convention, Montréal, May 1987

To the above should be added: two presented but unpublished *Opening Addresses*, one to the International Conference on DC Power Transmission, Montréal, June 1984, and the other to the Conference on HVDC Power Transmission, Montréal, October 1986; and many unpublished talks and panel discussions on a variety of subjects, ranging from education, management, hydro development, electrical engineering and nuclear energy.

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