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DESIGN, CONSTRUCTION AND OPERATION OF ONTARIO HYDRO CANDU PLANTS

ADDRESS TO THE
CANADIAN NUCLEAR ASSOCIATION
BY

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INTRODUCTION

For those unfamiliar with Canada's nuclear power program it may seem remarkable that a nation of modest industrial size should be a world leader in nuclear technology. There have been a dozen or so different reactor systems developed to the prototype stage since the second world war, and yet Canada's CANDU reactor is one of only three or four types that have been firmly established as a competitive source of electric energy within a utility setting.

Our success with CANDU is partly the result of fortunate circumstances and partly the result of foresight, bold decision-making and cooperation by utility leaders, industry, and governments.

Back in the early 50s, the demand for electricity in Ontario was growing at 14 percent annually, and with the major hydro-electric sites already developed, Ontario Hydro looked to other ways to develop power. Conventional thermal plants, mainly coal, were planned, but the energy source for these was not indigenous to Ontario. Over 90 percent of the coal had to be imported from the United States.

In 1952, Ontario Hydro approached AECL at Chalk River who had staff working on heavy water moderated reactors. In 1954, a group of engineers headed by Hydro's Harold Smith, worked with scientists at Chalk River on the possibility of building a natural uranium, heavy water power reactor.

What evolved from the study, exemplified by a high level of coordination and cooperation between the Atomic Energy of Canada Limited, The Canadian General Electric Company, and Ontario Hydro was NPD, the Nuclear Power Demonstration Plant.

Such was the confidence in the design of NPD that even before it went critical in 1962, Ontario Hydro agreed to cooperate in building a 200 MW prototype plant at Douglas Point.

And this kind of confidence was repeated in the Ontario Hydro decision, with financial backing from governments, to proceed with a 2000 MW 4-unit station at Pickering even before Douglas Point had come on line.

Pickering did not represent any fundamental design change from Douglas Point, but there was a clear recognition of the economic benefits that would result from a multi-unit station with larger units.

That such an original design -- using heavy water as a moderator and coolant with horizontal pressure tubes and bidirectional on-power fuelling -- evolved in Canada, reflected imagination, vision, and daring. CANDU's design -- and success -- clearly represents a tribute to Canada's engineering skills.

MULTI-UNIT STATIONS AND REPEAT PLANT

Ontario Hydro built its fossil-fuelled power stations using a multi-unit plant arrangement and decided that the generally favourable features of this approach warranted its adoption for nuclear stations beginning with Pickering A.

The practice of locating four identical units at one location results in substantial cost savings due to shared common services and a substantial degree of standardization. The overall engineering effort is reduced and economies are realized from ordering the same equipment for all units at one time. Also, utilizing the same construction management team and many of the same Tradesmen for the whole station results in improved productivity. Furthermore, utilization of common site construction facilities results in lower costs. All these factors shorten construction time and contribute to bringing the later units into service sooner than would be the case in single-unit construction.

In taking advantage of the multi-unit arrangement, care is necessary to minimize common mode faults or component weaknesses and to eliminate cross-link faults between units which could otherwise seriously affect station performance. Each of the Pickering units operates independently of the other units with a minimum of inter-connection of services.

Many similar benefits are derived from Ontario Hydro's practice of constructing repeat plants. A significant aspect of this practice is the knowledge that the second plant will, in fact, function well, based on the experience with the first one. A repeat plant tends to be brought into service sooner than a comparable first-time facility and there is the expectation of an earlier achievement of a high plant capacity factor.

Our experience confirms that repeat plant also brings savings in engineering and construction effort relative to a prototype station, even though the total manpower effort is not likely to be less than was used on the first plant because of new or changing regulatory requirements.

One must recognize, however, that there are some disadvantages to the repeat plant approach. One is that poor equipment selection or poor design for the first plant may be repeated in the second plant. And, more demanding regulatory requirements subsequent to completion of the first plant mean changes to a number of systems planned for the second plant.

ORGANIZATION FOR DESIGN AND CONSTRUCTION

Project Management

The Nuclear Power Program in the Province of Ontario has been carried out through the close collaboration of Atomic Energy of Canada Limited (AECL), Ontario Hydro, and the Canadian Nuclear Industry. However, Ontario Hydro retains responsibility for the project management of all its nuclear stations.

Hydro's project management process has evolved over the years from the early days when it was necessary to add thermal stations to the power system. At that time, the management approach was essentially a carryover from practices employed on hydraulic jobs, wherein the necessary engineering effort was provided from the various technical departments and coordinated on each job by a project engineer. Due to the size and complexity of nuclear projects, it became evident that there was a need for increased project emphasis and, following a series of studies in 1969, it was decided to form dedicated project teams. Since then, Ontario Hydro has assigned full responsibility for each project to a Project Manager who is given direct control over the major resources needed to complete the job.

Thus, the concept of project management employed by Ontario Hydro is an organizational arrangement by which authority and responsibility are clearly assigned within a policy framework to one person - the Project Manager. He is accountable for the realization of his assigned project from completion of the concept phase up to and including the handing over of the facility to those responsible for its operation.

Reporting to the Project Manager are a Manager of Engineering and a Manager of Construction, who are responsible for the design and construction of the assigned project respectively. Some engineering or construction may be contracted out. However, retained within the Project Manager's organization are the vital managerial support services concerned with scheduling, cost estimating and control, procurement and accounting.

Within the overall project management framework, effective planning and control results from the basic management structure and philosophy executed through a comprehensive Management Information System.

The components of the Management Information System are based on a Work Breakdown Structure of the physical systems in the completed plant. As soon as the overall project parameters are established the Work Breakdown Structure is developed and, based on this, schedules are formulated and responsibilities are assigned. Key event dates are determined throughout the project life cycle from executive approval to in-service date of the final unit.

Along with the development of the project life cycle, the Work Breakdown Structure and the schedules, a series of cost estimates is produced with ever-increasing levels of refinement as more detailed information about the project becomes available. Cost control systems are then put in place to gather and assemble data on actual expenditures matched with the estimates. The management reports produced by the cost control systems are designed to be useful for control by the managers at whatever level maintenance or corrective action can be taken with respect to cost.

The management system machinery which comprises Ontario Hydro's project management process takes account of the often difficult interfaces between engineering, procurement, and construction activities, and establishes milestone events which are closely monitored through regular Project Reviews carried out by senior executives of the Corporation.

Engineering

All project-specific engineering is performed in a project engineering department under a Manager of Engineering reporting to the Project Manager. The Engineering Department consists of sections responsible for the engineering and design requirements in each of the technical disciplines -- civil, mechanical, electrical, etc.

The staff for the Project Engineering Departments is provided by technical departments in Ontario Hydro's Design and Development Division. These functional departments carry a large measure of the responsibility for the quality of engineering and the skills of the staff provided to the project groups, and are set up to perform this function without detracting from the accountability of the Project Managers.

Adding to the efforts of the Design and Development functional departments is the work of Atomic Energy of Canada Limited which acts as Ontario Hydro's consultant for the design of the reactor and certain nuclear systems, and Canadian General Electric Company, which is our consultant on the design of fuel handling systems for Bruce and Darlington. The work of these consultants, and others, is performed under the direction of the project's Manager of Engineering.

Throughout the engineering, manufacture, construction and operation of Ontario Hydro's nuclear stations, a Quality Engineering program is in operation, the results of which are measured in terms of the safety, reliability, maintainability and performance of the various systems and equipment.

Construction

A Manager of Construction, reporting to the Project Manager, is responsible for the work on-site. He is accountable for the economic, timely and safe construction of the station according to the design parameters and specifications provided by the Manager of Engineering.

Construction is carried out almost entirely by Ontario Hydro's own field forces under the Construction Manager. This has the advantage of simplifying control over the manpower resources to meet schedules, exercising quality control, minimizing cost, and completing the job on time.

Given the many trades involved on a power plant construction site, a significant feature of the Ontario Hydro situation was the establishment, some ten years ago, of the Electric Power System Construction Association (EPSCA). Through the auspices of this Association, it has been possible to bring more standardization to working conditions on construction jobs and to negotiate labour contracts for all the trades. This has eliminated much of the labour unrest which preceded the formation of EPSCA and permits an orderly progression through the construction cycle of Ontario Hydro's power facilities.

COMMISSIONING AND PLACING IN SERVICE

The commissioning of the systems and equipment for an Ontario Hydro nuclear station is carried out by the permanent operating staff who will later operate the station and who are assigned well in advance of the in-service date. The Plant Manager is assigned to the project team early on to provide operations input; specifically, to review and comment on the adequacy of design.

Hydro believes that a high degree of operations input into commissioning is crucial and warrants a substantial commitment to staff levels to ensure proper commissioning.

Procedures and schedules for commissioning are developed at early stages of the project, and the operating staff sequentially test each piece of equipment and each system to be sure it operates as designed.

The turnover of each system and piece of equipment from the Construction staff to Operations is formally documented and any changes from that time on are closely controlled. However, if the equipment or the system does not operate as designed, the Site Engineering staff reporting to the Resident Engineer arranges rapid support from the Design Engineers and also from the suppliers if equipment modifications are required.

Needless to say, these procedures require a good working relationship between the commissioning team and construction forces. Effective communication is vital to all aspects of plant layout and design to improve operating performance and maintainability.

Careful commissioning, though, means more than just reliable check-outs and modifications of systems. It means having an adequate number of well-trained and capable operating staff. Not only must they be well trained, they must have good knowledge of the plant and its systems before and during commissioning.

STATUS OF CURRENT PROJECTS

Ontario Hydro currently has 10 nuclear units (5220 MW) in operation and 12 units (8400 MW) under construction. The major change in schedule over the past year has been the acceleration of the in-service date for the Darlington Generating Station.

Pickering Generating Station B

Plant Size	2,000 MWe (4 x 500)
Estimated Total Cost (Dry Plant)	$ 2,350 million
Estimated Total Cost (Incl. Heavy Water)	$ 2,964 million
Cost per kW	$ 1,482
Expenditure to Date (Apr '81)	$ 1,508 million

As you know, we ran into problems with our steam generators. During the heat treatment of the major welds, damage caused to the tubes necessitated a rebuild of the boilers.

We have received half of the rebuilt steam generators for Unit 5 at site, and the rebuilding program at the Babcock and Wilcox plant in Cambridge is proceeding well. The rebuild program will delay the in-service dates an average of 19 months, and cause Ontario Hydro to spend an extra $375 million to generate power using coal rather than uranium.

The construction program and the commissioning program are both proceeding on an accelerated basis to keep delays to a minimum. Our schedule calls for us to place the four units in-service over a period of 16 months beginning with Unit 5 in April, 1983, followed by Unit 6 in October '83, Unit 7 in March '84, and Unit 8 in April '84. This first to last unit pace is faster than we have ever achieved before.

The installation of the high pressure emergency core injection system was a late change to the project scope brought about to enhance reliability and safety. This installation will be tight to meet our schedule.

The resolution of licensing issues with the AECB is demanding a great deal of engineering effort by key people both at AECL and Ontario Hydro, and is another important area affecting scheduling. We are improving our communications with the AECB staff to get a better understanding of requirements, and to resolve as early as possible questions of design changes to meet these requirements.

To date, Ontario Hydro has spent about $1.5 billion on Pickering B out of a total estimated cost of $3.0 billion, which includes heavy water. The field work force now numbers about 2650 men and the engineering work force about 500. We expect Unit 5 to go critical in October, 1982.

<u>Bruce Generating Station B</u>

Plant Size	3,000 MWe (4 x 750)
Estimated Total Cost (Dry Plant)	$ 3,567 million
Estimated Total Cost (Incl. Heavy Water)	$ 4,518.8 million
Cost per kW	$ 1,494
Expenditure to Date (Apr '81)	$ 1,184 million

The civil and structural programs at Bruce GS B are on schedule and well advanced. Over 500,000 cubic yards of concrete, or about 87% of the total concrete required, and 29,000 tons of structural steel, or 62% of the total steel required, are in place. Units 5, 6 and the Common area have been enclosed. The intake tunnel has been completed and was recently flooded.

Construction of the water treatment plant and many of the Common and Unit 6 electrical systems has been completed. These facilities are now being tested during the commissioning phase.

The installation of turbine generators and other mechanical components is proceeding well and is on schedule. The piping program, however, is behind schedule, with only 18% of the scheduled program completed. This has been caused by delays in deliveries of valve fittings and related components affecting piping.

The major problem affecting the program schedule is the late delivery of the steam generators and preheaters. It was necessary to change the preheater design due to more stringent requirements demanded of the steam generators, which are now required to be able to operate under very severe operating conditions.

Present predictions call for delivery of the Unit 6 vessels this summer and early fall, which is approximately 20 months late to the original contract dates and up to 9 months late to the revised agreement dates. This delay may affect the Unit 6 in-service date. However, a definitive assessment will not be made until the vessels actually arrive at site. It is hoped that there will not be significant delays in subsequent deliveries for other units affecting their in-service dates.

Another key area which could have an adverse impact on the Unit 6 reactor critical date is the high pressure emergency core injection system, which is a major design change introduced at a later stage of the project schedule.

Increasing analysis of safety systems and subsequent changes have meant a significant increase in the engineering effort required in the scope of the project for the design of the station and for documentation supporting our operating license.

To date, $1.2 billion of a total project estimate of $4.5 billion which includes heavy water has been spent on Bruce B.

The work force at present numbers 3,850, comprised of 850 engineering staff and 3,000 field staff.

Unit 6 is scheduled to be in service in October '83, Unit 5 in July '84, Unit 7 in April '86, and Unit 8 in January '87.

Darlington Generating Station

Plant Size	3,400 MWe (4 x 850)
Estimated Total Cost (Dry Plant)	$ 5,552 million
Estimated Total Cost (Incl. Heavy Water)	$ 6,743 million
Cost per kW	$ 1,983
Expenditure to Date (Apr '81)	$ 209 million

Construction activities at Darlington to date have centered around site preparation, construction services and buildings. Construction of the generating station is just starting, and by September, the first concrete will be poured for the building foundations. The construction license was recently granted by the AECB three and a half years after our application.

To date, $209 million has been spent on Darlington, and $1.3 billion has been committed out of a total predicted cost of $6.7 billion which includes heavy water. The work force at present numbers 947, including 657 engineering and administration staff and 290 field staff.

A recent major change at Darlington was a decision by the Hydro Board of Directors to accelerate the in-service dates of the first two units by 6 months each and the last two units by 12 months each.

The Board's decision takes into account Ontario Government's policy outlined in the BILD program -- which calls for an economy "based increasingly on electrical power and nuclear technology" -- and the potential effects of the federal off-oil proposals.

Unit 2 is now scheduled to go into service in May '88, Unit 1 in February '89, Unit 3 in November '89, and Unit 4 in August, 1990.

OPERATING RESULTS

From the very beginning of the operation of Canadian nuclear stations, a Management by Objectives system has been utilized.

The five rudimentary objectives are:

- Worker Safety
- Public Safety
- Environmental Emissions
- Reliability
- Cost

Worker Safety

1. From 1962 to 1980, nuclear operations employees have worked 64.0 million man-hours.

2. There has never been a fatality of a nuclear operations employee at work for any reason.

3. There has been a very low frequency of temporary disabling injuries. Specifically, the frequency has been 2.5 injuries per one million man-hours for the decade from 1971 to 1980 inclusive.

4. No employees have ever been injured due to radiation.

5. There has never been a serious radiation exposure (greater than 25 rem per annum).

6. The highest whole body exposure which exceeded the regulatory limit of 5 rem per annum was an exposure of 7.3 rem.

7. Over-exposures to employees are very infrequent corresponding to 0.25 over-exposures per million man-hours worked.

8. Nuclear employees have been much safer at work than when not at work.

Public Safety

Public safety has to do with the protection of the public against acute events which would result in injury, disability, or death of a member of the public caused by nuclear generating stations for any reason.

1. During 82 reactor years of operation in Canada there has never been a fatality nor has there been an injury of any kind for any reason to a member of the public.

2. There has never been a release of radioactivity from any nuclear generating station which resulted in a measurable dose to any member of the public.

3. The radioactivity risk criteria have been fully met at every station for every year.

Environmental Emissions

Environmental emissions mean chronic emissions from nuclear generating stations which could potentially impair the health and/or well-being of a member of the public, or cause adverse effects to the environment.

Radioactive emissions are carefully controlled at extremely low levels.

1. Ontario Hydro has a perfect record -- the annual regulatory limit has never been exceeded. That is, all radioactivity emission criteria have been met every year at every station.

2. Radioactivity emissions have been maintained at extremely low fractions of the annual regulatory limits, typically less than 1% of the limits.

Reliability

1. The lifetime performance of the CANDU-PHW units has exceeded any other type of nuclear-electric stations (Pressurized Water Reactors, Boiling Water Reactors, Gas Cooled Reactors).

World Comparison of Reactor Types
500 MWe Units and Larger - Lifetime*

*(Since first production of electricity)

(Gross Capacity Factor - %)

CANDU-PHW	77
PWR	57
BWR	56
GCR	45

2. The eight CANDU commercial units in Canada have good lifetime reliability. The table below is a ranking of the eight CANDU units in the world's 115 large operating reactors.

Canadian Ranking in World's 115 Commercial Reactors
500 MWe and Larger - From First Electricity Date
to End of 1980

Unit	Gross Capacity Factor (%)	World Rank
Bruce 3	82.6	1
Pickering 2	81.5	3
Pickering 1	79.5	4
Pickering 4	78.1	5
Bruce 4	77.6	7
Pickering 3	76.1	9
Bruce 1	74.2	14
Bruce 2	68.6	22

Canadian Ranking in World's 115 Commercial Reactors
500 MWe and Larger - 1980 Annual Performance

Unit	Gross Capacity Factor (%)	World Rank
Bruce 2	93.7	1
Pickering 3	92.1	2
Bruce 3	91.7	3
Bruce 1	86.5	4
Pickering 2	83.3	11
Pickering 4	82.2	13
Bruce 4	76.7	20
Pickering 1	74.1	27

Cost

In the Province of Ontario, the CANDU-PHW is very competitive with coal-fired generating stations, the only other practical option for base-load application, hydro-electric having been developed.

The following table is a cost comparison of Pickering NGS-A, a nuclear station comprised of four 515 MWe units with Lambton TGS, a four 495 MWe units coal-fired station. Both stations are modern design and were constructed at the same time.

Cost Comparison Pickering NGS-A and Lambton TGS - 1980

Unit Energy Cost (Milli-dollars per kilowatt-hour electric, 1980 Canadian dollars.)

	Pickering NGS-A	Lambton TGS
Interest and Depreciation	6.06	1.94
Operation, Maintenance, and Administration	3.95	1.57
Heavy Water Upkeep	0.43	-
Fuelling	2.33	17.57
Total Unit Energy Cost	12.77	21.08

Component Experience

The on-power fuelling feature of CANDU-PHW has contributed to the high capacity factor of the commercial stations and to the low Total Unit Energy Costs. The lifetime Incapability Factor caused by on-power fuelling problems is 0.8%. Off-power fuelling for other reactor types typically results in Incapability Factors between 6% and 20%.

The fuel in CANDU stations can be manufactured in a relatively simple and small shop. The performance of the CANDU-PHW fuel has been excellent with a defect rate of 0.1%. Defective fuel has a negligible effect on station incapability.

Following extensive development, the heat transport pumps are working well with proven features allowing good maintainability and low incapability. For example, shaft seals can be replaced without major dismantling of either the motor or the pump.

The pressure tube development has produced excellent results. No ruptures have ever occurred. Continued research indicates that the ductile pressure tube will leak long before break. Rupture of one pressure tube is not expected to cause failure in adjacent tubes.

A problem of leaks near the rolled joints was encountered at Pickering NGS. Some tubes were replaced and the problem has now been solved.

The pressure tube life was originally expected to exceed 10 years. This has been achieved. Radiation induced lengthening of pressure tubes will use up original design allowances after a minimum life of 14 years for the first commercial units. The pressure tubes may be replaced at that time, however, other solutions appear viable to extend their life. New pressure tube specifications are seeking a life of more than 20 years and probably 30 years.

The performance of CANDU-PHW boilers has been excellent with a very low incapability of 1.1%. A major problem has been experienced during manufacture of the boilers which required a change in the boiler design and stress-relieving procedure.

The CANDU-PHW station at Pickering NGS-A used the first digital computer control system for a nuclear station. Today, all CANDU-PHW stations utilize dual digital computer controllers with outstanding performance.

The heavy water management of CANDU-PHW stations is important to minimize heavy water losses in systems operating at high pressure and high temperature.

The basic methods achieve low cost even though large leaks can occur. Enclosures ensure the effective recovery of both vapour and liquid leakage. The heavy water management costs have been low. The quality control which must be taken to ensure low heavy water cost has contributed to the high capacity factors achieved.

EFFECT OF THREE MILE ISLAND ON THE DESIGN AND OPERATION OF CANDU

The accident at the Three Mile Island nuclear plant in Pennsylvania has had an effect on more than just public attitudes toward nuclear energy. Even though CANDU plants are of a different design than the U.S. light water reactor, regulatory officials in Canada have been influenced by the reported equipment failures and human errors associated with the Three Mile Island accident. Thus the safety of the "CANDU" station has been reviewed in detail relative to the conditions that existed at the time of the T.M.I. accident.

One cannot quarrel with the need to re-examine one's thinking and designs from time to time. Certainly, a need to re-examine can be healthy, leading to increased safety and public confidence. There can, however, be dangers in a reassessment that knows no bounds, and Hydro hopes that regulation in Canada will continue to be one of cautious discretion.

In Ontario we have come through the post TMI review reasonably well. Our nuclear operator training and retraining programs and facilities are being constantly reviewed and are looked upon as a good standard for the industry. The work we have done on man-machine interface put us in the lead in this important area. Our plant designs have withstood careful scrutiny, and although minor changes were made, such as a change from manual to automatic trips on low boiler level, no major shut-downs or modifications were required.

Of course, we must continue to improve the safety of our nuclear stations, but we already have a reactor concept with outstanding safety features which is judged by review bodies to be adequately safe.

That doesn't mean we should be complacent. One cannot disagree with the demand that CANDU plants have a very high level of safety. We are making substantial expenditures to improve the reliability of safety systems and to achieve additional safety margins.

The approach to nuclear safety in Canada has been both responsible and creative. It is appropriate that the regulatory body set the overall standards for public safety and monitor the operating results relative to the safety standards. It is very important that Ontario Hydro accepts and demonstrates its responsibility for meeting safety standards set by the AECB so that no reason exists for the escalation of regulatory requirements which have occurred in other countries.

FUTURE NUCLEAR POWER PROGRAM

Life Expectancy of CANDU Reactors

Ontario Hydro has recently decided that the overall life expectancy of nuclear generating stations be extended from 30 to 40 years with specific groups of plant components being identifed with estimated service lives ranging from 15 to 50 years.

The materials of construction for CANDU were specified on the basis of experience and performance to ensure minimum maintenance or repair over the life of the station. Furthermore, the stations were designed so that all components could be replaced if required.

An example of replacement of major components is Ontario Hydro's plan to retube Pickering A reactors and three of the four units at Bruce A.

The CANDU reactor was designed so that the channels could be replaced if and when required. Allowances were made for changes in dimensions of the reactor fuel channels under operating conditions during the design of the Pickering and Bruce stations. However, ongoing programs of measurement at both stations indicate that the rate of change of dimensions of these channels is in excess of that allowed for in design.

It is estimated that the channels in the Pickering A reactor may reach the allowed limits of expansion between 1985 and 1991. The Bruce A reactor channels are expected to reach these limits between 1992 and 1996. All units beyond and including Bruce 8 have been designed with increased allowances for tube elongation, and retubing will not be necessary.

Ontario Hydro is pursuing two programs to deal with the concerns of increasing elongation. The first is the Large Scale Fuel Channel Replacement Program for which Spar Aerospace, AECL and CGE are developing equipment and tooling to remove the elongated tubes and replace them in with new ones. Hydro is developing the capability to carry out retubing starting in 1985.

The second program, which will continue in parallel with the first, involves repositioning one end of the fuel channels to allow additional elongation of pressure tubes and thus continued operation of the reactor. With such adjustments, it may be possible to extend the life of fuel channels by about 10 years, thus delaying the need to retube.

Each reactor retubing operation will require the unit to be out of service for 12 to 15 months. Only one unit will be retubed at a time while the other units in the stations continue to operate. Particular emphasis is being placed on minimizing the radiation exposure to workers when this retubing work is undertaken by decontamination of the reactor and by the use of remote handling equipment and shielding.

Total cost for this work at Pickering is estimated at $350 M with energy replacement estimated at $550 M.

It may be technically feasible to replace other major nuclear components resulting in extensions of station service lives beyond 40 years. But because of the limited operating experience with nuclear facilities and the uncertainty with respect to the economics of replacing major components, a life extension of greater than 10 years from 30 to 40 years is not considered advisable at this time.

Size of Units & Future Additions

Ontario Hydro has gradually increased the size of its nuclear units from 500 MWe at Pickering to 750 MWe at Bruce, to 850 MWe at the Darlington station.

Based on our present needs, Ontario Hydro does not plan to build units larger than 850 MWe. However, we do know as a result of substantial work undertaken by Ontario Hydro that units of 1250 MWe are feasible and could be constructed if needed.

Beyond Darlington, Ontario Hydro will likely continue to add to the nuclear generation component of its system with more 4-unit stations. Although not yet committed in an approved program, preliminary planning suggests the possible commissioning of a 4-unit, 3400 MWe station by 1997 and the completion of half of a second such station by the year 2000. This would bring the nuclear portion of the system's capacity to about 50% and would result in some 70% of the total energy production coming from nuclear plants. I would stress that these additional units are based on the assumption that our present long-term load forecast proves accurate.

There are sound economic and environmental reasons for Ontario Hydro to expand its nuclear base, but in doing so we recognize that such a course of action is not without some risk.

We perceive four major areas of concern to future nuclear expansion.

First is the regulatory climate. The Canadian concept of regulation has allowed the CANDU design to evolve into a superbly efficient and safe reactor. Ontario Hydro hopes that our regulatory attitude will remain responsive and pragmatic. Yet we have concerns that a long-term escalation of regulatory requirements for various reasons could, by multiplying the effort needed to obtain operating licences, significantly delay schedules and increase costs.

Second, a system expansion program wholly devoted to nuclear generation could disrupt the balance of generating mix and reduce the flexibility that Hydro has taken some pains to develop over the past two decades. There are risks in having too many eggs in one basket, even if the basket does look like a good one. The possibility of encountering "generic" problems in one class of plant could necessitate widespread shutdowns over a major portion of the system.

A third concern is the possible effects of labour relations difficulties where the continual operation of the system is dependent on small key groups.

Finally, we should be concerned about public attitudes. Those continue to be potential major obstacles to expansion in view of continuing public concerns about the safety of plant operation, uranium mining, the transportation of radioactive material, and permanent disposal of irradiated fuel.

Our planning and our actions are designed with these and other concerns and cautions clearly in view. Ontario Hydro is committed to its nuclear direction with the confidence of some 20 years of successful progress but we shall proceed with care and only within the bounds of economic common sense and acceptable risk.