Q. With reference to the Technical Conference on Project B-14 Holyrood Condition Assessment, provide a copy of the Hydro internal discussion paper prepared following discussions with APTEC and Bechtel in 1992?

A. A copy of the discussion paper is attached.

NEWFOUNDLAND AND LABRADOR HYDRO

PLANT LIFE EXTENSION AND OPTIMIZATION

A discussion paper outlining the approach which may be taken by Newfoundland and Labrador Hydro in order to maximise the total life cycle of its generation, transmission and distribution plant and equipment.

1 INTRODUCTION

There is a plethora of information, research papers, guidelines, position papers and consultants' literature on the topic of Plant Life Extension. In the late 1970's the electricity supply industry in the U.K., was actively involved in Remanent Life Assessment and repowering of plants which were reaching, and in many cases had passed, their twenty-five year life span. Since the mid 1980's many North American utilities as well as both EPRI and the CEA have sponsored research, conferences, symposiums, seminars, training sessions and workshops on Life Extension and it's related topics, i.e. Plant Condition Assessment, Remaining Life Analysis, Life Optimization, Life Management and Unit Evaluations.

There are a number of reasons for this activity, however, suffice to say that cash-strapped utilities faced with stagnant or limited load growth, in an increasing environmentally conscious climate, find it prudent to consider extending the life of their existing plants rather than to rebuild or replace. Utilities need to evaluate this process in a least cost, organised way which will give the greatest return on investment. Papers and presentations offered to date all purport to provide the optimum way of achieving this objective.

The vast majority of the published data on the topic of Life Extension addresses the subject from a fossil fuel power plant perspective although the theory and concepts apply equally to hydro plants and also to transmission and distribution equipment. Also, almost all the literature refers to the market forces which drive the repowering-replacement decision making process where an investor owned utility is competing for it's share of a very competitive electricity demand market. None of the papers available to date cover a case such as this Company (Hydro) which has an electricity monopoly, is approaching the normally anticipated end of the economic life cycle of some of it's key plant and equipment and yet has Thermal Power Plant equipment which, although old in years and in some cases obsolete has yet seen only limited service.

The EPRI and CEA literature seems to give the best generic advice on the topic of life extension and these sources are used throughout this report. This discussion paper is an attempt to associate this material with Hydro's specific future needs.

2 BACKGROUND

Traditionally the economic life of a utility electrical generating facility has followed three modes:

1. Base loaded when new and efficient, receiving maximum maintenance and engineering resources, (first 10 years in the case of thermal plants).

2. Load following, (10 to 15 years for thermal plants).

3. Peaking, i.e. low capacity factors and minimum maintenance, (5 to 10 years).

This predicted life cycle has resulted in a total life expectancy for thermal plants of twenty-five to thirty-five years. Typically, market forces have determined the capacity factor profile of an existing unit i.e. as the unit has become less efficient and technically obsolete its utilization has decreased. This is no longer true in the 1990's and is particularly not true at the Holyrood Thermal Plant.

In a period of load growth following stagnation the following factors become concerns:

1. Reserve margins are shrinking making the loss or extended outage of a major unit or transmission line of concern to the whole system.

2. Plants and units and auxiliary equipment is getting older, obsolete, less efficient, more costly to maintain and less reliable.

3. Equipment is approaching the end of its normal operating life.

In such a situation a utility has three primary options,

a) Conservation (Demand Side Management or DSM),
b) construction, of new generating plant and equipment,
c) life extension and refurbishment.

In Hydro's case there are some opportunities for savings resulting from DSM and there are some limited economic justifications for new construction particularly in the private sector i.e. Non-Utility Generation. Ultimately, however, existing generating plant and equipment, particularly the thermal plant, will be required to operate at higher capacity factors at proportionately higher levels of availability. Hydro plants will be required to maintain a high availability standard.

If plants are to be refurbished or replaced the work must be prioritized, planned and performed without impacting on the already tight production schedules of individual units. In short, in a utility which may have no alternate sources of power, i.e. other than its own generation and transmission equipment, the time for preparation is now.

With replacement costs as high as $2,000 per kW, not including environmental control equipment which may add another $1,000 per kW, and refurbishing costs typically in the $500 to $1,000 per kW range this utility should be looking to extend the economic operating life of existing plants and equipment beyond the traditional twenty five to thirty five years.

3 THE LIFE OPTIMIZATION PROGRAM

The management of plant life extension or optimization has, over the last fifteen to twenty years, followed a steep learning curve. Considerable expertise has been developed by practitioners and this expertise has been brought together by, in the first instance, the Electrical Power Research Institute (EPRI) and later by the Canadian Electrical Association (CEA) in cooperation with EPRI as a result of a technology transfer demonstration project. Therefore, based on practical experience the method and procedure for Life Extension programmes has now reached a sophisticated and formal standard.

The following outline is taken from the latest EPRI/CEA paper and describes the characteristics of a successful Life Extension, Life Management or Life Optimization program.

3.1 CORPORATE ISSUES

- The concept and application of a production strategy is an essential part of the utility planning process and is necessary to understand the role of life optimization in the utility. (Attachment A gives guidance on the elements of a production strategy)

- A corporate philosophy statement, where it can be obtained at the beginning of a life optimization program, will greatly ease the burden of required liaison activities for the program coordinator. (See attachment B for sample Corporate Philosophy Statement)

- A unit mission statement has been shown to have a number of advantages both as an end point for a unit condition assessment and as a working document within the utility. (See attachment C for sample Unit Mission Statement)

- Identifying the effects of environmental control options is critical to program decisions.

Generic Guidelines:

3.1.1 Formalize which groups or individuals within the utility will be responsible for life optimization activities. Some utilities have set up an internal structure to oversee and manage the whole process with a full time team manager and representatives, typically, from Corporate Planning, System Planning, Plant Planning, Engineering, Operation and Maintenance. Other utilities have employed consultants and/or Original Equipment Manufacturers to survey, study and report on the condition of plant components.

3.1.2* Establish corporate objectives for life optimization.

a. Define the functions of the life optimization activity.

b. Choose the timing of the program, either as a front-end or phased approach. (A phased approach is preferred)

c. Consider whether equipment uprating will be a part of the process.

d. Determine to what extent the objective of the program is to focus specifically on performance characteristics such as availability, heat rate or efficiency, reliability and cycling capability.

e. Determine how life optimization activities are to be integrated with system generation planning.

f. Define preferences for the desired life of the refurbished equipment.

g. Define specific cost components to be targeted as part of the program.

h. Define and specify environmental objectives or constraints that need to be addressed by the program.

i. Define other objectives reflecting unique utility requirements.

3.1.3* Choose criteria to be used for ranking units, (Hydro, Thermal and Transmission) and identify eligible candidate units for consideration.

3.1.4 Review past life optimization activities and critically evaluate their applicability and success.

3.1.5 Establish the goals, timing and available resources for the initial planning study or revision to the program plan.

3.1.6 Review information systems and initiate activities to assure that adequate systems are available for future decisions.

3.1.7 Identify environmental control options.

3.1.8* Outline factors outside the utility that should be considered as a part of the initial planning study or revised program plan.

3.1.9* Compile performance and cost data from existing generating units.

3.1.10* Compile system-wide supply, demand, performance and cost data.

3.1.11* Integrate historical and current data to provide a system view about life optimization and forecast of future system and plant activities, as required.

3.1.12 Evaluate the benefits of life optimization to the system or to a specific plant, depending upon the objectives of the program.

3.1.13 Establish the degree of cost information that will be required for the initial planning study and evaluate program costs.

3.1.14 Prepare initial planning study or revised program plan, including ranking of units, estimates of cost and schedule.

3.1.15 Evaluate risks and uncertainties of the life optimization program.

3.1.16 List the triggers that will initiate the next program review.

* Note - Guidelines marked with an asterisk are part of the production strategy action items.

3.2 PLANT ISSUES

- The distinction between critical components and "influence" components provides a useful tool for establishing priorities.

- Phased levels of assessment interface well with on-going plant operation.

- Outage scheduling can be optimized by considering the equipment assessment needs in addition to system planning requirements.

- When planning for outage schedules, enough time must be allowed to effect repairs of defective conditions found by the inspections.

- Although the problems found in one unit can provide information about similar units, one cannot assume "identical" units will have identical conditions.

Generic Guidelines:

3.2.1 List all major systems in-plant and divide the systems into components.

3.2.2 Evaluate historical condition of the unit and its key components and assess the present operational characteristic using plant data.

3.2.3 Investigate other sources of equipment information to supplement plant records when required.

3.2.4 Choose an equipment ranking procedure

3.2.5 Establish initial equipment priority

3.2.6 Establish initial schedule and projected costs for life extension of the unit and use the information to revise the corporate program plan, as needed.

3.3 COMPONENT ASSESSMENT ISSUES

- The overall generic procedure for component life assessment should include the key concepts of root cause analysis, mitigation of driving force and cost justification for detailed examination.

- If thorough documentation of historical practice and current operations is to hand, some components and damage types can be evaluated with only a Level I assessment (See Paragraph 3.3.1). However, in many cases, insufficient information is available.

- A knowledge of the key information required for the assessment of particular components is vital to the life assessment program. Once the important questions are known about each critical component, data acquisition systems can be specified to collect and analyze the information and thus ease the burden of the manual review of records.

- Unexpected benefits of component life assessment can be realized through a formalized program.

- The use of a multi-level approach offers a logical and resource effective way to evaluate most components.

Generic Procedures

3.3.1 All practitioners of Plant Life Assessment recommend a multi-level approach in which the basic, lowest level (Level I) is preferred and the progressively higher levels (Levels II and III) are used only to gather information not obtained at the lower levels. This approach is summarized in the following table: (Figure 3-1)

Figure 3-1

Data Requirements for a Multi-Level Approach
to Component Life Assessment

FEATURE	**LEVEL I**	**LEVEL II**	**LEVEL III**
FAILURE HISTORY	PLANT RECORDS	PLANT RECORDS	PLANT RECORDS
DIMENSIONS	DESIGN OR NOMINAL	MEASURED OR NOMINAL	MEASURED
CONDITION	RECORDS OR NOMINAL	INSPECTION	DETAILED INSPECTION
TEMPERATURE AND PRESSURE	DESIGN OR OPERATIONAL	OPERATIONAL OR MEASURED	MEASURED
STRESSES	DESIGN OR OPERATIONAL	SIMPLE CALCULATION	REFINED ANALYSIS
MATERIAL PROPERTIES	MINIMUM	MINIMUM	ACTUAL MATERIAL
MATERIAL SAMPLES REQUIRED?	NO	NO	YES