

Strategic Provisioning of Replacement Parts for CANDU® Power Plants

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ABSTRACT

Provisioning of replacement parts and management of critical spares are key factors in optimizing maintenance programs for CANDU® power plants. With a view to supply assurance, Atomic Energy Canada Limited (AECL) has created a Spare Parts Branch (SPB) to provide a clear pipeline from the client to the delivered replacement part(s). SPB provides the client with assured access to a qualified supplier database, computer aided design, engineering and manufacturing services and material upgrades and design registration through the authorized inspection agency.

The AECL spare parts strategic provisioning service plan that has four thrusts: 1) the efficient delivery of cost-effective replacement parts; 2) obsolete parts resolution; 3) a website that will provide our clients with real-time access to replacement part data and 4) inventory recovery opportunities. Thrusts one and two are actively ensuring plant maintenance for on-shore and off-shore CANDU® clients. Thrusts three and four are longer-term commitments. This paper will explore these thrusts in the context of our CANDU® business practices.

INTRODUCTION

As reactors age there is an increased likelihood that the availability of suitable replacement parts will either become critical path items during a plant outage or may lead to an unplanned shutdown. In the case of the later, this has happened in a United States (US) reactor where an obsolete analog control board for the feeder-pump control system could not be replaced in time and lead to a 4 day shutdown at a loss of approximately 1 million dollars per day [1]. Hence, this issue is becoming increasingly important to the management of the plant life cycle.

As suggested above, there are significant challenges to satisfy the demand for engineered products that will become more complex as the approved vendors list becomes more difficult to maintain. In the US market it is acknowledged that 60+% of nuclear qualified manufacturers have exited the market or dropped their nuclear programs in recent years, 75% of the obsolete items are found during the procurement/procurement engineering phase. Contrary to the traditional definition of obsolescence, where an item is out-moded or no longer used, nuclear supply obsolescence refers to in-place equipment that is still needed, but unavailable or no longer supplied by the Original Equipment Manufacturer. Even if an alternate item is found, it is a significant challenge to ensure that the item meets

the original specification and quality level. As time progresses, these issues will increase in severity if there is no remedial action.

AECL (Atomic Energy of Canada Limited) has a mandate to design, construct and supply CANDU power reactors and MAPLE research reactors. We have a large technical resource base that is familiar with all aspects of the supply chain process; from the item design inception through to parts installation. AECL has a vested interest in ensuring the long-term, safe, efficient operation of the plants.

This paper outlines AECL's cradle-to-grave strategic thrusts for replacement parts. Thrust one was realized through the formation of the spare parts branch, which provides a point of reference to ensure consistent access to cost-effective replacement parts. As the originating plant designer, AECL has resolved obsolescence issues through qualifying alternate sources of supply and re-engineering parts as needed. The focus of thrust two is to supplement the existing service with a simplified upgrade process that includes pressure boundary items. In keeping with the change in business-to-business applications, the third thrust is to develop a website that will provide our clients with real-time access to replacement parts information. Thrust four focuses on inventory recovery through brokerage and pooled inventory management, which is a new area of interest for AECL and can be explored with interested groups of utilities. AECL is prepared to work with our clients to participate in a total-cost effective supply chain management program.

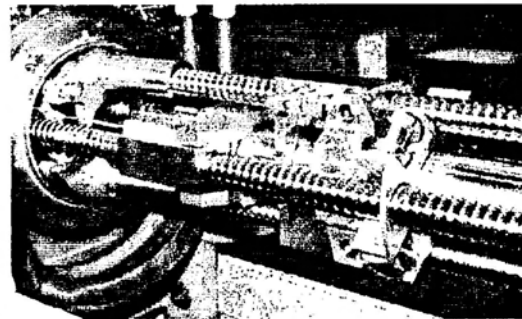
Thrust 1: Spare Parts Provisioning through the *CANDU Centre for Nuclear Parts and Services*

A general problem across the CANDU industry is the lack of a centralized resource center with the tools to connect technically qualified people and information relating to procurement issues. Globally, the CANDU family duplicates a list of common costly services (e.g., procurement engineering, procurement (including logistical support), manufacture, obsolete item replacement services, acceptance testing and quality surveillance/control), hence the total cost of provisioning replacement parts may not be fully considered and can be expensive. This problem is exacerbated since individual utility orders are small and they cannot fully take advantage of volume or bulk purchases. Furthermore, despite the success of the CANDU reactors in the current climate, even with generous premiums and it is difficult to convince some manufactures to supply the small orders typically needed by operating plants.

The AECL spare parts branch provides the one-stop-shop to relieve the utility of the burden of maintaining separate provisioning departments, buying lifetime supplies of items of difficult to find replacement parts and providing a comprehensive parts service. This new branch has stream-lined AECL's replacement parts business processes to reduce costs, while utilizing the 30 years of commercial CANDU experience to the supply of fully-qualified, total-evaluated-cost replacement parts. Supply assurance is met through the branch options, which include design, procurement engineering, procurement, manufacture, nuclear upgrades,

reverse-engineering, environmental and acceptance tests to qualify a wide range of replacement parts.

The creation of this branch captures the synergy in the supply chain by being a resource for all CANDU stations. By focusing these efforts, AECL is leading the way in the development of parts equivalencies, a generic parts supply and reduced duplication in services. Furthermore, the center provides access to a steady resource of pooled expertise and shared parts solutions that will reduce the obsolescence risk for future reactor operations.



A Fuelling Machine RAM assembly, showing the ball-screw, ball-nut, and RAM-tube arrangement.

Thrust 2: Obsolescence-Solid Solutions by Design, Test or Build

In the event that a nuclear component is no longer supplied through traditional sources, AECL has provided support in the areas of

- replacement of obsolete equipment with upgraded technology or alternate sources from our on-going plant construction
- nuclear upgrade and reverse engineering
- exchange of common and surplus spares amongst CANDU plants
- studies for parts substitution
- finding replacement parts using Internet services (see RAPID below).

These processes have been supported by our in-house acceptance test and manufacture/fabrication facilities, environmental qualification and seismic evaluation capabilities. Examples of these replacement parts solutions are given below.

Alternate Sources of Supply

Several replacement parts solutions were needed during the recent fuelling machine manufacturing for QINSHAN build project underway in China and WOLSONG reactor in Korea. For example, AECL qualified alternate sources of supply for nuclear grade Quick Disconnect Couplings, Radiation Resistant Wire and Clamps and Seals for Fuelling Machine Magazine Housing and RAM Forgings.

Nuclear Upgrades/Commercial Grade Dedication

Under a comprehensive quality assurance program, AECL has offered nuclear upgrades, and/or commercial grade dedication services for both materials and components (examples below). These services provide clients with significant cost savings, improved scheduled delivery and avert parts obsolescence. Typically, nuclear upgrade entails either the “upward” qualification of components from non-nuclear to nuclear grade or “upgrade” the

nuclear class from a lower to higher grade in conformance with the applicable regulatory and jurisdictional requirements.

Commercial Grade Dedication is new to the Canadian marketplace. In a generic sense, dedication of a commercial grade item requires that the item not be subject to design or specification requirements that are unique to nuclear facilities, that it is used in applications other than nuclear facilities and it is to be ordered from the manufacturer/supplier on the basis of specifications set forth in the manufacturer's published product description (for example, catalog). The dedication process involves specifying the critical characteristics for the safety related, typically non-pressure boundary application, following a process to ensure the item meets the requirement (e.g., acceptance testing) and complying with any additional requirements of the jurisdictional authority including registration.

Examples of Upgraded Materials and Components are:

- **Barton Pressure Transmitters:** In this case, it was required that supplier would provide a transmitter that was registered with the Jurisdictional Authority prior to use. After one year of unsuccessful attempts to register the item, the project schedule was threatened. Hence, AECL work with the supplier to upgrade the commercial quality transmitters to the requirements of ASME Section III, class 3. The detailed work included upgrade of material, preparation of certified material test reports (CMTR) for nuclear components, and submitted the design registration package to the Jurisdictional Authority.
- **10" Flow Nozzle:** This commercial item was needed for a class 3 installation. AECL worked with both the material and design to upgraded it, which included providing a certified material test report from AECL. Based upon the materials upgrade, the design of the commercial nozzle was registered to ASME Section III, Class 3 with the jurisdictional authority (TSSA).
- **Weed Pressure Transmitters:** This is an example of the project being threatened with a significant delay. AECL performed the required stress analysis, upgraded to meet the requirements of ASME Section III, class 3 and submitted the design registration package to the Jurisdictional Authority.
- **2" Gate and Ball Valves:** The combined cost and delivery of these items as nuclear class was unacceptable. The work performed included hardness testing, chemical and physical analysis, ultrasonic inspection for minimum wall thickness, Dimensional Inspection and preparation of all documentation, including History Docket. This information was certified and submitted to both the regulatory (Canadian Nuclear Safety Commission (CNSC) formerly the AECB and the jurisdictional authority, Technical Standards and Safety Authority (TSSA) for approval and acceptance.

Reverse and Re-Engineering:

Where items are no longer available in the marketplace, AECL has carried out reverse-engineering services develop a replacement item that is based on a component that highly

similar to the obsolete original item in the CANDU station. In addition, AECL has provided re-engineering services which is a method that improves the original design above what is available in the current marketplace. Examples of AECL reverse or re-engineered items include:

- Paper Tape Emulators (PTE) for BRUCE A: These PTE units resulted from reverse engineering of the reader/punch units of the original configuration. The redesign replaces the obsolete, mechanical relay-type technology with digital I/C floppy drive based units.
- Airlock Valves for Darlington NGS: AECL re-engineered the valves so that the final replacement product is registered as nuclear class and incorporates upgraded elastomer seals to improve the item performance. The work included redesign, manufacturing, inspection, extensive performance and acceptance testing and registration with the TSSA.
- Pickering "B" Fuel Transfer Mechanism Pump Cover/Pedestal: The original pump pedestals were made of cast iron and developed cracks with routine operation. The CNSC, which is the Canadian Nuclear Safety Commission (that is the Regulatory Authority formerly known as AECS) dictated that the replacement cover/pedestals must meet nuclear Class 3 requirements. AECL re-engineered the pedestals utilizing ASME Code material, manufactured, inspected, tested and registered the item with the TSSA.

Thrust 3: Web-based Replacement Parts Service

Effective materials management involves activities ranging from materials planning to investment recovery. All or most of these activities depend on readily available accurate information. Sharing of product specifications and other inventory information among operating stations has been difficult due to a variety of reasons such as the use of utility specific component IDS. With the use of the Internet and advances in eCommerce "know how", resolution of these technical barriers can be overcome.

AECL maintains the original design basis of each plant it has designed and can provide the original design basis of any system. AECL works with the client to verify the existing plant configuration and with the suppliers to incorporate the latest design data for the affected products-i.e., we ensure that we are all on the same page at the same time. This information is the foundation of the web-based service. The objective of this service is to provide global access to information and technical staff around the clock to support the CANDU resource center.

A proto-type of the web-site is under review within AECL. The primary search features of the website are shown in figures 2 through 5.

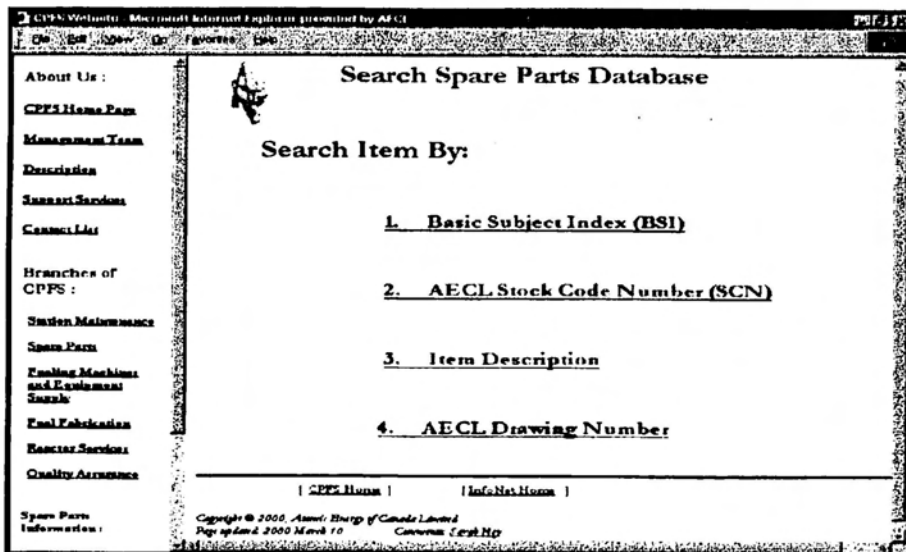


Figure 2. Conceptual interface for searching spare parts database.

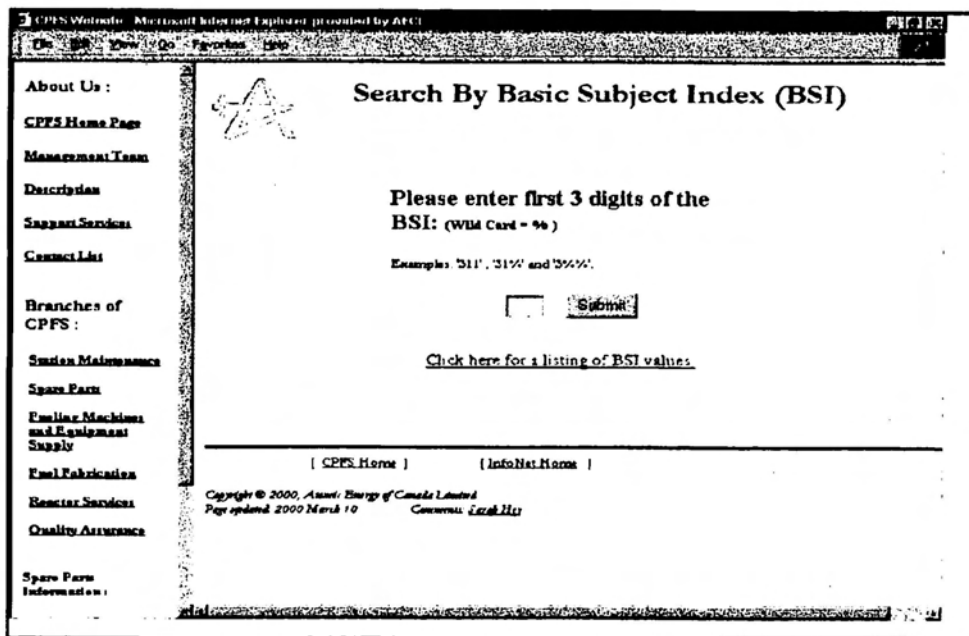


Figure 3. Typical Search function interface for spare parts database.

The database can be searched using partial descriptors. For instance, the stock code number (SCN) can be searched using up to 5 alphanumeric characters and the "*" wildcard. The item description search will also facilitate up to three separate lines of text (figure 4). The drawing description can also be searched in a similar fashion.

Figure 4. Interface to search database by item description.

The result of these search features will be a subset with the specific data, which can be compiled as a Request for Information (RFI) shown in (figure 5).

Figure 5. Request for Information view.

This RFI is emailed directly to the spare parts branch. This is not a Request for Quote system and does not obligate the user or AECL to the sale of the item. The response information will include the lead time, or availability of the item and several order options. The source of available parts could be cross-linked to pooled inventory resources and manufactured parts, such as through the RAPID webpage (see below).

Additional features envisioned for this website include

- a Procurement Engineering Chat Room with threaded discussions;
- a resource for Environmental Qualification data;
- support for eProcurement;
- a remote inspection service using streamed video or other digital photos of equipment at various stages of manufacture/fabrication, and
- on-line document sharing.

On-line Document Sharing

With the global access provided through the Internet, AECL is investigating on-line electronic document sharing to simplify the validation of data and preserve the critical details necessary to ensure that replacement parts are correct. The success of this effort would largely depend upon the co-operation of the individual utility. Other electronic support documents could include Shipping documentation, history docket templates, associated QA items (Mill Certs, CofC) and Component Specification Sheets.

RAPID

Since December 1999, AECL has also used the on-line directory called RAPID. (Readily Accessible Parts Information Directory), which is a common database of inventories accessible through the Internet. The members include power utilities, other industries and their suppliers. The directory facilitates the buying and selling of parts between the stations and their suppliers, and among the stations themselves. This service relies upon the purchaser to ensure they understand the full engineering-related implications from purchasing the product. As an added-value to our clients, AECL assesses the engineering equivalency of the item, performs reconciliation of code items from various standards when needed and upgrade if is necessary, with documentation, to meet the station's need. Hence, the correct item is available when needed thereby optimizing the total cost of replacing the component. With the help of RAPID and other online tools, AECL plays an important role in spare parts refurbishment for all the CANDU stations.

Inventory Recovery Opportunities

There are several options available to recover some of the investment tied up in inventory. As part of the inventory initiative, AECL is currently working with CANDU utilities to create plant life maintenance programs that allow the client to optimize their investment in maintenance activities. As an outcome of this process, the utility can better specify parts demand, which in turn leads to minimized inventory investment and warehousing. This service is further supported by inventory brokerage and pooling of slow-moving, high-cost assets. AECL has access to sophisticated inventory manager programs such as CMMS (CANDU Material Manager System).

Inventory Brokerage

CANDU stations can realize cost savings by having a common inventory broker who facilitates the bulk purchasing and exchange of common, specialized spare parts amongst the stations. The cost savings would be realized through the centralized information resource to reduce procurement engineering labour hours, improved material availability and disposal of surplus inventory through sales to other utilities. As a result, there is the potential for reducing operating costs and capital investment and, through agreements with other plant sites for joint stocking, operating stations can reduce their line item counts. As an active vendor for CANDU stations, AECL is well-positioned to provide this type of brokerage service.

Inventory Pooling

In addition to brokerage, AECL has the capability to create and maintain an inter-utility pool of high cost, low usage critical items. This inventory may be physically relocated to a/several key warehouses, or may be virtually stored. In both cases, the inventory can be Internet-ready to allow real-time client access. A potential business model could include creation of a venture company by the interested parties. Each participating utility would write the inventory item off their balance sheet and the item would be held as property of the venture company. When sold, the owners would realize a share of the profits. The venture company would charge a few percent of the total value of the assets to administer the warehousing costs.

Quality Assurance

When purchasing replacement equipment, components and parts, jurisdictional, safety and technical requirements must be met. The station must have the necessary information on technical and quality assurance requirements pertaining to the procurement of the replacement items. Procurement engineering at AECL conforms to stringent quality assurance requirements described in a comprehensive quality assurance program. This quality assurance program has been implemented by past and ongoing projects.

The station must have the necessary information on technical and quality assurance requirements pertaining to the procurement of the replacement items. AECL's overall quality assurance (QA) program and applicable sub-tier programs, including procurement, procurement engineering and design, satisfy CSA N286 and ISO 9001 series of standards and are reviewed and audited by CNSC (AECB) and the Quality Management Institute (QMI). AECL's Commercial Products and Field Services Division (CPFS) programs are certified by the Technical Standards and Safety Authority (TSSA), an ASME accredited Authorized Inspection Agency in the province of Ontario, Canada for CSA N285.0 and ASME Section III (Class I, II, III) for pressure-retaining nuclear systems and components and CSA B51 and ASME Section VIII for the manufacture of boilers, pressure vessels, pressure piping. AECL Sheridan Park and Chalk River seal manufacturing facility are registered to ISO 9001. AECL has also retained the CSA Z299 features within its ISO 9001 program.

Summary

AECL is driven to ensure a total-cost sensitive procurement process to meet the operational needs of the utility and regulatory requirements. The AECL initiatives explained above are the backbone of our business model, which provides technical expertise, qualified equipment and inventory recovery opportunities. These activities capture the knowledge base to reduce complex engineered products to the level of a commodity with an enhanced QA program. Ultimately, this new business model is vital in sustaining the effectiveness of our work-force and supports the broad range of requirements necessary to meet the current and future supply chain challenges of our clients.

Reference

1. Nuclear Utility Obsolescence Group, Meeting and Trade Show, Toronto, Aug 15-17, 2000.