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# THE Y2K PROGRAM FOR SCIENTIFIC-ANALYSIS COMPUTER PROGRAMS AT AECL

by

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## *Abstract*

The evaluation of scientific-analysis computer programs for year-2000 compliance is part of AECL's year-2000 (Y2K) initiative, which addresses both the infrastructure systems at AECL and AECL's products and services. This paper describes the Y2K-compliance program for scientific-analysis computer codes. This program involves the integrated evaluation of the computer hardware, middleware, and third-party software in addition to the scientific codes developed in-house. The project involves several steps: the assessment of the scientific computer programs for Y2K compliance, performing any required corrective actions, porting the programs to Y2K-compliant platforms, and verification of the programs after porting. Some programs or program versions, deemed no longer required in the year 2000 and beyond, will be retired and archived.

## Introduction

Scientific-analysis computer programs (or "scientific codes") are used extensively in CANDU design and safety-analysis work. Examples include computer programs in:

- Reactor physics
- Fuel analysis
- Reactor-transient analysis
- Heat transfer
- Thermalhydraulics
- Reactor chemistry

These programs model or simulate different aspects of nuclear-plant behaviour. Usually, they make only rather simple use of calendar dates (e.g., date-stamping of runs for data management purposes). However, in some rare cases, calendar dates may play a significant role in calculations. Identifying and correcting Y2K non-compliance for scientific codes is relatively straightforward on an individual code basis. However, in view of the large number of disciplines and administrative units in AECL, large numbers of codes and distinct code versions have had to be examined.

As noted, since the use of dates in scientific-analysis computer programs is not generally extensive, the compliance of the computer platforms on which the codes execute is often the greater concern. (By computer platform we mean the computer hardware, operating systems, libraries and compilers.) The platforms also must be checked and made Y2K compliant to ensure that the scientific codes will continue to run correctly beyond 1999. Various network-connected computer platforms (primarily HP and SGI UNIX workstations, VMS minicomputers, IBM RISC machines and Windows 95 and NT PCs) are used at AECL, and most of them in fact require operating-system upgrades or vendor-supplied patches to achieve Y2K compliance. Thus, the AECL Y2K-compliance program for scientific-analysis codes involves the integrated evaluation of computer hardware, middleware, and third-party software in addition to the scientific codes developed in-house.

Once Y2K-compliant computer platforms have been procured, the identified scientific codes must be ported to these platforms in advance of the year 2000, and their correct operation on these platforms must be verified. Software quality assurance (SQA) standards for scientific codes used in nuclear-system design or nuclear safety analysis require systematic verification that a change of platform does not corrupt the functionality or numerical results of a code.

## Y2K Program for Scientific Codes

At AECL, the Y2K program for scientific codes has proved to be a substantial effort, involving evaluation and verification of over 600 scientific-analysis program versions. The program involved scientific-code assessment and porting on many different computer platforms at the various AECL sites.

The primary focus of AECL's Y2K program for scientific codes has been on codes that are in active use for design and service support.

Y2K Project Area Leaders are responsible for leading the planning and execution of the detailed Y2K analysis and compliance work and for preparing and identifying applicable Y2K project guidelines and procedures.

The detailed work consisted of Y2K-compliance analysis, formulation of proposed remedial measures, testing, contingency planning and implementation of corrective actions where required. This work was mostly assigned to the code holders, also referred to as "primary holders" from the scientific-code "product owner" branches, typically referred to as "performing branches". These code specialists performed the detailed work on their respective products under the Y2K Program - Engineering Systems and Products Project work authorizations.

## Y2K Program for Information Technology (IT) Infrastructure

The Y2K IT Infrastructure Program includes computer systems, software, and equipment with embedded digital processors used in the following applications:

- **Business support systems** deploying Oracle and other database and programming environments, used in support of business functions such as Finance, Human Resources, Facilities Management, Nuclear Inventory Management, etc. This category included applications purchased commercially or developed by or for AECL.
- **Intel-based computers and Windows- or DOS-based operating systems and applications** that make up the general purpose computing environment within AECL. It includes desktop, notebook and server class computers, Windows 95, NT and DOS operating systems and applications that run within this environment such as MS-Office, MS-Exchange, Adobe Acrobat, etc.
- **UNIX-based workstations and server hardware, operating systems and commercial applications**. This group covers all versions of UNIX in use at AECL and commonly used tools such as compilers, editors, database systems and selected applications.
- **VMS-based workstations and server hardware, operating systems and commercial applications**. This category covers all versions of VMS in use within AECL, common tools such as compilers, database systems and selected commercial applications.
- **Network and computer centre equipment not thought of as a computer or workstation, such as a router, a PBX, a tape backup system, etc**. It also covers devices such as printers, scanners, fax machines. These typically use microcomputer chips, but in an embedded fashion.

Of these project areas, only the PC (Wintel), UNIX and VMS projects have an effect on the Y2K Program for Scientific Codes.

Y2K Project Leaders are responsible for leading the planning and execution of the detailed work in each of these project areas, and for preparing and identifying applicable project guidelines and procedures.

The detailed technical work associated with Y2K compliance assessment and correction has been assigned to qualified staff familiar with those computer systems and software. The detailed work consists of Y2K-compliance assessment, corrective action planning and scheduling, testing, and implementation of corrective actions where required (corrective actions being upgrade, replace or eliminate). The staff for the detailed work in the IT Infrastructure part of the Y2K program is typically drawn from the Information Technology Branch.

## Major Steps of the Y2K Compliance Process for Scientific Codes

The major steps of AECL's Y2K compliance process for scientific codes are the following:

1. Inventory of scientific codes
2. Prioritization
3. Project planning and organization
4. Assessment of codes for use of dates
5. Assessment and/or correction of codes for Y2K compliance
6. Assessment of computer platforms for Y2K compliance
7. Program porting to Y2K-compliant platforms
8. Testing and verification
9. Implementation (bringing into production)

The details/activities associated with the above steps are outlined in the following subsections. It should be noted that some of these steps may not be within AECL's scope of Y2K responsibility for all products. For example, implementation of corrective actions for products installed in clients' facilities and under their full technical control may be part of the clients' scope, or under third-party vendors' scope, as in the case of products supplied by third parties.

*Inventory of scientific codes*

Ensuring that a full and accurate inventory of scientific codes was captured, and correct "product owner" and "product user" branches were identified, proved a significant challenge.. An integrated, Company-wide inventory had not been maintained routinely prior to the Y2K project. The existence of three major sites (Mississauga, Chalk River, and Whiteshell), the duplication of some scientific-analysis programs at the various locations, and the existence of different program versions on various computer platforms used by various branches at different sites created a logistical challenge. The situation was complicated by the fact that each product typically had not only a designated "primary holder" who looked after the product overall, but also users of different versions of the product, based in different "product-user" branches across the Company. For the Y2K project, all the information on scientific codes has been captured in a single, consolidated database. Supporting information was provided to accurately describe operating systems, compilers, libraries, third-party suppliers, etc. Branch managers were contacted for inventory completion sign-offs.

The scientific-code inventory currently lists over 600 products. There are 24 "product owner" branches, with about 120 primary holders, supporting 10 "product user" branches. The inventory is being kept up-to-date and is revised as required to capture

details of reorganizations, staff changes, and development of new products. Details of Y2K compliance of products is also entered in the database as it becomes available.

*Prioritization*

Once the inventory listing was completed and signed off by owner branches and projects, the products were assigned priority categories based on the assessment of their need for current and future business. For purposes of planning, four levels of priority were identified:

- **Urgent priority** was assigned to programs essential for licensing purposes.
- **High priority** and **medium priority** were assigned to codes used by projects and customers based on the urgency of schedule commitments.
- **Low priority** was assigned to codes identified as seldom used, obsolete, or replaceable. These codes are prime candidates for retirement.

Note that, while some of the scientific-analysis codes are safety-related, none were classified as critical from the viewpoint of reactor operation because the codes are used off-line, and faults—whether from year-2000 problems or resulting from other causes—do not have the same immediacy of consequence as do faults in the on-line special safety systems or reactor control systems.

*Project planning and organization*

Based on the information received during the inventory phase, a more detailed work plan and schedule were developed to implement the actual Y2K evaluation and remediation of scientific codes. Three main phases were identified: *assessment, corrective action, and porting*. Each of these phases is described in more detail below.

- **Assessment:** In this phase, the use of dates in the program was inspected, leading to the assessment of the coding as Y2K compliant or not Y2K compliant. In addition, the platform on which the code is executed and the middleware in use with the code were also assessed for Y2K compliance.
- **Corrective Action:** In this phase, the coding was repaired if it had been declared as not Y2K compliant.
- **Porting:** Regardless of the coding's Y2K compliance, this phase was required if the original platform and/or compilers were not compliant. In this case, the code was moved to a compliant platform and/or recompiled with compliant middleware. It was then verified that the code executed properly on the new system, that it was producing the same results, and that it could correctly handle dates in 2000 and beyond.

*Assessment of codes for use of dates*

Y2K-specific procedures were developed to define the process for assessing scientific codes. These procedures formed part of the comprehensive Y2K engineering program at AECL.

If the program is to be used in 2000 and beyond, it has to be assessed for use of dates. The definition of year-2000 conformity that was used in this work was that of the British Standards Institute, which was adopted by AECL's Y2K program and used in other parts of the program as well.

For scientific codes, the manner in which dates are used in the code input, algorithm and output needed assessment, and the number of digits used for the year (2 or 4) needed to be documented.

No detailed assessment was needed for those programs that were identified by their owner branches as unessential for AECL business beyond 1999. However, another set of actions was identified for these programs: *intent to retire, notification, archiving.* The manager of the "owner branch" was requested to file an "Intent to Retire" statement for the code in question. End users of the program/program version, usually other analysts or projects, are notified either by "code owner" branches or by the Y2K scientific-code team about the intent to retire, and their agreement or opinion on this intent is solicited. In the fall of 1999, the Y2K team will review these programs, ensuring that they have been archived in compliance with Company SQA procedures, and removed from the Company's network computers.

*Y2K-compliance code analysis/conversion*

For codes that will remain in active use beyond 1999, the aim of the project is to ensure full Y2K compliance, i.e., conversion of dates to a 4-digit year. The repair of non-Y2K-compliant coding is performed in the corrective-action phase.

*Assessment of computer platforms for Y2K compliance*

Platform compliance information was gathered by communicating with hardware and software vendors through e-mail, telephone and fax, and through Web-site searches. Documentation was solicited from these vendors on the compliance status of each product. In addition, letters were sent to each vendor by the Y2K Client and Supplier Interface team, requesting documentation of proof of compliance. The vendor was also asked to document recommendations on the best upgrade path to a compliant stage, such as upgrading to version HP-UX 10.20 for HP UNIX workstations. Vendor information continues to be monitored in case of changes to compliance statements.

Use of particular standard operating system versions (see Table 1) was recommended for each platform, to reduce variation that would result in increased time spent porting and testing programs. For each major platform, we purchased or re-allocated current systems for use as Y2K test systems, and upgraded each to the-Y2K-compliant operating system and software version.

The test systems were subjected to Y2K date tests, and verification reports were written. The capability to change dates in test systems was provided to enable users to test programs with dates in 2000 and beyond. User's manuals were provided, defining the test-system configurations and user tips for tests.

*Program porting to Y2K-compliant platforms*

Porting and verification of the scientific codes proceeded as Y2K-compliant computer platforms became available. In addition to checking date functionality, SQA requirements for scientific codes used in nuclear-system design or safety analysis imposed the systematic verification of program performance, to ensure that the change of platform did not corrupt the functionality or numerical results of a code.

Y2K-specific procedures were developed to define the process for porting scientific codes. These procedures formed part of the comprehensive Y2K program at AECL.

*Testing and verification*

The primary holder of each program was responsible for writing a verification report or reports documenting assessment and porting activities. These reports were then subjected to branch technical review and acceptance by the Y2K Scientific-Analysis Computer Program team.

For platforms, test criteria and procedures were produced, based on the Year 2000 Test Procedures Manual from Chrysler Corporation and from the system's vendor (e.g., HP, Digital), in order to test the compliance status of our major operating systems (i.e., HP-UX, SGI IRIX, IBM AIX and OpenVMS). Because of the specialized nature of scientific software, we relied on information from the vendors, except for those software items considered business-critical, such as compilers and backup software, for which we prepared basic Y2K test procedures.

*Implementation (bringing into production)*

Once the Y2K assessment work began, it was soon confirmed, as expected, that the use of dates in scientific codes is not generally as extensive as in other business applications. Coding assessments therefore proceeded fairly smoothly. Usually, scientific codes use dates only for date-stamping of runs for data management purposes. However, in rare cases, calendar dates may play a significant role in the calculations performed by the code. Identifying and correcting Y2K non-compliance for scientific codes was relatively straightforward in simple cases; however, every code had to be considered separately. In view of the large number of disciplines and administrative units in AECL, large numbers of codes and distinct code versions have had to be examined for Y2K compliance.

Even when the corrective action for scientific codes required a simple fix of dates, "patching" of the computer platforms to make them Y2K compliant (or providing new,

Y2K-compliant platforms) and porting programs to these platforms required significant effort.

AECL has a number of different, network-connected computer platforms (primarily HP and SGI UNIX workstations and servers, VMS minicomputers, IBM RISC machines, and Windows '95 and NT PCs). It was discovered that **all** UNIX and VMS systems in use at AECL were non-compliant, and that over one third of the 3200 PCs required BIOS changes. In addition, compilers also had to be checked for Y2K compliance. The major issue for the Y2K team, therefore, was to ensure that compliant test and production platforms were available for code testing so that work could proceed on schedule. (Production platforms were provided later.)

Once these operating systems and software versions were in use in the Scientific-Analysis program verification exercises, they were "frozen"; i.e., the system configuration could not be changed, no new library patches could be added, and FORTRAN and C compilers could not be further upgraded since this may have required revalidation of the porting. For the Company-standard UNIX platform, HP-UX, additional systems were purchased to be used as Y2K-compliant production systems, in order to alleviate upgrade scheduling problems. The schedule was derived for upgrades of all users systems, and achievement of Y2K compliance of the scientific codes is scheduled for September 1999.

**Benefits of Y2K Program for Scientific Codes**

Besides providing a set of Y2K-compliant programs on Y2K-compliant platforms, the Y2K program provided other benefits. Maintaining an up-to-date inventory of scientific codes, communicating and co-ordinating with "owner" and "user" branches were important activities on the project, because of the large number of branches, projects, program holders and users.

**Up-to-date inventory**: Providing a "live" inventory of scientific programs and versions and documentation was among the most important benefits of this project; this exercise provided the opportunity to identify those codes/platforms that are important for AECL's business and those codes/platforms that are no longer required.

**"Housecleaning":** The Y2K exercise provided a good opportunity to retire old or obsolete programs, no longer needed for business in the future. It was also an incentive to consolidate program versions, generally keeping only one or a very few versions of any given code. The inventory of scientific codes is now leaner, cleaner, and more meaningful.

"**Cutting Across Silos"**: The size and diversity of AECL, and the number of different sites, sometimes result in less than ideal level of interaction between branches. The Y2K exercise created an opportunity for branches to cut across communication "silos" and develop a more comprehensive picture of the many facets of AECL.

**Communication** was necessary with other Y2K teams to ensure smooth work interfaces and effective communication between program owners, primary holders, and users. With three sites, and over 120 primary holders involved, communication has been crucial, and will have benefits in the future.

**Co-ordination** between all parties—i.e., owner branches and other Company units (projects), primary holders and end users, the Information Technology System Y2K team and third-party suppliers—has provided an opportunity for collaboration and work towards a common goal.

## Summary and Conclusions

In summary, the Y2K project provided the impetus for a consolidation of AECL's scientific-code products. The project will provide Y2K-compliant programs on compliant platforms for uninterrupted scientific work in 2000 and beyond. A clearer picture has emerged of the extent of the intellectual property available in-house and of its value. In addition, an opportunity was provided for code holders and developers to renew their familiarity with their software, middleware and hardware, and with the overriding requirements of software quality assurance.

### *Acknowledgements*

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## References

A Definition of Year 2000 Conformity Requirements, British Standards Institute- DISC PD 2000-1, 1998.

Table 1
Standard Platforms at AECL for Year 2000

| Platform | OS | Recommended Y2K Compliant Standard Operating Versions<br>*+ indicates patches/enhancements reqd.* | Y2K Version Status | Test Systems Available |
|---|---|---|---|---|
| Apollo | Domain/OS | Obsolete | **Replaced by HP-UX** | NO |
| Digital | dUNIX | **4.0D** | OS available | NO |
| Digital | ULTRIX | 4.3+, 4.3A+, 4.4+, 4.5+ | Y2K kit available | NO |
| HP | HP-UX | **10.20+** | OS and patches available | Yes -**y2keng1 available now** |
| IBM | AIX | **4.3.1+** | OS and patches available | Yes -**y2kibm1 available now** |
| Intergraph | CLIX | Obsolete | **Replaced by Windows NT** | NO |
| SGI | IRIX | **6.5, 5.3+** | OS and patches available | Yes -**cu84 available now** |
| Sun | SunOS | 4.1.3 U1 ver B+, 4.1.4+ | Patches available | NO |
| Sun | Solaris | **2.6+** | OS and patches available | NO |
| Digital | OpenVMS | **5.5-2+, 6.2+, 7.1+** | Y2K kits available | Yes -**cm22 (Alpha) & wp71 (VAX)** |
| Intel | DOS | **6.22+*** | No fixes available | NO |
| Intel | Windows | Windows 3.11+*,**Windows95+*, NT 4.0+*** | Fixes available | Yes - upon request |

*** Operating systems are listed by Microsoft as Compliant with minor issues.**
**- Dos 6.22 recognizes dates beyond the year 2000 but there is an issue with the MS-DOS DATE command and MSBACKUP command.**
**- Windows95 recognizes dates beyond 2000 but there is an issue with the command.com and the winfile.exe. Both versions (OSR1 &OSR2) require these files to be updated**
**- NT4.0 recognizes dates beyond 2000 but there are issues with IE3.02, User Manager and Find Files.**