APPLICATION OF A PORTABLE BRIEFCASE PERSONAL COMPUTER TO RESEARCH REACTOR SAFEGUARDS

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ABSTRACT

The Kookaburra Portable Briefcase Personal Computer (PBPC) has been applied to safeguards inspections at the HIFAR research reactor.A complete portable measuring system provides for Non-destructive assay on both fresh and spent fuel. Application programs developed for the PBPC make it possible to immediately analyse the results of the measurements to verify the amounts of nuclear material declared by the operator.This contributes significantly to meeting the essential safeguards criteria of timely detection of diversion.Special ROM software,such as diary,word processor,spreadsheet and communications software can also provide useful improvements in inspection procedures.

INTRODUCTION

The many PBPC's now available have powerful operating features,close to those of the larger desk personal computers.This paper reports progress in the application of the Kookaburra PBPC to research reactor safeguards,extending earlier work which relied upon a programmable calculator (1).The particular features of the PBPC which are of primary importance to safeguards applications are its small size and portability ,large capacity (160 kB) battery backed RAM "disk",MS-DOS operating system and a BASIC interpreter and other special software in plug-in ROMs.When the Kookaburra is switched on all the necessary programs and inspection data are available in either ROM or RAM,independent of floppy disks.A program sequence can be initiated by pressing one button.The standard parallel port,dual serial ports and a bus expansion port are fitted for connection of various peripherals.

A complete portable High Resolution Gamma Ray (HRGR) system for Non-Destructive Assay (NDA) generates the measurement data,which requires analysis by the PBPC.It consists of a High Purity Germanium Detector,with a low power preamplifier,connected to a portable MCA(PMCA).Such a system makes it possible to readily carry out measurements,data analysis and tabulation of results at a number of scattered locations within a facility.The two disadvantages of the Kookaburra are the decreased "readability" of the low power LCD screen -a video can be connected back in the office- and the lack of a graphics capability.

PBPC's may also improve research reactor operations,quite apart from safeguards inspection work(2,3).Their low cost and "user-friendliness" could be an advantage at small reactors,for example in developing countries. The Australian School of Nuclear Technology and the Australian Safeguards Office are planning to include the Kookaburra in some practical sessions of an IAEA Regional Training Course to be held in June 1986.

INSPECTIONS

During inspections the operator provides data regarding nuclear material;for HIFAR this is in the form of HEU fuel elements.Measurements are made on both the unirradiated and irradiated fuel,the first relying upon 235 uranium gamma ray emission ,the latter upon the gammas from the various fission products resulting from the burn-up of the uranium.

For the fresh fuel the operator data consists of weights of 235 U and total U. A standard element,kept under seal,provides a reference with which the other elements are compared.Following burn-up in the reactor the operator declares the irradiation history of each element, which is later verified by measurements of the fission product spectra and comparison of selected isotope activity ratios with calculated values(1).The amount of data and complexity of calculations are greater with the spent fuel.The PBPC provides a significant improvement in this case over the programmable calculator previously used.

BASIC PROGRAMS

A ROM interpreter provides for the development and running of applications programs;the 16 line,8Ø character LCD display is adequate for program development,when supplemented by occasional print out of program listings.As a program runs it displays in clearly readable form prompt messages regarding the operations to be performed ,data entry and the checking of the results of the verification.

Large amounts of operator and measurement data can be quickly entered,as strings in a "sequential" file,with the word processor,prior to or during an inspection.This data can then be accessed from the program as required for analysis and is also readily available at any time for checking,revision and entry of new data.

Two programs have now been operated during a number of inspections.For the fresh fuel the 186 keV peak counts are corrected for differences in contained 235 U and counting time and checked as being within the expected range.The second program handles the peak count data for the irradiated fuel;some ten peaks are of interest.It corrects for the variation in detector efficiency and absorption with gamma ray energy, and for radioactive decay.The activity ratios of 95 Zr,1Ø6 Ru,144 Ce and 134 Cs to 137 Cs are then calculated and compared with the values calculated from the irradiation histories supplied by the operator.(A third program is under development to derive these calculated values,including the contributions from the fission of plutonium produced from 238 U.)The differences in the two sets of ratios are then expressed in terms of the equivalent differences in cooling days and 235 U consumed and then checked as being within the expected range of values.The results are accumulated in a word processor file for continuing review during and after the inspection.

Between measurements the HRGR spectra,which may be required for future reference,are transferred from the PMCA and stored as word processor files in either the ramdisk or on larger capacity floppy disks.It is much easier to access spectra from disk than from a large number of PMCA tape casettes.A later display of the spectra requires the transfer of the file back to the PMCA.

SPECIAL SOFTWARE

The diary software feature of the PBPC can be useful, before, during and after an inspection, which rarely proceed according to schedule. As a result of the various changes of plan an ordinary written diary can often be difficult to follow when a review is made some time after the events. With the PBPC revisions are readily entered, with no practical limit on space. The word processor can provide more sophisticated editing where required, for example prior to printing.

Apart from usual type of wordprocessor applications, such as the preparation of the typescript for this paper, inspection work can be assisted by a recording, in this mode, a variety of reference and "housekeeping" data such as

* isotope half lives, gamma line energies, branching ratios
* frequently used instrument settings
* record of measurements made
* forms listing nuclear material locations and seal numbers.

The 250 square "cell" spreadsheet has been tested on the preparation of accountancy records, requiring simple additions of many lists of batches of nuclear material; while it showed the potential of this type of software, it may be better to enter the original data with more sophisticated software on a larger computer. Communications or terminal software is available for the ready transfer of spectrum data from the MCA to the Kookaburra. It can also be used to transfer all types of file to other more powerful computers, where necessary.

FUTURE DEVELOPMENTS

This paper is in the nature of a progress report on a continuing project. The major area for development is establishing the most convenient method of transfer of data between the PMCA and the Kookaburra, probably through the serial port under BASIC program control. This will make it possible to take full advantage of the many microprocessor controlled features, such as background subtraction, already built in to the PMCA. The Kookaburra could also control the setting up of the PMCA for different types of NDA measurements. Another area for study is the degree of need for hard copy from a portable printer, in the field situation. In most cases the computer storage capacity and word processor display of data makes the paper record redundant.

The Kookaburra has been made available to the IAEA under the Australian Bilateral Assistance Program and is being evaluated in Vienna for possible application in international safeguards work.

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