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DATA ARCHIVING AND ANALYSIS FOR CWDD (U)\* JUL 13 1992

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ABSTRACT. (U) A computer system has been developed to handle archiving and analysis of data acquired during operations of the Continuous Wave Deuterium Demonstrator (CWDD). Data files generated by the CWDD Instrumentation and Control system are transferred across a local area network to the CWDD Archive system where they are enlisted into the archive and stored on removeable media optical disk drives. A relational database management system maintains an on-line database catalog of all archived files. This database contains information about file contents and formats, and holds signal parameter configuration tables needed to extract and interpret data from the files. Software has been developed to assist the selection and retrieval of data on demand based upon references in the catalog. Data retrieved from the archive is transferred to commercial data visualization applications for viewing, plotting and analysis.

INTRODUCTION (U)

(U) During operations of the Continuous Wave Deuterium Demonstrator (CWDD) certain control parameters, feedback and diagnostic signals are obtained by the Instrumentation and Control system (I&C) and saved in data files.<sup>1</sup> A small number of these data log files can be stored locally at each I&C subsystem computer on a magnetic hard disk. To preserve these files and to utilize the data contained within them, the files can be copied to another computer system for

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archiving and analysis. This system, the CWDD Archive system (CWARC), provides the ability to centrally store and manage the data logged on the I&C subsystems, and assist with user requested retrieval and analysis of specific data from the files.

(U) The CWARC system was developed by Argonne National Laboratory and Grumman Aerospace Corporation for CWDD. The system runs on a desktop workstation connected by local area network (LAN) to the I&C system. It provides long term storage of CWDD data files on removeable write-once-read-many (WORM) optical disks. It maintains an on-line catalog of every file archived to the WORM media in a relational database management system. CWARC uses information in the database to find the location of user requested signals and to extract signal data from the files. It extracts only the signals required by a user and may retrieve data from multiple I&C log files. CWARC translates the I&C log data and creates derivative files compatible with several commercial software packages for data analysis and visualization available on the workstation.

### DATA ARCHIVING (U)

(U) The CWARC system runs on two Sun Microsystems<sup>2</sup> workstations that are connected via LAN to the I&C system. These computers have high resolution color monitors for graphic displays and share one gigabyte of system hard disk. Two removeable media optical disk drives are present. The first is a WORM drive which is reserved for media volumes containing the archived I&C log files. The second is a rewriteable optical drive provided to retain files created by users. Each of these devices has a capacity of 600 megabytes per double sided disk volume. A laser printer is available for hardcopy plots and reports.

(U) CWARC provides the user interface to the archive, integrates several commercial software packages, and facilitates the interpretation of the I&C file formats and contents. The locally developed components of the CWARC system are the Registrar, Storekeeper, Reporter, Clerk, and Retriever. Commercial software packages in the system include the relational database management system, and several data analysis and visualization programs. The following sections describe the flow of data through the components of the CWARC system, as shown in Figure 1.

### I&C Log Files (U)

(U) Log files are generated by each CWDD I&C subsystem and are initially stored on I&C subsystem hard disks. The files contain signal values and waveforms in raw digitized format with a variety of data types and record structures. The

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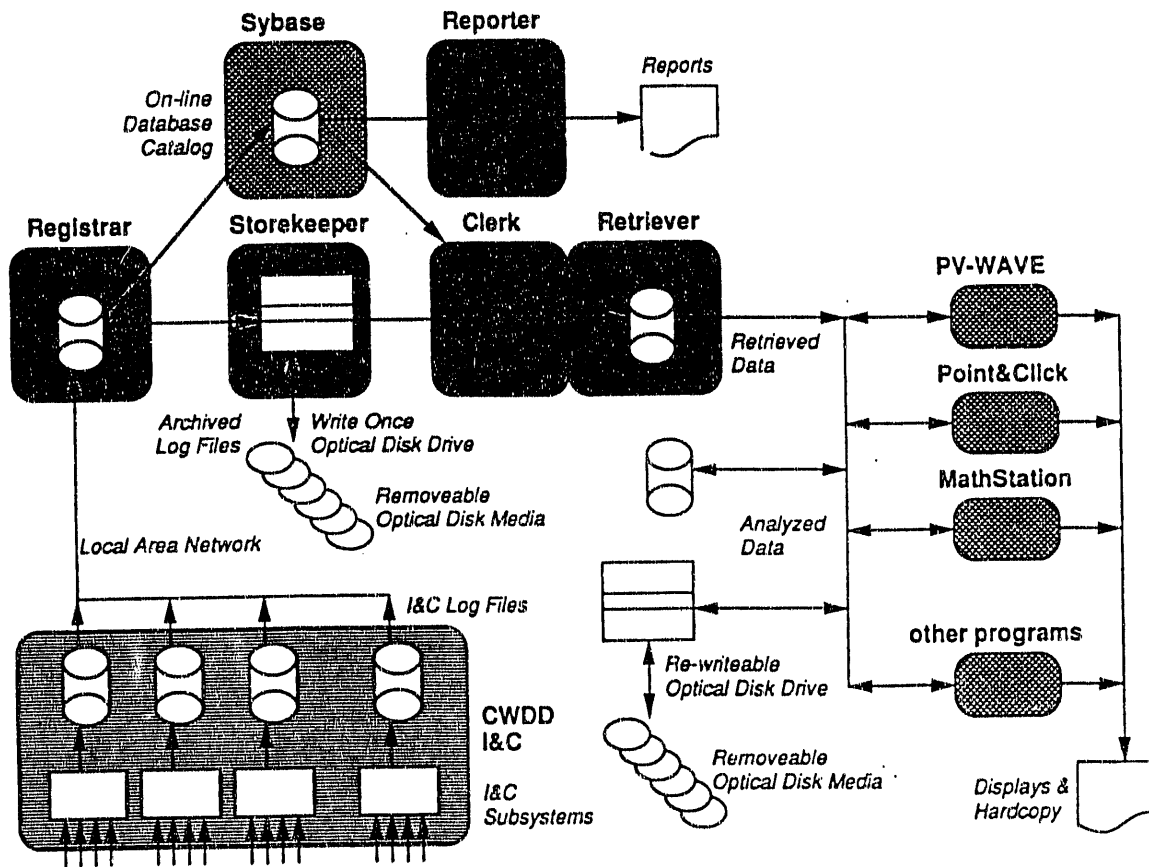


Figure 1. (U) Data Flow Through the CWARC System.

construction of these files depends upon the configuration of data acquisition modules at each subsystem.

(U) The subsystem configuration determines the quantity of each data type and the identity of each signal recorded in the log file. This information is maintained in a configuration parameter file on each subsystem. The parameter file includes information such as signal name, data type, acquisition module, and calibration factors used to convert raw data to engineering units. Subsystem configurations and parameter files will change with time, and consequently, so will the size and content of each log file. Therefore, the CWARC system must accommodate a history of I&C configurations and file constructions to correctly interpret all archived files.

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(U) The CWARC system provides for interpretation of archived I&C log files through several mechanisms. CWARC uses source code ported from the I&C system that defines the basic data structures contained in the log files. CWARC also archives subsystem parameter configuration files. Information from the parameter file is entered into the on-line database and then used during data retrieval.

### CWARC Registrar (U)

(U) Files are transferred from the I&C subsystems and entered into the archive with the CWARC Registrar. Three tasks are accomplished by this software component. The first step is to copy a specific file from an I&C subsystem across the LAN using a standard file transfer protocol. The second task is to read identifying information from the file and insert the information into the archive database catalog. Registrar enters specific file attributes such as the file type, contents summary, and storage location. If a subsystem parameter configuration file is being archived, then its entire contents are entered in the database catalog. The third task is to write the file to a WORM disk volume.

### CWARC Storekeeper (U)

(U) The CWARC Storekeeper is a software component that manages the allocation of optical disk drives and coordinates optical media access. It provides the interface between the user, the optical disk drives, and the other software components that request access to the optical media. The Storekeeper provides workstation independent and network transparent device operations. In addition, it monitors the storage space on archive volumes and stores this information in the archive catalog.

### Database Management (U)

(U) The CWARC system relies on a relational database management system from SYBASE.<sup>3</sup> SYBASE provides an extensive database management environment and powerful database access interfaces. A Structured Query Language (SQL) Server manages the database tables and provides structured mechanisms to update and query the tables. The SYBASE SQL Toolset provides application building tools to generate graphical user interfaces to the database, and software development libraries for supporting custom written applications.

(U) The CWARC database catalog is a collection of data tables describing the contents of the archive. The catalog indexes the contents of each WORM volume,

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recording the location of every archived file. The catalog stores information on each file appropriate to the file type. Typical entries for log files would contain the file type, date, generating subsystem, experiment number, control settings, summary records, and a reference to the corresponding parameter file. Entries for parameter files would contain signal name, data type, record format, acquisition module, and calibration factors.

### CWARC Reporter (U)

(U) The CWARC Reporter produces archive summary reports from the database catalog. Several standard reports can be selected for printing from a menu. Miscellaneous reports can be requested interactively using SYBASE database query and reporting tools.

### CWARC Clerk (U)

(U) The CWARC Clerk provides the user interface for selecting and retrieving data from the archive for analysis. The user requests data by using Clerk screen forms and the workstation mouse to construct a set of expressions identifying the signals and files desired. Expressions are constructed from the properties indexed in the archive catalog, such as signal name, data type, date, log type, experiment number, and control settings. The expressions are combined to form search constraints on the archive database. Clerk queries the database catalog and returns a list of signals that meet the criteria. Figure 2 shows an example of Clerk being used to select injector signals by name from two CWDD experiments.

### CWARC Retriever (U)

(U) The CWARC Retriever is the software component that extracts data from the archive optical media and transfers it to a file suited for one of the data visualization applications. Retriever uses the requested list of signals derived with Clerk. Retriever determines where to find the signal data within the archive. Retriever requests WORM volumes from Storekeeper as needed to read the archived files.

(U) Retriever is responsible for converting and formatting data into a user retrieval file. While the archived files are preserved in their original I&C format, retrieved data is transferred into a file format that can be imported directly into a data visualization or analysis application. During retrieval, the data is converted from the raw digitized signals into engineering units according to information obtained from the archive catalog. Retriever also transfers signal names, units, data type, and record length to the analysis programs.

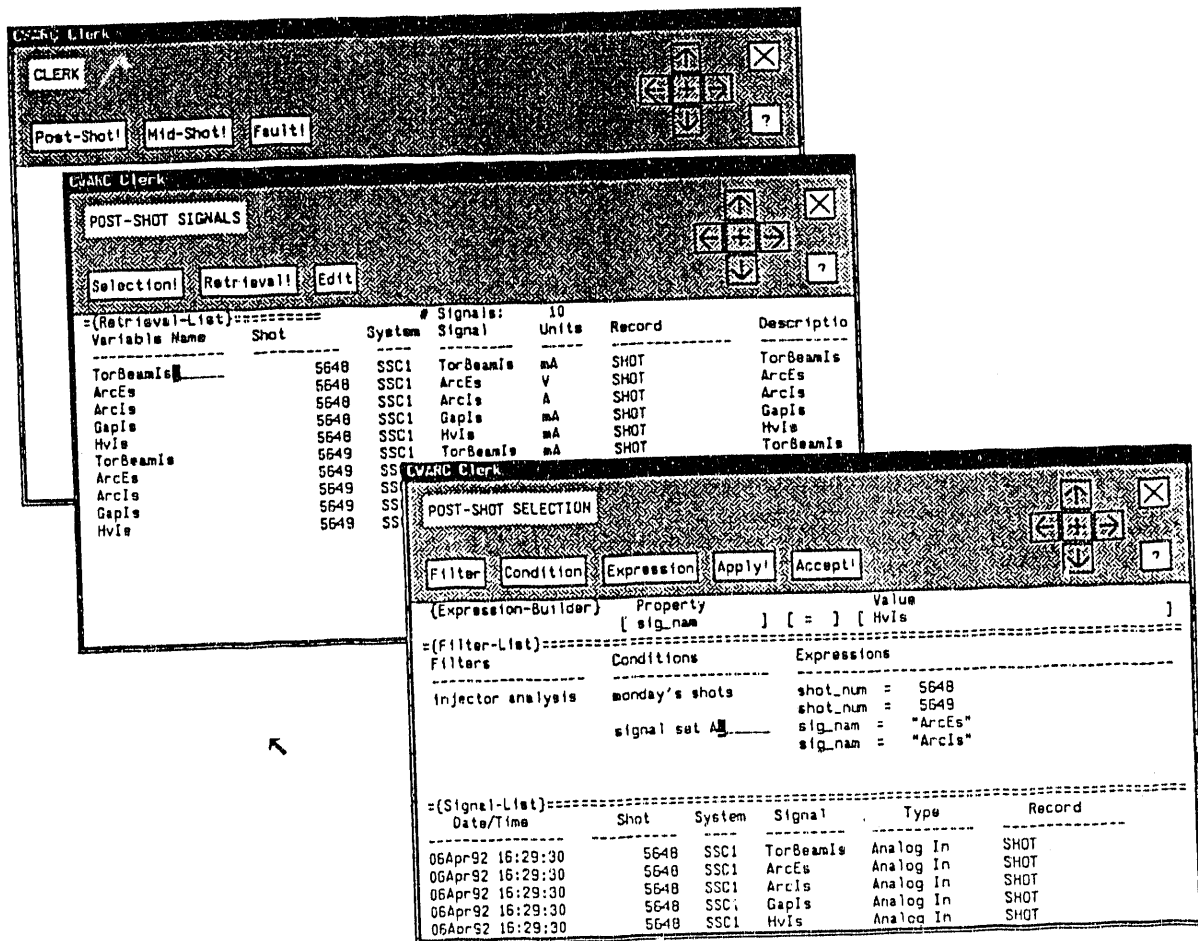


Figure 2. (U) Data Selection Using CWARC Clerk.

DATA ANALYSIS (U)

(U) Data analysis is conducted with retrieval files using commercial data visualization applications including Precision Visuals<sup>4</sup> Workstation Analysis and Visualization Environment (PV~WAVE) Command Language and PV~WAVE Point&Click, and MathSoft<sup>5</sup> MathStation. These tools provide the user with powerful flexibility for manipulating the data. These visualization applications available on the CWARC system can instantly produce 2D and 3D plots of the data.

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They can easily perform standard mathematical and analytical operations, and can simplify the customization and annotation of plots interactively without requiring programming. Animation and image processing is also available. To compliment this interactive environment, high-level functions can also be coded to execute procedures repetitively. Figure 3 shows an example Point&Click being used to analyze data retrieved by CWARC.

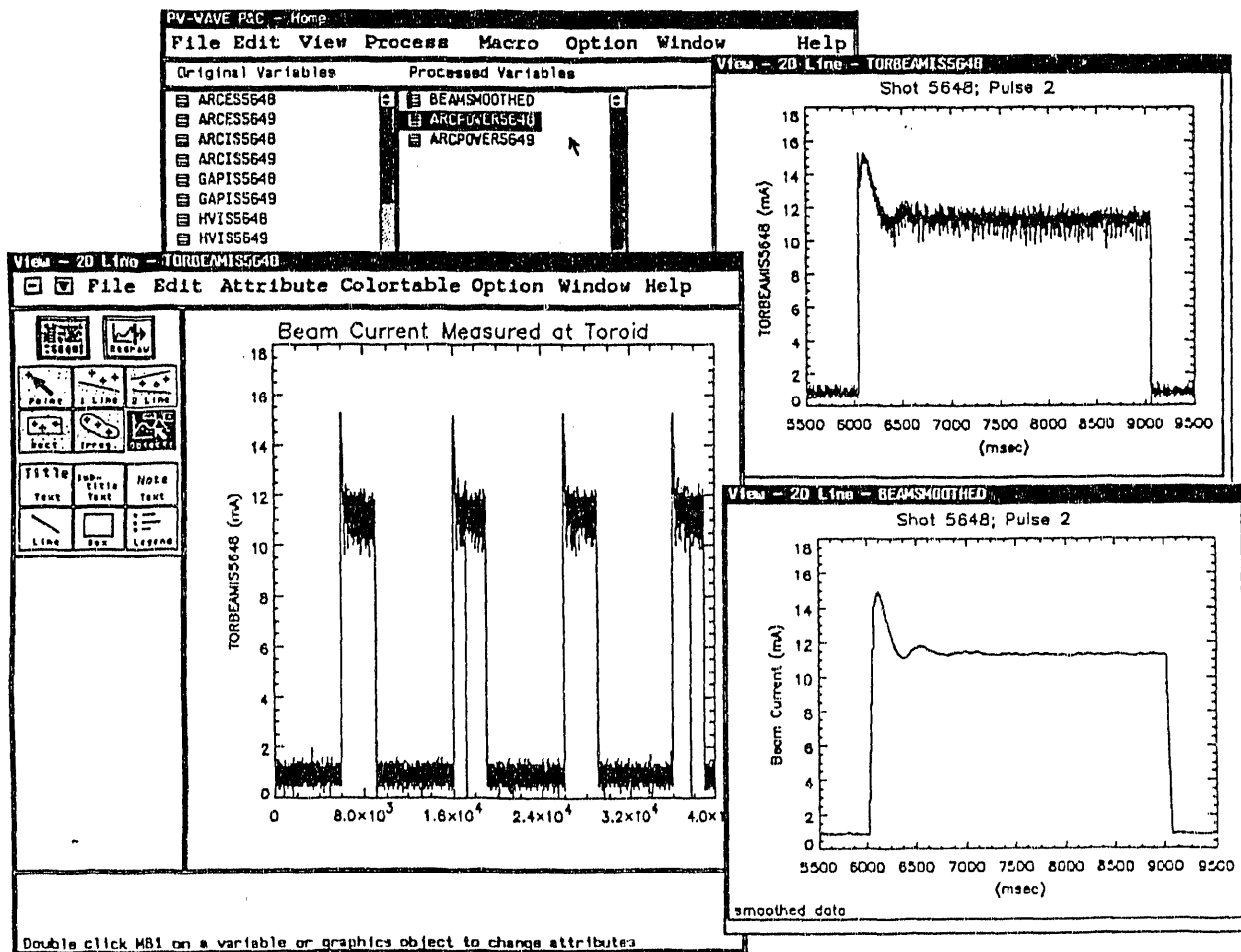


Figure 3. (U) Data Analysis using PV-WAVE Point&Click.

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### SUMMARY (U)

(U) The CWARC system provides archival storage of CWDD I&C log files on optical media and a convenient method of extracting data of interest from any file. It converts that data from internal raw format to engineering units and stores that data in a file that can be transferred directly into powerful and easy to use data visualization applications.

### REFERENCES (U)

1. (U) D. Brown, et al, Culham Laboratory, U.K., "Review of the Design and Operation of the CWDD Injector I&C Subsystem", presented at the Third NPB Technical Symposium, SDIO, Boulder, CO, April 15-19, 1991.
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