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THE CENTRALIZED RELIABILITY DATA ORGANIZATION (CREDO): PAST, PRESENT, AND FUTURE

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THE CENTRALIZED RELIABILITY DATA ORGANIZATION (CREDO): PAST, PRESENT, AND FUTURE

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ABSTRACT

The Centralized Reliability Data Organization (CREDO) is a component-based data system and data analysis center jointly sponsored by DOE and the Power Reactor and Nuclear Fuel Development Corporation (PNC) of Japan. Efforts within CREDO are focused on reliability, availability, and maintainability (RAM) data and analyses for mechanical, electrical, and electronic components that were designed to function in liquid metal environments and their support systems. Data are currently received from a variety of sources, including DOE facilities and PNC facilities at O-arai Engineering Center.

Engineering, event, and operating data records are submitted by site staff for inclusion into the CREDO database. Engineering records provide detailed information on component design and operating parameters, abnormal or unusual occurrences are documented in the event reports, and facility operating status is provided in the operating report. Event rates on individual components or sub-populations may be calculated. In addition to data collection, CREDO staff disseminate RAM data and publish analyses of their findings. Results from two recent analyses are summarized: a journal article on large sodium circulation pumps and a paper on motor-operated globe valve performance.

Funding for continued data collection has not been committed for FY1993. A proposal to shift the CREDO database management system from a mainframe computer to a PC-based system has been supported by DOE. Under this proposal, the entire contents of the database will be distributed directly to approved members of the LMR community.

THE PAST

The Centralized Reliability Data Organization (CREDO) is a component-based data system and data analysis center, which since 1985 has been jointly sponsored by the United States Department of Energy (DOE) and the Power Reactor and Nuclear Fuel Development Corporation (PNC) of Japan. Efforts within CREDO are focused on reliability, availability, and maintainability (RAM) data and analyses for mechanical, electrical, and electronic components (e.g., valves, pumps, power supplies, etc.) that were designed to function in liquid metal environments and their support systems. Data are currently received from a variety of sources, including DOE facilities (Experimental Breeder Reactor II, Fast Flux Test Facility, and Energy Technology Engineering Center) and PNC facilities at O-arai Engineering Center.

CREDO was founded in the late 1970s with the specific goal of becoming a national reliability center for advanced reactor systems and components. To develop such a capability, three tasks were identified: (a) definition of data to be collected, (b) development of a database management system (DBMS), and (c) initiation of data collection. By the end of 1981, these objectives had been met: data collected from EBR-II, FFTF, and four DOE sponsored liquid metal test facilties were established in the JOSHUA database management system (DBMS) at ORNL. From 1981 to 1985 the scope and magnitude of the program expanded, including the addition of a CREDO Engineering Data Supplement Form and revisions to the CREDO Event Form.

Three types of data records were established in CREDO:

(1) Engineering data: each record includes detailed component descriptions with design parameters and operating factors from various liquid metal cooled reactors and test loops in the U.S.A. and Japan (over 22,000 records on file);

(2) Facility operating data: consisting of hours of operation for each of several operating modes (power operations, hot standby, shutdown, etc.) and other relevant data. More than 800 records are now on file, one record per period of operation, typically calendar quarters;

(3) Event data: consisting of one record per occurrence of a defined abnormal or questionable condition (approximately 2000 records). Includes narrative fields (description of event, cause, maintenance, remarks, etc.), keywords (event type, mode, cause, severity, etc.), and chronological data (dates and times).

With the above data records, calculating a failure rate for a particular component type involves:

(1) tallying the number of events for each component within the defined search criteria (user's may search on any of the keywords in the enginnering or event data sets, identifying the group members by system, design parameters, event mode, cause, and/or severity, etc.);

(2) tallying lifetimes for each group member by accessing the respective engineering and facility operating data records, and computing the group sum; and

(3) calculating the failure rate by dividing the event total for the group by the lifetime (group sum) for the group.

In 1985 PNC agreed to become a cosponsor with DOE and CREDO became a multinational organization. Approximately half the data now in CREDO originates from PNC facilities. In addition, PNC staff have participated as liaisons to CREDO, serving temporary assignments at ORNL. Their contribution has been substantial: bridging cultural gaps, identifying problem areas, and assisting in the resolution of issues and concerns.

In 1989 CREDO staff began the process of converting from the JOSHUA hierarchical database management system to the IBM DataBase2 (DB2) relational DBMS. In DB2, data is defined and accessed in terms of two-dimensional tables and operations on these tables. CREDO data that formerly existed in hierarchical records are now logically divided to span several tables linked together by common keys. Advantages in user flexibility arise due to the power of Standard Query Language (SQL). This query language allows custom RAM analyses that, under JOSHUA, would have required a modification to a FORTRAN program. The user may obtain quantities which are algebraic expressions of various column values in a table. In addition, users may generate custom output forms for their applications.

Also in 1989, the operational focus in CREDO shifted from the collection of new data to the completion and verification of data records previously collected. Informal data audits found substantial numbers of missing data fields, questionable or errant data entries, duplicate data forms, and other data inconsistencies. Early in 1991 the CHECKER code became operational on the DB2 DBMS and a rigorous screening process was undertaken to improve the quality of the CREDO database contents. Quality assurance of the database contents has remained the number one priority for CREDO staff.

THE PRESENT

The CREDO program represents more than just data collection and storage. Data dissemination and analyses are also important facets of the CREDO program. CREDO staff conduct detailed RAM analyses utilizing the existing data, in addition to responding to information requests from the advanced reactor community, including Probabilistic Risk Assessment (PRA) teams for EBR-II, ALMR, and SP-100. Previously published papers include assessments of LMR component unavailability, critical parts, and maintenance activities. Two analyses completed this year reviewed the operating history of large sodium centrifugal circulation pumps[1] and the performance of motor-operated globe valves in a liquid sodium environment.[2] An annual report, documenting staff activities and changes to the CREDO database, is published every August.[3]

The sodium pump paper, "An Assessment of Liquid Metal Centrifugal Pumps at Three Fast Reactors," submitted to Nuclear Technology, examined pump event rates to identify trends in their performance as a function of their operating history. A particular objective was the determination of the onset of the wearout life period, if possible. Large circulation pumps from three operating sodium cooled reactors were included in the study. Only the two main coolant pumps from EBR-II exhibited a definitive pattern of increased maintenance and downtime as the pumps age approached 100,000 hours of operation. Circulation pumps from FFTF (6) and JOYO (4) were also included in the study; none of these pumps provided any indication of reaching the end of their useful lives.

Performance data on 179 motor-operated globe valves in a liquid sodium environment were presented at the 1992 ANS-ASME Nuclear Energy Conference. These valves accumulated 39 event reports in over 8.7 million operating hours. The failure rate of 4.47 events per million operating hours compared favorably with similar data from light water reactors. The paper provided a brief discussion of the data sources (three sodium cooled reactors and five sodium test loops) and the distribution of events (by event origin and mode).

THE FUTURE

The future of CREDO is uncertain. The agreement between DOE and PNC expired on September 30, 1992 and funding for continued data collection and processing has not been committed. A proposal to shift the CREDO database management system from an IBM mainframe at ORNL to a more accessible PC-based system has been supported by DOE. Under this proposal, the entire contents of the database will be downloaded to a PC format and distributed directly to approved members of the LMR community. After loading the CREDO-PC system on their personal computer, users can access the data records by way of browse and search programs (provided by ORNL). Users will be able to print inventories and records and perform failure rate calculations. The complete system will be available to the advanced reactor community to preserve the database contents and allow a broad accessibility to the data. Users could then perform their own RAM/PSA studies using the CREDO data.

The CREDO staff are also examining the potential for developing reliability database systems for non-nuclear components and facilities. The tools and methodologies developed to track the reliability, availability, and maintainability of liquid metal reactors can easily be applied to other complex systems. CREDO staff have developed a PC-based Event Log for the Toxic Substances Control Act (TSCA) incinerator at the K-25 site in Oak Ridge. A prototype system has been delivered that gives TSCA staff the ability to document and retrieve, search and edit, event records for the TSCA incinerator. Other systems under consideration include robotics systems, advanced servo-manipulators, and fuel reprocessing facilities.

References

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3. M. S. Smith et al, "Report on the Status of the Centralized Reliability Data Organization (CREDO) as of August 31, 1992," ORNL/LMR/AC-92/4, Oak Ridge National Laboratory, August 1992.