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In 1986 he joined the Nuclear Directorate of UNESA, the association of the Spanish electric utilities, as co-ordinator of the Nuclear R & D Program. He has represented the Spanish Electricity Sector in numerous international organisations, particularly, in the Component Event Data Bank (CEDB) of the European Union, whose Steering Committee chaired from 1989 to 1992.

DACNE: THE SPANISH NUCLEAR POWER PLANT DATABASE

J. E. DIEZ - MORENO

INTRODUCTORY REMARKS ON DATABASES

Designing and implementing a common database for different nuclear power plants is an arduous and costly task. Firstly it is necessary to specify the objectives, the scope of the information to be stored, the information processing systems, the management and quality assurance methods and the inquiry mechanisms; then there is a need to develop software products allowing the information to be suitably handled, this implying identification, classification and coding of the different items (data) integrated in the bank and establishment of the necessary quality controls; following this it is necessary to install the system on an appropriate computer platform and develop a communications system allowing for remote user access; it is necessary also to establish the data collection and storage procedures; and finally to continuously feed the database with information on unfolding events.

An effort such as that described above is justified only when use of the databases provides important benefits in plant operation. This implies the establishment of criteria based on cost-benefit analysis prior to definition and development of the database. Certain of the criteria which have governed

FIGURE 1. DACNE STATUS (30/11/1995)

COMPONENT DATA BASE

COMPONENT REPORTS	EXPERIENCE (COMPxYEAR)	FAILURE REPORTS (INDEX)	IMMEDIATE FAILURE REPORTS (INDEX)	INCIPIENT FAILURE REPORTS (INDEX)	UNAVAILABILITY REPORTS
8.918	44.736	1.063 (2.38)	497 (1.11)	566 (1.26)	271

INDEX= NUMBER OF FAILURES PER 100 COMPONENTS AND PER YEAR

EVENT DATA BASE

SCRAMS	137
POWER REDUCTIONS (>10 %)	55
INTERNAL EVENTS	103
EXTERNAL EVENTS	27
OTHER SIGNIFICANT EVENTS	27
TOTAL	349

FIGURE 2. DACNE MANAGEMENT SYSTEM

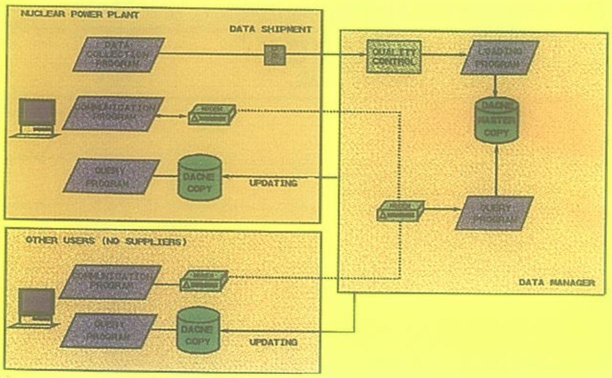
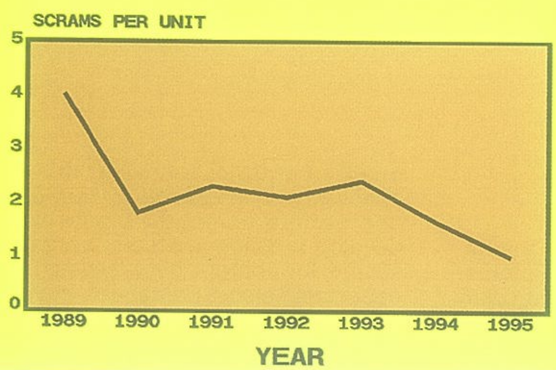


FIGURE 3. EVOLUTION OF NUMBER OF SCRAMS PER UNIT



development of the DACNE system are briefly described below.

Shared system. DACNE is conceived as a shared system operating rather like a club in which the members contribute their data and have access to those provided by the rest. In order for the system to work and be of use to all, the information provided by each member must be of interest to the others; in addition to other considerations relating to equity, this means that the scope must be uniform for all. Furthermore, the criteria used for preparation and coding of the information supplied to the bank must be clear and shared by all the members.

Information needs. Nuclear power plants have information needs which are defined by regulatory and administrative requirements, by exchange agreements with national and international organisations and by development of operational programs. Specifically, the Spanish nuclear power plants are collectively involved in a series of information needs which require co-ordinated action, of which the following are of special importance:

- Significant events in operating plants. The aim of this activity is to identify those events which might have an impact on nuclear safety or radiological protection and which are to be reported to the Regulatory Body in accordance with the Technical Specifications.

- Probabilistic Safety Assessment (PSA). In 1986 the Spanish Nuclear Regulatory Body published and initiated the so-called Integrated Nuclear Power Plant PSA Program, according to which all the Plants must perform a PSA and update it periodically with increasing scope in keeping with a previously established program. This type of analysis requires plant-specific data to guarantee the acquisition of realistic results.

- Maintenance Rule (10 CFR 50.65). The US regulatory standards issued by the NRC are normally applied in Spain, because eight of the nine units in operation in the country are of US design. According to this proposed rule, the plants must track the status and performance of risk significant components and systems and establish safety objectives for them. Comparison of the actual reliability of these components with the objectives mapped out serves as a basis for the adoption of corrective measures whenever deficiencies are detected.

- Information exchange with INPO and WANO. UNESA, representing the Spanish Nuclear Power Plants, maintains a series of information exchange agreements with these organisations, developed within the framework of the INPO Significant Event Evaluation Program (SEE-IN Program) and the WANO Operating Experience Exchange Program.

Data sources. The database is fed with information generated during normal plant operation, the only tasks required in this respect being gathering of this information and making it available to the database manager. The specific sources of information used are the significant events reports addressed to the Regulatory Body, the maintenance work orders and Control Room logbooks, test reports, technical specifications and equipment and system documentation.

Scope. The scope of the database is established by the set of systems and components registered for surveillance and tracking. Generically speaking, the common scope for all the plants is limited to safety-related equipment meeting the following criteria: (1) information on their reliability is considered to be of interest to the majority of the plants, (2) it is feasible to acquire the information on this equipment to be supplied to the database from the maintenance management system and other plant data sources, and (3) inclusion of an equipment in the database is an adequate method to obtain information on its reliability.

Structure. As far as possible the structure of the database will be kept stable, this structure being understood as the classification and ordering of the information contained. Changes arising as a result of new needs should be oriented towards increasing the capacity for inquiry and processing of the stored information.

THE DACNE SYSTEM

The DACNE system (DAtos de Centrales Nucleares Españolas - Spanish Nuclear Power Plant Data) was developed by UNESA, with the collaboration of Tecnatom, in response to a request issued in 1986 by the Regulatory Body to all the plants. The objective is to collect and store information of two types: the first one relates to significant events which have occurred in the plants and which are relevant to safety. Through adequate analysis and computer processing of this information it is possible to obtain data on initiating events supporting the performance of PSA's and on reportable events for submittal to international databases (particularly those of INPO and WANO) and for information exchange. The second type of information relates to component reliability and includes the design and operating characteristics of safety-related equipment and components and their failures. Processing of this information makes it possible to obtain specific equipment reliability and unavailability parameters, for application in PSA's, and to satisfy other information needs, from simple exchange to the establishment of reliability and maintenance optimisation objectives. Integrating both types of information in a single database is a complex matter in nuclear power plants because of ordering and classification requirements, the large number of components producing

operating data of interest and the need to prepare highly detailed accounts of reportable events. For these reasons, the system has been structured in two separate databases known as BDIO (Banco de Datos de Incidentes Operativos - Event Database) and BDC (Banco de Datos de Componentes - Components Database).
Operation of the system began at the beginning of 1989. The volume of information that has been accumulated over the seven years that have elapsed since then is summarised in Figure I.

EVENT DATABASE

The basic objectives of this database are to store data on significant events occurring in Spanish plants, classify transients and analyse and exchange information. The most relevant characteristics of the bank are described below.

Event classification. The events to be reported to the BDIO are: (a) reactor or turbine trips, (b) non-scheduled power reductions in excess of 10%, (c) in-house events actually or potentially affecting typical safety functions or normal development of the corresponding activities, (d) external events leading to damage to the plant or potentially jeopardising plant operation, and (e) other significant events which cannot be included in any of the previous categories but which in the opinion of the plant operator are relevant to plant operation or safety. Figure I shows the classification by type of the events registered.

Content of reports. The plants draw up a report on events reportable to the BDIO, including general coded data, textual descriptions and anomalies.
- The general event data are submitted in a *classified and coded form.* It includes fields for IDENTIFICATION of the event, such as event reference, affected plant, date and time of the event and initial plant status; event DESCRIPTORS, including the reporting criterion, type of transient or initiating event, root cause and actuating safety systems or safeguards; and finally the EFFECTS of the event, such as the final plant status and radiological effects.
- The textual description of the event is structured by way of the following fixed sections: summary, background, initial plant conditions, event sequence, causes and effects of the event, corrective actions and conclusions.
- Finally, anomalies describe those abnormal situations which have given rise to the event or affected its evolution, such as component failures, abnormal system or component performances or human errors. For each event, the number of anomalies reported is that which might be required. In addition to identifying data, each anomaly report contains information on the affected system and component, the causes and corrective actions implemented and a textual description.

COMPONENTS DATABASE

The BDC is conceived as a component reliability database with the objectives of collecting data on the design and operational characteristics of the components, recording failure and unavailability data, obtaining reliability parameters and making information readily accessible to the analysts for the exchange and accumulation of operating experiences. The information is supplied to the database ordered by way of the following four types of reports:

Component reports. This first type consists of a block of *coded* information for component identification and characterisation. The components registered and tracked in the database are grouped into 27 different families or types, whose physical limits are accurately defined. The report includes fields for the recording of data on the system, safety class, manufacturer, environmental operating conditions and type of maintenance. In addition, a set of fields is included for the design and operating characteristics of each family of components.

Failure reports. The failures affecting registered components are considered to be of two types: *immediate,* when the component is not able to perform its function, and *incipient,* when there is an alteration to the operating conditions which does not prevent the component from performing its function but which requires corrective action to prevent immediate failure. Failure reports contain coded information including unavailability and repair times, failure mode and effects,

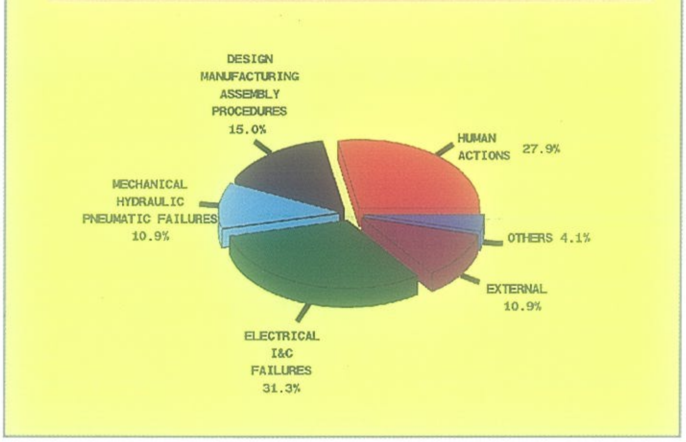


FIGURE 4. SCRAM CAUSE DISTRIBUTION

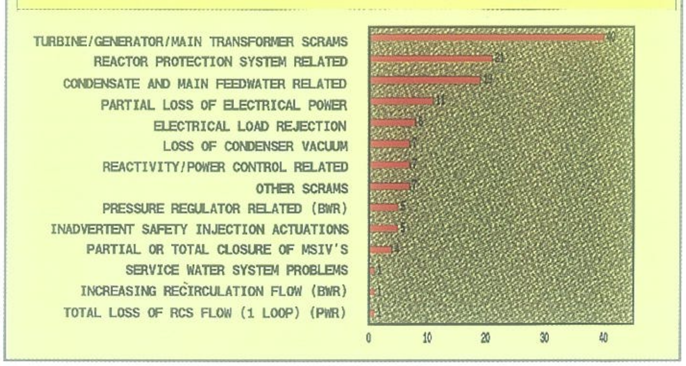


FIGURE 5. TRANSIENT TYPES (PSA INITIATORS)

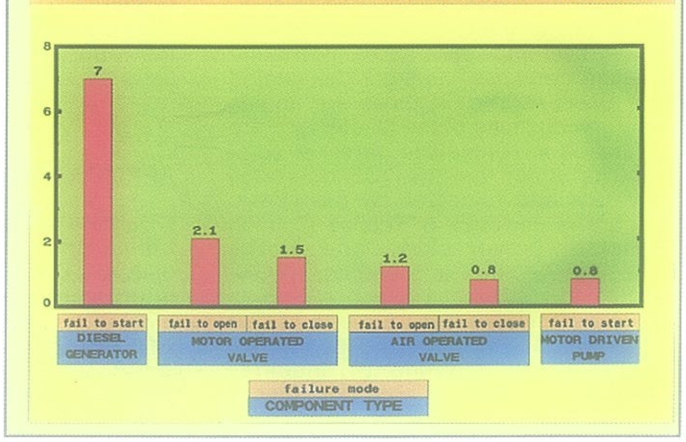
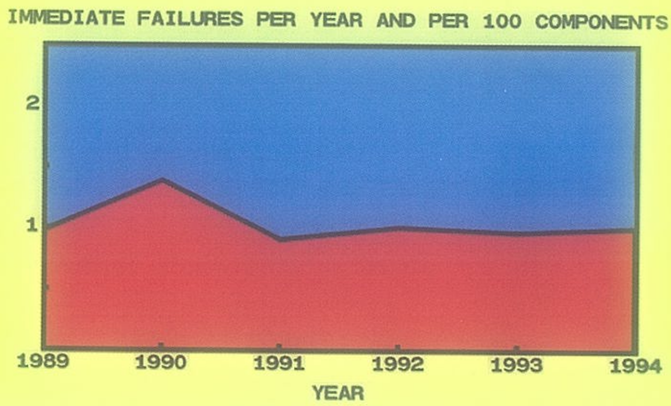


FIGURE 6. FAILURES OVER 1000 DEMANDS

FIGURE 7. IMMEDIATE FAILURE INDEX



causes, failed parts and corrective and administrative actions, along with a detailed textual description.

Unavailability reports. As from January 1995, the BDC includes the storage of data on the unavailability of equipment as a result of testing or maintenance actions.

Annual operating reports. The operating hours and cycles (demands) are registered annually in the database in order to allow failure rates to be obtained.

DACNE MANAGEMENT SYSTEM

In developing the DACNE computer system, attempts have been made to achieve the greatest flexibility and the widest possibilities for the users. This has led to the development and implementation of two versions of the database, operating simultaneously as shown in the diagram included as Figure II, these being the "Master database" and the "Replicas or Copies". Both use the commercial off-the-shelf INFORMIX database as a platform. The Master is installed in a Hewlett Packard HP 9000-817s computer under the UNIX multi-user operating system, operated by Tecnatom as the database manager designated by UNESA. The Replicas are copies or reproductions of the Master and are installed in compatible personal computers under the MS-DOS operating system and operated by the users. There is currently a Replica at each nuclear power plant, one at the Regulatory Body and another at UNESA.
The system operates by way of five Programs: (1) Data Collection (2) Loading, (3) Updating, (4) Inquiries and (5) Communications. The first of these programs allows the nuclear power plants to automatically and interactively draw up reports for feed into the Master database. These reports are sent to the database manager on magnetic support (diskettes) or electronic mail for revision and quality verification. The loading program is used exclusively by the database manager for the incorporation of information into the Master, following verification and quality control. As in the previous case, the updating program is used only by the database manager; the program generates disks which may be used by the users to update their Replicas. The query program allows the users to access the information contained in the replicas making local retrievals. Finally, the communications program allows the users to access the information contained in the Master, via modem.
The database manager is responsible for updating and maintenance and for guaranteeing the quality and coherence of the information coming from the different sources. The database manager also guarantees correct application of coding standards and criteria by the plants supplying the data; prepares comments as appropriate to be sent to the plants for their consideration; adds information to the Master with updated data by means of the Loading program; likewise, only the Manager may generate update disks for modification of the Replicas.

APPLICATIONS

Given the facilities it offers for the retrieval and later analysis of stored data, the DACNE system is capable of addressing various nuclear power plant information needs. Certain specific examples of application are presented below.
Scrams. Figures III and IV show respectively the annual evolution of the number of scrams per plant and their distribution by cause. Most trips occur as a result of electrical or instrumentation and control failures.

Types of transients. Figure V shows a classification of the 137 scrams registered by transient type. It may be appreciated that the largest number of trips occurs as a result of transients related to the turbine or generator. These data, used in combination with the hours of plant criticality, make it possible to obtain initiating event frequencies for PSA applications.

Component failures. Specific component reliability data may be obtained for use in PSA's or maintenance programs. It is also possible to compare the failure rates with typical data obtained from the industry or manufacturers, in order to detect potential maintenance problems. Trend analysis is useful for the detection of abnormal situations. Figure VI shows the failures on demand for different types of components, by way of an example. Figure VII shows the annual evolution of the immediate failures index, defined as the number of failures per year for every 100 components. This index may be used as a performance indicator and to identify deviations when different types of components are compared.

CONCLUSIONS

The DACNE System is a multi-purpose database that is a valuable tool when used in different operational programs collectively developed by nuclear power plants, the following being of special importance: exchange and analysis of operating experience, operational indicators, PSA and optimisation of maintenance. The BDIO stores information on significant events actually or potentially affecting safety, for use in operating experience exchanges, event analysis and obtaining frequencies of initiating events in PSA's. The BDC includes data on the main components integrated in safety-related systems and modelled in PSA's.
The scope and contents of the database, the quality and homogeneity of the data stored, the possibilities for access, the structure and the management system provide capacities equivalent to or better than those of similar banks operating in the European Union and the Unites States. Although DACNE is already a modern database, it will be enriched further with time as its contents increase, this also increasing the possibilities for use and the performance of the system.