INTRODUCTION

Since the Second World War, the philosophy behind the quality systems of industries and service companies has evolved to embrace the whole life cycle of the product, system or service. In this evolution process, quality has become a strategic factor in the survival of entreprises.

The first steps in trying to establish quality systems were taken for the armed forces, followed by space, aeronautical and nuclear projects, whose products were more and more complex and sophisticated. These systems were established by means of quality plans or programmes, and their basic objective was to guarantee a high safety level for the user and/or the general population. In later years, the main concern was to reach a determined quality level not only in one phase of the product life, but in the complete life cycle of the final product.

Today a new goal is established and pursued: better quality of the product, service or system life cycle at a lower cost.

Methods of improving the quality of systems and processes are the subject of numerous initiatives and studies, to better availability and maintainability of complex equipment or installations, with an extended useful life and greater requirements.

Experience in the performance of complex projects shows that a higher quality may be obtained through designing a comprehensive quality plan which pays special attention to information management and modifications of the original design.

Obtaining a high reliability level for an installation (equipment, systems, etc), increasing its availability and rationalizing its maintenance may be little less than fanciful without a deep knowledge of the installation, of its activities and its
current status in day-to-day operation, which shows the importance of truthful information available to operators and corresponding exactly to their needs.

In this frame of mind, a quality plan comprising a configuration management system of information and documents constitutes the basic support tool for logistics in the design, engineering, fabrication, erection, operation, maintenance, etc of complex installations.

In view of the above, we may say that commonly defined and generally accepted objectives for Concurrent Engineering and Computer-Aided Logistics Support (CALS) must be met with the support of efficient installation configuration management and effective implementation of global quality plans.

QUALITY PLAN

Even at the beginning of the installation design phase, a plan must be established to obtain and maintain the required quality level at each stage of the life cycle, whether it is conceptual design, engineering and design, production, operation (including maintenance) or dismantling for possible recycling or controlled storage, if applicable.

This plan may be done as a whole or made up of different constituents integrated in a coordinated fashion and taking in consideration all interfaces (immediate or not) with the others. Overall success in reaching, maintaining and improving the quality of a product is obtained through each of the product life phases, just as the strength of a chain depends upon the strength of each individual link.

An appropriate quality plan is based on a suitable design of the product obtained from initial definition and allowing possible modifications for improvement or optimization on the basis of the information gathered during operation and maintenance.

The quality plan must establish for each phase of product life, as precisely as required, the quality objectives and principles in relation with activities, documents, equipment and materials of the installation.

As regards work systems and processes, the quality plan must define the different parameters of the information system: definition, source, validation, destination, storage, safeguard, communication and access possibility for different types of users, so as to ensure precise data availability at all times in every work station, and data consolidation as the installation life cycle advances.
It is recommended for the quality plan to acquire its definite form on the basis of different documents—technical, administrative and on programmes-oriented at different levels for every type of user. At the first level, the plan objectives and policy must be described, as well as the criteria and resources used to meet those objectives. At the second level, rules are established for the management and administration activities, processes and documents; the third level is when are described the technical activities, processes and operations related to design, fabrication/erection, operation (under normal conditions, emergency or other), maintenance (and other steps) for the installation.

CONFIGURATION MANAGEMENT

The information requirements of people related to the system through its life cycle are the following:

- Maintenance of installation and components within design limits.
- Complete identification of the data applying to the installation and to each of its components.
- Clear definition of data location in documents.
- Update and maintenance of the documents containing data based on the changes brought to the installation and its components.
- Exact location of the documents in the different files.
- Maintenance of document material support so that the document can be visualized as a whole.
- Proper document distribution and easy access to information.

Therefore, it is a matter of establishing a set of guidelines based on the above, to ensure the installation data:

- Is always properly identified.
- Always corresponds to the physical and functional reality of the installation.
- Is considered in the modifications envisaged and implemented.
- Is appropriately filed, updated and available to operators in a centralized fashion.

Of course, these guidelines must be supported in a clear and precise definition of the configuration, or similarly in the identification of the set of documents containing the information on the installation, ordered so that their applicability is perfectly defined. The best way to reach this goal is to establish a Base of Reference comprising:
- **The physical elements** of the installation, ie components, systems and structures.

- **The information** on these physical elements, as individual entities integrated to the installation.

- **The documents** containing this information.

Selection of the physical elements of the Base of Reference is supported by pre-established criteria, to set a reasonable number of elements in order to obtain full initial system operability without ruling out future extensions.

The information to be included in the Base of Reference for each of the selected elements must comply with the following basic requirements:

1. Unmistakable identification of the element.

2. Meet the operators' requirements related to operation and modification processes, providing an overview of all aspects to consider when performing operations on the elements or projecting physical or functional changes in the installation.

3. Consider the element individually and in its interfaces with others, as a physical entity functionally integrated in the installation.

Therefore, the data shall comprise the following:

1. Usual code or identification.

2. Description of the physical and functional aspects of the element.

3. Input data for the element design.

4. Justification of the application of design input data to installation elements.

5. Data produced during the design and engineering process.

6. Maintenance and operation data on the element, including aspects such as:

Once identified all the information applicable to each of the physical elements selected, the Documents and Data Bases containing this information are located. This task involves analysis and selection; indeed, while a great part of the above-
mentioned information is comprised in specific documents (eg. physical description and dimensions of equipment in manufacturer drawings or operation procedures in the user manual), some information will be repeated in different documents. Therefore, it is necessary to select the data to be included in the Base of Reference, as it will be consulted by operators and updated when affected by modifications.

The above ensures that the operator always gains access to the same document or data base which is of common use and consults the same information.

Once the elements and documents are selected and the data identified, the Base of Reference is structured into a relational-type Data Base featuring the following:

- Specific data on the physical element, such as:
  - Physical element identification.
  - Type (pump, heater, engine, system, etc).
- Document-specific data for easy localization and visualization, such as:
  - Document identification.
  - Document title.
  - Type (drawing, specification, maintenance guide, etc).
  - Revision number.
  - Information relating the element with the documents and data bases available, comprised in attributes, characteristics and specific data.

Verification of the Base of Reference is then performed, taking into account the quality plans previously implemented, to ensure that the information comprised in the Configuration data bases and documents corresponds to the physical and functional reality of the installation, and that the Design Bases and Requirements are maintained.

After obtaining of the final Configuration, and once the Base of Reference has been established and verified, appropriate methods and procedures are established to meet the requirements defined priorly for Configuration Management.

These methods and procedures refer to both form and structure:

- Maintenance of Installation Configuration during its useful life:
  - Ensures that the physical and functional reality is adequately reflected in the documents.
  - Guarantees that the installation and its operation are within the design margins and meet the requirements and design bases.
  - Controls evolution of installation and documents, following modifications.
- Keeping users informed:
- By controlling documents and maintaining the quality of information they contain.
- Providing location and access to information.
- Configuration management accounting.

CONCLUSION

Definition and implementation of a Configuration Management System featuring the above-mentioned characteristics, comprised in the Organization Quality Plan, will help to meet the challenge of today's industries in their effort to produce better products in less time and with greater reliability.

EA's experience in the implementation of quality plans and configuration management systems for installations as complex as a nuclear power plant has been very useful for its application in the concurrent engineering framework through the most advanced techniques in the fields of graphic design, expert systems, communications, data management, etc.
TOTAL QUALITY PLAN

CONFIGURATION MANAGEMENT

USER

SYSTEM

INFORMATION

ACTION
Figura 2.
Figura 4. Baseline data structure
Figure 5. Information included in the configuration
Figure 6. Baseline data structure with modifications
Figura 7. Configuration management plan
JORNADA DE PRESENTACION DEL EUROCODIGO 2:
"ESTRUCTURAS DE HORMIGON"

Madrid, España
02 Abril/April 92