INSPECTION OF NUCLEAR POWER PLANTS UNDER CONSTRUCTION IN SPAIN

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En esta comunicación se expone un breve resumen de la situación de la industria nuclear en España a fin de comprender mejor la problemática de la inspección de las centrales nucleares españolas, así como de la experiencia adquirida, describiéndose a continuación algunos de los problemas surgidos durante la fase de construcción. También se expone la problemática con que se enfrenta la Inspección de la Junta de Energía Nuclear para cumplir con las misiones que este organismo tiene encomendadas en este campo. Por último, se hacen algunas recomendaciones elaboradas a partir de la experiencia española.

This report includes a brief summary of the situation of the nuclear industry in Spain, in order to better understand the questions involved in the inspection of the Spanish nuclear power plants, as well as the experience acquired, followed by a description of some of the problems which have arisen during the construction phase. Also the problems faced by the Inspection of the Junta de Energía Nuclear are described in order to fulfill the missions entrusted to it. Finally, some recommendations are made in light of the experience had by Spain.

1. INTRODUCTION

In accordance with the Law on nuclear energy of April 29, 1964 (Chapter V, article 28), throughout the construction of the nuclear or radioactive facilities, the Nuclear Energy Board (JEN) shall oversee such construction for the purpose of verifying that it is carried out according to the project which served as the basis for the pertinent authorization.

In order to carry out this mission, the JEN has a team for the Inspection of Nuclear Power Plants under construction ( ). In figure 1 the organization planned for this team is shown and in annex 1 the missions assigned to the various positions are described.

At the present time there are seven nuclear units under construction in Spain, as can be observed in Table 1 which includes general data on them.

In order to better understand the questions involved in the inspection of the Spanish nuclear power plants under construction, this report includes a brief summary of the situation of the nuclear industry in Spain, as well as the experience acquired, followed by a description of some of the problems which have arisen during the construction phase. Also, the problems faced by the JEN Inspection in order to fulfill the missions entrusted to it are described. Finally, some recommendations are made in light of the experience had by Spain.

2. SITUATION AND EXPERIENCE OF THE NUCLEAR INDUSTRY IN SPAIN

The experience acquired from the construction of the Spanish nuclear power plants in the so-called "first generation" (José Cabrera Plant, Santa Maria de Garoña Plant and Vandellos Plant) carried out in part through contracts of the "turn key" type on the part of the main suppliers, is having significant repercussions on the present-day construction of the power plants mentioned in the beginning which constitute what in our country we call "the second generation". Below, we are analyzing the situation for the different facets in participation.

( ) See the report "Official Inspection of Nuclear Power Plants in Spain", submitted to this Meeting.

a) Organization of the project

In contrast with what was established in the first nuclear power plants, where the organization of the project depended mainly on the main supplier, at the present time, this is carried out by organizations formed form the owner companies themselves. The experience achieved in this field is very important, especially with regard to those activities which are not included in the main supplier's contract. At the present time, in almost all cases, programming and follow-up methods for the projects are used through the utilization of computers.

b) Design engineering

The design engineering of the nuclear steam supply system (NSSS) is carried out completely by the main supplier. The design engineering of the temainder of the plant, including the design of the buildings, is carried out by Spanish engineering firms, generally grouped or associated, which have available the counseling of foreign engineering firms, mainly from the United States.

c) Manufacture

At the present time the greater part of the mechanical components of a nuclear class are being manufactured in Spain. In the case of the nuclear steam supply system, the manufacture is normally carried out under a foreign license, while the situation is very different for the mechanical components of the remainder of the plant.

The manufacture of electrical equipment is basically domestic, except for the emergency diesel generators which are imported.

The situation of the manufacture of the instrumentation and control equipment is quite diverse according to each particular case. Some NSSS suppliers have set up factories in Spain for assembling this equipment. It can be said that the field of manufacture of instrumentation and control equipment is less developed within the Spanish nuclear industry.

d) Erection and civil work

The erection of the plant, both mechanical as well as electrical, is carried out almost entirely by Spanish companies.

The civil work is likewise carried out by Spanish companies with extensive experience.

3. SOME PROBLEMS WHICH AROSE DURING THE CONSTRUCTION OF SPAIN'S NUCLEAR POWER PLANTS

Experience shows that in many cases, deviations arose which could be avoided, if the quality assurance techniques had been applied in a more strict manner from the beginning of the project. In other cases, in contrast, there were foreseeable deviations in the development of a project which are easily controlled or either caused by unforeseen technological situations difficult to avoid in any case; however, these should appear very rarely as the reference plant concept is used.

a) Problems related to the organization of the project

Among the typical problems found in Spain regarding the organization of the project, we can point out the following:

- The lack of definition in the lines of responsibility of the structures of the project organization. In some cases, problems have arisen in relation to the independence between the organization of quality assurance and other organizations.
- Lack of experience of the staff of the organization of the project with regard to the tasks assigned, together with the little-defined situations brought by a not highly specialized staff which tends to different tasks indifferently and to changes of staff occupying positions of great responsibility due to the great demand for nuclear technicians. In some cases, persons with little experience can hold positions of great responsibility.
- Lack of definition and procedure in the relationship between defferent organizations (inter-phases) thus creating poorly defined areas giving rise to problems occurring at posteriori which are very difficult to solve.

b) Problems regarding the site studies

The deviations occurred during the site studies stage are those which have given rise to the most important problems involved in the construction of Spain's nuclear power plants. Many of these problems are derived from a lack of application of the quality assurance techniques during this stage of the project.

The repercussions of these failures in some cases have been important, both from an economic point of view as well as regards execution deadlines, while occasionally costly studies, changes in design and repetitions of work in conditions much inferior than initially have been necessary.

We are going to mention the following cases:

- Modification of the seismic acceleration of the ground after making the dynamic design of building and structures.
- Inadequate planning of geotechnical drilling campaigns.
- Incomplete or inadequate geotechnical studies on the samples taken.
- Inadequate or incomplete topographical following of differential movements of the ground and the buildings

c) Design engineering

The main problems arising in the design engineering are derived form the lack of capacity and preparation of the project organizations in order to carry out an adequate follow up and control of the activities of the engineering firms, and very especially as regards the main suppliers. In some cases modifications have been introduced in the design without being properly verified and controlled, and thus these verifications were required after the manufacture of the equipment, which brings about an undesirable situation from a quality assurance point of view.

Among the most typical cases in which this situation tends to occur, we can mention the following: the antiseismic design of structures of components, the modifications of the pressure and temperature transitory values as well as the modifications in the specifications and starting system of the pumps and the modifications introduced in the materials and geometry of the equipment in order to prevent certain problems found in the plants in operation.

At the present time, the project organizations tend to contract consulting firms in the field of design quality assurance.

d) Problems arising during manufacture

The problems arising during the manufacture of the mechanical nuclear equipment do not differ from those which tend to appear in other countries. The application of the systematic inspection plans has made it possible to detect classic deviations such as oxidations, contamination of the stainless steel, rejected pieces mainly of cast steel, sizing errors, incomplete quality assurance documentation, as well as the discovery of non-conformities in pump prototype tests, hydrostatic tests on equipment having parts originating from different factories assembled for the first time in the field, etc.

With regard to the manufacture of electrical equipment, mention should be made of the difficulties in the application of the standards of environmental qualifications of electrical cables and the problems derived from the prototype tests on motors manufactured in the United States with a frecuency different from that used in Spain.

The problems of the manufacture of instrumentation and control equipment deserve special interest, as this is an area which traditionally receives little attention in the quality assurance programs, mainly due to the complexity and disperse nature of the pertinent regulations. Among the most important problems encountered, we can mention that of the physical separation of circuits and that of the seismic qualification of this equipment.

e) Problems arising during transportation of the nuclear components

A large part of the deviations of highest significance in quality assurance of the nuclear components have been produced during transportation, mainly due to the failure of applying the quality assurance standards in this stage. This fact should be blamed mainly on the circumstance that the transportation of these components is a typical inter-stage situation in which situations difficult to control arise.

Among the most typical deviations produced in this phase, the following deserve being pointed out: oxidation occurring in large components due to insufficient protection during sea transport or to the use of inadequate vessels, damage caused by defective handling in ports, losses of identification and documentation, temporary storage in places with contraindicated ambients, etc.

f) Problems occurring during erection

The problems occurring during the mechanical erection are the normal ones in this type of activity. Some unforeseen problems have arisen regarding the welding in the field of large components and with inadequate erection sequences of large tanks and structures, especially in cases of changes in design with insufficient experience on the part of the erection engineering.

Insofar as the electrical installation, problems have been encountered insofer as the laying of cables and their identification, with the antiseismic design of the cable pallets and with the introduction of modifications which were not revised for all of the parts involved. A most particular problem was that caused by the start up tests system of the emergency diesel generators.

g) Problems involved with the civil work

The main problems involved in the civil work are due to settlements greater than those foreseen in the group or the filler supporting the building, which has made it necessary in some cases to alter the design of the slabs supporting them. Also, problems now solved arose due to the fact that Spanish standards, quite well developed in this field, are noticeably different in some cases from those of the country of origin of the plant referred to.

Other questions which initially gave rise to frequent deviations are: laying of concrete in cold wheather and in hot weather, the pouring of concrete in very dense reinforcement structures and the auqlification of "Cadweld" welding procedures. In some cases, the complexity of the geometric arrangement of the bars, orifices and posttensioned sheaths has made it necessary to carry out a modeling in order to solve problems of erection se quence.

4. PROBLEMS IN THE JEN INSPECTION WITH REGARD TO THE NUCLEAR POWER PLANTS UNDER CONSTRUCTION

In the previous section some of the problems which tend to arise during the construction of the nuclear power plants in Spain have been described. In this section, a study is made of the problems confronting the JEN inspection team in order to fulfill the missions entrusted to it in this field.

Leaving aside the problem of the inspection staff and their specialization and experience which are clearly insufficient, let us focus this question under three aspects, the solution of which is fundamental for the adequate following up of the construction of the nuclear power plants on the part of the JEN.

In the first place, we shall consider the subject of the indispensable formation on the project if the plant to be constructed, secondly, the topic of the information necessary in order to learn how the projected plant is carried out and thirdly, the most important subject for an inspector, that is, realizing whether the project and its execution are correct.

a) Information regarding the project of a plant

It is evident that the inspection team should be familiar with the project of the nuclear facilities to be inspected in sufficient detail. Knowledge of the project should be acquired at the same rate as it is developed.

In the first stage, knowledge of the basic design is obtained from the Preliminary Safety Study (PSAR). Experience shows that in this first stage it is very advisable for the inspectors to be in touch with the personnel making the evaluation of the preliminary safety study, which in the JEN corresponds to the Evaluation Operating Unit, in order to be informed about or receive clarification of the following points:

- Standards applicable in each case.
- Aspects of the different equipment, structures and buildings particularly related to safety and which should be inspected with careful attention.
- Modifications with respect to the standard plants and the plant referred to.

Insofar as the detail design of the systems, which

is largely carried out after the PSAR is approved and after the granting of the construction authorization, it is possible to have knowledge of it as thoroughly as required, as provided for in the pertinent articles of the aforementioned construction authorizations. Nevertheless, at the present time and taking into account the lack of available staff, only the presentation to the JEN of the detail design of all of the 1st class safety systems and some of the second class is required.

With regard to the information relative to manufacturers, builders and erectors, which besides the design itself includes the manufacture, building and erection procedures, the materials used and the inspection and the control procedures, it is considered that it is sufficient for the realization of the pertinent inspections. The national companies send this information directly to the JEN in order to obtain the pertinent authorization from the Ministry of Industry for manufacturing, erecting or constructing nuclear power plants (Title VII of the Regulations for nuclear and radioactive facilities). With respect to the foreign manufacturers, this same information is sent by the proprietor electric companies, as provided for in the articles of the building authorizations.

b) Follow-up of the construction of the nuclear power plants

The follow-up of the construction of the nuclear power plants on the part of the JEN inspection team is carried out basically along three avenues.

1. From the information received fron the proprietor electric companies in their quarterly and monthly reports. This information is generally quite complete and its contents are taken into consideration in the pertinent construction authorizations, and includes, among other points: situation of the construction program, list of manufacturers, erectors and builders contracted, list of modifications in the project, list of inspection and audits carried out by the holder of the authorization and outcome of same, reports on deviations and situations of non-conformity, etc.

2. Inspection at the location of the plant, quality assurance offices, engineering offices, erection installations and testing laboratories

   Experience shows the advisability of making a general inspection quarterly, and unplanned inspections to very

specific points whenever necessary. Unfortunately, the lack of available inspection staff means that these inspections are made less frequently than called for.

As an example, we can indicate that a normal inspection of a plant lasts about three weeks, with one week dedicated to its preparation, one week for execution, and another week for organizing the data obtained and to write up the inspection report. The number of persons participating in an inspection ranges from four to six.

3. Inspection of factories

With some exceptions, all of the inspections of factories have been carried out within the national territory. These are considered as effective inspections on account of the specific nature of the subject to be inspected, because usually the manufacture of components for several plants is involved and because these inspections lighten the eventual load of the inspection on the site.

c) Verification of the appropriateness of the project and the and the construction

The main mission of the JEN inspection team in this phase is that of checking that the project and the construction of the nuclear power plants are carried out in an adequate manner under the point of view of nuclear safety.

It has already been pointed out that the verifications on the approproateness of the basic design insofar as nuclear safety are carreid out by the Evaluation Operation Unit. The JEN inspection team must check that calculations and the calculation procedures used for developing the detail design are correct. Taking into account that in Spain the criterion of the reference plant is used, the design verifications should be particularly directed to those points which have undergone modifications with respect to this. In many cases these modifications are brought about necessarily because they depend on the circomstances proper to the location. There are enormous defficulties involved in the proper execution of these verifications, especially in those cases in which there are no adequate standards and particularly when the design moves away from the applicable standard, since it is difficult to have one's own criteria supported on sufficient experience on order to make decisions in this regard.

Insofar as the manufacture and erection procedures are used, there are also difficulties involved in the ins-

pection of those situations which do not adapt to the applicable standards.

In order to solve problems in which the inspection team lacks adequate experience, at times recourse is made to the counseling of specialized consulting forms.

In many cases the existing nuclear standard is insufficient in order to establish valid criteria for the inspection, which gives rise to situations requiring extensive experience. A particularly delicate case is one in which the country of origin of the reference plant does not have a sufficiently complete nuclear standard, adequately strutured and coherent, which tends to occur with countries having a second-hand nuclear technology.

As an example of situations difficult to interpret for the inspection we shall mention the following: failures in the recorders of the weld parameters in the field for large components, fires affecting structures and nuclear components, national standard deffering from that of the country of origin of the reference plant in relation to the hydrostatic test of the components, lack of definition in the dates of application of the resisions of the standards, etc.

Experience shows that it is important to reinforce the inspection in those areas related closely to nuclear safety and which do not directly influence the economic yield of the plant: examples are the seismic design of supports and structures, seismic qualification tests, prototype tests on components and systems related exclusively to safety, leak-tightness of the reactor building, design of the emergency water systems , start up tests on the emergency diesel engines, etc.

5. CONCLUSIONS

On the basis of the experience acquired, from the point of view of the inspection of the nuclear power plants under construction, it is considered interesting to take into account the following questions, among others:

1. To include in the preliminary safety study (PSAR) the standard applicable in each case, without leaving undefined areas which could give rise to unadvisable improvisations. The standard applicable should be coherent and reliable, while codes and standards of different origins should not be mixed.

2. To develop an administrative standard which would make it possible for the inspection team to be sufficiently informed of the progress and realization of the nuclear projects. A requirement should be that the initial nucleous responsible for the project and the quality assurance of each plant be composed of persons with broad experience in this field, and that the lines of responsibility and the assignment of tasks be well defined. A system should be established so that the inspection team will act at the proper time in order to prevent later irreversible situations.

3. To apply the eighteen quality assurance criteria of Appendix B of the 10CFR50 of the NRC (Nuclear Regulatory Commission) of the United States or the Code of Quality Assurance Standards of the International Atomic Energy Agency. The application of the Quality Assurance program should be required from the beginning of the project, including the prior work studies on the site and the selection phase of offers and awarding of contracts of the engineering firms and NSSS suppliers. It should be sought to include clauses in the contracts guaranteeing that the quality assurance documentation will be provided in an adequate manner and within allowable deadline dates. The quality assurance techniques will also be applied to the transportation phase of the components.

4. To control most especially the modifications in design regarding the reference plant, as well as those safety systems not directly related to the economic yield of the plant. Also, proper operation in the inter-stages between the engineering organizations should be controlled.

5. To inspect the manufacturers and erectors, attending some points of the quality control programs. Special attention should be dedicated to the prototype tests on motors working at 50HZ, to the tests on seismic qualification of electrical equipment and environmental qualification tests on electrical cables.

6. To follow up with special attention the erection sequence of large structures and tanks, particularly when changes have been introduced regarding the procedures used in the reference plant.

7. To particularly control the studies referring to foreseeable settlements of the land, requiring from the start of the excavations the establishment of an adequate topographical network for following it up.

8. Finally, the frequency considered adequate in order to carry out general inspections is that of a quarterly inspection. The inspectors should seek counseling from the specialized consulting firms whenever they do not have sufficient staff or appropriate experience.

ANNEX 1

MISSIONS ASSIGNED TO THE POSITIONS CORRESPONDING TO THE ORGANIZATION OF THE INSPECTION GROUP OF NUCLEAR FACILITIES UNDER CONSTRUCTION

1. CHIEF OF THE INSPECTION GROUP OF NUCLEAR FACILITIES UNDER CONSTRUCTION

Coordination and direction, within the instructions received from the Head of the Inspection Operating Unit, of the inspections to be carried out on the nuclear facilities during the construction stage and prenuclear verification, including:

- Organization of the tittle-holder from the point of view of integral control of quality.
- Construction of components in the factory.
- Qualification tests of components.
- Installation of systems and erection of structures on site.
- Tests, verifications and preoperational tests

2. INSPECTOR IN CHARGE OF THE SURVEILLANCE OF THE CONSTRUCTION OF A NUCLEAR POWER PLANT

- Coordination, direction and inspection, within the instructions received from the Chief of the Group on the follow up during the construction of the nuclear power plant assigned to him.
- Cooperation in matters of his specialty (components and mechanical systems or civil work) within the instructions received from the Chief of the Group in:

  a) Participation in inspections to other nuclear power plants.
  b) Analysis of documentation which may be assigned to him from the authorization applications provide for in Tittle VII of the current RINR.
  c) Inspections to the factories of components assigned to him

3. INSPECTOR RESPONSIBLE FOR SURVEILLANCE OF THE PREOPERATIONAL TESTS

- Coordination, direction and inspection, within the instructions received from the Chief of the Group for surveillance insofar as the inspection of the prenuclear tests on the nuclear power plants.

4. AUXILIARY INSPECTORS FOR THE SURVEILLANCE OF THE PREOPERATIONAL TESTS

- Cooperation, within the instructions received from the Inspector Responsible for the surveillance of the prenuclear tests on the different plants.

5. INSPECTOR SPECIALIST IN DESIGN QUALITY ASSURANCE

- Coordination, direction and following up of specific problems related to the design quality assurance within the instructions from the Chief of the Group.
- Participation as an expert in the inspections to the engineering firms.
- Updating of the technical information related to the Inspection activities of the Group

6. INSPECTOR SPECIALIST IN CIVIL WORK

- Participate as an expert in civil work in the inspections to nuclear power plants within the instructions received from the Chief of the Group.
- Analysis of the documentation assigned to him from the authorization application by Civil Work Builders provided for in Tittle VII of the RINR.
- Inspection of the specific activities of civil work assigned to him.

7. INSPECTOR SPECIALIST IN ELECTRICAL SYSTEMS AND COMPONENTS

- Participate as a specialist in electrical systems and components, within the instructions received from the Chief of the Group, in the inspections to nuclear power plants and components factories.
- Analysis of the documentation assigned to him from the authorization applications of manufacture and erection of electrical systems and components provided for in Tittle VII of the RINR.
- Inspection of specific activities of manufacture and erection of electrical systems and components assigned to him.

8. INSPECTOR SPECIALIST IN INSTRUMENTATION AND CONTROL SYSTEMS AND COMPONENTS

- Participate as a specialist in instrumentation and control systems and components in the inspections to nuclear power plants and component factories, within the instructions

received from the Chief of the Group.
- Analysis of the documentation assigned to him from the authorization applications for manufacture and erection of instrumentation and control systems amd components provided for in Tittle VII of the RINR.
- Inspection of specific activities of manufacture and erection of instrumentation and control systems and components assigned to him.

9. INSPECTOR SPECIALIST IN SITE STUDIES

- Participate as a specialist in all of the activities related with the site itself (excavating, geotechnical soundings, topography, fillers, ecology, radiological study, etc.).
- Inspection of activiteis related to the above paragraph.

10. COORDINATOR OF AUTHORIZATIONS FOR MANUFACTURE OF COMPONENTS, CIVIL WORKS BUILDERS AND ERECTORS

- Coordinate and plan, within the instructions of the Chief of the Group, the analysis and processing of the documentation from the authorization applications provided for in Tittle VII of tne RINR.

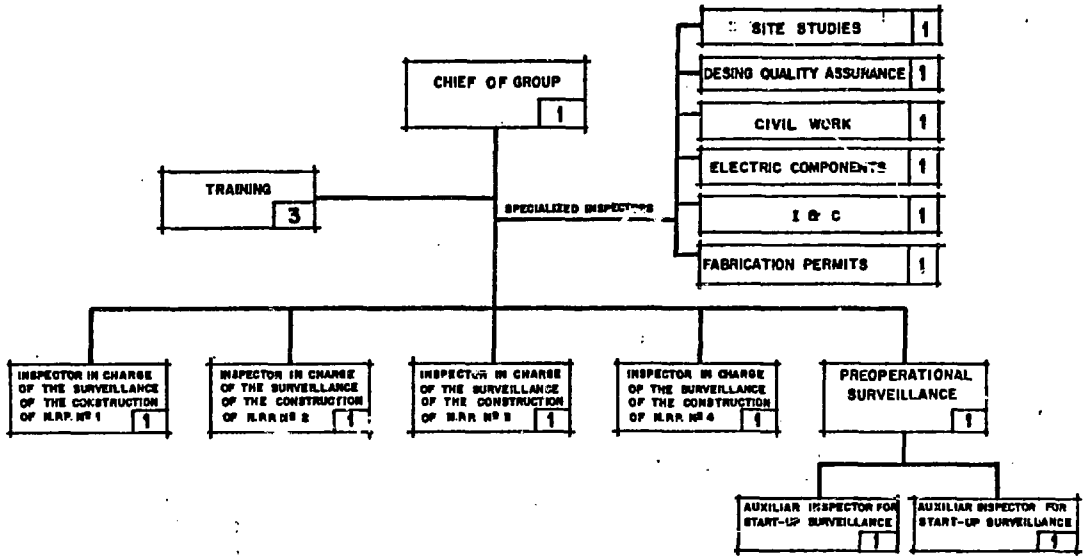

FIG. 1.- TENTATIVE ORGANIZATION OF THE INSPECTION GROUP OF NUCLEAR POWER PLANTS UNDER CONSTRUCTION.

TABLE I - GENERAL DATA OF THE SPANISH NUCLEAR POWER PLANTS UNDER CONSTRUCTION

	Almaraz I y II	Lemoniz I y II	Ascó I	Ascó II	Cofrentes
Site	Almaraz (Cáceres)	Lemoniz (Vizcaya)	Ascó (Tarragona)	Ascó (Tarragona)	Cofrentes (Valencia)
Applicant	CSE; HE, UE	Iberduero	FECSA	Fecsa-Enher-Hec-Segre	Hidroelectrica Española
Reactor Type	PWR (2 unidades)	PWR (2 unidades)	PWR	PWR	BWR / 6
Thermal Power (MW)	2696 x 2	2696 x 2	2696	2696	2894
Electrical Power (MW)	900 x 2	900 x 2	900	900	975
Preliminary Permit Date	29-10-71	23/5 / 72	21/4/72	21/4/72	13/11/72
Construction Permit Date	2-7-73	14-3-74	16/5/74	7/3/75	9/9/75
Starting day of the works	1972	1972	1974	1975	1976
Reference plant	North Anna 1 y 2	N. Anna 1 y 2	N. Anna 1 y 2	North Anna 1 y 2	Grand Gulf 1
Contention building reference plant	North Anna 1 y 2	Farley	Farley	Farley	Mark III
NSSS design	Westinghouse	Westinghouse	Westinghouse	Westinghouse	G.E.
Contention building design	Gibbs & Hill	Bechtel	Bechtel	Bechtel	Gibbs & Hill / E.A.
B.O.P. design	E. Agrupados (E.A.)	Sener - Auxiesa	Auxiesa - Inypsa	Auxiesa - Inypsa	E. Agrupados
Civil Works	Entrecanales & Tavora	Entrecanales & Tavora	Nuces	Nuces	Entrecanales & Tavora
Mechanical installation	Sade - Moncasa - B & K.	Ibemo - Tasoin	Copisa	Copisa	Moncasa - Ibemo
Inspection Agency for Spain	E. Agrupados	Tecnos-Ciat.	B. Veritas	B. Veritas	Tecnos
Inspection Agency for the U.S.A.	U.S. Testing		Bechtel	Bechtel	U.S. Testing
Inspection Agency for Europe	Lloyd's		B. Veritas	B. Veritas	