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THE PRODUCTION OF NUCLEAR POWER-BASED ELECTRICITY IN 1989 (*)

P. RIVERO

Before getting down to details, I should like to thank the Spanish Nuclear Society for their kind invitation to open this Annual Meeting a description of the results obtained from operation of Spanish nuclear power plants during this last year.

A little less than a year ago we heard from this same platform that 1988 was characterized by the entry into commercial operation of the Vandellós II and Trillo plants; it is time now to point out that for these two plants 1989 has seen consolidation of what was expected in terms of successful operation. Along with the contribution made by the other Spanish nuclear power plants, and despite the fire that occurred last October in turbine-generator set number 2 at Vandellós I, this has made it possible to achieve remarkable overall results that may be summed up in two figures: 38% participation in total production and a load factor of almost 82%.

I should like to provide a few data that illustrate the importance of nuclear power for the production of electrical energy in the overall context, and which also allow insight to be gained into the evolution of this energy source.

THE ELECTRICITY BALANCE

The installed power in Spain as of 31st December, 1989 amounted to 45,484 MW, broken down as follows; hydroelectric power, 16,509 MW; classical thermal-based power, 21,136 MW, and nuclear power, 7,838 MW, these figures corresponding to percentages of 36.47 and 17 %, respectively. The most outstanding change since the beginning of the decade has been the increasing relative weight of nuclear power.

The provisional balance of electrical energy production for 1989 gives an overall figure of 147,000 kWh, reflecting an increase of 6.2% over the previous year.

This overall figure may be broken down as follows: hydroelectric power, 19,600 million kWh, a reduction of 15.8% with respect to 1988; clasical thermo electric power, 71,800 million kWh, an increase of 37.2% over the figure for the previous year, and nuclear power, 56,100 million kWh, an increase of 11.3% over 1988.

In percentage terms, hydroelectric production amounted to 13% at the end of

(*) *This paper was presented at the seminar about "Spanish Nuclear Production in 1989", organized by the Spanish Nuclear Society.*

T I

MONTHLY EVOLUTION OF NUCLEAR PRODUCTION (millions kWh)

	1988	1989
January	4,188	4,906
February	3,404	4,183
March	3,544	4,204
April	3,743	4,843
May	4,398	4,716
June	4,327	4,164
July	3,846	5,385
August	3,951	5,150
September	4,556	4,603
October	4,906	4,662
November	4,999	4,617
December	4,551	4,691
	50,413	56,124

the year, as against the 26% it represented at the end of 1988; classical thermal energy gave a figure of 49%, in comparison with the 38% it had totalled a year before, and nuclear energy represented 38% of the total, as against the 36% for 1988.

These data show that the first place in the overall electricity production structure is held by the traditional thermal-energy plants, i.e., those operating with liquid and solid fuels and natural gas, the difference amounting to 10 points over the second-place energy source, the nuclear power plants, and to 35 points over hydroelectric power, due to the poor hydraulic conditions existing during 1989. If hydraulicity had been normal, traditional thermo-electric production would have been similar to that provided by the nuclear plants.

This low level of hydraulic production in 1989 was made up for to some extent by the change that look place during the latter part of the year. The reservoirs of interest from the point of view of hydroelectric production were at 57% of their capacity at the end of December. Just one month before they had been 25 points below this value, which ilustrates the important recuperation in level that occurred over the last few days of the year.

As regards the rest of the balance for the year, it remains to be said that the consumption of the generating installations themselves amounted to 7,465 million kWh, 26.5% more that in 1988; this being duo to the increased production by thermo-electric means.

The figures for international electrical energy interchange show a situation favourable to exports, the total amounting to 1,830 million kWh, as against the positive balance of 1,322 million kWh for 1988. Consequently, the operating balance increased by 38.4%. The total consumption in pumping was 920 million kWh. The figure for 1988 was 1,422 million kWh, the reduction amounting therefore, to 35.4%.

From what has been said above, it may be deduced that the energy consumption measured at the outlet of the generating plants, i.e., the energy available for the market, amounted to 137,285 million kWh, this representing an increase of 5.4% over the 130,258 million kWh consumed in 1988.

Finally, if we deduct the losses in transport and distribution, and bearing in mind that we are referring to a provisional balance, we obtain a net consumption of 123,900 million kWh, an increase of 5.4% over the previous year.

NUCLEAR PRODUCTION

The monthly evolution of nuclear production for the last two years in shown in table I. As can be appreciated, the largest contribution made by the nuclear power plants to overall electricity production during 1989 (46%) occurred during the month of August.

By way of an anecdote I might point out that the maximum hourly production by the nuclear power plants for 1989, in percentage terms, was achieved at 03:00 hours on 24th September (Sunday), when their contribution amounted to 60% of total production.

Although in their respective interventions the directors of the different nuclear power plants will be providing you with more detailed information on the operation of their plants during 1989, I should like simply to underline a few general data that illustrate the overall progress made by our nuclear-powered electricity generating installations. In this respect I have paid special attention to three types of data:

- Production data.
- Frequency of reactor trips.
- Fuel-related data.

Table II shows the individual production figure for each plant, along with its load and operation factors and the number of hours it was coupled to the grid.

The high load factor achieved during 1989, 81.58%, is to be underlined, and

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ANNUAL PRODUCTION OF SPANISH NUCLEAR POWER PLANTS (1989)

Plant	Gross Production MWh	Load Factor (%)	Hours on Line	Operation Factor (%)
José Cabrera	1,188,580	84.80	7,766	88.66
Garoña	3,689,310	91.56	8,324	95.03
Vandellós I	2,537,234	58.39	6,349	72,47
Almaraz I	6,827,550	83.81	7,641	87.23
Almaraz II	6,800,380	83.47	7,638	87.19
Ascó I	7,008,701	86.03	7,772	88.72
Ascó II	6,981,676	85.70	7,730	88.23
Cofrentes	7,318,290	84.31	7,651	87.34
Vandellós II	6,131,127	71.03	6,358	72.58
Trillo I	7,642,990	83.65	7,665	87.51
TOTAL	56,125,718	81.58	—	85.49

even more positive is the steady progression of this parameter: in 1987 it was 81.01% and the figure for 1988 (without counting Vandellós II and Trillo) was 81.80%.

The operation factor reached 85.49% during 1989, and the number of hours the plants were coupled to the grid ranged from 6,349 to 8,324.

Attention should be brought to two significant events that occurred during 1989 and that had a negative influence preventing the load factor for 1988 being exceeded. On the one hand, Vandellós II did not begin production until 7th March, following a plant shutdown initiated in December 1988 due to defects detected in the plant's main transformer. The other event that had a negative impact on the final load factor value was the interruption of electricity production at Vandellós I as a result of the fire that occurred in the plant's turbine-generator set number 2 on 19th October last. It should also be pointed out that the Garoña plant did not shut down for refuelling during 1989, as can be seen in table III, a fact that contributed to palliating the impact of the two negative events I have just referred to.

It may currently be stated that the personnel of the Spanish nuclear power plant has sound experience in the field of refuelling outage management and planning, a fact that is clearly demonstrated by the average duration of plant shutdowns for refuelling in 1989 (36 days) and by the interest shown by an organization of such prestige as INPO in learning of Spanish experiences in this area.

Another parameter that has improved over the past few years, albeit silghtly, is the number of reactor trips per year, which has gone from an average of 4.7 during 1987 to an average of 3.75 in 1988 and of 4.1 in 1989. The most significant aspect as regards these values, from the point of view of availability, is that the plant outage period following trips has decreased. I should like to take advantage of this occasion to indicate that as regards comparison between plants, the definition of this parameter to be used in the future —as a result of the performance indicators agreed on by INPO and UNIPEDE— will be the number of automatic trips occurring every 7,000 hours of reactor criticality, and not per calendar year.

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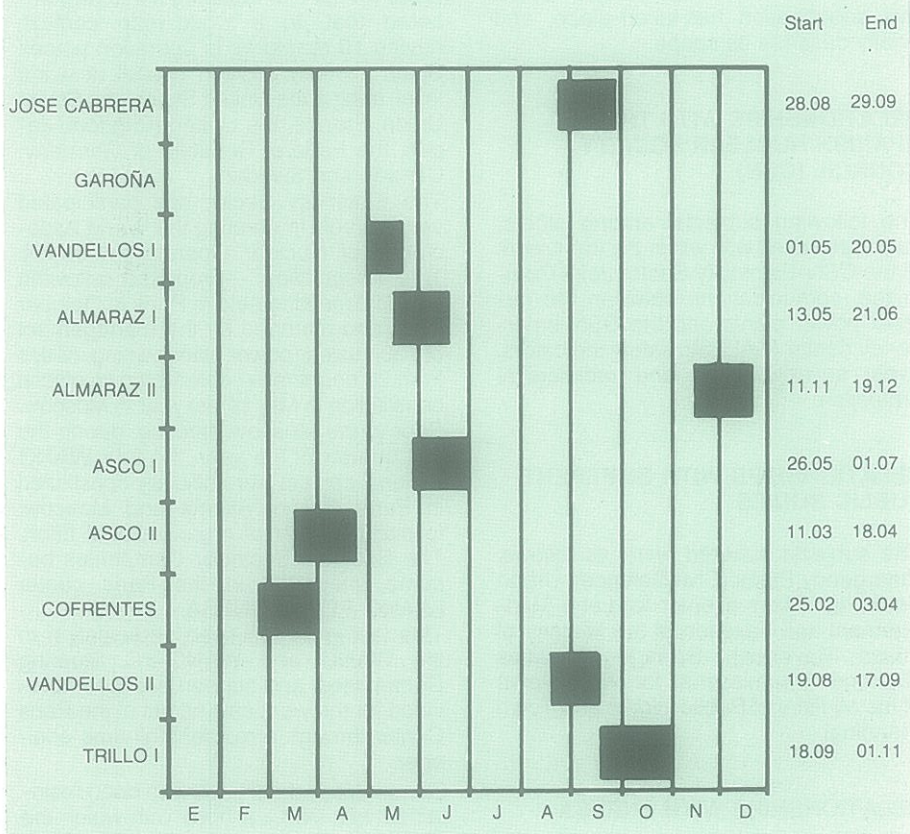
RELOADING AND MAINTENANCE OUTAGES DIAGRAM
(1989)



— The dates of start and end of the outages are those of disconnection and connection to the grid.
— The outage of Vandellós I is for maintenance.

INTERMEDIATE AND LOW-LEVEL RADIOACTIVE WASTES

In reference to the evolution of low-level radioactive waste generation in light water nuclear power plants over the last three years, the following data may be presented: during 1987 the pressurized-water (PWR) plants produced an average 111 m^3 of wastes, the value for 1988 being 136 m^3 (without taking into consideration either Vandellós II or Trillo). In 1989 waste generation amounted to 132 m^3. As regards the boiling water (BWR) plants, the average production in 1987 was 211 m^3, the values for 1988 and 1989 being 222 m^3 and 254 m^3, respectively. These values are low in comparison to the standards for other countries.

NUCLEAR FUEL

The Spanish PWR plants reloaded a total of 345 fuel elements during 1989, the figure for the only BWR plant that had a refuelling outage during the year (Cofrentes) being 200. No authorization was forthcoming during 1989 for the Temporary Fuel Storage (TFS) installation contemplated in the General Radwaste Plan. As a result, both the affected plants and ENRESA have opted for an alternative solution allowing the situation foreseen for 1993 to be delayed and consisting of projecting an increase in the capacity of the current fuel pools by means of more compact fuel racks (re-racking). On 4th September 1989, the Directorate General of Energy of the Ministry of Industry and Energy (MIE) issued a resolution authorizing ENRESA to undertake responsibility for the cost arising as a result of re-racking at the Almaraz and Ascó plants.

COORDINATION WITHIN THE SECTOR

I have no wish to overwhelm you with more figures, and so I shall go on now to comment on the efforts made within the

Electricity Sector in coordinating the nuclear-related activities carried out over the last year, with a view to uniting forces and capacities in nuclear power plant operation.
I shall refer to the main areas in which this coordination has taken place, and briefly describe its scope.

RELATIONSHIPS WITH THE SPANISH NUCLEAR SOCIETY COUNCIL (CSN)

The following subjects, among others, have been dealt with within the framework of the CSN-Electricity Sector Joint Committee: comunications between the nuclear power plants and the CSN emergency center (SALEM), safety indicators, event severity scale and radiological protection.

RELATIONSHIPS WITH DIFFERENT PUBLIC BODIES

The subjects covered were as follows: Emergency Plans (Civil Defence), Urban Territorial Taxes (Center for Land Management and Taxation of the Ministry of Inland Revenue), Spillage Royalties (General Commissariat for Waterworks of the Ministry of Public Works and Town Planning).

RELATIONSHIPS WITH ENRESA

The most significant event during 1989 was approval by the MIE of a Type Contract for waste management and decommissioning of the Spanish nuclear power plants, as per the Resolution published by the DGE on 17th April 1989. This made it possible to formally constitute the Electricity Utilities-ENRESA Paritary Commission, the communications channel between the electricity generating sector and ENRESA for matters relating to radioactive wastes.
Apart from final preparation of the Type Contract and its Appendices, the most important activities carried out during this last year were the removal of waste drums from the José Cabrera and Garoña plants, and these associated with increasing the capacity of the spent fuel pools at Almaraz and Ascó.

RELATIONSHIPS WITH ENUSA

These relationships were established via the above-mentioned Electricity Utilities-ENRESA Paritary Commission. The most important points dealt with during 1989 were those relating to the basic agreement for supply, calculation of nuclear fuel costs and studies of the fuel manufacturing period.

RELATIONSHIPS WITH INTERNATIONAL BODIES AND ASSOCIATIONS

The question of international relations takes on special meaning if it is remembered that, in a world-wide context, having 10 reactores in operation places Spain in ninth position overall at world level, behind the United States, the Soviet Union, France, the United Kingdom, Japan, the Federal Republic of Germany, Canada and Sweden.
The Electricity Sector has participated very actively in creating the World Association of Nuclear Operators (WANO). This Association —proposed following an initial meeting held in Paris in October 1987 and attended by the management of 130 nuclear power plant-owning utilities from 29 countries— celebrated its official constitution in May of last year in Moscow. Prior to the Moscow meeting, during the first quarter of the year, the four WANO regional centers were officially constituted in Paris, Tokyo, Atlanta and Moscow, following a year of organizational effort. The Spanish Electricity Companies became integrated in the Paris center (WANO-PC) via UNESA.
This last year has seen participation in the WANO and WANO-PC Steering Committees, and support has been provided for the work carried out at the Paris Center through a resident full-time engineer.
Close relationships have also been maintained with INPO, a body with which the Electricity Sector has been associated since 1981, a resident engineer being permanently posted at the Institute's offices in Atlanta (United States).
Finally, participation has continued with the UNIPEDE Working Groups, and there has been an increase in collaboration with and participation in various Working Groups, Commissions, etc., belonging to the IAEA, European Community, NEA/OCDE, etc.

RESEARCH AND DEVELOPMENT

The progress achieved during 1989 within the framework of the General Nuclear Research and Development Program of July 1987 has been as forecast, the following projects having been completed: LOCA Simulation Chamber, Integranular Corrosion I and Fusion by Inertia Confinement. A new project, "NET Materials Project", was included in the General Program, in the area of fusion by magnetic confinement.
A draft of the future Materials Research and Development Plan was also drawn up during 1989.
As regards the overall budget of the General Nuclear R&D Program, spending during 1989 amounted to some 800 million pesetas.

COORDINATION BETWEEN NUCLEAR POWER PLANTS

Those aspects which are common to the different Spanish nuclear power plants, and with respect to which coordinated action is possible, are channelled either through UNESA, as I pointed at the beginning of the second part of my intervention, through the PWR and BWR Owners Groups, in the case of matters relating specifically to one plant type or another, or through AMYS, in the case of subjects relating to medicine and radiological protection.
Within the overall field of coordination between plants, the transfer of operating experience stands out as being particularly important, especially with respect to plant events, good operational practices, etc., as does the subsequent assimilation of this experience in the different plants. The criteria on which this transfer of experience is based, both among the Spanish nuclear plants and between our plants and those abroad —especially via our participation in INPO and WANO— are established by the Nuclear Power Plant Directors working group, which operates within the Nuclear Division of UNESA. In this respect use is made of the technical services provided by TECNATOM, which acts as UNESA's executive agent, undertaking responsibility for all tasks relating to the reception and diffusion of information among the Spanish plants and for technical relations between these plants and INPO and WANO.

SPANISH NUCLEAR POWER PLANT DATABASE (DACNE)

In January 1987, UNESA presented a proposal for creation of a Spanish Nuclear Power Plant Database, to be created for the dual purpose of solving problems relating to the need for information by the plants and satisfying the requirements established by the CSN in July 1986. This proposal was approved by the Plenary Meeting of the CSN, as a result of which a specific Commission was set up within UNESA, the DACNE Commission, responsible for the management and design of the database in accordance with the approved prososal.
The engineering tasks were carried out by TECNATOM, development being completed in March 1989. The system was subjected to a five-month test period which ended on 31st July, the operations period then beginning. Information on operational events and component fallures is currently being received and stored.

STANDARDIZATION

Standardization Technical Committee 73, "AENOR Nuclear Industry", was consti-

tuted in October 1988. The Committee is made up of technical personnel from the utilities, the nuclear industry, the Administration and professional associations. The chairman and secretary are from the Electricity Sector and UNESA, respectively. During 1989, its seven sub-committees have been working intensely and have submitted "Considerations" regarding eleven UNE standards to AENOR, as well as presenting drafts for a further four standards to the Technical Committee. Technicians from the different nuclear plants have also participated in the efforts made by the Spanish Nuclear Society in the field of standardization.

EMERGENCY PLANS

Experts in this field from the nuclear plants make up the Emergency Plan Working Sub-Group, which operates within the Nuclear Divison of UNESA. Their main activity during 1989 has been preparation of the following documents, among others:

- Guideline on declaration and reporting of emergencies.
- Comparison between events activating the On-Site Emergency Plan (OSEP) and certain aspects regarding communications between Spanish nuclear powers plants.
- Comparative analysis of the On-Site Emergency Plans of Spanish nuclear power plants.

The aim of this last other similar documents is to attempt to harmonize to the extent possible the On-Site Emergency Plans of our different plants.

QUALITY ASSURANCE

In view of the problems experienced over the last few years in relation to supply of replacement parts, the nuclear plants, via their Quality Assurance organizations, had initiated a joint program of supplier homologation.
The audits included in this program have continued throughout 1989, this year also having seen the first re-evaluations of those suppliers who were homologated more than 3 years ago.
A total of 65 homologated suppliers existed at the end of 1989.

CONCLUSIONS

Coordination of the nuclear-related activities of the Electricity Sector within the framework of UNESA has trodden a long and fruitful path since the creation of the Nuclear Division at the end of 1984. The Nuclear Management Committee, made up of representatives from the top management of the utilities, currently presides over the entire coordination organization, which includes several Working Commissions as well as the Nuclear Division, which is broken down in turn into various Working Sub-Groups. The total number of persons involved in this effort amounts to some 200, including the personnel of the UNESA nuclear departmens, who provide the full-time resources required for performance of the coordination tasks.
However, even recognizing the importance of what has been achieved over the last five years, we are bent on continuosly improving our efforts and on striving towards excellence. The UNESA Nuclear Management Committee is currently carrying out studies with this aim in mind, with a view to achieving an organizational framework allowing the nuclear activities of the Sector to be managed in a tight-knit and jointly responsible manner, in keeping with a common desire to work together under the same guidelines.
Nuclear power is now an essential part of electricity production in Spain, and this obliges us to set ourselves the highest possible targets as regards efficiency and effectiveness, in the interests of whatever Spanish society should decide regarding the future of nuclear energy.