
EMPRESARIOS AGRUPADOS

References – Nuclear Power Plants



EMPRESARIOS AGRUPADOS

COMPANY PROFILE

Empresarios Agrupados (EA) is a leading architect-engineering organisation in Spain with significant international experience, providing a complete range of consulting, project management, engineering and design, procurement, construction management, plant testing, safety assessment, quality assurance, as well as plant operation and maintenance support services to the electric utility industry.

Founded in 1971, EA has a permanent multidisciplinary staff of approximately 1000, 65% of whom are university graduates, involved in engineering projects and services in the electric utility sector.

Serving the electric utility industry is one of EA's primary objectives as an architect-engineering company. In the field of power generation, EA's work includes the design, construction and operation support of nuclear, fossil-fired and hydroelectric power plants and radioactive waste management facilities, as well as the safety assessment, modernisation, backfitting, repowering and life extension of operating plants and facilities.

Services provided by EA in the field of power generation are:

- Feasibility studies
- Site selection and project development studies
- Preparation of Bid Invitation Specifications (BIS) and evaluation of bids
- Project management
- Engineering and design
- Procurement management
- Construction management
- Plant testing and startup
- Plant operation and maintenance
- Quality assurance/quality control

EA has completed the engineering and construction of power plant projects totalling more than 39,000 MWe of power generating capacity worldwide.

EA has provided engineering and consultancy services, and completed projects in Spain and some 35 other countries. The company has been ranked by *Engineering News-Record* among the Top 200 International Design Firms.

With regard to nuclear projects, the company provides consulting and architect-engineering services to nuclear units and electric utilities in Spain and in many other countries (eg, Argentina, Brazil, Bulgaria, Chile, Czech Republic, Italy, Mexico, Russia, Slovak Republic, Taiwan, Turkey, Ukraine, USA, Yugoslavia, etc).

EA's extensive experience in the field of power plant projects covers the following aspects:

- Energy market studies, preliminary and site studies for the development of power plant projects
- Preparation of specifications for invitation to tender (Bid Invitation Specification – BIS), evaluation of tenders and contract negotiation support to the Client
- Project management and organisation of technical teams to undertake engineering projects covering all areas of planning, scheduling, management of resources, economic evaluations, project financing schemes, cost control, etc
- Basic and detail engineering and design for nuclear power plant projects with different reactor types, covering the full range of project engineering and design disciplines (eg, civil-structural, mechanical, electrical, I&C, radwaste treatment, plant layout, piping design, piping stress analysis and support design, radiation protection, nuclear safety, thermal-hydraulic analysis, etc)
- Preparation of project documentation such as technical design criteria, design drawings, equipment specifications, evaluations and follow-up of contracts, safety analysis reports, licensing support documents, etc
- Procurement, construction management and preoperational testing and startup services
- Retrofitting and modernisation, upgrading and repowering of nuclear power plants
- Engineering and O&M support to plants in operation
- Development of in-house computer programs and development of specific applications based on commercial software to perform thermodynamic analyses and simulation of modern power plants

Architect-Engineering Services in Nuclear Projects

A full range of Architect-Engineering services is provided for nuclear power plant projects, as follows:

EA has been the main or sole architect-engineering company responsible for the project management, engineering, design, procurement, construction management, pre-operational testing and startup in six 1000-MWe nuclear units, of both PWR and BWR types, in Spain. EA also provides engineering and support services to all nine nuclear units currently in operation in Spain. EA is currently participating in activities associated with modernisation, upgrading and repowering in practically all the Spanish NPPs.

EA has carried out or actively taken part in projects involving a variety of reactor types: light-water reactors of American and European design (BWR, PWR and Russian VVER); heavy-water reactors (PHWR); gas-cooled graphite reactors (GCR), graphite-moderated boiling-water reactors of Russian design (RBMK), advanced light-water reactors (ABWR, SBWR, ESBWR, AP-600 and EPP, SPWR and preparation of EUR documents) and more recently the Pebble Bed Modular Reactor (PBMR). All these projects have enabled EA to gain extensive knowledge and experience in the integration of the majority of available nuclear and non-nuclear technologies, NSSS from different suppliers, as well as in the application of the associated codes, standards and regulatory requirements.

Recent relevant projects in nuclear power generation include:

- Engineering and design services for Lungmen NPP, Units 1 and 2 (Taiwan), under contract with General Electric (USA). This plant features two Advanced Boiling Water Reactors (ABWR) with an electrical unit rate of 1350 MWe each. Work carried out for GE in this project includes: containment steel liner design, design of the containment fuel pool and auxiliary fuel building pool liner and gate, human factors engineering (HFE) for the plant control system and control room design, suppression pool submerged loads and high-energy line break (HELB) in the secondary containment, feedwater pipe break analysis, steam tunnel pressurisation analysis, large bore piping analysis and support design, small-bore piping design, small-bore piping analysis and support, design verification services, instrument setpoint calculations, preparation of schematic and wiring diagrams, instrument panel installation specifications, procedures for periodic surveillance of equipment, emergency procedures, probabilistic risk analysis for shutdown conditions, alarm system engineering and

procedures, ASME overpressure design reports, airborne radiological condition calculations, etc

- Engineering support services and operation and maintenance support services are provided by EA on a continuous basis to all nine (9) nuclear units operating in Spain, including the complete design of backfitting projects required in plants to cope with technology updates (eg, I&C modernisation), new requirements by licensing authorities, improvements in operation and maintenance, resolving operational problems, etc
- Engineering, design and construction management services for the spent fuel cask storage facilities at the Trillo NPP site (PWR, 1066 MWe, Siemens). This project includes the basic and detail engineering and design of a storage facility for 80 spent fuel casks, and provisions for extension to 128. The engineering and design services cover all activities in the mechanical and electric area, physical safety, shielding and radiological protection of the new building, as well as preparation of the Safety Analysis Report
- EA has participated in all the Probabilistic Safety Analyses (PSAs) performed or currently under way in Spanish nuclear power plants, which include 2 BWR-type reactors, 6 PWR-type American-design reactors, and 1 PWR German-design reactor
- Shutdown Probabilistic Safety Analysis (PSA) for Leibstadt NPP, a 1220 MWe, BWR 6, Mark II containment, nuclear plant in Switzerland
- Containment bubble condenser experimental qualification for VVER-type plants. Carried out under the European Commission's Phare Programme, this project consists in defining and performing two test programmes on a prototype bubble condenser configuration for VVER-type plants in order to assess thermohydraulic and fluid-structure interaction phenomena at Paks NPP (Hungary) and verify the structural integrity of the bubble condenser steel structure of Dukovany NPP (Czech Republic) and Bohunice NPP (Slovakia) during the first moments of a design basis accident (DBA)
- In collaboration with other Spanish companies, EA headed the supply of an engineered equipment package of 30 million USD for Atucha 2 NPP (PHWR, Siemens, 745 MWe) in Argentina. The scope of supply included the following: 10 MWe hydraulic turbine-generator, elevators, fuel pool crane, NSSS and conventional thermal insulation, telephone system, public address system, fire detection system, clock system, paging system and lighting equipment

- Analysis of the nuclear sector in the Argentine Republic to support the Secretariat of Energy and the Ministry of Economy in the elaboration of future strategies for the nuclear-electric sector in this country
- Consultancy services to Eletronuclear in Brazil, to evaluate the technical-economic viability of its Angra 3 NPP (PWR, Siemens, 1300 MWe). Previously EA had evaluated the status of the engineering and construction of its Angra 2 NPP (PWR, Siemens, 1300 MWe) and prepared a budget estimate for the completion of plant construction
- EA led the Probabilistic Safety Analysis (PSA) carried out on Novovoronezh NPP (VVER 440/230 reactor) in Russia, under EC sponsorship
- As member of international consortia, EA participated in the PSA of Balakovo NPP (VVER 1000/380, 1000 MWe) in Ukraine and Kozloduy NPP Units 3 and 4 (VVER 440/230, 440 MWe) in Bulgaria
- As leader of an international consortium, EA supported the engineering company Energoprojekt in Kiev (Ukraine) in the engineering of the VVER 1000 plant. The main objective of this project was the technology transfer required to perform safety calculations and analyses, consisting in engineering support, training, and assistance in the implementation of the QA Programme and Engineering Procedures. This constitutes an extension to a project whose purpose was the establishment of nuclear engineering procedures, QA and the use of codes within Energoprojekt
- Support to Project Management for the Modernisation Programme at Kozloduy NPP Units 5 and 6 (Bulgaria). Project under the sponsorship of the European Commission Phare Programme, whose objective is to assist NEK (the Bulgarian Electricity Board) in the setting up and integrated coordination and running of a Project Management Group to provide the most effective assistance to Kozloduy NPP Units 5 and 6 in the integrated management of the various Modernisation Programme projects
- EA is collaborating with the Spanish Agency for Radwaste Management and Disposal (*ENRESA*) on the selection of sites for final, deep underground disposal of high-level waste in Spain. Spanning 10 years, this project which initially focuses on the entire Spanish territory involves the successive systematic selection of favourable formations, regions, areas and zones (based in turn on geological, hydrological and socio-economic studies), concentrating on progressively smaller areas with an increasingly greater degree of detail

- Dismantling management services for Vandellós Unit 1 NPP: a 500 MWe Gas Cooled Reactor (GCR) of French design in Spain undergoing the decommissioning process
- Engineering and dismantling management services for the decommissioning of the nuclear installations of CIEMAT, a state-owned nuclear research centre in Madrid (Spain)

Advanced Reactors

EA is taking an active part in international projects to develop the future generation of advanced nuclear reactors. For example:

EA is taking part in the drawing up of the European Utility Requirements (EUR) documents for future nuclear power plants, being prepared by a group of leading European utilities.

EA has been collaborating with General Electric on the ABWR, SBWR and ESBWR projects, and with Westinghouse on the AP-600, EPP, AP-1000 and SPWR projects for advanced light water reactors.

Of particular interest as an example of EA's involvement in advanced nuclear power projects, is EA's current work for the Lungmen NPP project as a subcontractor of GE (ABWR, GE, 2 x 1350 MWe, Taiwan), previously described and further detailed in Table IN6-2.

Also worth mentioning is EA's contract with PBMR plc (Eskom/BNFL, South Africa) for the complete structural-mechanical engineering and design of the primary pressure boundary components of the Pebble Bed Modular Reactor (PBMR), as well as for the basic design of the fire protection system for this plant.

BIS Preparation and NPP Bid Evaluation

EA has carried out the preparation of Bid Invitation Specifications (BIS) and the technical and economic bid evaluation as well as supporting the Owner during contract negotiation for a number of nuclear power plants.

Recent work in this area involves the provision of engineering services to Teollisuuden Voima Oy (TVO) of Finland in the preparation of the Bid Invitation Specification (BIS) and in the evaluation of technical proposals for the Olkiluoto Unit 3 nuclear power plant project.

The BIS, which constituted the basis for the call for tenders, was open to all LWR technologies such as PWR, BWR, Russian VVER, as well as to evolutionary- and passive-type reactors.

Of particular interest is the preparation of the BIS for TVO's Olkiluoto 3 in Finland, for the purpose of which was prepared a complete set of Bid Invitation Specifications, including: 1) Instructions to Bidders; 2) Draft Contract (Contract Terms and Conditions); 3) Scope of Supply; 4) Technical Specifications; 5) Project Implementation Requirements (ie, quality assurance, planning and scheduling requirements, procurement process and cost centres, information technology and project database organisation, and project and O&M documentation to be submitted).

The BIS for Olkiluoto 3 provides the possibility of tendering for the full nuclear power plant (NI+TI), for the Nuclear Island (NI) only or for the Turbine Island (TI) only.

Another example of recent work by EA in this area is the engineering services contract completed with the Turkish Electricity Generation & Transmission Corporation (TEAS) to evaluate the technical tenders submitted by three international consortia led by AECL, NPI and Westinghouse, for the turnkey delivery of a complete nuclear power plant (of approximately 1300 MWe) to be built at Akkuyu, on Turkey's Mediterranean coast. The contract also included technical support to TEAS during the contract negotiation period.

Modernisation Projects

One important aspect of our experience is the engineering and implementation of modernisation projects for older NPPs in order to meet current safety standards. Our participation in the José Cabrera NPP (Westinghouse PWR) Systematic Evaluation Programme (SEP) should be noted, as this programme led to significant upgrading and modernisation of the plant, which had started commercial operation in 1968. The experience gained in this project was vital to our participation, among others, in the Seismic Upgrading and Qualification of Safety-Related Systems Programmes of Kozloduy NPP Units 1 & 2 (VVER 440/230) in Bulgaria, the VVER 440/213 reactor type Engineering Safety Evaluation of Dukovany NPP (Czech Republic), Paks (Hungary) and Bohunice (Slovak Republic) and the Safety Evaluation of Confinement of Rovno NPP (VVER 440/213), in Ukraine, funded by the European Commission.

Licensing and Safety

EA has gained broad experience in the licensing and safety of NPPs from its participation in the Spanish nuclear programme and from assisting foreign authorities and organisations in various international cooperation projects. EA has participated directly and in support of Spanish electric utilities, in the complete licensing process of 4 out of 7 nuclear power plants currently in operation in Spain and in two nuclear power projects recently cancelled. In all of them, EA provided Safety

Engineering services, covering all the associated technological areas, including: safety and risk assessment, environmental studies, reliability/availability studies, preparation of procedures and development of computer tools required for support in emergency situations.

EA has also performed studies and projects for different official organisations in Spain (Nuclear Safety Council (CSN), National Agency for Radwaste Management and Disposal (ENRESA), etc) and abroad (EEC, IAEA, etc). EA has collaborated with different Spanish professional associations and official organisations in the establishment of environmental and safety standards, and has participated in committees to comment and review Spanish environmental and safety legislation, such as the Spanish Basic Nuclear Emergency Plan and its different sector plans.

Radwaste Management and Disposal

EA has also been active in the area of radwaste treatment, conditioning, management and disposal facilities, both for low- and high-level radioactive waste, and located on the NPP site or at a centralised facility outside the plant.

EA has been responsible for the engineering of a centralised temporary spent fuel storage facility in Spain, using both wet and dry storage technologies. We are presently involved in a long-term project to select candidate sites for and design a deep underground high-level waste repository.

In the area of interim spent fuel storage in Spain and abroad, we have taken part in projects for dry-cask and wet or vault storage, as well as in the selection of technologies. As indicated above, we have recently completed the design and construction management of a spent fuel storage facility at Trillo NPP (PWR, 1066 MWe, Siemens) using dual purpose metal casks.

Preliminary studies on decommissioning Spanish NPPs were also recently carried out by our organisation, as well as a Phare-funded project for the decommissioning of Bohunice A1 NPP, in consortium with two other European companies.

Finally, EA, in consortium with other European companies, has recently been awarded by the European Bank for Reconstruction and Development (EBRD, London) a contract for the management of the decommissioning project for Bohunice NPP Units 1 and 2 (VVER, Slovakia).

Other radwaste treatment and storage projects have been awarded to EA within the framework of the European Commission's Phare Programme, for institutional wastes as well as for NPP wastes.

CIS and Central East European Countries

EA maintains a strong presence in the CIS and in Central and East European countries through projects carried out directly under contract with electric utilities, through bilateral funding from Spain, or within the framework of the European Commission's Phare and Tacis Programmes. EA is currently providing engineering services related to VVER (440/230, 440/213 and 1000) and RBMK nuclear power plants, radwaste storage facilities and fossil-fired power plants. EA is carrying out activities in Bulgaria, Czech Republic, Lithuania, Hungary, Poland, Romania, Russia, Slovakia and Ukraine.

IAEA Projects

EA has been collaborating for many years with the International Atomic Energy Agency (IAEA) in Vienna in numerous international missions. Recently, EA has been involved in the IAEA's Programmes for Safety Review of NPPs of the VVER 440/230, 440/213 and 1000 type and RBMK type, providing experts for various missions to Bulgaria (Kozloduy NPP), Czech Republic (Temelin NPP and Dukovany NPP), Russia (Kola NPP and Smolensk NPP), Ukraine (Rovno NPP and Zaporozhye NPP), Slovakia (Bohunice NPP) and Cuba (Juragua NPP). EA has also participated in IAEA-organised seminars, workshops and courses on specific VVER topics such as *NPP Project Organisation and Management, Bidding Process for NPP, Quality Assurance, Probabilistic Safety Analysis, Training, Waste Management, Seismic Studies on Site and Equipment, Safety System Analysis, Maintenance, Fire Protection, Safety Assessment*, etc.

Nuclear R&D Projects

EA is actively participating in the engineering and design aspects of international R&D projects in the nuclear field. For example, in the European Union Euratom's programmes for fission and fusion technologies (5th and 6th EU Framework Programmes), EA is carrying out a wide variety of engineering and design work for several key projects, such as: HTR, devoted to the development of High Temperature Reactor technology; ADS, focusing on the development of the Accelerator Driven System (ADS) for high-level waste transmutation (actinide transmutation); ATHERMIP, large containment penetrations behaviour under severe accident conditions; EVITA, thermo-hydraulic code validation; and THINCAT, post-accident hydrogen control systems.

Fusion Technology

EA has been working in the development of fusion technology for the last 10 years, carrying out a wide variety of engineering and design activities for the International Thermonuclear Experimental

Reactor (ITER) project. EA forms part of EFET (European Fusion Engineering and Technology), an economic interest grouping of the main nuclear system companies in six European countries, created to develop the overall engineering and design of the ITER project and of any other major fusion devices. Areas of EA participation include plant layout, balance of plant systems and equipment design, electrical system design, remote handling systems, radioactive waste treatment, etc.

Environmental Protection

One of the areas of EA's work covers environmental protection projects and the processing of solid, liquid and gaseous effluents associated with the construction and operation of nuclear and fossil-fired power plants in which the Company has participated as the main architect-engineer or as member of international consortia. In most power plant projects, EA has prepared environmental and safety assessment reports and has been responsible for the design of the corresponding environmental protection and nuclear safety systems.

Quality System Certification

EA holds the ISO-9001 quality certificate, awarded by AENOR (Certification Agency in Spain) which is a member of EQNet, the European Network for Quality Systems Assessment and Certification. This certificate endorses EA's quality system and recognises our longstanding commitment to quality engineering and services.

EA also works to the following quality standards for nuclear projects:

- US 10 CFR 50, Appendix B
- ASME NQA-1
- IAEA 50-C-QA

An Independent Company

It should be mentioned that, as an independent consulting and engineering organisation, the engineering services EA provides are not dependent upon any specific supplier or equipment vendor. Therefore, the management decisions and technical solutions it recommends are optimal and based on the best technology available in the industry, without being tied to any specific product and/or design.

EMPRESARIOS AGRUPADOS' REFERENCES IN NUCLEAR PROJECTS

The scope of engineering activities performed for nuclear power plant projects in Spain and foreign countries are summarised in the accompanying tables, which are listed below:

- **Summary of EA's Main Power Plant Project Experience as a Full-Scope Architect-Engineering Company**
(EA's overall experience in power plant projects)

- **Nuclear Power Plants**
 - IN1 EA References in Bidding Process Activities for Nuclear Power Plants
 - IN2 EA References in Nuclear Power Plant Projects in Spain
 - IN3 EA References in Nuclear Power Plant Projects in Western Countries Other than Spain
 - IN4 EA References in the CIS and in Eastern and Central Europe
 - IN5-1 EA Main References in PWR NPPs
 - IN5-2 EA Main References in BWR NPPs

- **Radioactive Waste Management, Decontamination and Decommissioning**
 - IN6 EA References in Radioactive Waste Management, Decontamination and Decommissioning

- **Licensing and Safety**
 - IZ1 EA References in Probabilistic Safety Analyses
 - IZ2 EA References in Radiation Protection

**SUMMARY OF EA MAIN POWER PLANT PROJECT EXPERIENCE
AS A FULL-SCOPE ARCHITECT-ENGINEERING COMPANY**

EA's SCOPE OF SUPPLY:

**Engineering and Design (all) + Procurement (some) +
Construction Management (some) +
+ Preoperational Testing & Commissioning (some)
+ EPC Turnkey Contract (some)**

• Combined Cycle Power Plants:	53 units	-	22,366 MWe
• Coal and/or Oil-Fired Power Plants:	27 units	-	8,380 MWe
• Nuclear Power Plants:	8 units	-	8,717 MWe
• Hydroelectric Power Plants:	2 units	-	250 MWe
	90 Units	Total	39,713 MWe

Table IN1 - Empresarios Agrupados' References in Bidding Process Activities for Nuclear Power Plants (1/2)

Nuclear Facility (Country)	Type/ Capacity MWe	Name of Bidders	Bidder Selected	Commercial Operation Start	Type of Activity				
					1	2	3	4	5
Temelín 3 and 4 (Czech Republic) (Bid Invitation Specifications)	PWR 2 x 1000 to 1700	TBD	--	2018	◆				
New NPP at Beznau Site (Switzerland) (Feasibility Study)	LWR 1000 to 1700	TBD	--	2019	◆	◆			
New NPP (Lithuania)	TBD	TBD	--	TBD					◆
Next NPP (Czech Republic) (Feasibility Study)	PWR 2 x 1000 to 1700	Westinghouse, Atomstroyexport, AREVA	--	2018	◆	◆		◆	◆
Olkiluoto 3 NPP (TVO - Finland)	LWR/1000-1600	AREVA General Electric, ASE	AREVA	2012	◆	◆			
Akkuyu NPP (TEAS - Turkey)	--	AECL, NPI, W	--	Cancelled after completion of preliminary evaluation		◆		◆	◆
Next NPP (Czech and Slovak Republics)	LWR/1000-1400	<i>Already-licensed design:</i> W, ABB-CE, Siemens NPI, Framatome NPI, Mitsubishi, Atomenergoexport <i>Advanced reactor design:</i> W: AP-600 Mitsubishi: APWR		Cancelled after completion of preliminary evaluation	◆	◆			◆
Valdecaballeros 1 & 2 (Spain)	BWR/2x975	General Electric	General Electric	Construction at 60% Plant cancelled	◆	◆	◆	◆	
Trillo 1 (Spain)	PWR/1066	Siemens, Westinghouse, General Electric, Babcock & Wilcox	Siemens	1988	◆	◆	◆	◆	
Trillo 2 (Spain)	PWR/1040	Siemens	Siemens	Plant deferred after award of contract	◆	◆	◆	◆	
Regodola (Spain)	PWR/1040	Siemens, Westinghouse, General Electric, Framatome	Siemens	Plant deferred after submittal of PSAR	◆	◆	◆	◆	
Santillán (Spain)	PWR/1000	Westinghouse, General Electric, Siemens, Combustion Engineering	Westinghouse	Plant cancelled after submittal of PSAR	◆	◆	◆	◆	
Aragón (Spain)	LWR/1000	Westinghouse General Electric		Cancelled before final selection	◆	◆	◆		
Sayago (Spain)	LWR/1000	Siemens, Westinghouse, General Electric, Combustion Engineering	--	Cancelled before final selection	◆	◆			
Tarifa (Spain)	LWR/1000	Westinghouse General Electric		Cancelled before final selection	◆	◆	◆	◆	
Prevlaka (Yugoslavia)	LWR & HWR	Westinghouse General Electric Combustion Engineering Siemens		Cancelled after commencement of bid evaluation	◆	◆ ^a			
Interim Spent Fuel Storage Dukovany (Czech Republic)		NAC, GEC Alsthom, Skoda, GNS/Nukem	GNS/Nukem	1996	◆	◆	◆	◆	◆
I&C System Replacement Temelín (Czech Republic)	VVER/2x981	ABB Westinghouse	Westinghouse	Under construction		◆		◆	

**Table IN1 - Empresarios Agrupados' References in
Bidding Process Activities for Nuclear Power Plants (2/2)**

Nuclear Facility (Country)	Type/ Capacity MWe	Name of Bidders	Bidder Selected	Commercial Operation Start	Type of Activity					
Condenser Modernisation Dukovany (Czech Republic)	VVER/4x440	--	--	--	◆	◆	◆			
IAEA regional training courses (various countries)	--	--	--	--						◆

Key to Type of Activity Performed

1. Preparation of Bid Invitation Specification (BIS) or preparation of Request for Information Package (RFI) for feasibility studies
2. Technical evaluation of bids or information packages from Vendors, as applicable
3. Economic and financial evaluation of bids or information packages from Vendors, as applicable
4. Support to utility during information package evaluation, bid evaluation and contract negotiations (where applicable)
5. Training in bidding process activities

Abbreviations

BWR	Boiling Water Reactor
HWR	Heavy Water Reactor
LWR	Light Water Reactor
PWR	Pressurised Water Reactor
PSAR	Probabilistic Safety Analysis Report
SAR	Safety Analysis Report
VVER	Pressurised Water Reactor (Russian design)

**Table IN2
Empresarios Agrupados' References in Nuclear Power Plant Projects in Spain**

Project (Country: Spain)	Type/Manufacturer/ Capacity (MWe)	Type of Work Performed														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Almaraz 1	PWR / W / 1035	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Almaraz 2	PWR / W / 1045	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Ascó 1	PWR / W / 1032			◆				◆	◆		◆		◆			◆
Ascó 2	PWR / W / 1027			◆				◆	◆		◆		◆	◆		◆
José Cabrera	PWR / W / 160			◆	◆			◆	◆	◆	◆	◆	◆	◆	◆	◆
Cofrentes	BWR / GE / 1095	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Santa María Garoña	BWR / GE / 466			◆				◆		◆	◆		◆	◆		◆
Trillo 1	PWR / Siemens / 1066	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Trillo 2	PWR / Siemens / 1040	◆	◆	◆												◆
Valdecaballeros 1 & 2	BWR / GE / 2x975	◆	◆	◆	◆			◆	◆						◆	
Vandellós 1	GCR-France / 500															◆
Vandellós 2	PWR / W / 1087			◆	◆			◆	◆	◆	◆	◆	◆	◆	◆	◆
Aragón	1000	◆														
Regodola	1040	◆		◆												◆
Sayago	1000	◆														
Santillán	1000	◆														
Tarifa	1000	◆														
Spanish Nuclear Safety Council							◆	◆	◆			◆		◆	◆	◆
UNESA (Consortium of Spanish Nuclear Utilities)																◆
CIEMAT (Research Centre for Energy, Environment & Technology)																◆

Key to Type of Work Performed

1. Feasibility Studies and Project Planning:
 - Preliminary Project Studies
 - Site selection studies
 - Preparation of NPP Bid Invitation Specifications (BIS)
 - Organisation of NPP bidding process, and technical and economic bid evaluation
 - Preparation, negotiation and financial evaluation of contracts
 - Environmental impact studies and reports
2. Project Management
3. Project Engineering and Design: Preparation of design criteria, specifications, drawings, calculations, analyses, reports, etc, in all project disciplines (ie, mechanical, electrical, I&C, civil, safety, radiation protection, HVAC, fire protection, radwaste system, chemistry, etc)
4. Procurement and Suppliers' Inspection:
 - Evaluation of tenders
 - Purchasing and expediting
 - Suppliers' inspection and QA/QC supervision
 - Transport of heavy equipment
5. Construction and Erection Management
6. Plant Commissioning:
 - Preoperational testing and plant startup
 - Preparation of testing, preoperating and operating procedures
7. Safety and Accident Analysis/Safety Review:
 - Thermohydraulic analysis
 - Probabilistic Safety Analysis (PSA)
8. Radiation Protection
9. Plant Life Extension Programmes
10. Plant Modification Projects and Power Upgrading
11. Maintenance Programmes:
 - Maintenance procedures
 - Spare parts and dedication programmes
 - Computerised maintenance systems
12. Plant Operation Support:
 - Engineering support to operation
 - Refuelling outages
 - Health physics
 - Equipment and system diagrams
13. Quality Assurance Programmes and Procedures
14. Training
15. Licensing:
 - Codes and standards
 - Safety analysis reports (preparation and updating)
 - Technical specifications of the plant
 - Safety assessment
 - Design basis reconstitution
 - Licensing basis reconstitution

**Table IN3
Empresarios Agrupados' References in Nuclear Power Plant Projects in
Western Countries Other than Spain**

Project (Country)	Type/Main Supplier/ Capacity (MWe)	Type of Work Performed												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Temelín 3 & 4 (Czech Republic)	PWR/ TBD /2X1000 to 1700	◆												
New NPP at Beznau (Switzerland)	LWR/TBD/1000 to 1700	◆												
Lungmen 1 & 2 (Taiwan)	ABWR / GE / 2x1350		◆							◆				
GE ESBWR	BWR / GE / 1500	◆	◆					◆	◆					◆
W/AP-1000 (USA)	PWR/ W / 1000	◆	◆					◆	◆					◆
JHR Project-CEA Centre de Cadarache (France)	Research reactor 110 MWth							◆						
PBMR Project (South Africa)	PBMR/ESKOM/Demo		◆											
Olkiluoto 3 NPP (Finland)	TBD/TBD / 1000-1600	◆												
Akkuyu (Turkey)	- / 1300	◆												
KEDO (North Korea)	LWR/1000	◆												
GE ABWR (USA)	BWR / GE / 1350		◆								◆			
EUR Project (Europe)	--	◆	◆											
GE SBWR (USA)	BWR / GE / 600		◆					◆		◆				◆
W EPP (USA)	PWR / W / 1000		◆					◆						
W Advanced PWR AP-600	PWR / W / 600		◆					◆		◆				◆
Angra 1 & 2 (Brazil)	PWR / W(1) – Siemens (2) / 657/1300	◆			◆	◆(2)		◆			◆			
Angra 3 (Brazil)	PWR / Siemens / 1300	◆												
Atucha 1 (Argentina)	PHWR / Siemens / 350													◆
Atucha 2 (Argentina)	PHWR / Siemens / 745		◆	◆										
Laguna Verde 1 & 2 (Mexico)	BWR / GE / 2x654		◆			◆					◆	◆	◆	
NPP No. 2 (Mexico)	BWR / GE / 970	◆												
Alto Lazio (Italy)	BWR / GE / 2x1010		◆											
Trino Vercellese 1 & 2 (Italy)	PWR / W / 2x960		◆						◆					
Progetto Unificato (Italy)	PWR / 1200		◆											
PEC Project (Italy)	Reactor Research Centre		◆											
Sinop (Turkey)	-	◆												
GE Reference Turbine Island (USA)	BWR / GE / 1260		◆											
GE Reference Turbine Island (USA)	PWR / W / 1260		◆											
Comanche Peak 1 & 2 (USA)	PWR / W / 2x1150		◆											

Key to Type of Work Performed

1. Feasibility Studies and Project Planning:
 - Preliminary Project Studies
 - Site selection studies
 - Preparation of NPP Bid Invitation Specifications (BIS)
 - Organisation of NPP bidding process, and technical and economic bid evaluation
 - Preparation, negotiation and financial evaluation of contracts
 - Environmental impact studies and reports
2. Project Engineering and Design:

Preparation of design criteria, specifications, drawings, calculations, analyses, reports, etc, in all project disciplines (ie, mechanical, electrical, I&C, civil, safety, radiation protection, HVAC, fire protection, radwaste system, chemistry, etc)
3. Procurement and Suppliers' Inspection:
 - Evaluation of tenders
 - Purchasing and expediting
 - Suppliers' inspection and QA/QC supervision
 - Transport of heavy equipment
4. Construction and Erection Management and Services
5. Plant Commissioning:
 - Preoperational testing and plant startup
 - Preparation of test /preoperating and operating procedures
6. Safety and Accident Analyses:
 - Thermohydraulic analysis
 - Probabilistic Safety Analysis (PSA)
7. Radiation Protection
8. Plant modification projects and backfitting implementation
9. Human Factors Engineering (HFE), Human-Machine Interface (HMI):
 - Functional design, allocation of functions, operator task analysis
 - Design of displays
10. Plant Operation Support:
 - Engineering support to operation
 - Refuelling outages
 - Health physics
 - Equipment and system diagrams
11. Quality Assurance Programmes and Procedures
12. Training
13. Licensing:
 - Codes and standards
 - Safety analysis reports
 - Technical specifications of the plant
 - Safety assessment

Abbreviations:

ABWR:	Advanced Boiling Water Reactor
BWR:	Boiling Water Reactor
ESKOM	South-African Electric Utility
GE:	General Electric
KEDO:	Korean Peninsula Energy Development Organisation
LWR:	Light Water Reactor
PBMR:	Pebble Bed Modular Reactor
PHWR:	Pressurised Heavy Water Reactor
PWR:	Pressurised Water Reactor
SBWR:	Simplified Boiling Water Reactor
W:	Westinghouse

**Table IN4 (1/5)
Empresarios Agrupados' References in CIS, Eastern and Central Europe and Cuba**

Country/Plant/ Beneficiary	Plant/Reactor Type/Facility	Programme/Contractor Project No.	Project Title
Armenia			
Medsamor NPP	VVER 440/230	• Tacis	• Leak Before Break
Bulgaria			
Kozloduy NPP	VVER 440/230	• Phare 91-SMWP Item D • Phare 91-SMWP Item E • Phare 91-SMWP Item HB • Phare ZZ-9217-01-04 • Phare BG-9512-02-01 • Phare BG-9512-02-03	• Qualification of Confinement • Qualification of Safety-Related Equipment under Accident Conditions • Seismic Upgrading • PSA for Units 3 and 4 at Kozloduy NPP • Seismic Upgrading Kozloduy 1 to 4 • Prototype Test of Safety-Related Equipment under Accident Conditions
	VVER 1000	• KNP • Phare BG-9512-04-01	• Jet Vortex Condenser Analysis • Project Management Support for Kozloduy NPP Units 5 & 6 Modernisation Programme
Committee of Energy	Institutional and Residential Buildings	• Phare BG-9307-01-05	• Demonstration Project on Energy Management
Ministry of Environment	Laboratory	• Phare 92	• Supply of Radiation Monitoring Equipment
SERAW	Novi Han Repository	• Phare BG-632.01.01.01	• Design of Waste Processing and Storage Facilities, and Safety Analysis
SERAW	National Disposal Facility for Low and Intermediate Level Radwaste	• EBRD Project No 17.149	• Project Management Unit for the Site Selection, Licensing, Design and Construction of the Facility (PMU Leader)
Central, East European and CIS Countries			
All VVER NPPs	All VVER	• Tacis 91-6.2	• Analysis of Western VVER Safety Projects Documentation
Paks/Dukovany/Bohunice 3 & 4	VVER 440/213	• Phare 92- 4.2.8 • Phare 2.06/95	• Bubble Condenser Qualification Feasibility • Monitoring Ageing of Electrical Cables in Containment
All Countries	All Reactors	• DG-XI (EC)	• Survey of European Leak-Before-Break Procedures and Requirements Related to the Structural Integrity of NPP Components
	Offsite Facilities	• Phare PH REG 6.04/97	• Training on Offsite Emergency Management in Central and Eastern Europe

**Table IN4 (2/5)
Empresarios Agrupados' References in CIS, Eastern and Central Europe and Cuba**

Czech Republic			
Country/Plant/ Beneficiary	Plant/Reactor Type/Facility	Programme/Contractor Project No.	Project Title
Temelin NPP (U1&2)	VVER 1000	<ul style="list-style-type: none"> • Phare 90/ENE 16 • 3E Praha Engineering 	<ul style="list-style-type: none"> • Basic Engineering for I&C System Replacement • Training and Support in Use of PRAC Cable Routing Program
Temelin NPP (U3&4)	PWR, Supplier tbd	<ul style="list-style-type: none"> • CEZ 	<ul style="list-style-type: none"> • Preparation of RFI Document • Preparation of Feasibility Study • Preparation of Complete BIS
Dukovany NPP	Interim Spent Fuel Storage Facility	<ul style="list-style-type: none"> • CEZ 	<ul style="list-style-type: none"> • Preparation of Bid Invitation Specifications • Evaluation and Technical Assistance for Bidding and Contracting Process
Dukovany NPP	VVER 440/213	<ul style="list-style-type: none"> • CEZ 	<ul style="list-style-type: none"> • Consultancy Services for Modernisation of Condenser
All NPPs	VVER 440/213 & 1000	<ul style="list-style-type: none"> • CEZ 	<ul style="list-style-type: none"> • Consultancy on Preliminary Bid Evaluation for the Centralised Spent Fuel Storage Facility <ol style="list-style-type: none"> 1. Public information centre 2. Site selection criteria 3. Tendering process and bid evaluation 4. Environmental assessment
Slovak Republic			
Bohunice 1 & 2 NPP (V1)	VVER 440/230	<ul style="list-style-type: none"> • Phare NS 91/01 	<ul style="list-style-type: none"> • Confinement and ECCS Analysis
Bohunice A1 NPP	Gas-cooled (HW moderated)	<ul style="list-style-type: none"> • Phare 4.05/94 	<ul style="list-style-type: none"> • Reactor Radiological Safety (Pre-decommissioning)
Bohunice 1 & 2 NPP (V1)	VVER 440/230	<ul style="list-style-type: none"> • EBRD 	<ul style="list-style-type: none"> • Project Management for Plant Decommissioning – PMU
Czech and Slovak Republics			
VVER plants	All VVER	<ul style="list-style-type: none"> • Phare 	<ul style="list-style-type: none"> • Terms of Reference for various I&C projects
Dukovany and Bohunice 3 & 4 NPPs	VVER 440/213	<ul style="list-style-type: none"> • Phare 4.2.9/92 • Phare 4.2.3/93 	<ul style="list-style-type: none"> • Engineering Safety Evaluation • Qualification of Leak Detection System
Hungary			
All NPPs	VVER 440/213	<ul style="list-style-type: none"> • Phare & Tacis 95-2.13 	<ul style="list-style-type: none"> • Bubble Condenser Experimental Qualification
Lithuania			
Ignalina NPP	RBMK	<ul style="list-style-type: none"> • Tacis 	<ul style="list-style-type: none"> • Human Factors • PSA (mainly focused on a pilot study for Smolensk 3 NPP)

**Table IN4 (3/5)
Empresarios Agrupados' References in CIS, Eastern and Central Europe and Cuba**

Country/Plant/ Beneficiary	Plant/Reactor Type/Facility	Programme/Contractor Project No.	Project Title
Poland			
Ministry of Environmental Protection	All industrial facilities	• Phare	• Mitigation of Environmental Threats Study. Master Plan
National Atomic Energy Agency	LLW/ILW Repository	• Phare 4.0.7/94	• Closing of the Rozan Repository
Romania			
CEEC	Cogeneration Plants	• Phare Multicountry Programme	• Promotion of Small Scale Cogeneration Solutions in CEEC
Russia			
Novovoronezh and Kola NPPs	VVER 440/230	<ul style="list-style-type: none"> • Tacis 91-1.4 • Tacis 91-1.5 • Tacis 91-1.7 • Tacis 91-1.8 • Tacis 91-1.9 • Tacis 91-1.10 • Tacis 91-1.14 	<ul style="list-style-type: none"> • Probabilistic Safety Analysis • Modernisation of VVER 440 • VVER Simulator • Training Procedures and Material • Operating Procedures • Confinement • Residual Lifetime Evaluation
Novovoronezh and Kola NPPs	VVER 440/230	<ul style="list-style-type: none"> • NSA (EBRD) • Tacis R2.04/96 • Tacis R2.02/96 	<ul style="list-style-type: none"> • Project Management Unit • Guideline Documents for Residual Lifetime Assessment of NPP Mechanical Components (Except RPV) • Emergency Protection Signal Effectiveness Evaluation for VVER 230
All VVER NPPs	VVER 440 & 1000	<ul style="list-style-type: none"> • Tacis 91-3.1 • Tacis 91-3.2 • Tacis R2.03/96 	<ul style="list-style-type: none"> • PSA Support Data • Quality Assurance • Quality Assurance System Finalisation and Implementation on NPP Site
Future NPPs in Europe and Russia	VVER 1000, RBMK & FBR	• DG-XI (EC)	• Joint EC-Russian Federation Analysis of Nuclear Challenges and Solutions for the Next Generation of NPPs
All Reactors	VVER and RBMK	• Tacis R2.07/96	• Classification and Qualification of Actuators and I&C
Kalinin NPP	VVER 1000	• Tacis R1.03/92	<ul style="list-style-type: none"> • On-Site Assistance Programme • Deputy Manager Position for this Programme • Erosion-Corrosion Programme

**Table IN4 (4/5)
Empresarios Agrupados' References in CIS, Eastern and Central Europe and Cuba**

Country/Plant/ Beneficiary	Plant/Reactor Type/Facility	Programme/Contractor Project No.	Project Title
Russia (Cont)			
Smolensk 3, Sosnovy Bor 1 and Kursk NPPs	RBMK	• Tacis (EC)	<ul style="list-style-type: none"> • Human Factors • PSA (mainly focused on a pilot study for Smolensk 3 NPP) • Quality Systems • Flooding and Explosions • Code Validation and Verification • Configuration and Evaluation of Safety Systems • Fire Protection
All VVER NPPs	All VVERs	<ul style="list-style-type: none"> • Tacis R2.10/92 • Tacis R2.02/93 	<ul style="list-style-type: none"> • Russian Documentation Analysis • Upgrade of a Service Maintenance Centre for Diagnostic System
Rostovenergo	Fossil-Fired Power Plants	• Tacis (EC)	<ul style="list-style-type: none"> • Improvement of Power Supply Security and Raising of Fossil-Fired Power Plant Efficiency
Russian Institutions and Companies	All types	• BISTRO (EC)	<ul style="list-style-type: none"> • Training of experts in classification, qualification and certification of I&C and electrical equipment for nuclear power plants
All NPPs in Russia	All VVER	• Phare-EC/90/ENE/17	<ul style="list-style-type: none"> • Upgrading of Management Knowledge in the Field of Nuclear Power Technology Use
Ukraine			
Rovno NPP	VVER 440/213 & 1000	• Tacis (EC)	<ul style="list-style-type: none"> • Safety Evaluation of confinement and site conditions for VVER 440/213 • Safety Evaluation of confinement and site conditions for VVER 1000
Energatom	All VVERs	• UK DTI	<ul style="list-style-type: none"> • Configuration Management and Safety Assurance
Rovno 4 and Khmelnytski 2 NPPs	VVER 1000	• Tacis (EC)	<ul style="list-style-type: none"> • Plant Completion and Design Upgrading
South Ukraine NPP	VVER 1000	• Tacis U1.02/92	<ul style="list-style-type: none"> • On-Site Assistance Programme: <ol style="list-style-type: none"> 1. Feasibility Study for I&C Modernisation 2. Documentation Management Plan
Zaporozhye NPP	VVER 1000	<ul style="list-style-type: none"> • Tacis U1.02/96B • Tacis 94B-1.03 	<ul style="list-style-type: none"> • Review of Normal and Emergency Operating Procedures • On-Site Assistance Programme. Tender Evaluation for Hydrogen Monitors
All VVER NPPs	All VVERs	• Tacis 93B-2.01	<ul style="list-style-type: none"> • Engineering Procedures, QA and use of Codes at Energoprojekt - Kiev
Energoprojekt (Kiev)	VVER 1000	<ul style="list-style-type: none"> • Tacis U2.01/94A • Tacis U2.01/94B 	<ul style="list-style-type: none"> • Engineering for VVER 1000 (Part 1) • Engineering for VVER 1000 (Part 2)
Minchernoobl	All reactors and industrial radwaste	• Tacis 93-4.02	<ul style="list-style-type: none"> • Scheme for Safe Management of Radioactive Waste in Ukraine

Table IN4 (5/5)
Empresarios Agrupados' References in CIS, Eastern and Central Europe and Cuba

Country/Plant/ Beneficiary	Plant/Reactor Type/Facility	Programme/Contractor Project No.	Project Title
Ukraine (Cont)			
Chernobyl	RBMK	<ul style="list-style-type: none"> • EBRD-C11126 • EBRD-C12367 	<ul style="list-style-type: none"> • SIP. Licensing Consultant Evaluation • SIP. PMU Management Audit
Burshtyn Thermal Power Station	Coal-fired (12'200 MW)	• Tacis 91-WW91.03/04.01/ B012	• Plan to Increase Availability, Reliability and Ecological Safety of the Plant
Minenergo	Energy Sector	<ul style="list-style-type: none"> • Tacis (EC) • Tacis EUK-9502 	<ul style="list-style-type: none"> • Project Identification Mission • Transfer of Know-How in Economic Analysis of Modern Combustion Technologies
Cuba			
Juragua NPP	VVER 440/318B	• Atomenergoexport (USSR)	• Seismic Qualification of HVAC Equipment

Note: In some of the above references, Empresarios Agrupados acted as subcontractor or as member of a consortium

Key:

SMWP: Six-Month WANO Project
 CEZ: Ceske Energeticke Zavody
 NSA: Nuclear Safety Account
 EBRD: European Bank for Reconstruction and Development

**Table IN5-1 (1/2)
Empresarios Agrupados' Main References in PWR NPPs**

Project/ Reactor Type, Manufacturer / Capacity / Country	Work Performed
José Cabrera / PWR, W / 160 MWe / Spain	<p>Engineering and design as subcontractor to the turnkey contractor (Westinghouse) for the original project</p> <p>Systematic Evaluation Programme (SEP) to bring plant design up to date with regulatory requirements</p> <p>Engineering support to the plant, including plant design modifications, systems upgrading and optimisation, evaluation of operating experience, general technical support, etc</p> <p>Licensing support: FSAR updating. Support to the Owner before the Regulatory Authorities (CSN)</p> <p>Refuelling outage support</p> <p>Preparation and optimisation of Plant Technical Specifications</p> <p>I&C upgrading and human factors engineering</p> <p>Participation in the PSA</p>
Almaraz 1&2 / PWR, W / 974 MWe (Unit 1) & 982 MWe (Unit 2) / Spain	<p>Main Architect-Engineer for the complete project (See EA References in NPP Projects in Spain, Table IN1)</p> <p>Engineering support to the plant, including plant design modifications, systems upgrading and optimisation, evaluation of operating experience, general technical support, etc</p> <p>Power up-rating engineering</p> <p>Preparation and updating of safety & accident analysis reports. Participation in the PSA</p> <p>Severe Accidents programme: preparation of guides</p> <p>Licensing support: FSAR updating. Relationships with Regulatory Body</p> <p>Refuelling outage support</p> <p>Plant life extension programme</p> <p>I&C upgrading by implementing a DC system</p> <p>Configuration management services</p> <p>Steam generator replacement</p> <p>Design of essential service water spray pond system</p> <p>Snubber reduction programme</p> <p>Individual Plant Examination for External Events (IPEEE)</p>
Trillo 1 / PWR, Siemens / 1066 MWe / Spain	<p>Main Architect-Engineer for the complete project (See EA References in NPP Projects in Spain, Table IN1)</p> <p>Engineering support to the plant, including plant design modifications, systems upgrading and optimisation, evaluation of operating experience, general technical support, etc</p> <p>Preparation and updating of safety & accident analysis reports. Participation in the PSA</p> <p>Severe Accidents programme: secondary side feed and bleed</p> <p>Licensing support: FSAR updating. Support to the Owner before the Regulatory Body</p> <p>Preparation and optimisation of Plant Technical Specifications</p> <p>Refuelling outage support</p> <p>Plant life extension programme</p> <p>Configuration management services</p> <p>Feedwater piping fatigue analysis</p> <p>Pressuriser head replacement</p> <p>Improvement of offsite power supply system</p>

**Table IN5-1 (2/2)
Empresarios Agrupados' Main References in PWR NPPs**

Project/ Reactor Type, Manufacturer / Capacity / Country	Work Performed
Ascó 1&2 / PWR, W / 1027 MWe (Unit 1) & 1028 MWe (Unit 2) / Spain	Engineering support to plant operation and maintenance PSA Level 1 and 2 Backfitting of condenser circulating water system with a new, wet type, natural draft cooling tower Design and construction supervision of the steam generator storage building and waste treatment plant during the steam generator replacement phase Safe shutdown capability analysis
Vandellós 2 / PWR, W / 1082 MWe / Spain	Engineering support to plant operation and maintenance PSA Level 1 and 2
PWR Reference Turbine Island Design / 1300 MWe / USA	Development of a Reference Turbine Island design using a 1300-MWe GE steam turbine to match a generic PWR Nuclear Island of the same capacity for GE LSTGD (Schenectady, NY, USA)
Progetto Unificato Nucleare / PWR, W & Ansaldo Nucleare / 1200 MWe / Italy	Engineering and design of the heating, ventilating and air conditioning (HVAC) system for the Standardised Nuclear Project (PUN) in Italy (Client: Ansaldo Nucleare)
AP-600 / Passive type PWR, W / 600 MWe / USA	First Of A Kind Engineering (FOAKE) Design of the mechanical, electrical and I&C systems for the nuclear and turbine islands of the Westinghouse AP-600 passive type plant, as part of the EPRI Advanced Reactor Programme
EPP / Passive type PWR, W / 1000 MWe / USA	Engineering and design activities as part of Westinghouse's effort to develop a 1000-MWe European Passive Plant (EPP) in compliance with EUR documents
AP-1000 // Passive type PWR, W / 1000 MWe / USA	Participation in the engineering and design activities necessary for the design certification of Westinghouse's AP-1000 passive type plant
Angra 2 / PWR, Siemens / 1300 MWe / Brazil	Engineering support during the commissioning phase Operating procedures Support during refuelling outage
Angra 1 / PWR, W / 657 MWe / Brazil	Refuelling outage support Radiation protection procedures for plant refuelling operations
Comanche Peak 1&2 / PWR, W / 2 x 1150 MWe / USA	During the final phase of construction, detail design verification and completion on plant site for the mechanical, electrical and I&C systems
Atucha 1 / PHWR, Siemens / 350 MWe / Argentina	Support for the PSA
Atucha 2 / PHWR, Siemens / 745 MWe / Argentina	Supply of an engineered equipment package estimated at USD 30,000,000

**Table IN5-2
Empresarios Agrupados' Main References in BWR NPPs**

Project / Reactor Type, Manufacturer / Capacity / Country	Work Performed
Lungmen 1 & 2 / ABWR, GE / 2 x 1350 MWe / Taiwan	Engineering and design services to GE Nuclear Energy in the mechanical, civil-structural, piping design, stress analysis and support design, thermal-hydraulic analysis, Low Power & Shutdown PSA, Human Factors Engineering (HFE) and I&C areas,
Cofrentes / BWR-6, Mark III, GE / 1081 MWe / Spain	Main Architect-Engineer for the complete project (See EA References in NPP Projects in Spain, Table IN1) Engineering support to the plant, including plant design modifications, systems upgrading and optimisation, evaluation of operating experience, general technical support, etc Power up-rating engineering Preparation and updating of safety & accident analysis reports. Participation in the PSA. H ₂ Water Chemistry and IGSCC programmes Severe Accidents programme: containment venting systems, Mark III containment ultimate capacity Licensing support: FSAR updating. Relationships with Regulatory Body Technical operating specifications preparation, optimisation and improvement Refuelling outage support Plant life extension programme I&C upgrading by implementing a DC system and human factors engineering Configuration management services
Valdecaballeros 1 & 2 / BWR-6, GE / 2 x 975 MWe / Spain	Main Architect Engineer (See EA References in NPP Projects in Spain, Table IN1)
Santa M ^a de Garoña / BWR, Mark I, GE / 466 MWe / Spain	Engineering support to plant operations, including plant design modifications Mark I containment reevaluation programme Participation in the Systematic Evaluation Programme (SEP) Recirculation Loops Modification Programme Engineering services for Plant Life Extension Updating of FSAR Technical operating specifications preparation, optimisation and improvement
BWR Reference Turbine Island Design / GE / 1300 MWe / USA	Development of a reference Turbine Island design to match a 1260-MWe BWR-NSSS Nuclear Island for GE LSTGD (Schenectady)
GE Advanced BWR (ABWR) / 1360 MWe / USA	First-of-a-kind engineering (FOAKE). Design of nuclear island and turbine island mechanical, electrical and I&C systems, and of man-machine interface (MMI)
GE Simplified BWR (SBWR) / Passive type BWR / 65 MWe / USA	Initial certification phase of the passive-type SBWR. Engineering of mechanical, electrical and I&C systems. Design of man-machine interface. Studies on severe accidents. PRA studies. Optimisation of technical specifications. Civil design
Laguna Verde 1 & 2 / BWR, GE / 2 x 654 MWe / Mexico	Technical support on piping engineering: piping stress analysis, Class I piping analysis, jet impingement, piping vibration and thermal expansion tests
Número 2 NPP / BWR, GE / 970 MWe / Mexico	Preliminary engineering and design of the Balance Of Nuclear Island (BONI) and Balance of Plant (BOP) BONI Cost Evaluation
Alto Lazio / BWR-6, GE / 2 x 1010 MWe / Italy	HVAC systems engineering & cable trays support design EA expert missions under IAEA PRE-OSART programme
Leibstadt / GE BWR-6, Mk III / 1220 MWe / Switzerland	Shutdown Probabilistic Safety Analysis (PSA), Integrated Reliability Analysis (IRA)
GE ESBWR / Passive type SBWR, GE / 1500 MWe / USA	Collaboration with GE Nuclear Energy in the engineering and design for the development of the passive-type ESBWR

Table IN6
Empresarios Agrupados' References in
Radioactive Waste Management, Decontamination and Decommissioning

Project (Country)	Type of Work Performed														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Takreer NORM Handling & Disposal (UAE)	◆	◆	◆				◆	◆					◆		◆
Novi Han Repository (Bulgaria)	◆	◆	◆				◆	◆					◆	◆	◆
Bohunice V-1 NPP decommissioning (Slovakia)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆			◆	◆	◆
Dismantling CIEMAT labs (ENRESA) (Spain)	◆	◆	◆				◆	◆	◆						◆
Vandellós 1 NPP dismantling (ENRESA) (Spain)					◆										
Trillo NPP Spent Fuel Storage Facility at Reactor Site	◆	◆	◆		◆	◆	◆	◆					◆		◆
Rozan Repository (Poland)									◆						
Bohunice A-1 pre-decommissioning (Slovakia)									◆						
Almaraz NPP 1 & 2 (Spain)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Angra NPP (Brazil)	◆							◆							
Ascó NPP 1 & 2 (Spain)	◆						◆	◆		◆					◆
José Cabrera NPP (Spain)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆
Cofrentes NPP (Spain)	◆	◆	◆	◆	◆	◆	◆	◆		◆			◆	◆	◆
Santa María de Garoña NPP (Spain)	◆						◆	◆	◆						◆
Trillo NPP (Spain)	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆		◆	◆	◆
Valdecaballeros NPP 1 & 2 (Spain)	◆	◆	◆	◆	◆	◆	◆	◆							
Vandellós 1 NPP (Spain)	◆		◆				◆	◆	◆						◆
Vandellós 2 NPP (Spain)	◆						◆	◆							◆
Cinso Hot Cells (Spain)	◆	◆	◆				◆	◆							◆
ENRESA Hot Cells (Spain)	◆	◆	◆				◆								
ENRESA HLW and Spent Fuel (Spain)	◆	◆	◆	◆				◆							◆
ENRESA Final HLW Repository (Spain)	◆	◆	◆					◆							◆
ENRESA – LLW (Spain)	◆						◆	◆							◆
Dukovany NPP (Czech Republic)	◆	◆													
Kozloduy NPP (Bulgaria)	◆														
Czech and Slovak Fuel Storage	◆	◆													
Institutional Radwaste Repository Novi-Han (Bulgaria)	◆	◆	◆				◆	◆					◆	◆	◆
National Radwaste Repository (Bulgaria)	◆	◆	◆	◆	◆	◆	◆	◆					◆	◆	◆
ENRESA Generic (Spain)	◆								◆						◆

Key to Work Performed

1. Feasibility Studies and Project Planning:
 - Site selection
 - Conceptual design
 - Preliminary technical and economic studies
 - Specification of invitation to tender and evaluation of tenders
2. Project Management
3. Project Engineering and Design:
 - Interim spent fuel storage facilities
 - LLW treatment and conditioning
 - Final HLW repositories
 - Decontamination and hot shops
 - LLW temporary storage
 - Spent fuel handling and transport
4. Procurement and Suppliers' Inspection:
 - Spent fuel handling and transport equipment
 - Spent fuel storage casks
 - Equipment for gaseous, liquid and solid treatment
5. Construction and Erection Management:
6. System and Facilities Commissioning
7. Safety Analysis:
 - Principles and criteria of HLW and LLW facilities
 - Exemptions and clearances for very low level radwaste
8. Radiation Protection:
 - Dose evaluation
 - Shielding of radwaste systems
 - Radiation monitoring
9. Decommissioning of nuclear facilities:
 - Conceptual design
 - Radwaste inventories
 - Cost evaluation
 - Plans
 - Dismantling management
10. Plant Modifications:
 - LLW systems
 - Hot shops and decontamination facilities
 - Spent fuel storage pools
11. Maintenance Programmes
12. Plant Operation Support for Radwaste Systems:
 - Refuelling outages
13. Quality Assurance Programmes and Procedures
14. Training
15. Licensing

**Table IZ1
Empresarios Agrupados' References in Probabilistic Safety Analyses (PSAs)**

Type of Work Performed	Project														
	LNPP	KKL	CNA	CNC	CNS	CNZ	CNV	CNT	CNG	IAEA	VVER	RBMK	SBWR	ESBWR	
Technical Advice and Support			◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		
Project Management															
Project plan development	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆			◆	
Technical & administration procedures	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆				
Project management & control	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆				
Technical documentation analysis	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆				
PSA Software															
Software development & maintenance			◆	◆	◆	◆		◆							
Hardware & software documentation			◆	◆	◆	◆	◆	◆			◆				
Quality Assurance	◆	◆			◆	◆		◆	◆	◆					
PSA Level 1															
Initiating event success criteria	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆			◆	
Accident sequence delineation	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆			◆	
Database handling and analysis	◆	◆	◆		◆	◆		◆		◆	◆			◆	
System analysis	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	
Human reliability	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	
Quantification (system & accidents)	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆		◆	
Common cause failure analysis	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆		◆	
PSA of low power and shutdown modes	◆	◆			◆		◆		◆		◆		◆	◆	
PSA maintenance (living PSA)			◆	◆	◆	◆								◆	
Interpretation of results	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	
PSA Level 2															
MAAP Parameter file			◆		◆			◆							
Containment event tree analysis			◆		◆				◆	◆					
PSA level 2 analysis			◆		◆	◆			◆	◆					
PSA External Events															
Flooding analysis		◆	◆	◆	◆	◆	◆	◆	◆	◆		◆			
Fire analysis		◆	◆	◆	◆	◆	◆		◆	◆	◆		◆		
Seismic margin evaluation			◆		◆						◆				
Tornado											◆				
Deterministic Fire Hazard Analysis		◆	◆	◆	◆	◆		◆		◆	◆				
System reliability analysis	◆		◆			◆		◆					◆		
Courses and seminars		◆	◆	◆	◆	◆	◆	◆		◆					

Key to Project

LNPP: Lungmen NPP, 1350 MWe, GE	Level 3 PRA completed
KKL: Leibstadt NPP, 1220 MWe, GE	Level 2 PSA completed
CNA: Almaraz 1&2 NPP, 1035 & 1045 MWe, W	Level 2 PSA completed
CNC: Cofrentes NPP, 1095 MWe, GE	Level 2 PSA completed
CNS: Ascó 1&2 NPP, 1032 & 1027 MWe, W	Level 2 PSA completed
CNZ: José Cabrera NPP, 160 MWe, W	Level 2 PSA completed
CNV: Vandellós 2 NPP, 1087 MWe, W	Level 2 PSA completed
CNT: Trillo 1 NPP, 1066 MWe, Siemens	Level 2 PSA completed
CNG: Sta M ^a de Garoña NPP, 466 MWe, GE	Level 3 PSA completed
IAEA: International Atomic Energy Agency	
VVER: PWR type. Tacis and Phare Programmes VVER 440-213, 440-230, 440-318B and 1000	
RBMK: International RBMK Safety Review	
SBWR: Passive BWR Type. Simplified Boiling Water Reactor	
ESBWR: Economic Simplified Boiling Water Reactor	

Table IZ2
Empresarios Agrupados' References in Radiation Protection

Scope of Services	Project									
	CNA	CNC	CNV	CNT	CNZ	ENR	CMT	CSN	EC	DGPC
Shielding										
Radiation zoning and shielding	◆	◆	◆	◆	◆		◆			
Calculation of neutron dose in spent fuel pool	◆									
Calculation of skyshine			◆			◆				
Equipment environmental qualification	◆	◆	◆	◆						
Spent fuel storage casks						◆				
ALARA project (criteria and application)			◆	◆						
Operational safety of ATC preliminary design						◆				
Dose during accident										
Radiation dose assessment during accidents	◆			◆	◆	◆				◆
Preliminary design of the radioactivity alarm network										◆
Control room habitability	◆		◆	◆	◆					
Database for the management of Environmental Radiological Monitoring Programme						◆				
Participation in emergency simulations	◆			◆	◆					
Equipment specification										
Radiation and contamination measurement equipment				◆						
Area radiation monitoring system				◆						
Dosimetry systems (DLD, internal, TLD)				◆						
Doses during normal operation from routine releases										
Doses from liquid and gaseous effluents	◆			◆	◆	◆				
Doses from effluents of Spanish NPPs								◆		
Analytical radiological study					◆					
Effluent management and on-site dose calculation software	◆									
Database: Solid waste and spent fuels						◆		◆		
Meteorological reports and data validation					◆					
Off-site dose calculation manual and effluents technical specifications	◆	◆		◆	◆					
Plant procedures applicable to radioactive effluents	◆			◆	◆					
Radiation protection during refuelling										
RP training courses	◆			◆						
Management of operational doses during outages	◆									
ALARA team during refuelling outages	◆									
Radiation protection procedures	◆			◆						
Low level waste										
Waste drum management	◆									
Low level waste and materials management						◆			◆	
Spent fuel										
Criticality studies	◆					◆				
Spent fuel storage pools						◆				

Key to Project

CNA	Almaraz 1&2 NPP, 1035 & 1045 MWe, PWR-W	ATC	Interim Spent Fuel Storage
CNC	Cofrentes NPP, 1095 MWe, BWR-GE	CE	European Commission
CNV	Vandellós 2 NPP, 1087 MWe, PWR-W	CMT	CIEMAT: Research Centre for Energy, Environment and Technology
CNT	Trillo 1 NPP, 1066 MWe, PWR-Siemens	CSN	Spanish Nuclear Safety Council
CNZ	José Cabrera NPP, 160 MWe, PWR-W	DGPC	Dirección General de Protección Civil
		ENR	ENRESA: Spanish Agency for Radwaste Management and Disposal