

SPECIALIZED SERVICES ON NUCLEAR AND CONVENTIONAL POWER PLANTS

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Complementing the services described in the nuclear engineering field, where activities mainly related to cores of reactors and safety analysis have been considered, others specialized technological services were also performed in design and analysis of systems and equipments of nuclear reactors, fuel cycle installations and cogeneration power plants. The expertise of our professionals is directed to solve technical problems related to conceptual design, operation, aging of components, in service inspection, and so on. The background acquired is also applied to conventional thermal and general process plants. A brief description of the relevant activities carried out in each specialty follows below:

Instrumentation and control - Conceptual studies to plan the modernization of Angra I NPP secondary heaters using digital technology; tests of fire sensors under radiation, to evaluate their behavior for qualification and dedication purposes; and specification of instrumentation of research reactor upgrades.

Electricity - Proposal of methodologies for the evaluation of aging and life extension of electrical components; tests of electrical cables and environmental qualification of safety related items for nuclear power plants; specification and procurement of electrical and instrumentation components for Angra I NPP. Also a dedication process was proposed as a methodology of application of commercial grade components - COTS (commercial of the shelf).

Structural mechanics - Stress analysis of piping systems for Angra II NPP, design, as built and fatigue; structural design and analysis of the piping supports of Angra I and II NPP; Snubber Reduction Program for Angra I NPP; Automation of the Steam Generator Tube Integrity Assessment and Tube Selection for In Situ Testing. A previous computer program was developed to obtain the critical values using a Monte Carlo statistical approach to consider all uncertainties for some defects. It was modified to: (1) include new defects types, covering almost all defects types observed in Angra I NPP and, (2) perform a new type of analysis where the specific in situ limits for axial and circumferential defects were obtained. Another computer program was developed to analyze an actual defect profile and obtain an idealized defect (uniform depth and length) that fails for the same pressure the actual one fails. This idealized defect dimensions are used in the selection of the tubes candidates to be tested in situ.

Conventional power plants - Specialized services on thermal plants were also developed, covering reliability analysis of cogeneration thermal plants with combined cycle. Reliability block diagrams were used to estimate the frequency of interruption of steam and electricity to consumers. Besides this subject, evaluation of the dynamic models of gas turbines coupled to recovery boilers were developed to propose a control system strategy. The objective was to predict plant behavior in failures and load transients. Simulation of different configurations of cogeneration plants were studied, to evaluate and to propose improvements in their load capability, control strategy and reliability. In general, technological redundancy is required in cogeneration plants, to fit very strong steam consumers requirements on reliability.

Calibration and metrology - Calibration of process instruments was performed in a well equipped laboratory, where secondary standards of mass, pressure and temperature follow strictly the national standards.

Fuel cell - Design of a laboratory setup to test PEM assemblies under customer orientation. A set of different lines of gases and also electrical and instrumentation devices were installed together in a practical way to facilitate the experimental work.

All the specialized services described above were conducted by a team of approximately 20 professionals skilled in engineering and technology. All these professionals work at the Nuclear Engineering Center (CEN). A total of approximately 20,000-man-hour was spent in all these activities related to experiments, laboratory and engineering services. The outcome of these technical activities was demonstrated through: technical reports, engineering documents, calibration sheets, inspections reports and training notes. The customers were some other departments of IPEN, the Brazilian nuclear regulatory authority (named CNEN) and other companies such as the Brazilian oil company (named PETROBRAS), the Brazilian nuclear utility (named ELETRONUCLEAR) and the Brazilian navy technological centre (named CTM-SP).