THIRD

NATIONAL REPORT

OF

BRAZIL

FOR THE

NUCLEAR SAFETY CONVENTION

September 2004

FOREWORD

On 20 September 1994 the Convention on Nuclear Safety was open for signature at the headquarters of the International Atomic Energy Agency in Vienna. Brazil signed the Convention in September 1994, and deposited the instrument of ratification with the Depositary on 4 March 1997.

The Convention objective is to achieve and maintain a high level of nuclear safety throughout the world. One of the obligations of the Parties to the Convention is the preparation of a periodical National Report describing the national nuclear programme, the nuclear installations involved according to the Convention definition, and the measures taken to fulfill the objective of the Convention.

The first National Report was prepared by a group composed of representatives of the various Brazilian organizations with responsibilities related to nuclear safety, and presented to the Parties of the Convention in September 1998. The Second National Report of Brazil was prepared to update the information provided in the previous Report with information related to the period 1998/2001. The Report contained also additional information as recommended by the Report of the Review Meeting of April 1999.

This Third National Report is a new update to include relevant information for the period of 2001/2004.

The authors decided to prepare the Third National Report of Brazil as a self-standing document, with some repetition of the information provided in the previous National Reports so that the reviewers do not have to consult frequently the previous document. The most relevant new information refers to the operation of the two Brazilian nuclear power plants during the period. According to the amendment to the Guidelines Regarding National Reports (INCIRC/572), an additional section was added to each relevant article to cover activities, achievements and concerns regarding the improvement of safety. An additional chapter was included to address to specific issues raised during the second Review Meeting.

SUMÁRIO

Em 20 de setembro de 1994 a Convenção sobre Segurança Nuclear foi aberta para assinaturas na sede da Agência Internacional de Energia Atômica em Viena. O Brasil assinou a convenção em setembro de 1994 e ratificou-a através do decreto legislativo n. 4 de 22 de janeiro de 1997, depositando o instrumento de ratificação no Depositário em 4 de março de 1997.

O objetivo da Convenção é alcançar e manter o alto nível de segurança nuclear em todo o mundo. Uma das obrigações das Partes da Convenção é a preparação, a cada 3 anos, de um Relatório Nacional descrevendo o programa nuclear nacional, as centrais nucleares existentes, e as medidas tomadas a fim de cumprir os objetivos da Convenção.

O primeiro relatório nacional do Brasil foi preparado por um grupo composto por representantes das várias organizações brasileiras com responsabilidades relacionadas com a segurança nuclear, e apresentado às Partes da Convenção em Setembro de 1998. O Relatório continha uma apresentação da política nuclear brasileira e o programa relacionado com a segurança das centrais nucleares e uma descrição das medidas tomadas pelo Brasil para implementar as obrigações de cada artigo da Convenção. Durante o processo de Revisão pelas Partes estabelecido pela Convenção, o relatório nacional do Brasil foi analisado pelos demais países que formularam 62 perguntas e 2 comentários. Estas perguntas foram respondidas num suplemento ao primeiro Relatório Nacional que foi apresentado na reunião de revisão que se realizou em Abril de 1999, em Viena.

O Segundo Relatório Nacional do Brasil foi preparado para atualizar a informação contida no relatório anterior com dados relativos ao período 1998/2001. Na sua revisão foram formuladas 119 perguntas, que foram igualmente respondidas em um Suplemento apresentado na reunião de revisão em Abril de 2002.

Este Terceiro Relatório Nacional do Brasil, atualiza a informação para o período de 2001/2004. Os autores decidiram preparar o Terceiro Relatório Nacional do Brasil como um documento completo, com alguma repetição das informações contidas no primeiro Relatório Nacional de maneira que os revisores não tivessem que consultar freqüentemente o relatório anterior. O capítulo 1 contém uma descrição da política nuclear brasileira e do programa de centrais nucleares. Os capítulos 2 a 5 apresentam, de acordo com cada artigo da Convenção, uma análise das organizações, estruturas e atividades brasileiras relacionadas com as obrigações da Convenção. O capítulo 2 descreve as centrais nucleares existentes. O capítulo 3 dá detalhes sobre a legislação e normas, incluindo uma descrição dos processos regulatórios e dos órgãos reguladores. O capítulo 4 cobre as considerações gerais de segurança descritas nos artigos 10 a 16 de Convenção. O capítulo 5 refere-se à segurança das centrais nucleares durante as fases de localização, projeto, construção e operação. De acordo com as recomendações da Segunda Reunião de Revisão, foi adicionada para cada artigo uma sessão relativa a atividades, realizações e preocupações relacionadas com a melhoria da segurança. O capítulo 6 contém informações adicionais em tópicos específicos, conforme recomendado pelo relatório da segunda reunião de revisão de Abril de 2001. O capítulo 7 faz considerações finais sobre o grau de cumprimento das obrigações da Convenção sobre Segurança Nuclear pelo Brasil.

As considerações finais apresentadas no capítulo 7, levam à conclusão de que o Brasil alcançou e vem mantendo um alto nível de segurança em suas centrais nucleares, implementando e mantendo defesas efetivas contra o potencial perigo radiológico a fim de proteger os indivíduos, a sociedade e o meio ambiente de possíveis efeitos da radiação ionizante, evitando acidentes nucleares com conseqüências radiológicas e mantendo-se preparado para agir efetivamente em uma situação de emergência. Consequentemente, o Brasil alcançou os objetivos da Convenção sobre Segurança Nuclear.

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Chapter 1. INTRODUCTION

1.1. The Brazilian nuclear policy

The Brazilian Federal Constitution of 1988 states in articles 21 and 177 that the Union has the exclusive competence for managing and handling all nuclear energy activities, including the operation of nuclear power plants[1]. The Union holds also the monopoly for the survey, mining, milling, exploitation and exploration of nuclear minerals, as well as the activities related to industrialization and commerce of nuclear minerals and materials. All these activities shall be solely carried out for peaceful uses and always under the approval of the National Congress.

The national policy for the nuclear sector is implemented through the Plan for Science and Technology 2000/2005 (Plano Plurianual de Ciência e Tecnologia - PPA 2000/2005), which establishes quantitative targets that define the Government strategy. Among these targets is the National Nuclear Power Policy aiming at guiding research, development, production and utilization of all forms of nuclear energy considered of strategic interest for the Country in all aspects, including scientific, technological, industrial, commercial, energy production, civil defense, safety of the public and the environment.

Another important target is to increase the participation of nuclear energy in the national electricity production. This involves the continuous development of technology, and the design, construction and operation of nuclear industrial facilities related to the nuclear fuel cycle. This includes also the technological and industrial capability to design, construct and operate nuclear power plants, to provide electrical energy to the Brazilian grid in a safe, ecologically sound and economic way. Moreover, this also requires the development of necessary human resources for the establishment and continuity of the activities in all these fields.

1.2. The Brazilian nuclear program

The Comissão Nacional de Energia Nuclear (Brazilian National Commission for Nuclear Energy - CNEN) was created in 1956 (Decree 40.110 of 1956.10.10) to be responsible for all nuclear activities in Brazil. Later, CNEN was re-organized and its responsibilities were established by the Law 4118/62 with alterations determined by Laws 6189/74 and 7781/89. Thereafter, CNEN became the Regulatory Body in

[1] In this Report the terms Nuclear Installation and Nuclear Power Plant are used as synonyms, in accordance with the definition adopted in the Nuclear Safety Convention (Art. 2 - i).

charge of regulating, licensing and controlling nuclear energy, and the nuclear electric generation was transferred to the electricity sector.

Currently, Brazil has two nuclear power plants in operation (Angra 1, 657 MWe gross/626 MW net, 2-loop PWR and Angra 2, 1345 MWe gross /1275MWe net, 4-loop PWR), and one under construction (Angra 3, 1312 MWe gross/1229 MW net, 4-loop PWR). Angra 3 has had the construction temporarily interrupted since 1991 and its restarting is presently being considered by the Federal Government. Angra 1, 2 and 3 are located at a common site, near the city of Angra dos Reis, some 130 km from Rio de Janeiro.

The construction of nuclear power plants in Brazil required great efforts in qualifying domestic engineering, manufacturing and construction firms, to comply with the strict nuclear technology transfer. The result of these efforts, based on active technology transfer, has led to an increasing national participation.

Brazil has established a nuclear power utility/ engineering company Eletrobras Termonuclear S. A. (ELETRONUCLEAR), a heavy components manufacturer, Nuclebras Equipamentos Pesados (Nuclebras Heavy Equipment - NUCLEP), a nuclear fuel manufacturing plant (Fábrica de Combustível Nuclear - FCN) and a yellow-cake production plant belonging to Industrias Nucleares do Brasil (Nuclear Industries of Brazil - INB). Brazil has also the basic technology for Uranium conversion and enrichment, as well as private engineering companies and research and development (R&D) institutes and universities devoted to nuclear power development. Over 15,000 individuals are involved in these activities. Brazil ranks sixth in world Uranium ore reserves which amounts to approximate 310,000 t U_3O_8 in situ, recoverable at low costs.

1.3. Structure of the National Report

This Third National Report was prepared to fulfill one of the Brazilian obligations related to the Convention on Nuclear Safety[1]. Chapters 2 to 5 present an article by article analysis of the Brazilian structures, actions and activities related to the Convention's obligations (Chapter 2 of the Convention), and follow the revised Guidelines for the preparation of National Reports[2]. In Chapter 2 some details are given about the existing nuclear installations. Chapter 3 provides details about the legislation and regulations, including the regulatory framework and the regulatory body. Chapter 4 covers general safety considerations as described in articles 10 to 16 of the Convention. Chapter 5 addresses to the safety of the installations during siting, design, construction and operation. According to the amendment to the Guidelines Regarding National Reports (INFCIRC/572)[2], an additional section was added to each relevant article to cover activities, achievements and concerns regarding the improvement of safety. Chapter 6 addresses questions raised during the second review meeting[3] and for which additional information was requested from the Parties to the Convention. Chapter 7 presents final remarks related to the degree of compliance with the Convention obligations.

The Third National Report of Brazil has been prepared as a self-standing document, with some repetition of the information provided in the previous Report [4] so that the reviewers do not have to consult frequently the previous document.

Since Brazil has only two nuclear installations in operation, more plant specific information is provided in the report than is recommended in the Guidelines[2]. This was purposely done for the benefit of the reader not familiar with the current Brazilian situation.

The report also includes two annexes providing more detailed information about to the nuclear installations and the Brazilian nuclear legislation and regulations.

Chapter 2. NUCLEAR INSTALLATIONS

2.1. Article 6. Existing nuclear installations

As mentioned in item 1.2, Brazil has two nuclear power plants in operation (Angra1, 657 MWe gross/626 MW net, 2-loop PWR and Angra 2, 1345 MWe gross/1275 MWe net, 4-loop PWR) and one plant with construction temporarily interrupted (Angra 3, 1309 MWe gross/1229 MW net, PWR, similar to Angra 2). Angra 1, 2 and 3 are located at a common site, near the city of Angra dos Reis, some 130 km from Rio de Janeiro. More details about these units can be found in Annex 1 or in the PRIS[5], available through the Internet as well as in the ELETRONUCLEAR home page http://www.eletronuclear.gov.br.

Angra 1 and Angra 2 are very important to ensure a reliable power supply to the state of Rio de Janeiro which imports some 70% of its electricity needs from long distance hydro power plants. The plants also play a fundamental role in supplying reactive power to the system near the main load consumption centers, thus becoming a valuable factor in the reliable operation of the interconnected system.

2.1.1. Angra 1

Site preparation for Angra 1, the first Brazilian nuclear unit, started in 1970 under the responsibility of FURNAS Centrais Eletricas SA. The actual construction of the plant began, however, only in 1972, shortly after the contract with the main supplier of equipment, Westinghouse Electric Co. (USA), was signed. The Westinghouse contract included supply and erection of the equipment, as well as engineering and design of the plant on a turnkey basis. Westinghouse sub-contracted Gibbs and Hill (USA) in association with the Brazilian engineering company PROMON Engenharia S.A. for engineering and design. For the erection work, Westinghouse brought in a Brazilian contractor, Empresa Brasileira de Engenharia S.A. (EBE). For the supply of the containment steel structure and the civil works not included in the Westinghouse contract, FURNAS contracted directly, respectively the Chicago Bridge & Iron Company and Construtora Norberto Odebrecht S.A, a Brazilian contractor which eventually also became contractor of the civil works of Angra 2.

CNEN granted the construction permit for the plant in 1974. The operating licence was issued in September 1981, at which time the first fuel core was also loaded. First criticality was reached in March 1982, and the plant was connected to the grid in April 1982. After a long commissioning period due to a steam generator generic design problem, which required equipment modifications, the plant finally entered into commercial operation on 1st January 1985.

In 1998, plant ownership has been transferred to the newly created company ELETRONUCLEAR, which has absorbed all the operating personnel of FURNAS, and part of its engineering staff, and the personnel of the design company

Nuclebras Engenharia (NUCLEN).

The personnel in charge of all modifications and improvements carried out since the first grid connection of the plant, from FURNAS, NUCLEN (now both at ELETRONUCLEAR) and other engineering companies, acquired considerable experience in dealing with the plant's technical matters.

The improvement in engineering support together with the implementation of specific improvement programs in maintenance, chemistry and better planning of reload down times are reflected in the plant performance of the last years (2001- to 2003) shown below, as measured by the WANO Plant Availability indicator.

Table 1 - Angra 1 Plant Availability

Year	Energy Generation (MWHe)	Accumulated Energy (MWHe)	Plant Availability(%)
2001	3.853.499,20	37.499.392,40	82,94%
2002	3.995.104,00	41.444.496,40	86,35%
2003	3.326.101,30	44.770.596,70	85,36%

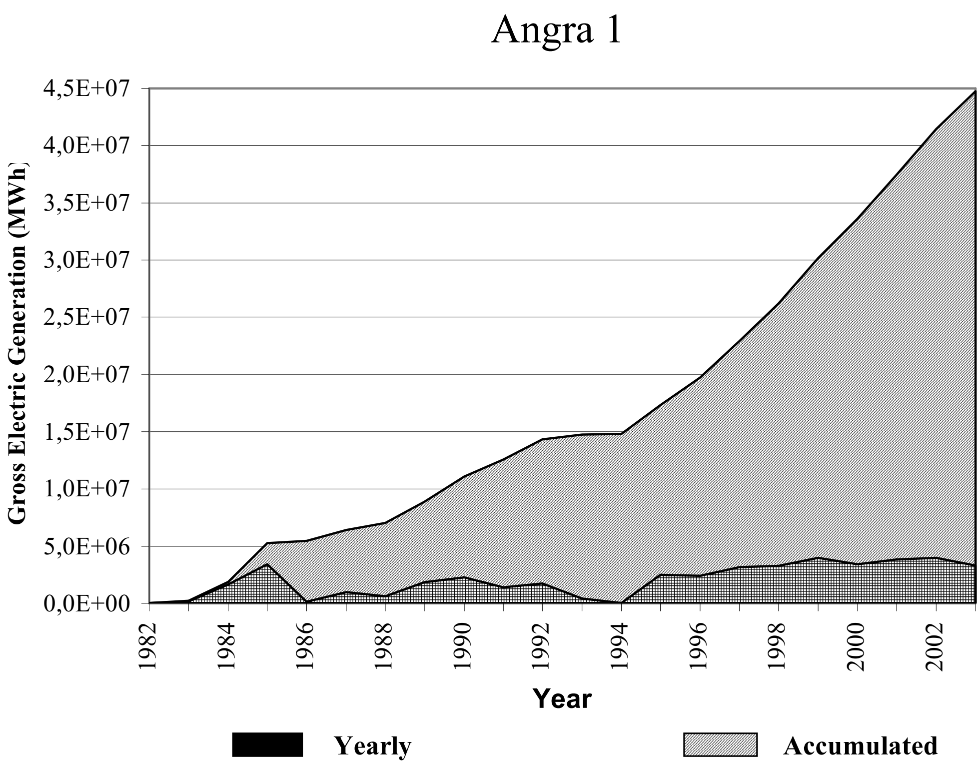


Fig.1 - Angra 1 – Energy Generation

2.1.1.1. Recent Safety Improvements at Angra 1.

Angra 1 safety status had been under constant review by FURNAS, and continues to be reviewed by ELETRONUCLEAR. Plant safety upgradings have been carried out during the life of the installation.

Within the period 2001/2003 the main safety concerns were related with obsolescence and degraded Steam Generators (SG). Several programs for improvement of safety and reliability have been started or were continued, in this period, as follows:

- follow up of condition, preservation and replacement of the plant SGs;
- follow up of condition, preservation and evaluation of need for replacement of the Reactor Pressure Vessel (RPV) head;
- reduction of generation and volume, as well as enlargement of storage capacity for radioactive wastes;
- addition of depleted Zinc to the reactor coolant, for dose reduction;
- implementation of Leak Before Break (LBB) to the primary circuit;
- reduction of snubbers;
- replacement/qualification of mechanical/electrical components inside containment required for post-accident conditions;
- obsolescence related activities, such as modernization of I&C and modernization of fire detection system.

More details on these programs will be given in chapters 4 and 5.

Some selected safety related modifications implemented in the period were:

- Installation and implementation of BEACON code system for core monitoring;
- installation of additional pump for fuel pool cooling;
- replacement of battery banks and containment penetrations;
- installation of new system for measurement of feedwater flow;
- improvements in the plant Safety Parameter Display System (SPDS);
- replacement of secondary sampling system;
- duplication of the meteorological station system; and
- continuation of upgrading of the containment instrumentation for design basis accident (DBA) conditions.

On the analysis side, the level 1 PSA study completed in 1999 is being continuously revised, taking into account actual plant data, developments in human reliability analysis and in models. More details are given in section 4.5 (article 14).

A comprehensive set of performance and safety indicators, in addition to the WANO ones, as well as a system of “system health indicators” have been developed and applied. More details are given in section 5.3.

2.1.2. Angra 2

In June 1975, a Co-operation Agreement for the peaceful uses of nuclear energy was signed between Brazil and the Federal Republic of Germany. Under that agreement Brazil accomplished the procurement of two nuclear power plants, Angra 2 and 3, from the German company, KWU - Kraftwerk Union A.G., later SIEMENS/KWU nuclear power plant supplier branch, at present Framatome ANP.

Considering that one of the objectives of the Agreement was a high degree of domestic participation, Brazilian engineering company Nuclebras Engenharia S.A. - NUCLEN (now ELETRONUCLEAR, after merging with the nuclear part of FURNAS, in 1997) was founded in 1975 to act as architect engineer for the Angra 2 and 3 project, with KWU as the overall plant designer, and, on the process, to acquire the required technology to design and build further nuclear power plants.

Furthermore, great efforts were dedicated to qualify Brazilian engineering firms and local industry to comply with the strict standards of nuclear technology.

Angra 2 civil engineering contractor was Construtora Norberto Odebrecht and the civil works started in 1976. However, from 1983 on, the project suffered a gradual slowdown due to financial resources reduction. In 1991, Angra 2 works were resumed and in 1994, the financial resources necessary for its completion were defined. In 1995, a bid was called for the electromechanical erection and the winner companies formed the consortium UNAMON, which started its activities at the site in January 1996 .

Hot trial operation was started in September, 1999. In March 2000, after receiving from CNEN the Authorization for Initial Operation (AOI), initial core load started, followed by initial criticality on 17 July 2000, and first connection to the grid on 21 July 2000. The power tests phase was completed in November, 2000. The Angra 2 NPP has been operating at full power since mid November 2000. The Authorization for Initial Operation (AOI) has been extended for periods of one year, to allow the closure of some open questions still remaining from the FSAR review and assessment activity.

Angra 2 operational record for the period 2001/2003, as measured by the WANO Availability indicator, is show in Table 2 and Fig 2.

Table 2 - Angra 2 Plant Availability

Year	Energy Generation (MWHe)	Accumulated Energy (MWH)	Plant Availability (%)
2001	10.498.432,70	13.121.084,70	93,90%
2002	9.841.746,10	22.962.830,80	91,50%
2003	10.009.936,10	32.972.766,92	91,30%

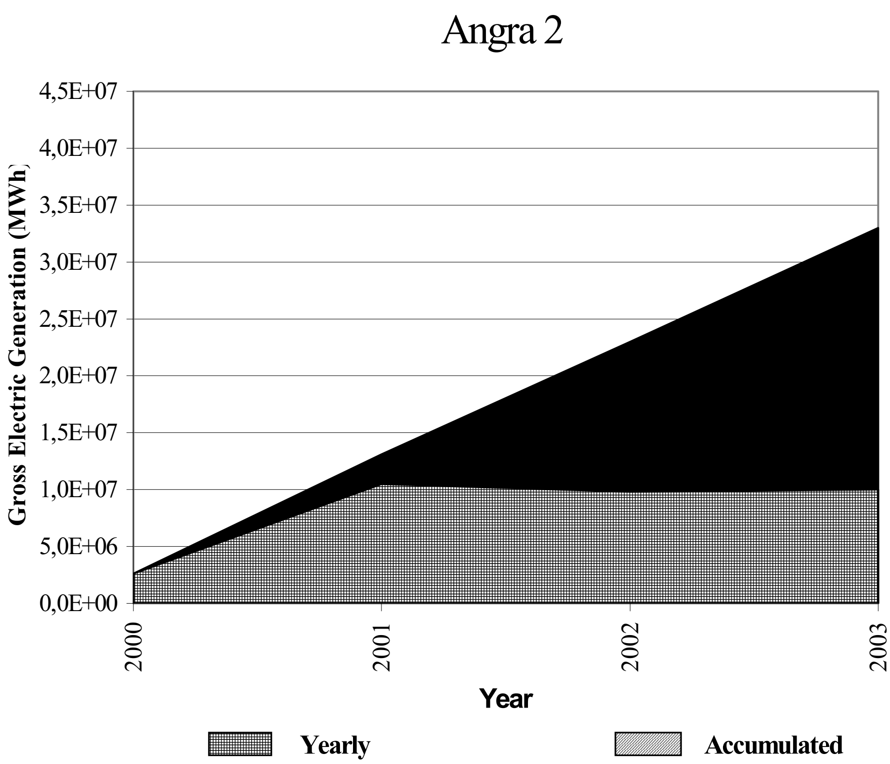


Fig.2 - Angra 2 – Energy Generation

Angra 2 had a very good performance in its first three years of operation. In 2001 the Angra 2 plant ranked 16th in the world in energy generation . This is an indication of the adequacy of the planning and execution of the different plant stages, beginning with design and engineering, equipment procurement and storage, construction, commissioning and operation, in spite of its very long construction time.

2.1.2.1 Recent Safety Improvements at Angra 2

The Angra 2 NPP belongs to the 1300 MWe Siemens-KWU PWR family, with 4 x 50% redundant safety systems, with consequent physical separation of trains. The plant has also a high degree of automation of the control, limitation and protection systems, complying with the 30 minutes non-intervention rule and a very reliable emergency power supply system, consisting of 2 independent sets of 4 Diesel generators each. A separate, fully protected building is provided to host the Emergency Control Room and the required water and energy (batteries and 2nd set of Diesel Generators) supplies to shut down and maintain the cooling of the plant, in case of major natural or man-made hazards.

Angra 2 status is the one of a modern NPP, as a result of a consistent programme of upgrading that has been carried on along the construction years, with implementation of all safety related modifications added to the German reference plant Grafenrheinfeld, as well as most improvements built in the newest German

KONVOI plant series.

Within the period 2001/2003 the main safety related activities were related to elimination of deficiencies, mostly minor, identified during commissioning and initial operation, performance of plant "as built" verification and consolidation of the plant processes. The major problems arising during initial operation occurred with conventional equipment. More details can be found in chapter 5, section 5.3.

Some selected safety related modifications implemented in the period were:

- installation of flow restrictors in the emergency feedwater system for vibration reduction;
- installation of electrostatic filters in the oil tank vents of the main coolant pumps;
- modifications in the isolation valves of the residual heat removal system to improve leaktightness;
- installation of mechanical seals and replacement of lower bearing in pumps of the secured service water system;
- correction of supports according to “as built” analysis; and
- improvements in main steam valves to reduce actuation time;

On the analysis side, a level 1+ PSA study is being contracted through international bidding. The expected completion date is 2007, 30 month after contract signature. More details are given in section 4.5.

As for Angra 1, a comprehensive set of performance and safety indicators, in addition to the WANO ones, as well as a system of “system health” indicators have been developed and applied. More details are given in section 5.3.

2.1.3 Angra 3

To date (July 2004), the Angra 3 construction program remains interrupted. Most of its components of imported scope, are already in Brazil and the site is ready for concrete pouring. The required engineering is essentially all available since for economy and standardisation reasons Angra 3 is to be as similar as possible to Angra 2. Several positive independent evaluations of the economics of concluding Angra 3 were done by Brazilian and international consultants and the subject is presently being discussed at Government level.

Following the original concept, Angra 3 is planned to be a twin plant of Angra 2. This concept has been submitted to and accepted by the Brazilian licensing authority – CNEN, proposing “Angra 2 as-built” as the reference plant for Angra 3.

Concerning supplies, more than 65% in value of the imported equipment is already stored in the warehouses, including not only the primary circuit heavy components and the turbine-generator set but also special pumps, valves and piping material. Excellence of the preservation plan for long term storage has been demonstrated during Angra 2 completion, whereby no relevant equipment malfunction due to long term storage had adverse impact on plant commissioning or initial operation. The preservation measures, including the 24 months inspection program, continue to be applied for the Angra 3 components stored at the site.

Preparation of the Preliminary Safety Analysis Report (PSAR) for the Nuclear Licensing process was completed and delivered to CNEN.

As a critical path for restarting construction, the Environmental Impact Study is being prepared in the frame of the Environmental Licensing Process.

Plant construction is planned for a 66 months duration, from starting of reactor annulus slab concrete work up to end of power tests and start of commercial operation. Effective restart of Angra 3 project depends on final decision of the Brazilian Government authorities.

Chapter 3. LEGISLATION AND REGULATION

3.1. Article 7. Legislative and regulatory framework

Brazil has established and maintained the necessary legislative and regulatory framework to ensure the safety of its nuclear installations. The Federal Constitution of 1988 specifies the distribution of responsibilities among the Federal Union, the States and the Municipalities with respect to the protection of the public health and the environment, including the control of radioactive materials and installations (Articles 23, 24 and 202). As mentioned in item 1.1, the Union is solely responsible for nuclear activities related to electricity generation, including regulating, licensing and controlling nuclear safety (Articles 21 and 22). In this regard, the Comissão Nacional de Energia Nuclear (Brazilian National Commission for Nuclear Energy - CNEN) is the national regulatory body, in accordance with the National Nuclear Energy Policy Act.

Furthermore, the constitutional principles regarding protection of the environment (Article 225) require that any installation which may cause significant environmental impact shall be subject to environmental impact studies that shall be made public. More specifically, for nuclear power plants, the Federal Constitution provides that the siting of the installation shall be approved by Law (Article 225, Paragraph 6). Therefore, licensing of nuclear power plants are subject to both a nuclear licence by CNEN and an environmental licence by the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Institute for the Environment and Renewable Natural Resources – IBAMA), with the participation of state and local environmental agencies as stated in the National Environmental Policy Act. These principles were established by the Federal Constitution of 1988, at the time that Angra 1 had already been in operation, and Angra 2 had already been under construction. Therefore, licensing procedures for these power plants followed slightly different procedures, as described below.

The relation amongst regulatory organizations and operators is shown in Figure 3.

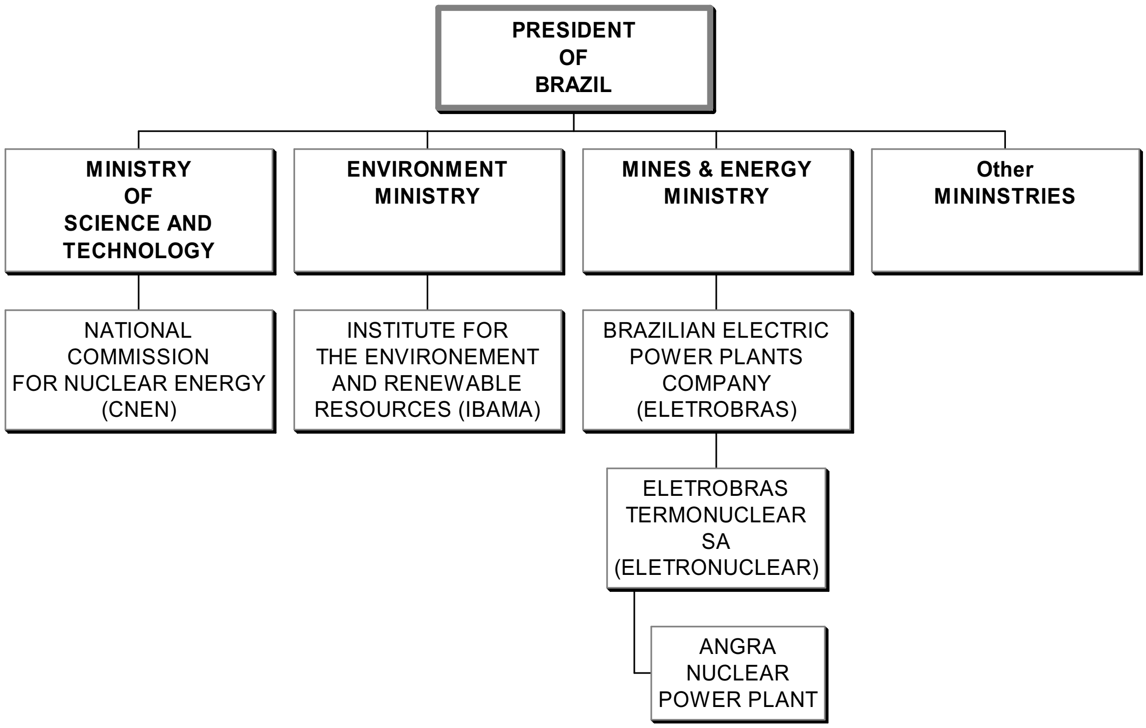


Fig. 3 – Brazilian Organizations Involved in Nuclear Power Plant Safety

3.1.1. Nuclear licensing process

CNEN was created in 1956 (Decree 40.110 of 1956.10.10) to be responsible for all nuclear activities in Brazil. Later CNEN was re-organized and its responsibilities were established by Law 4118/62 with alterations determined by Laws 6189/74 and 7781/89. Thereafter, CNEN became the Regulatory Body in charge of regulating, licensing and controlling nuclear energy. Since 2000, CNEN is now reporting to the Ministério de Ciência e Tecnologia (Ministry of Science and Technology - MCT).

CNEN responsibilities related to this Convention include, among others:

- the preparation and issuance of regulations on nuclear safety, radiation protection, radioactive waste management and physical protection;
- accounting and control of nuclear materials (safeguards);
- licensing and authorization of siting, construction, operation and decommissioning of nuclear facilities;
- regulatory inspection of nuclear reactors;
- acting as a national authority for the purpose of implementing international agreements and treaties related to nuclear safety activities;
- participating in the national preparedness for, and response to nuclear emergencies.

Under this framework, CNEN has issued radiation protection regulations and regulations for the licensing process of nuclear power plants, safety during operation, quality assurance, licensing of operational personnel and their medical certification for active duty, reporting requirements for the operational nuclear power plants, plant maintenance, and others (see Annex 2. Item A 2.3 for a list of CNEN regulations).

The licensing regulation CNEN NE 1.04[6] establishes that no nuclear installation shall be constructed or operated without a licence. It also establishes the necessary review and assessment process, including the specification of the documentation to be presented to CNEN at each phase of the licensing process. It finally establishes a system of regulatory inspections and the corresponding enforcement mechanisms to ensure that the licensing conditions are being fulfilled. The enforcement mechanisms include the authority of CNEN to modify, suspend or revoke the licence.

The licensing process is divided in several steps:

- Site Approval;
- Construction Licence;
- Authorization for Nuclear Material Utilization;
- Authorization for Initial Operation;
- Authorization for Permanent Operation;
- Authorization for Decommissioning

Federal Law 9.756 has been approved in 1998 establishing taxes and fees for each individual licensing step, as well as for the routine work of supervision of the installation by CNEN.

For the first step, site selection criteria are established in Resolution CNEN 09/69[7], taking into account design and site factors that may contribute to violation of established dose limits at the proposed exclusion area for a limiting postulated accident. Additionally, by adopting the principle of “proven technology”, CNEN regulation NE 1.04 requires for site approval the adoption of a “reference plant” for the nuclear installation to be licensed.

For the construction licence, CNEN performs a detailed review and assessment of the information received from the licensee in a Preliminary Safety Analysis Report (PSAR). The construction is followed closely by a system of regulatory inspections.

For the authorization for initial operation, CNEN reviews the construction status, the commissioning program including results of pre-operational tests, and updates its review and assessment of plant design based on the information submitted in the Final Safety Analysis Report (FSAR). At this time CNEN also licenses the reactor operators in accordance with regulation CNEN-NN-1.01[8]. Startup and power ascension tests are closely followed by CNEN inspectors, and hold points at different power levels are established.

Authorization for permanent operation, limited to a maximum of 40 years, is given after a complete review of commissioning test results and the solution of any deficiencies identified during construction and initial operation. The authorization establishes limits and conditions for operation and lists the programs which should be kept active during operation, such as the radiological protection program, the physical protection program, the quality assurance program for operation, the fire protection program, the environmental monitoring program, the qualification and training program, the preventive maintenance program, the retraining program, etc. Reporting requirements are also established through regulation CNEN-NN-1.14[9]. These reports, together with a system of regulatory inspections performed by resident inspectors and headquarters personnel, are the basis for monitoring safety during plant operation.

Other governmental bodies are involved in the licensing process, through appropriate consultations. The most important ones are the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Institute for Environmental and Renewable Natural Resources - IBAMA), which is in charge of environmental licensing and the Coordination of Technical and Scientific Programs of the Ministry for Science and Technology (MCT) with respect to emergency planning aspects.

3.1.2. Environmental licensing

IBAMA was created through Law n. 7.735 of 22 February 1989 under the Ministério do Meio Ambiente (Ministry for Environment - MMA) with the responsibility to implement and enforce the National Environmental Policy (Política Nacional do Meio Ambiente - PNMA) established by Law N^{o}. 6938/81. The objective of the PNMA is to preserve, improve and recover the environmental quality, ensuring the conditions for social and economic development and for the protection of human dignity.

The PNMA established the National System for the Environment (Sistema Nacional do Meio Ambiente - SISNAMA), which is composed by the Conselho Nacional para o Meio Ambiente (National Council for the Environment - CONAMA) and executive organizations at the federal, state and municipal levels. The central executive body for SISNAMA is IBAMA, which is, therefore, responsible for the environmental licensing process of any installation with potentially significant environmental impact.

The environmental licensing process includes the following steps:

- Pre-installation Licence, given at the preliminary planning stage, approving the siting and general concept of the installation, evaluating its environmental feasibility and establishing the basic requirements and conditions for the next implementation phases.
- Installation Licence, authorizing the construction of the installation in

accordance with the approved specifications, programs and projects including measures which are considered essential to protect the environment.

- Operating Licence, authorizing the operation of the installation after the verification of the effective fulfillment of the previous licence conditions, and the effective implementation of measures to protect the environment during operation.

One of the requirements for the issuance of a Pre-installation Licence is the development of an Environmental Impact Study (EIA) and the preparation of an Environmental Impact Report (RIMA). The RIMA is prepared to explain the project and evaluate other alternative sites and technologies and to describe the proposed activities, in order to allow for public participation and discussion with the local community in an effective way.

Public participation in the environmental licensing process is ensured by legislation through the conduct of public hearings (CONAMA Resolution 09/87). One of the requirements is transparency in the process, through the publication in the official newspapers and local press of any licence application and the decision to grant it or not by the relevant environmental agencies.

3.1.2.1 Environmental Licensing of Angra 1, 2 and 3.

The construction of Angra 1 and Angra 2 took place before the creation of IBAMA. The initial operation of Angra 1 started in 1981, before the current environmental regulation was established.

At that time, the Fundação Estadual de Engenharia do Meio Ambiente (State Foundation for Environment Engineering - FEEMA), the Rio de Janeiro state agency in charge of environmental matters, issued an Installation License.

Since 1989, with the definition of the legal competence of IBAMA for environmental licensing of nuclear installations, with the participation of CNEN and state and local environmental agencies, IBAMA has been involved in the licensing process of Angra 1 and Angra 2.

The status reported in the previous National Report[4] was that procedures had been agreed with the Federal and State environmental agencies for performance of the environmental licensing of both plants, and that issuance of the respective licenses were expected in the short term. This expectation did not materialize.

In beginning of 2001 IBAMA, following intervention of the Public Ministry,(Ministério Público – MP, a peculiarity of the Brazilian legal system), informed ELETRONUCLEAR that the Angra 2 environmental operating license could not be issued before fulfillment of a “Term of Conduct Adjustment ” (Termo de Ajuste de Conduta - TAC), that specifies compensations for the environmental effects caused by the presence of the plant.

This TAC covers regularization of the environmental licensing of Angra 1, of new interim radioactive waste storage facilities and pending IBAMA and MP requirements relative to issuance of the permanent environmental license for Angra 2.

In the case of the Angra 1 Plant, already in commercial operation since 1985, the terms of agreement for an "adaptive licensing" procedure developed to allow adjustment of the plant to the new environmental regulation, and which defined the necessary environmental studies to justify the issuance of an operating license, was signed in 2002 with the Federal and State environmental Agencies, FEEMA and IBAMA and the Nuclear Regulator, CNEN. This process was halted by an Act of the Public Ministry (MP) in beginning of 2003, which required an additional "Term of Conduct Adjustment" (TAC),. ELETRONUCLEAR is now waiting for the establishment by the Public Ministry of a Working group for preparation of this TAC.

The environmental licensing situation for Angra 2 is similar, in spite of the fact that the plant had both the Environmental Impact Study (EIA) and a Report on Environmental Impact (RIMA) prepared before applying for its Environmental Operation License.

These documents were submitted to IBAMA and formed the basis for IBAMA evaluation of the environmental impact. They also served as a basis to define environmental plans and programs detailed in a Basic Environmental Project (Projeto Básico Ambiental - PBA) , to be carried out by the licensee.

The RIMA served also as a basis for the 2 public hearings about Angra 2 impact, which took place in the surroundings of the plant in the period of 1999-2000. Based on these evaluations and taken into consideration the discussion during the hearings, IBAMA has issued a special Licence for Initial Operation.

As previously mentioned, as a precondition for the environmental license in addition of the EIA and RIMA reports, a TAC was requested for Angra 2, which started operation on a Provisional Environmental License and a nuclear Authorization Initial Operation (AOI) in beginning of 2001. This TAC specified improvements of roads and sheltering to be made by ELETRONUCLEAR relative to emergency planning, environmental compensation to be applied to the Serra da Bocaina National Park and others.

An additional public hearing was conducted at the Public Ministry in 2003 for checking of fulfillment of the requirements of the TAC. Presently ELETRONUCLEAR is waiting for the closure of the Angra 2 TAC process to be able to apply for the permanent environmental and nuclear permanent operating licenses.

With respect to Angra 3, IBAMA has proposed in 1999 the Terms of Reference for the preparation of the development of the EIA/RIMA which still under preparation by ELETRONUCLEAR.

Since CNEN has the technical competence for the evaluation of radiological impact in the environment, IBAMA and CNEN have established a formal agreement to specify the respective scope of action in both licensing processes (see also 5.1).

3.1.3. Emergency preparedness legislation

With respect to emergency preparedness, additional requirements have been established by the creation of the System for Protection of the Brazilian Nuclear Program (SIPRON) through Law 1809 of 7 October 1980. The subsequent Decree 2210 of 22 April 1997 established the Secretaria de Assuntos Estratégicos (Secretariat for Strategic Affairs - SAE), directly linked to the Presidency of the Republic, as the Central Organization of SIPRON responsible for the general supervision of the preparedness and response to nuclear emergencies in the Country.

Since 2000, a Governmental restructuring has designated the Ministry of Science and Technology (MCT) as the Central Organization for SIPRON, which now stays under the Special Advisor for the Coordination of Technical and Scientific Programs of MCT.

The Decree 2210 also establishes a Commission for the Coordination of Protection of the Brazilian Nuclear Program (COPRON) composed of representatives of the agencies involved. Besides ELETRONUCLEAR, as the operator, and CNEN as the nuclear regulatory body, other agencies are involved as support organizations of SIPRON, such as the Municipal Civil Defense, the State Civil Defense, the Angra Municipality, the IBAMA, the National Transport Infrastructure Department (DNIT), the National Army, Navy and Air Force, and representatives of the Ministries of Health, Foreign Relations, Justice, Finance, Planning and Budget, Transportation and Communications.

SIPRON guidelines, issued by COPRON (see Annex 2, item A.2.5), require that ELETRONUCLEAR and the Municipal and State Civil Defenses prepare, keep up to date and exercise a plan for nuclear emergency situations. As a matter of fact, the guidelines require that CNEN and other organizations and agencies involved have their complementary emergency plans, as well (See additional details in item 4.7).

3.1.4. Activities, achievements and concerns regarding the improvement of safety

The main concern refers to the situation of the environmental license, which is now under the control of the Public Ministry (MP).

CNEN has issued enough regulations to allow the effective control of the licensing process. However it is recognized that revision and updating of these regulations are necessary.

Regarding emergency planning regulations, a proposal for review of Law n. 1809 and Decree n. 2210 was submitted to the Presidency in the end of 2003. In

January, 2004 the review was sent to the final approval of the Congress. It includes modifications due to restructuring of the Brazilian Government and increases the strength of SIPRON, involving more agencies in COPRON and extending SIPRON focus to all Brazilian nuclear organizations.

3.2. Article 8. Regulatory body

As mentioned in item 3.1, the Brazilian National Commission for Nuclear Energy (CNEN) has been designated as the regulatory body entrusted with the implementation of the legislative framework related to safety of nuclear installations. Other governmental bodies are also involved in the licensing process, such as the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA).

3.2.1. CNEN

CNEN authority is a direct consequence of Law 4118/62 and its alterations determined by Laws 6189/74 and 7781/89, which created CNEN. These laws established that CNEN has the authority "to issue regulations, licences and authorizations related to nuclear installations", "to inspect licensed installations" and "to enforce the laws and its own regulations".

Effective separation between the functions of the regulatory body (CNEN) and the organization concerned with the promotion and utilization of nuclear energy for electricity generation (ELETRONUCLEAR) is provided by the structure of the Brazilian Government in this area. While CNEN is linked to the Ministry of Science and Technology (MCT), ELETRONUCLEAR is fully owned by ELETROBRAS, a national holding company for the electric system, which is under the Ministry of Mines and Energy (MME) (see Figure 3).

The structure of CNEN is presented in Figure 4. The main organizational unit involved with the licensing of nuclear power plants is the Directorate for Radiation Protection and Nuclear Safety (DRS), although technical resources can be drawn from any other units in support of some licensing activities. Review and assessment is performed mainly by the Reactor Coordination (CODRE) of the General Coordination for Licensing and Control (CGLC). CODRE is also in charge of regulatory inspection of nuclear power plants, which includes a group of resident inspectors at the Angra site. In the areas of radiation protection and environmental monitoring, technical support is obtained from the Institute for Radiation Protection and Dosimetry (IRD). The necessary regulations and standards are developed by working groups under the coordination of the Norms Service (SENOR).

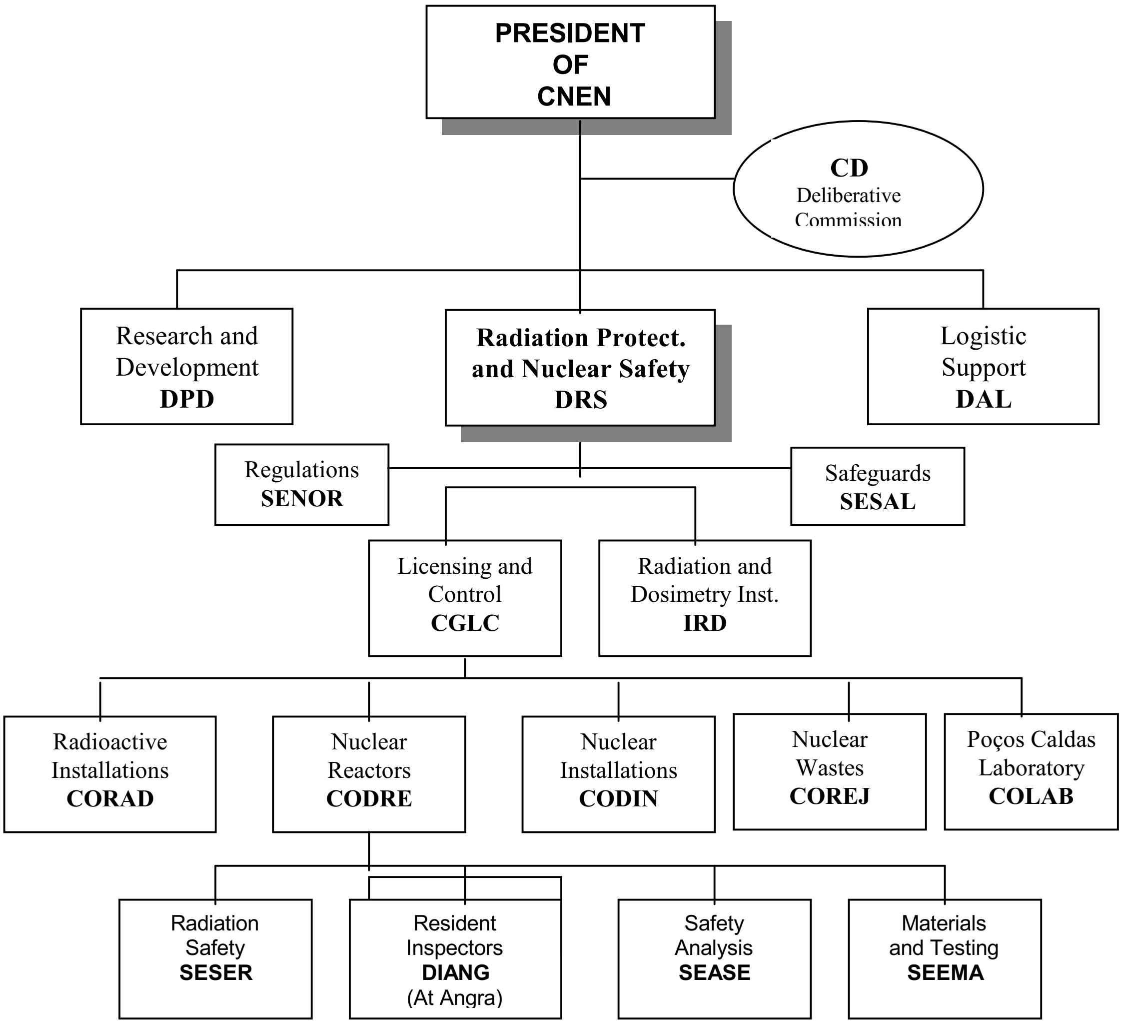


Fig. 4 – CNEN Structure

Adequate human resources are provided to CNEN. A total staff of 2800 people, of which 85% are technical staff, is available at CNEN and its research institutes. Forty eight percent (48%) of the staff are university graduates, 19% having a master degree and 9% having a doctoral degree. CGLC itself comprises 190 people, 150 of which are technical.

CODRE, the unit directly involved with nuclear power plants licensing and control, has a staff of 46, of which 45 are technical, with 16 possessing a doctoral and 17 a master degree in nuclear science or engineering. Presently, 4 persons are involved in a doctorate program and 3 persons are involved in a master program.

The main activities are review and assessment of the submitted documentation, and inspection of licensee’s activities. Inspection activities are conducted on a permanent basis by a group of resident inspectors at the power plant site. For specific inspections and audit activities, support from specialists from headquarters is used. During 2001-2003, CNEN conducted 36 inspections in Angra 1 and 31 in Angra 2. Complementary to field activities, operation follow up is performed also based on licensee reports, as required by regulation CNEN-NN.1.14[9].

CODRE technical staff receives nuclear general training and specific training according to the field of work, including both academic training and courses attendance, technical visits, participation in congresses and national and international seminars.

From the training courses conducted during the year 2003, the "Basic Course for Licensing and Control", during the period of 6 to 31 October must be highlighted.

CODRE personnel also attended, during the year of 2003, 10 external training courses.

Also during the year of 2003, the following technical visits were conducted by CODRE personnel:

- Nuclear Regulatory Commission – NRC (USA);
- Gesellschaft für Reaktor Sicherheit – GRS (Germany);
- Pisa University (Italy).

In the period of 2001 - 2003, CODRE received 3 technical assistance missions from the IAEA.

Financial resources for CNEN are provided directly from the Government budget. Since 1998, taxes and fees are being charged to the licensees, but this income is deducted from the Government funds allocated to CNEN.

Salaries of CNEN staff are subject to the Federal Government policies and administration. Presently there are two important concerns related to technical staff and salaries: i) most of the personnel is at the end of the scale; ii) the salaries are lower than those of equivalent utility personnel. The situation in 2003 became worse due the prices increases (inflation) and no perspective of changes in Government policies for public employees.

3.2.2. IBAMA

The licensing structure of IBAMA is presented in Figure 5. The environmental licensing for nuclear installations is conducted by the Directorate for Licensing and Environmental Quality, more specifically by its General Coordination for Environmental Licensing. This Coordination has a multidisciplinary technical staff of 50 professionals (3 Ph.D., 17 M.Sc. and 15 Specialists), 9 of which are dedicated to the licensing of nuclear power plants (1 Ph.D., 4 MSc, 4 Specialists). There is an effort to adequate this human resources to an increased demand of evaluation in the nuclear area.

For the licensing process of Angra 2, IBAMA works in close cooperation with CNEN in relation with the radiological impact aspects. Both also cooperate with the Rio de Janeiro State Foundation for Environmental Engineering (FEEMA) and the Angra dos Reis Municipal Secretary for Environment.

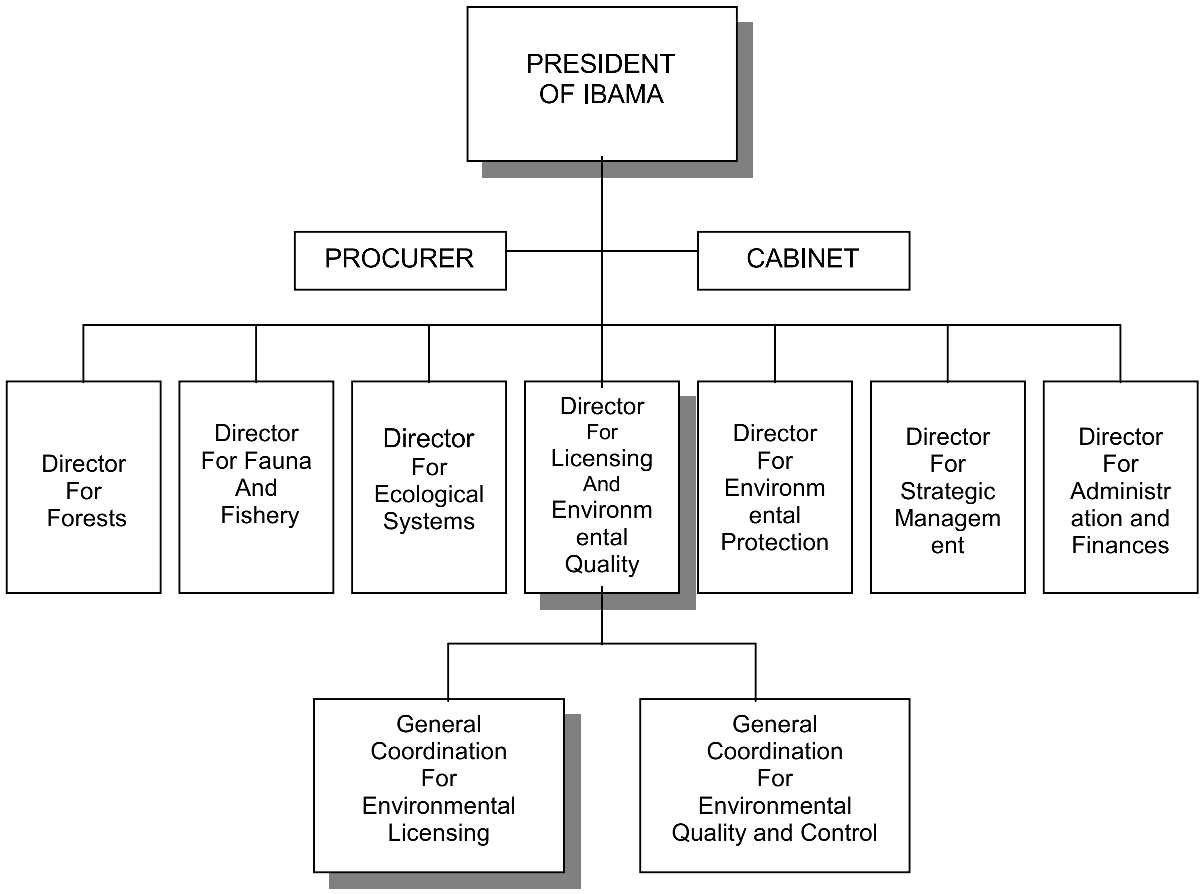


Fig. 5 – IBAMA Structure

3.2.3. Activities, achievements and concerns regarding the improvement of safety

The main concerns are related to the lack of personnel and the high average age of existing qualified personnel. These are expected to be overcome by hiring through national public contests, already under way in 2004. However, this will require a comprehensive training program in all organizations to qualify the new staff and to effectively transfer the knowledge of experience personnel to the new comers.

3.3. Article 9. Responsibility of the licence holder

The Brazilian legislation defines the operating organization as the prime responsible for the safety of a nuclear installation.

Therefore, to obtain and maintain the corresponding licences, the operating organization, ELETRONUCLEAR, must fulfill all the prerequisites established in the legislation, which are translated in regulations presented in Annex 2.

More specifically, the regulation CNEN-NE-1.26 [10] defines the operating organization as the prime responsible for the safety of a nuclear installation by stating:

> "**The operating organization is responsible for the implementation of this regulation.**"

ELETRONUCLEAR, as the owner and operator of the Angra 1 and Angra 2 plants, has issued a company policy stating its commitment to safe operation, which states:

> **"Safety is the priority and precedes production and economics. Safety shall never be jeopardized by any other reason."**

It states further that:

> **"Responsibility for safety is equally shared by all corporate structure – Directors, Advisors, Superintendents, Managers and Divisions Heads. Careless acts or actions by employees do not relieve the responsibilities of their supervisors".**

This company policy statement is fully based on the IAEA INSAG-4 publication on Safety Culture.

The implementation of this policy is based on a program that adopts the concept of Safety Culture, defines safety objectives and establishes requirements, appropriate management structure, resources and self-assessment.

CNEN, through the licensing process, and especially through its regulatory inspection program, ensures that the regulatory requirements for safe operation are being fulfilled by the licensee. The licensee reports periodically to CNEN in accordance with regulation CNEN-NE-1.14 [9]. In addition, CNEN maintains a group of resident inspectors on the site, who can monitor licensee performance on a daily basis. Finally, a number of regulatory inspections by headquarters staff take place every year, focusing on specific topics or operational events.

3.3.1. Activities, achievements and concerns regarding the improvement of safety

Evaluation of safety culture within ELETRONUCLEAR organization was performed by a formal pioneering program with support of IAEA in 2000. The action plan resulting from this evaluation has been implemented in 2001 and has been closely monitored ever since. Also OSART missions have evaluated these aspects of management responsibility and considered adequate, although some improvements were suggested with respect to the high number of minor problems waiting for resolution for long times.

CNEN has also identified this problem through a special inspection, and has requested action by the plant management. However, CNEN monitors closely, but does not want to regulate in detail management activities.

Chapter 4. GENERAL SAFETY CONSIDERATIONS

4.1. Article 10. Priority to safety

4.1.1 At CNEN

CNEN has issued a safety policy[11] and quality assurance policy statements[12] in December 1996, which is based on the concept of Safety Culture. In November 2000, a working group was constituted to coordinate the implementation of this policy in the General Coordination for Licensing and Control. In the beginning, the following activities have been performed: planning meeting with coordinators and supervisors; preliminary proposal of goals and activities, identification of existing procedures and instructions, preparation of a proposal with diagnosis. CNEN has joined the Program of Quality for Public Services. However, further activities were not undertaken due to lack of support and commitment by previous administration at the end of previous Government mandate. The new CNEN directorate has not yet taken a firm action with respect to implementation of the existing policies.

CNEN has established in its regulatory standards requirements to be met by the applicants or licence holders based on safety principles, defense-in-depth and ALARA concepts, quality assurance and human resources management. According to regulation CNEN-NE-1.26 [10] the licensee shall establish an organizational structure with qualified staff and managers to deal with technical and administrative matters using principles of a Safety Culture.

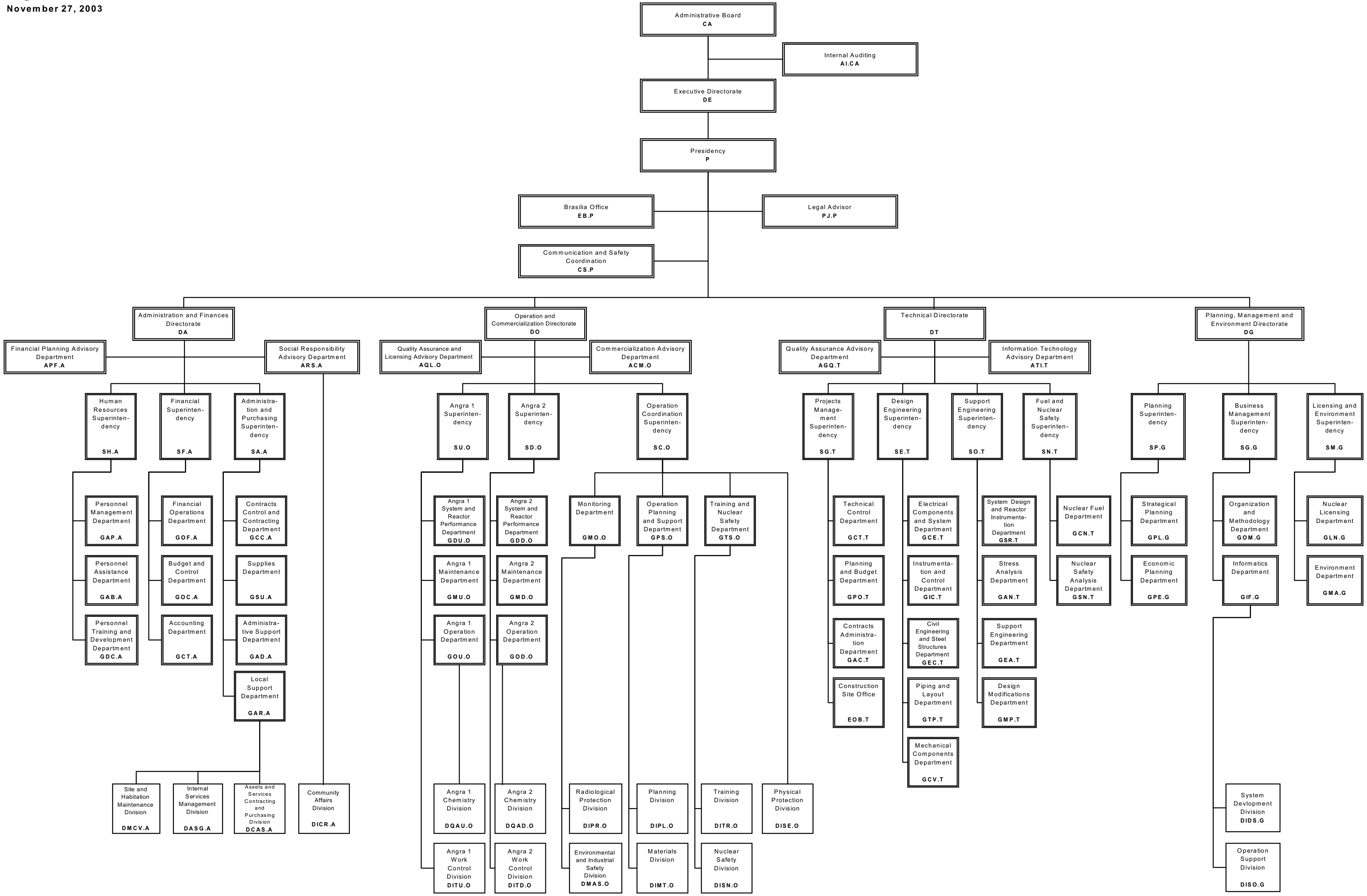
4.1.2. At ELETRONUCLEAR

ELETRONUCLEAR is a company resulting from the merger of the nuclear portion of the electric utility FURNAS and the nuclear design and engineering company NUCLEN, both with more than 20 years of experience in their field of activities. Both companies had already policies aiming at giving priority to nuclear safety. The current organization structure of ELETRONUCLEAR is presented in Figure 6. There were modifications in relation to the organization chart presented in the previous National Report, basically to account for the new company priorities with the end of construction and continuous operation of the Angra 2 Plant.

ELETRONUCLEAR

Organization Chart

November 27, 2003



At the time of the merger, one of the first acts of the new company ELETRONUCLEAR was the approval by the Board of Directors of a document establishing formally the company priority to safety policy. As mentioned in section 3.3, the safety policy statement establishes that "**Safety is the priority and precedes production and economics. Safety shall never be jeopardized by any other reason**."

To ensure that this policy is observed consistently, ELETRONUCLEAR has established a supervisory committee, Committee for Nuclear Operation Analysis (CAON), with the responsibility to review and approve all important aspects related to the plants safety. The members of this Committee are the Plants Managers and the Heads of Engineering, Safety, Licensing, Quality Assurance and Training, under the coordination of the Site Superintendent (SC.O). The CAON meets regularly once a month.

In practice, even if the resources are available, a safety police can only be fully effective if all employees are aware and convinced that safety is the priority. By its own initiative ELETRONUCLEAR has engaged, since beginning of 1999, in a pioneer program of "self assessment" of the safety culture of the company, with the support of the IAEA**,** following the guidelines of the IAEA documents, Safety Series No. 75, INSAG-4, "Safety Culture", Safety Report Series No. 11, "Developing Safety Culture in Nuclear Activities". The assessment was completed by the end of 2000. A satisfactory overall safety culture level was obtained, as the average of all safety culture aspects considered in the survey. However some safety culture aspects were identified as only regular. In mid 2001 the development of an action plan for enhancement of the safety culture aspects considered below satisfactory was completed. This action plan has been implemented and its development is being followed up since end of 2001.

Internal and external reviews are also a frequently used means to verify compliance with priority to safety at ELETRONUCLEAR. At about every three years each plant has been submitted to an OSART or WANO peer review (see section 5.3.7).

Self assessments have been performed in most of the Operation Directorate organizational units.

Following the line of the merged companies , a strong Quality Assurance (QA) unit was established at ELETRONUCLEAR, from the beginning in 1997, at the level of superintendency, with the responsibility of monitoring all design, construction and operation activities and co-ordination/supervision the plants nuclear and environmental licensing. This superintendency responded formally to the Technical Director at headquarters. With start of operation of the second Plant, in December of 2000, it was identified the need of a Quality Assurance unit inside the Operation organization. To meet this need the original QA superintendency was split in two units in 2003, one at headquarters, under the Technical Director and one on site, under the Operation and Production Director (see ELETRONUCLEAR Organization Chart, Fig. 6). To ensure the necessary independence of the QA activities, the QA unit at headquarters audits the QA unit on site(more details are given in section

4.4).

4.1.3. Activities, achievements and concerns regarding the improvement of safety

As discussed above the operating organization ELETRONUCLEAR has established a clear policy of priority to safety and provided the means to verify its implementation.

In particular the start, development and application of a comprehensive safety culture assessment and enhancement program was rather unique at the time. As a result of this, the IAEA decided to hold an International Conference on Safety Culture Programs for NPPs, in Brazil, in the city of Rio de Janeiro, in December of 2002, with ELETRONUCLEAR as the co-host.

The safety culture enhancement program has became a permanent program at ELETRONUCLEAR. The results of this program have been recognized internationally, at the above referred conference and in the Angra 2 and 1 OSARTs, in 2002 and 2003 respectively, where safety culture was considered a strong point of the respective Plant organizations.

However, concerns still exists relating to the large number of minor items waiting for closure for long time. These refer to both internal findings as well as CNEN requirements. This situation has lead to a delay of issuing a Authorization for Permanent Operation (AOP) for Angra2, for almost 4 years.

4.2. Article 11. Financial and human resources

4.2.1. Financial resources

As a governmental enterprise, ELETRONUCLEAR has its financial situation subjected to the holding company ELETROBRAS, which controls all federal electric utilities in Brazil. Its basic source of revenue comes from the selling electricity, originally the energy from Angra1(626 MW of net capacity) and since September of 2000, of Angra 1 plus Angra 2 (1901 MW of net installed capacity) through a long term energy supply contract ending in 2014, at a guaranteed minimum tariff, which today is of 78.41R$/MWhr (~26 US$/MWhr). This long-term contract is not subjected to the ongoing liberalization of the Brazilian electricity market.

As indicated in the previous National Report, adequate funds for operation and maintenance of Angra 1 and Angra 2 plants continue to be made available through the annual budget, which includes the plants upgrading program. For the sake of illustration the ELETRONUCLEAR budget for the year 2003 was about 207 million US dollars, split as follows:

Table 3. ELETRONUCLEAR Budget for 2003

Primary Costs	**In million US$**
Personnel (salaries + benefits)	66
Other costs (subcontractors, insurance, Office rent, equipment, consumables, etc.)	79
TOTAL	**147**
Investment	
Angra 1 (O&M, fuel and upgradings)	21
Angra 2 (O&M, fuel and upgradings)	35
Angra 3 (engineering)	2
Infrastructure	2
TOTAL	**60**

The reduction in investment, relative to the budget reported in the previous National Report (170 million US$ compared to the present 60 million US$) reflects the end of construction of the Angra 2 Plant.

Feasibility studies for restart of Angra 3 project estimated total investments for plant completion about US$ 1.7 billion, US$ 1.1 billion for supplies and services in the Brazilian scope and US$ 0.6 billion for the import scope. The import scope is connected with the supply and service contracts, transferred from SIEMENS A.G. to FRAMATOME A.N.P. Financing possibilities for the Brazilian scope are under evaluation in connection with the definition of the contractual arrangement with main suppliers to support the project.

The provision of funds for decommissioning activities is to be obtained from ratepayers, and is included in the tariff structure, during the same period of depreciation of the plants (3.3%/year). The decommissioning cost are presently estimated in 200 million dollars for Angra 1 and 240 million dollars for Angra 2.

4.2.2. Human resources

Adequate human resources are available for ELETRONUCLEAR from its own personnel or from contractors. Currently ELETRONUCLEAR has a total of 1945 persons on its permanent staff and a few long-term contractors which supply additional personnel. At present there are 251 subcontracted persons working for ELETRONUCLEAR, down from the 457 reported in the previous National Report. Of the 1945 ELETRONUCLEAR employees 741 (38%) have a university degree, 936(48%) are technicians and the remainder 268 are administrative personnel.

About 500 new employees have been hired by ELETRONUCLEAR in 2001-2003 to fill in different positions in the organization, to compensate for the personnel to be retired or left the company in the same period.

As it happened worldwide in the nuclear industry ELETRONUCLEAR work force is aging. Furthermore, a considerable number of experienced personnel was lost due to Government early retirement policies. New people had been hired but they need time and adequate training to acquire the required experience.

With the aim at identifying, in a systematic and formalized way, the know-how still existing in the company, a project was organized in 2001 called "Determination of the Technological Know-how of ELETRONUCLEAR".

The first phase consisted in the identification of the extent and location of the existing know-how, with existing and future gaps in the essential know-how being identified and evaluated. The results of the know-how survey are stored in an electronic data bank, which facilitates preparation of several types of reports, according to various criteria.

A second phase was performed in 2002, involving an in-depth analysis of the results of the survey. Proposals for solutions to fill in the know-how gaps were set up, comprising both a short-term and a long-term time-frame.

A third phase is under way (2003/2004), consisting of measures to establish Knowledge Management (KM) as a permanent activity in the Company. In particular, methods to elicit tacit knowledge from departing (e.g. retiring) experts are being developed.

Although the work was performed with ELETRONUCLEAR own staff, discussions with persons and institutions acquainted with this relatively new field, especially in the nuclear area, were very important for the implementation of the project. In particular, cooperation with EPRI (Electric Power Research Institute, USA) and IAEA, Division of Nuclear Power, was very instrumental to the attainment of its objectives.

ELETRONUCLEAR has participated in the preparation, by IAEA, of a TECDOC and a Guidance Document on Knowledge Management in the nuclear area [13],[14], which was very beneficial as exchange of experience with several other nuclear organizations in the world.

As a continuation of the basic KM work described above, now applied to the determination of detailed personnel necessities, a method was developed and used called the Competence Tree method [15]. Its objective is to represent, archive and use "intellectual competencies". A computerized system was applied to the practical case of determining personnel needs in the Technical Directorate, to fill in competencies which were being lost.

4.2.2.1. Training of plant personnel

Activities related to qualification, training and retraining of plant personnel are performed by the Training and Simulator Department of ELETRONUCLEAR, which reports to the Site Superintendent (Plant Coordination Superintendent in Fig.6).

Three facilities are available for training in the residential village close to the plant: a general training center, a training simulator for Angra 2, and a maintenance training center.

Angra 1 has no plant simulator on site. Operators for Angra 1 are trained in simulators of similar plants in the USA (Ginna Simulator), Spain (Tecnatom Simulator) and, more recently in Slovenia (Krsko Simulator).The installation of a full scope specific simulator for Angra 1 by 2004, as informed in the previous National Report[4], was delayed in 2001, by decision of ELETRONUCLEAR management board. The company decision was to condition acquisition of the simulator to the solution of the SG replacement issue (See section 5.3). Presently Angra 1 SG replacement decision was taken and the SG fabrication contract was placed in end of May, 2004. The restart of the simulator acquisition process in parallel or after SG replacement will be defined after clarification of availability of resources.

A full scope simulator for Angra 2 is available for training. Since the beginning of 1985 practical training of Brazilian specialists is being conducted. Due to the long delay in the Angra 2 construction schedule, a program for selling simulator training services was set up and pursued until restart of training of Angra 2 personnel, in 1995. Instructors from ELETRONUCLEAR have also ministered classroom and practical training for operators, managers and licensing specialists from Germany, Spain, Argentina and Switzerland. The first group of Angra 2 control room operators was licensed in the beginning of 2000, and up to now 44 operators have been qualified.

Simulator training load is at least 60 hours per year for each individual. The composition of control room teams is specified in plant administrative procedures. The minimum control room team comprises a Shift Supervisor (who must hold a current Senior Reactor Operator - SRO licence), a Shift Foreman (also a SRO), a Reactor Operator (who must hold a Reactor Operator – RO licence) and a Balance of Plant Operator (also a holder of a RO licence). Although not required by CNEN, all Angra 1 and 2 Shift Supervisors are graduated engineers with five years of academic education.

The requirements for organization and qualification of the entire Angra 1 and Angra 2 staff are established in Chapter 13 of the respective FSAR. Implementation and updating of these requirements are subject of CNEN audits of the licensee training and retraining program and examination of new operators to comply with the regulations NE1.01 [8] and NE-1.06 [16].

It is an internal policy of the Operation and Production Directorate to occupy important management positions at the plants with licensed or former licensed operators. In particular, the Plant Manager, the Deputy Plant Manager, the head of Operation Department, the head of Technical Support and the head of the Safety Team are currently licensed SROs or have previously held a SRO licence. The Radiation Protection Supervisor holds a special licence issued by CNEN, according to regulation CNEN-NE-3.03[17].

Specialized training is also provided to the personnel working in the different plant disciplines. Maintenance technicians follow a qualification program corresponding to their field of activity. Chemistry and radiological protection technicians follow extensive on-the-job training on a yearly basis aimed at a continuous updating of basic concepts learned during their initial technical training. The fire brigade and security personnel are trained according to the requirements established by related CNEN regulations.

Technical visits and reviews of ELETRONUCLEAR training program and training center by experts from the International Atomic Energy Agency (IAEA), the Institute for Nuclear Power Operation (INPO) and the World Association of Nuclear Operators (WANO) have provided valuable contribution to the identification and implementation of good practices for enhancing the quality of the training activities. One such good practice resulting from external review recommendation was the start in 2002 of a long term Systematic Approach to Training (SAT) program. To date the Chemistry and Maintenance departments of both Plants are involved. The remaining Plants areas will join the program gradually, depending on the availability of qualified personnel to work on SAT process development for the respective disciplines.

CNEN monitors the adequacy of the human resources of the licensee through the evaluation of its performance, especially through the analysis of the human factor influence on operational events. The training and retraining program is also evaluated by CNEN within the licensing procedure and through regulatory inspections.

In the specific case of reactor operators, CNEN has established regulations related to their authorization[8] and their medical qualification[16]. CNEN conducts written and practical examinations for Reactor Operators and Senior Reactor Operators before issuing each individual authorization.

During the period 2001-1003, for Angra 1 power plant, 10 new operator license have been issued and 53 licenses have been renewed. For Angra 2, in the same period, 19 new licenses have been issued and 29 renewed.

Radiation Protection Supervisors certification is done in accordance with regulation CNEN – NN 3.03 “Certification of the Radiation Protection Supervisor Qualification”[17]. With the beginning of Angra 2 commissioning tests, Radiation Protection Supervisors had to be trained for their qualification also in this unit. In 2001-2003, 4 new Radiation Protection Supervisors were qualified for Angra 1 and Angra2.

4.2.3. Activities, achievements and concerns regarding the improvement of safety

Regarding human resources, due to more flexible policies concerning staffing of Government owned companies in beginning in the late nineties, ELETRONUCLEAR has been able to hire new personnel to compose the Angra 2 staff and replace partially losses by retirement of Angra 1 personnel. Some of this retired operators were re-hired as external personnel. An intensive training program for preparation of new operators has been put in place for both plants. Presently Angra 2 has already its 6 shifts composed of ELETRONUCLEAR employees. The goal is to have enough licensed operators to cover not only the shifts but also other important operation tasks all with ELETRONUCLEAR employees.

One important activity for improvement of plant personnel training has been the launching of a Systematic Approach to Training (SAT) program planned to cover all the plants areas.

The Knowledge Management (KM) program can be considered a highlight because, as for the Safety Culture program, it was a pioneer effort by ELETRONUCLEAR. The systematic identification of the company human resources situation has been an important output of this program.

One concern has been the systematic loss of young well trained personnel to the oil industry, which is requiring more hiring and training effort than expected.

Regarding financial resources, the main concern refers to the lack of a formal legislation related to the provision of decommissioning funds, although ELETRONUCLEAR has voluntarily established such reserves based on international practices.

4.3. Article 12. Human factors

Angra 1 was designed at a time when human factors were not formally and systematically taken as a prime issue in nuclear safety. Following the accident at Three Mile Island, and still before commencement of operations, a critical review of plant design with respect to man-machine interface was undertaken. This resulted in numerous modifications in the control room, including the installation of the Angra 1 Integrated Computer System (SICA) which encompasses a Safety Parameter Display System (SPDS) for monitoring critical safety functions.

New process computer (more variables acquired) and improved SPDS has been installed in 2002.

At the same time, plant emergency operating procedures were greatly improved in their format, which now incorporate double columns, the left one with the expected action and the right one with actions to be taken in case of inadequate response.

Later on, human factors were considered in a much broader sense and several management initiatives were undertaken in this area, such as a program for team-work training and a Human Performance Enhancement System (HPES).

Training related to Safety Culture aspects was also undertaken using IAEA guidelines.

CNEN also established in the Regulation NE-1.26 [10] requirements for the Periodic Safety Review (PSR) which considers human factor as an important area of review. For Angra 1, the PSR underway will review and assess the situation in areas of I&C and man-machine interface.

For the Angra 2 plant, CNEN has required during the licensing process that an additional chapter 18 be included in the FSAR, addressing the Human Factor Engineering (HFE). The content and format of this new chapter was based on the guidance framework of chapter 18 of the Standard Review Plan (NUREG 800 - 1996 Revision), which defined the nine areas of human factor review by an HFE management group in accordance with NUEREG 711. The licensee has made a comprehensive review of the operational experience of German plants, Angra-1 and other plants. It has been also established the HFE Committee as part of the organizational structure, with the main responsibility to review the internal and external operational experience according to the nine areas of human factors and to approve any proposed man-machine interface modifications during the plant operational lifetime.

A main control room HFE analysis was performed by an external contractor during 2001 Angra 2 outage. The purpose of this analysis was to identify man-machine interface problems and to propose improvements in the control room. As example of the improvements of the man-machine interface that have been introduced in the original design, it may be mentioned the computer system to monitor the Critical Safety Functions(CSF). Also as a result from this HFE evaluation, the main control room was modified to limit unnecessary access and avoid access of non-shift personnel to the panel areas.

ELETRONUCLEAR has elaborated Chapter 18, Human Factors Engineering (HFE), according to the philosophy recommended by NUREG-711. Consequently the HFE Programme now being implemented has the purpose of assuring that the plant operational events will be evaluated following procedures which take due account of human factor aspects.

However, ELETRONUCLEAR has not answered completely the remaining licensing requirements related to the HFE. Therefore, there is a considerable delay in the procedures evaluation in terms of a HFE Program.

Still in the premises of the behavioural science, as already mentioned in item 4.1, ELETRONUCLEAR was engaged along 1999 and 2000, in a pioneering experience of self-evaluation of its safety culture. Based on the self assessment results a Safety Culture Enhancement Program was started in 2001. This program has become a permanent program at ELETRONUCLEAR, with visible results confirmed by international review (see section 4.1.3).

4.3.1. Activities, achievements and concerns regarding the improvement of safety

The activities related to Human Factor Engineering (HFE) can be considered a highlight in this area. The preparation of Chapter 18 of the FSAR was a good accomplishment in the period.

There remains some concerns over the delay in the implementation of a few recommendations of the study.

4.4. Article 13. Quality Assurance (QA)

The requirements for quality assurance programs for any nuclear installation in Brazil are established in the respective licensing regulations. Specific requirements for the preparation and implementation of programs are fully described in the Standard CNEN-NN-1.16 “Quality Assurance for Safety in Nuclear Power Plants and Other Installations”[18], which follows the IAEA recommendations, with the addition of the concept of independent inspection and expertise.

ELETRONUCLEAR has established its quality assurance program for Angra 1 and Angra 2, in accordance with the above mentioned requirements and with the Standard CNEN-NE-1.26 “Safety in The Operation of Nuclear Power Plants”[10]. The corresponding procedures have been developed and are in use. The program provides for the control of activities which influence the quality of items and services important to safety as: design, design modifications, procurement, fabrication, handling, shipping, storage, erection, installation, inspection, testing, commissioning, operation, maintenance, repair and training. The quality assurance program is described in Chapter 17 of the FSAR.

In June 1st, 2003 ELETRONUCLEAR organization chart was modified(See Fig.6). The departments responsible for Nuclear Licensing, Environment Management, and Quality Assurance, which before belonged to a same Superintendence, were separated. Aiming a stronger and more flexible structure, the new organization, instead of one Quality Assurance Department reporting to the level of Superintendence, comprises two Quality Assurance Advisory Departments, one of them, the Institutional Unit, located in Rio de Janeiro (AGQ.T), directly reporting to the Technical Directorate, and the other, (AQL.O) located in the site of the Plants, directly linked to the Operation and Commercialization Directorate.

Both Advisory Departments, according to its respective attributions established in proper documents, are responsible for the verification of implementation of ELETRONUCLEAR Quality System, by means of internal and external audits which are performed in accordance with written procedures. In the case of internal audits , persons involved in the activities being audited do not take part in the audit team. Audit reports are formally distributed to the organizations responsible for the areas object of the audits as well as to the Committee for Nuclear Operation Analysis (CAON).

CAON is a collective body under coordination of the Operation and Commercialization Directorate, whose purpose is to examine, follow-up and analyze issues concerning Angra 1 and Angra 2 operational safety and to recommend measures to improve safety. Furthermore, each Plant Superintendence (SU.O for Unit 1 and SD.O for Unit 2) coordinates a Plant Operation Review Committee (CROU), whose responsibility is to review and analyze, on a closer basis, questions related to the operation of the Units 1 and 2.

Audits and inspections by CNEN verify that quality assurance requirements are being implemented and that the quality assurance has been effective as a management tool to ensure safety. During the same period of 2001-2003, CNEN conducted 36 audits or regulatory inspections in Angra 1 and 31 in Angra 2.

4.4.1. Activities, achievements and concerns regarding the improvement of safety

In 2003 Angra 1 Superintendence (SU.O) received the National Prize for Public Management in the Silver Category for public companies, and the Rio Quality Prize of 2003 in the Silver Category. Angra 1 received also the Gold Trophy of the internal ELETRONUCLEAR Quality Prize – 6^{th}. Edition.

In spite of this, CNEN has monitored closely the quality assurances activities of Angra plant, trying to focus more on results than on the formalities. Special audits where carried out where quality aspects were discussed directly with the plant management , rather than with the QA group. These have identified some problems related to the lack of a grading system for the findings, both from CNEN inspections and ELETRONUCLEAR internal QA audits, a consequent lack of prioritization of their resolution, and a consequent long time for the closing of minor problems.

4.5. Article 14. Assessment and verification of safety

A comprehensive safety assessment is a requirement established by the licensing regulation in Brazil[6].

For the Angra 1 and Angra 2 plants, both a Preliminary Safety Analysis Report (PSAR) and a Final safety Analysis Report (FSAR) were prepared. The FSARs followed the requirements of US NRC Regulatory Guide 1.70 - Standard Format and Contents for Safety Analysis Report of LWRs. These reports were reviewed and assessed by CNEN, and extensive use was made of the US NRC - Standard Review Plan (NUREG - 800).

For Angra 1, after 10 years of commercial operation, Periodical Safety Review (PSR) is due, according to CNEN regulations [10]. About two years of preparatory work were spent gathering and evaluating international experience on the subject before the final approach was selected.

The PSR is being performed in-house based on the pertinent IAEA guidelines and international experience from similar plants in Spain and Slovenia, with initial guidance from an external experienced expert.

ELETRONUCLEAR has submitted to CNEN in beginning of 2004 the set of technical instructions to be used in the elaboration of the PSR Report. ELETRONUCLEAR has 18 months to conclude the PSR, by July 2005. The safety factors being evaluated are: Plant design; systems, components and structures conditions; equipment qualification; aging; safety analyses (deterministic and probabilistic);risks analysis (hazards); operational experience (national and international); organization and administration; human factors; procedures; emergency preparedness; and radiological impact in the environment.

For the Angra 2 plant, the licensing process was started in accordance to the German licensing procedure. Such process foresaw a series of partial approvals. For each step, a large amount of the actual design and licensing data being supplied for analysis to the Brazilian licensing authorities. No comprehensive licensing document such as a PSAR was adopted in this procedure . This approach turned out not to be practical; CNEN had already licensed Angra 1, along the line of USNRC procedures. It judged that to use two different approaches for licensing would be too time and resources consuming. Accordingly, it requested to have a FSAR following US NRC Regulatory Guide 1.70, to be able to use the Standard Review Plan methodology as done for the first plant. Preparation of an FSAR for Angra 2 was a major task, which involved extensive adaptation and revision work internally and extensive exchange of information with CNEN. Along the licensing period CNEN has submitted approximately 800 requests for information, which were answered by ELETRONUCLEAR. Through such a review, optimization of safety calculations, clarification of limit conditions of operation, and other relevant matters have been addressed. As far as applicable, the FSAR has been revised to incorporate the modifications derived from these improvements. On the basis of this revision ELETRONUCLEAR was granted the Authorization for Initial Operation.

The safety assessment, with the purpose of demonstration of the adequacy and safety of the plant design bases, included both deterministic and probabilistic approaches to safety analysis. The deterministic approach followed the traditional western methodology of using qualified, internationally accepted, conservative computer codes and assumptions for the analysis of a large set of postulated events, established in national/international guides and regulations, ranging from minor transients to a large loss of coolant accident (LOCA).

An exception to the above referred conservative approach is the Angra 2 large break LOCA Analysis. Based on the extensive Large Break LOCA research and development in recent years and evolution of the regulatory requirements, ELETRONUCLEAR has submitted to the Brazilian regulatory body a LB-LOCA analysis performed with the latest analysis tools and methodology, that is, use of a “best estimate code” of the RELAP5 MOD2 family, coupled with uncertainty evaluation. This analysis has been evaluated by CNEN through an independent calculation performed with the support of a contract with the University of Pisa.

ELETRONUCLEAR answers to the CNEN additional questions are being analyzed and a technical report is being prepared for the Authorization for Permanent Operation (AOP).

Although a full Probabilistic Safety Assessment (PSA) was not a formal licensing requirement at the time, a preliminary level 1 study was performed in 1983/85 for Angra 1 using generic plant data. This study indicated a strong contribution of the reliability of the Emergency Diesel-Generator system to the total risk, which supported the decision to install two additional Diesel-Generator sets at Angra 1. Additionally, the surveillance interval of seven check valves of the High Pressure Safety Injection (HPSI) system was reduced, to increase system reliability, and therefore reduce this system contribution to the total risk.

A new study, was concluded in 1998 (revision 0) and revised in 2000 (revision 1), consisting of a detailed level 1 PSA, for the Angra 1 plant, in accordance with the methodology described in NUREG/CR-2300, "PRA Procedures Guide". This study was partially evaluated by CNEN, with the assistance of IPEN staff, and several new requirements were sent to ELETRONUCLEAR in 2003.

Several important findings, leading to upgrading of plant hardware and operational procedures, arose from this second PSA study.

The implementation of hardware and/or procedural measures, originated from the results of the above referred PSA study, led to a considerable reduction of the calculated Angra 1 Core Damage Frequency (CDF), down to the range of 10^{-5} per reactor.year.

This PSA is being continuously updated with new plant data and revised to incorporate advances in modeling. Revision 2 started in 2002 and by now a revision 2d is completed. The main difference in this version is the incorporation of a state of the art model for analysis of the behavior of the pump seals in case of total loss of cooling. This led to an increase of the integral CDF from 3.5E-5/year to 4.7E-5/year and to an increase of the contribution of the initiating events "Loss of external power" and "station blackout" to the integral CDF.

As a further application, the Angra 1 level 1 PSA was used to support the development of the Maintenance Rule in agreement with the NUMARC 93-01 Revision 2. Also a plant configuration control based on the risk rate (CDF) and the weekly cumulative risk (CDP) is being used for on-line maintenance planning.

The PSA program reported in the previous National Report[3], prepared based on international experience and expert recommendation, foresaw performance of several studies for both plants in a relatively short time. This proved not to be feasible. Following re-evaluation of the ELETRONUCLEAR PSA program, the planned PSA studies for both plants have been reprogrammed.

For Angra 1, in the 2004 – 2007 period, the program will concentrate efforts to improve and update the level 1 PSA and performance of a Fire Analysis PSA to be performed by an external contractor.

A preliminary evaluation of the Angra 2 core melt frequency as well as the probabilistic analysis support for development of Accident Management countermeasures and other evaluations requiring probabilistic insight, have been done taking the German Risk Study (DRS) as well as PSA results of German sister plants, as a basis, and adapting their models for the main design differences between these plants and Angra 2. The validity of this approach is based on the similarity of the plant designs all belonging to the standard 1300 Mwe German PWR design, as indicated in section 2.1.2.1.

The estimated Angra 2 core damage frequency (CDF) for internal events, obtained from this approach is on the range of 10^{-6} /reactor.year, compatible with the CDFs for 6 German sister plants, all in the 1 to 3 x 10^{-6} /reactor.year range.

An international bidding process to award a contract for performance of a level 1+ PSA for Angra 2 is under way. This study is expected to start by end of 2004 and be concluded in 2007.

4.5.1. Activities, achievements and concerns regarding the improvement of safety

A concern is a lack of a complete PSA for Angra 2, a problem which will be solved only in the future.

Also, the Angra 1 PSA has not been formally approved by CNEN. This has limited its use for solution of some licensing issues, such as modifications of Technical Specification for Operation.

However, the daily use of Angra 1 PSA in several operational decision has increased in recent years, what can be considered a good improvement. The use of PSA for on-line maintenance planning was considered a good practice in the recent Angra 1 OSART mission.

4.6. Article 15. Radiation protection

Radiation protection requirements and dose limits are established in Brazil in the regulation for radiation protection[19]. These require that doses to the public and the workers be kept below established limits and as low as reasonably achievable (ALARA).

Implementation of this regulation is performed by developing the basic plant design in accordance with the ALARA principle and through the establishment of a Health Physics Program at each installation. Plant design is assessed at the time of the licensing review and by evaluating the dose records during normal operation.

The Health Physics Program of Angra 1 and Angra 2, included in the Final Safety Analysis Reports, sets forth the philosophy and basic policy for radiation protection during operation. The highest level policy is to maintain personnel radiation exposure below the limits established by CNEN and to keep exposures to as low as reasonably achievable (ALARA), taking into account technical and economical considerations.

The annual dose limits to workers are 50 mSv for effective dose equivalent and 500 mSv for dose equivalent for individual organs and tissues, except in the case of the eye lens whose limit is 150 mSv. For women of reproductive capacity the doses are limited to 10 mSv in any quarter of year and, if they should become pregnant, the limit is reduced to 1mSv for the entire gestation period. These limits are in accordance with CNEN regulations, with applicable labor legislation which has endorsed CNEN limits, and with the international Convention n. 115 of the International Labor Organization (ILO) to which Brazil is a Party.

The actual personnel radiation doses at Angra Nuclear Power Plants are much lower than the established limits. The dose distribution for workers at the Angra site demonstrates an adequate radiological protection program, with almost all averaged annual accumulated individual doses below 5 mSv and no one with radiation dose above the annual administrative dose limit (20 mSv). The annual collective dose for the last 3 years has usually been lower than 1,30 Man.Sv and 0,20 Man.Sv, respectively during a year with and without outage. The collective dose for Angra 1 in 2003 was 1,846 Man.Sv due to extra work related to Eddy current tests, installation of nozzle dams and inspection in the seals of main coolant pumps. For Angra2 the collective dose was just 0.173Man.Sv. The actual dose distribution for the year 2003 is shown in Table 4.

All doses in Angra 1 above 5 mSv were planed doses related to planed maintenance activities, except for 2 cases of higher doses (10,8 mSv and 22,7 mSv) related to an event occurred during the 12th refueling, where 2 workers entered a restricted area during an inspection without the appropriate supervision.

Table 4. Distribution of Effective Equivalent Doses in 2003

Dose range (mSv)	Number of workers	
	Angra 1	Angra 2
≥ 0,00 < 0,20	804	1388
≥ 0,20 < 1,00	374	229
≥ 1,00 < 2,50	255	22
≥ 2,50 < 5,00	150	2
≥ 5,00 < 7,50	61	0
≥ 7,50 < 10,00	16	0
Total workers:	***1660***	***1641***
Average Dose (mSv):	***1,212***	***0.106***

Release of radioactive material to the environment is controlled by administrative procedures and kept below CNEN established limits, in accordance with administrative procedures. Additionally, the amount of radioactive waste and the radioactive effluents discharged to the environment also follow the ALARA principle.

Those limits are in accordance with the limits fixed in the Offsite Dose Control Manual (ODCM), approved by CNEN. In this manual, the dose for the hypothetical critical individual is calculated.

According to the CNEN regulation[9], an Effluents Releasing and Wastes Report is issued every semester, documenting the liquid, gaseous and aerosol effluents: batch number, present radionuclides and concentration, waste quantity and type sent to the repository and the meteorological data in the period. Also, the effective equivalent dose for the critical individual is presented. In the period of 2001-2003, this dose reached the average 4×10^{-3} mSv, which is much lower than the 1 mSv value established in regulation CNEN-NE-3.01[19].

IBAMA also monitors the impact of the plants on the environment through a system of inspection in which the State Foundation for Environment Engineering (FEEMA) and the Prefecture of Angra dos Reis also participate.

A plant ALARA Commission composed of different groups (Operation, Maintenance, Chemistry, System Engineering and Radiation Protection) is in charge of implementing and monitoring the ALARA Program that describes procedures, methodologies, processes, tools and steps to be used in planning the work. The ALARA Program is continuously being revised and represents the best effort to minimize occupational doses.

A Radiological Environmental Monitoring Program, based on CNEN requirements, is conducted by ELETRONUCLEAR to evaluate possible impacts caused by plant operation. This program defines the frequency, places, types of samples (sea, river, underground and rain water, fish, beach sand, marine and river sediments, algae, milk, grass, airborne, banana and soil) and types of analyses (gamma spectrometry, beta counting and tritium) and types of analyses for the survey of exposure rates. The evaluation of exposure rates is also made by direct measurement using thermoluminescent dosimeters distributed in special sectors around the Angra site, and at points located in the nearest villages and cities. The results of the monitoring program are compared with the pre-operational measurements taken, in order to evaluate any possible environmental impact. Annual reports are presented to CNEN. To date essentially no impact has been detected. Typical results are presented in Table 5.

Table 5 – Environmental Monitoring Program Results for 2001-2003

	Year		
	2001	**2002**	**2003**
	Measured values in mSv/30 days (E-2)		
I – Impact Area	9.22	10.9	9.93
C – Control Area	7.50	12.13	9.30

Control Area: 39 measuring points within 10km radius from the plant
Impact Area: 4 measuring points beyond 10 km radius from the plant.

The average values for the Impact and Control areas measurements are statistically equivalent, indicating the absence of radiological impact from the power plants. Furthermore the initial operation of Angra 2, beginning in January, 2001, brought no increase whatsoever to the monitored local radiation values, when comparing the measured values for periods 1998 to 2000[4] and 2001 to 2003.

4.6.1. Activities, achievements and concerns regarding the improvement of safety

As mentioned in previous National Report [4] CNEN intended to revise the existing Regulation NE 3.01 Basic Radiation Protective Directives to adequate it to the new recommendations of the IAEA Basic Safety Standards for Radiation Protection (Safety Series N.115 of 1996).

The work of the standard review group has proceeded in the period, but a new regulation has not yet been issued, due to the complexity of the proposed modifications and their possible impact on the existing practices.

However, as reported in previous National Reports, some of the new concepts and limits of BSS have already been implemented in practice and through other regulations such as the control of X-Ray installations by the Ministry of Health.

4.7. Article 16. Emergency preparedness

The planning basis for on- and off-site emergency preparedness in case of an accident with radiological consequences in the Angra Nuclear Power Station is based on the Emergency Planning Zone concept.

The Emergency Planning Zone (EPZ) encompasses the area within a circle with radius of 15 km centered at the nuclear power plants. This EPZ is further subdivided in 5 smaller zones with borders at approximately 1.5 , 3, 5, 10 and 15 km from the power plants.

4.7.1. On Site Emergency Preparedness

The On-site Emergency Plan covers the area of property of ELETRONUCLEAR, and comprises the first zone (up to ~1,5 km from the power Plants). For these area, the planning as well as all actions and protection countermeasures for control and mitigation of the consequences of a nuclear accident are of ELETRONUCLEAR responsibility.

Specific Emergency Groups (Power Plants- Units 1 and 2, Support Services, Head Office and Medical) under the coordination of the Site Superintendent or his deputy are responsible for the implementation of the actions of the On-site Emergency Plan. Emergency Centers for coordination of the Emergency Plan activities, equipped with redundant communication systems and emergency equipment and supplies are established in different locations inside this area.

A redundant meteorological data acquisition and processing system composed of 4 meteorological towers, provides continuous data on wind temperature, speed and direction as well as air temperature gradient to a computerized system in the Technical Support Center / Control Room of Units 1 and 2, through which the follow up and calculation of the spreading of the radioactive cloud is made.

The On-site Emergency Plan involves several levels of activation, from single alert status, through area emergency up to general emergency.

The initial notification for activation of the On-site Emergency Plan is done by the Shift Supervisor from the Control Room, which notifies the Plant Manager, as Emergency Group coordinator, which alerts the coordinators of the other Emergency Groups, the Site Superintendent and the Authorities (resident inspector and Headquarters). The plant personnel and the members of the public inside this emergency zone are warned by means of the internal communication system, sirens and loudspeakers.

Twenty-four-hour / 7-day-a-week on-call personnel, under the responsibility of the Site Superintendent, ensures the prompt actuation of the Emergency Groups.

Plant personnel emergency training and exercises are performed yearly. Information to the public on how to behave in a situation of nuclear emergency is provided by ETN through periodic campaigns, distribution of printed information, the local press and permanent information available in the Site Information Center.

4.7.2. Off Site Emergency Preparedness

Brazil has established an extensive structure for emergency preparedness under the so-called System for Protection of the Brazilian Nuclear Program (SIPRON). This includes organizations at the federal, state and municipal levels involved with licensing and control activities as well as those involved with public safety and civil defense. Operators of nuclear installations and facilities and supporting organizations are also part of SIPRON (See Fig 7 and section 3.1.3).

Within SIPRON, the Central Organization issued a set of General Norms for Emergency Response Planning[20], consolidating all requirements of related national laws and regulations. These norms establishes the planning, the responsibilities of each of the involved organizations and the procedures for the emergency centers, communications, intelligence and information to the public (SIPRON General Norms are listed in item A.2.5 of Annex 2).

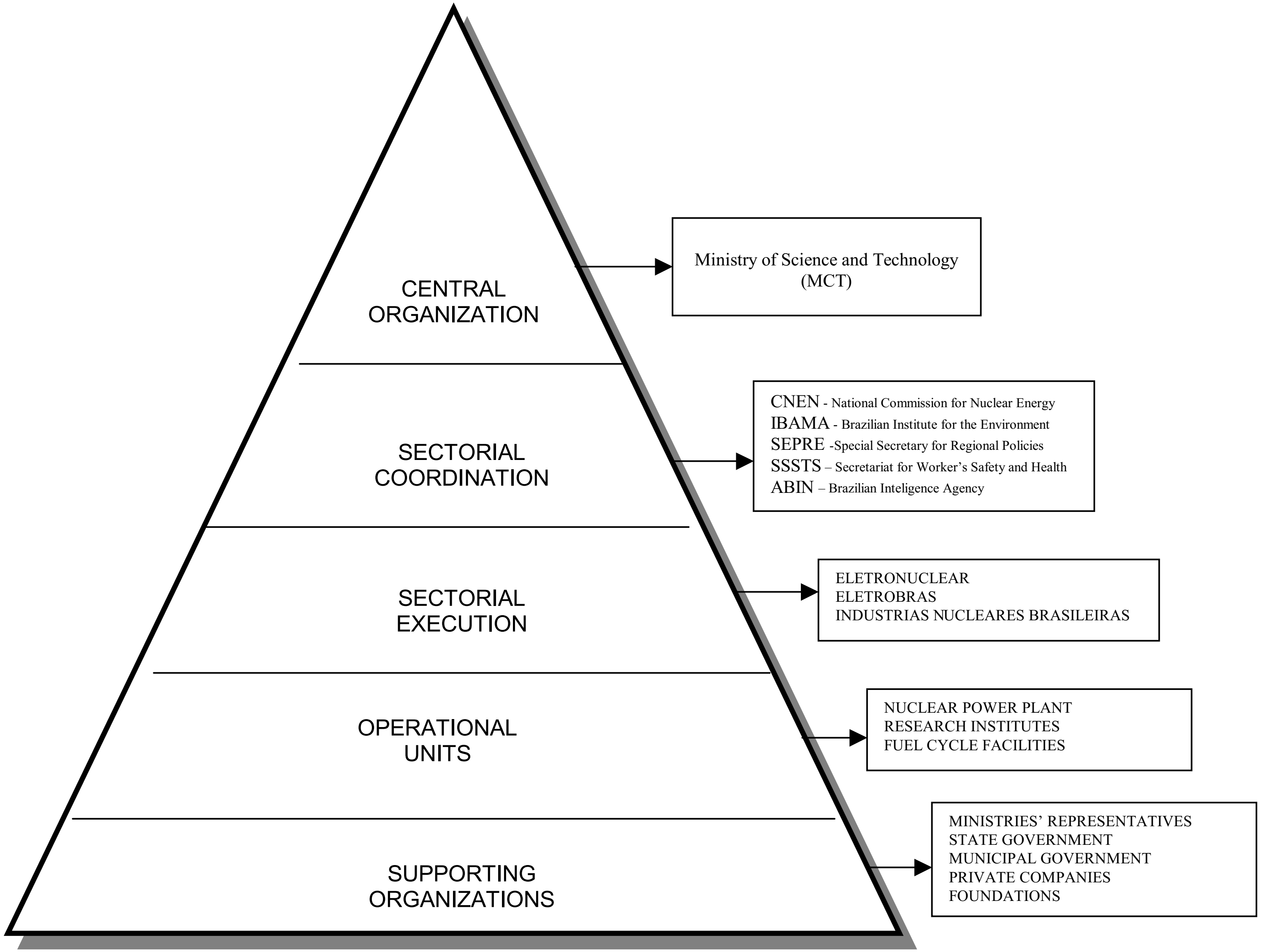
The approach to emergency preparedness is based in a “municipalization” of the response action to an emergency situation, utilizing mainly the resources available at the Municipality. The State and Federal Governments complement the local resources as necessary. In this way, SIPRON works at the operational level with the Municipal Government, and the State Government, and at the political level, through the Federal Government which provides the necessary material and financial resources.

At the plant level, a comprehensive Emergency Plan has been established and is periodically tested. The plan involves several levels of activation, from single alert status, through area emergency, to a general emergency. Dedicated facilities at the plant site have been designated and the equipment for emergencies has been greatly upgraded.

At the off-site level, a National Center for Management of Nuclear Emergency Situation (CNAGEN) has been created in Brasilia in the MCT. A State Center for Management of Nuclear Emergency Situations (CESTGEN) has been established in Rio de Janeiro. A Center for Coordination and Control of Nuclear Emergency Situation (CCCEN) and a Center for Information in Nuclear Emergency (CIEN) have been established in the city of Angra dos Reis. This centers’ activities during an emergency have been established in SIPRON General Norms[20],[21] (See also A.2.5 of Annex 2) and in the revised Rio de Janeiro State Plan for External Emergency, approved by the state governor by Decree 26586 of 21 June 2000. A revision of the State Plan is being carried out in 2004.

Corresponding plans for CNEN, its support Institute for Radiation Protection and Dosimetry (IRD) and other involved agencies have been prepared, and detailed procedures have been developed and are periodically revised.

Fig. 7. SIPRON STRUCTURE



The Central Organization established that a full scale exercise should be performed biannually. On the other hand, one partial exercise should be performed between two full scale exercises. Therefore, a partial exercise was performed in 2002, and full scale exercise was conducted in 2003. Another partial exercise is schedule for October 2004, and a full scale exercise for 2005. During the full scale exercises the activation of several shelters and the simulated evacuation of part of the population in the Emergency Planning Zone (EPZ) are tested. All exercises are carried out under the coordination of the MCT.

Regarding information to the public, SIPRON norm NG-05[22] establishes the requirements for public information campaigns about emergency plans. The first public information campaign was conducted by FURNAS in 1982 before the first criticality of Angra 1. Several other campaigns have been conducted on a regular basis. The campaigns combine information on both on-site and off-site emergency plans, including the population living in the 15-km area around the plant. These campaigns include the distribution of informative material on a house-to-house basis, to local newspaper, radio, TV broadcast, buses and bus stations, schools, community association, churches, and administrative offices. These campaigns are conducted by a joint working group composed by personnel from the federal, state and municipal civil defense, state fire brigade, ELETRONUCLEAR volunteers, and CNEN and ELETRONUCLEAR technical and public information personnel. Preceding every siren test or a general emergency exercise, specific flyers are distributed in relevant areas and handed along main routes to passing drivers and buses, and vehicles fitted with loudspeakers circulate through villages making announcements to ensure that all residents have been properly informed.

It should be noted that, due to the particular geographical location of the Angra plants, no radiological impact is expected in any neighboring countries, even in the improbable event of a major release. Notwithstanding that fact, Brazil has signed both the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency, and a bilateral agreement with Argentina for notification and assistance in case of a nuclear accident.

4.7.3. Activities, achievements and concerns regarding the improvement of safety

With respect to emergency planning, a task force has been formed to introduce a quality assurance program for organizations involved in SIPRON, to the extent possible.

In order to comply with the Angra 2 TAC requirements relative to emergency planning (see section 3.1.2.1) ELETRONUCLEAR awarded a contract to the Federal University of Rio de Janeiro to develop a comprehensive study on evacuation and sheltering possibilities. This study addressed, through computer simulation, movement of people and vehicles in different evacuation scenarios. In addition availability of sufficient transportation, training of drivers and suitability of sheltering installations were also evaluated. This study was completed in August,2002. The resulting recommendations were incorporated into an action plan which is under implementation. For this purpose, formal agreements have been signed to provide the Angra Municipality and Rio de Janeiro State civil defenses with better infrastructure for public shelters, health care and other measures related to emergency preparedness. These include an agreement between ELETRONUCLEAR and the National Road Department (DNER) to improve the BR-101 federal highway passing through the Angra site, at a cost of circa 7 million US dollars provided by ELETRONUCLEAR. The works, already finished, comprised restoration of 60 km of asphalt paving, of the road drainage and emergency lanes at the road sides, slope stabilization at the road hill side, building of crossings, underpasses and pedestrian passageways as well as elimination of three road bypasses.

In the same area of emergency preparedness, in order to provide an extra mechanism to monitor the environment, CNEN has installed an On-Line Radiation Monitoring System in the emergency planning zone (EPZ). The system is composed by thirteen Geiger Müller detectors disposed strategically around the Angra site. All data are locally collected and sent to the Institute of Radiation Protection and Dosimetry (IRD) by modem connection.

A training course on emergency preparedness and response was created in 2000 and is carried out every year since them, by the State Civil Defence of Rio de Janeiro in co-operation with CNEN and ELETRONUCLEAR. The course was primarily designed to civil defence personnel at the local and state levels. In May 2004, a new two week course was conducted.

Symposia on emergency preparedness have also been carried out in 2002 and 2003, for a public of around 300 persons yearly.

Chapter 5 - SAFETY OF INSTALLATIONS

5.1. Article 17. Siting

The Brazilian siting regulation CNEN 09/69[7] requires a site approval before the issuance of a construction authorization. The Angra site has already been approved in principle for the 3 units, but many aspects are being reviewed and updated to comply with current regulations for authorization of Angra 3. Site parameters were further evaluated during the PSAR preparation and review, and have been taken into consideration in the plant design.

For the Angra 1 plant, which started construction in 1972, the environmental impact was not formally evaluated before site approval, since no related regulations existed at the time. The environmental impact was assessed at the time of the installation licence by FEEMA, as described in section 3.1.2.1.

Since the promulgation of Law 6938 of 31 August 1981, which establishes the National Policy on Environment (PNMA), "the construction, installation, expansion and operation of facilities or activities which cause or may cause pollution or are capable of causing environmental degradation" requires an environmental licence. This involves the conduct of an Environmental Impact Study (EIA) and the preparation of an Environmental Impact Report (RIMA) before site approval. Considering that the site of Angra nuclear power plant has been already in use for a nuclear unit, the environmental licensing of Angra 2 included the preparation of an EIA/RIMA only for the operation licence. These documents were reviewed by IBAMA in cooperation with CNEN and from their evaluation a Basic Environmental Project (PBA) was established and is being implemented by ELETRONUCLEAR.

The RIMA also constituted the main document discussed during the public hearings which took place during the environmental licensing process. These hearings are established in accordance with Resolution CONAMA n. 9/87 with the objective to explain to interested parties the contents of the RIMA. The population directly affected has an opportunity to get acquainted with the RIMA and to raise questions about its contents.

Two of these hearings were conducted during the environmental licensing of Angra 2, on two different locations. Several questions were raised by participants, and responded by IBAMA and ELETRONUCLEAR. The main topics were:

- The conditions of roads in the vicinity of the plant and its possible impact in case of an evacuation;
- The treatment and storage of radioactive wastes;
- The conduct of emergency exercises on weekend and rainy days;
- The conditions of regional hospital facilities, and their possible impact in case of an emergency.

These and other topics are being considered in the environmental licensing process as discussed in item 3.1.2.

Site parameters continue to be evaluated during plant operation, especially those related to the demographic distribution in relation with the emergency preparedness. An updating of the detailed population census in the vicinity (5-km radius) of the power plant was conducted in 1996. In addition of the 1996 data, collected by ELETRONUCLEAR, new data on population density in the vicinity of the Site is available from the 2002 national census.

5.1.1. Activities, achievements and concerns regarding the improvement of safety

Monitoring of Angra site, especially with the aim of improving emergency preparedness is a continuos activity. Improvements on the road condition, at expenses of ELETRONUCLEAR has been carried out as described in 4.7.3.

Additionally, a detailed study of the demographic distribution, including an updated and more detailed census of the population around the site, was conducted by a consultant. This study included a comprehensive evaluation of the population flow during an emergency, with simulation of evacuation conditions and measurement of displacement times. From this study a detail plan of improvements was developed, which included new routes, better information to the public and some modification in the existing street lay out (see 4.7.3).

A concern still exists regarding population growth around the site, that is somehow out of the control of ELETROUNUCLEAR. The creation and expansion of ecological protection areas in the Angra region, as part of the Basic Environmental Project (Projeto Básico Ambiental – PBA), has been used to prevented future problems.

A re-evaluation of the Angra 1 plant design relative to external events, such as seismic, winds, floods, storms etc. is being performed in the scope of the plant 10-year Periodic Safety Review (PSR). In the process, the site external events will be also re-evaluated. This information may be also used for the licensing of Angra 3.

5.2. Article 18. Design and construction

The design of the Brazilian nuclear power plants are based on established nuclear technology in countries with more advanced programs. The licensing regulation CNEN-NE-1.04[6] formally requires the adoption of a “reference plant” which shall have a similar power rating, shall be under construction in the country of the main contractor, and shall go into operation with sufficient time to allow the use of the experience of pre-operational tests and initial operation.

Angra 1 was designed and constructed with American technology, which incorporates the concept of defense in depth, including the use of multiple barriers against the release of radioactive material. Extensive use was made of American codes and guides such as ASME 3, ASME 11, IEEE standards, ANSI standards and

US NRC Regulatory Guides. Operating experiences from American plants, especially the fire at Browns Ferry and the accident at Three Mile Island, were incorporated through modification in the design, during the construction phase. Design review and assessment were performed through preparation by FURNAS and its contractors of a PSAR and a FSAR, which were evaluated by CNEN during the licensing process.

Construction adopted a quality assurance program, which encompassed all activities related to safety conducted by FURNAS and its contractors and subcontractors. CNEN monitored the implementation of the quality assurance program through the regulatory inspection program and with the establishment of a resident inspector group during the construction phase.

In a similar manner, Angra 2 has been designed and constructed with German technology, within the framework of the comprehensive technology transfer agreement between Germany and Brazil. The German counterpart assumed technical responsibility for the jointly built plant during construction up to initial operation.

The plant is referenced to the Grafenrheinfeld nuclear power plant, currently in operation in Germany. The problem of the long construction delay has been addressed through a continuous updating of the design, incorporating feedback from operational experience from German and other nuclear power plants, and new licensing requirements in Brazil and Germany. The problem of long storage time of early manufactured components was dealt with by an appropriate and careful storage process, which involved adequate package, storage, monitored environmental conditions and a periodical inspection program. The electromechanical erection was performed by the Brazilian consortium UNAMON, which started its activities at the site in January 1996, with a strong technical support from ELETRONUCLEAR, Siemens and foreign specialised companies. A specific Quality Assurance Programme was established for the erection phase, including the main erector activities. Erection activities supervision and inspection were carried both by the main erector as well as by ELETRONUCLEAR. The electromechanical component pre-operational tests were performed in this phase, by the commissioning staff under the plant designer responsibility, as soon as allowed by the erection process.

5.2.1. Activities, achievements and concerns regarding the improvement of safety

The main achievement relative to nuclear safety regarding design and construction refers to the upgrading of the plants based on the operational experience, both national and international, and in accordance with the current state of the art. Upgrading of both Angra 1 and Angra 2 has been carried out continuously as described in 2.1.1.1 and 2.1.2.1.

A concern still exists about maintaining design capability within ELETRONUCLEAR. The Knowledge Management program referred in section 4.2.2 addresses these concerns. A positive decision about the completion of Angra 3 would be a great contribution to this objective.

5.3. Article 19. Operation

5.3.1. Item i. Initial authorization

The operation of a nuclear power plant in Brazil is subjected to two formal approval steps by CNEN within the regulatory process: authorization for initial operation (AOI) and authorization for permanent operation (AOP).

The authorization for initial operation is issued after the completion of the review and assessment of the Final Safety Analysis Report (FSAR), and taking into consideration the results of regulatory inspections carried out during the construction and pre-operational test period. Additionally, it requires the operator to have already an authorization for utilization of nuclear materials, and a physical protection program in accordance with CNEN regulations, to have an emergency plan in accordance with SIPRON regulations and to have financial guarantees with respect to the civil liability legislation. In parallel, the corresponding environmental licence has to be obtained from IBAMA, in accordance with the national environmental legislation.

The Authorization for Permanent Operation (AOP), in addition to the AOI requirements, is based on the review of start up test results. Safety requirements during operation are established by regulation CNEN-NE-1.26[10]. However, due to the fact that there are some CNEN questions to be closed by ELETRONUCLEAR the formal AOP has not been issued. Additionally, as indicated in section 3.1.2.1, legal disputes related to the environmental licensing are under way. Because of that, the Public Ministry (PM) has ordered CNEN not to issue a formal AOP. Therefore, the existing AOI has been periodically renewed.

Operation is monitored by CNEN through an established system of periodical reports[9], notification of safety related events and through the regulatory inspection during operation. A group of CNEN resident inspectors is present at the site.

In the period 2001-2003, CNEN has conducted 36 inspections in Angra 1 power plant, including the following areas: Radiochemistry of the Primary Circuit, Radiation Protection, Physical Protection, Implementation of the Local Emergency Plan, Meteorology, Unusual Events Investigation, Maintenance Quality Assurance, Event Analysis, Monitoring of the Radioactive Effluents Release, Commissioning of the Solid Waste Treatment System, Managing of the Plant Aging, Fuel Elements Integrity and Operators Training.

Referring to the Improvement Plan, mentioned in the Angra 1 Authorization for Permanent Operation – AOP, the following activities were followed up by CNEN: in service inspections of components welding; tests and inspections on supports and dampers; withdrawing of reactor vessel test samples; applicability of the pressurized thermal shock and thermal stratification phenomena; tests on the steam generators tubes by using eddy current; operational results obtained from the fuel elements of the KWU/SIEMENS project; fire hazard protection of the Diesel generators; and qualification program for electrical equipment.

During the period 2001-2003, CNEN conducted 31 audits and inspections activities in Angra 2, concentrated in the following areas: Radiation Protection, Physical Protection, Quality Assurance, Event Analysis, Monitoring of the Radioactive Effluents Release, Commissioning of the Solid Waste Treatment System, Fuel Loading Cycles and Operators Training.

5.3.2. Item ii. Limits and conditions for operation

Limits and conditions for operation are proposed by the applicant in the FSAR, reviewed and approved by CNEN during the licensing process, and referenced in the licence document. No changes in these limits and conditions shall be made by the licensee without previous approval by CNEN.

For Angra 1 the original Technical Specifications of the plant designer (Westinghouse) were later adapted to the Standard Format established in NUREG 1431. As part of the improvement program, ELETRONUCLEAR has submitted a Portuguese version of the Technical Specifications in 2003, which is under CNEN evaluation.

For Angra 2, the German licensing framework did not foresee Technical Specifications in the strict USNRC sense. The equivalent documentation, called “safety specifications” in the German procedure, is part of the Operating Manual, and is much more concise than the American ones. For the sake of uniformity, CNEN required that Technical Specifications following the Standard Format of NUREG 1431 be prepared also for Angra 2. This was again a huge adaptation job with extensive revision work. Being a new document, the Angra 2 Technical Specifications are being verified in practice and several revisions have been implemented to date as the result of feedback from operation. In the meantime the Specifications have been translated into Portuguese and this translation has been validated. The Portuguese version is presently under evaluation by CNEN.

For Angra 2, the operability criteria of the systems, as required in the Limit Conditions of Operation (LCOs), are defined in the Test Instructions. Each Test Instruction links the results of the test with the acceptance criteria of the associated LCO. A user-friendly software was developed and implemented in Angra 2 to support the Safety Function Determination Programme required in the Technical Specifications.

5.3.3. Item iii. Operation, maintenance, inspection and testing

Safety requirements during operation are established by regulation CNEN-NE-1.26[10]. Additional CNEN regulations establish more detailed requirements for maintenance[23] and in service inspection[24].

The implementation of these requirements at the plant is done through the preparation of an Operation Manual, which contains guidelines to develop, approve and control plant procedures according to the nuclear class and the Quality Assurance program. It also contains the actual procedures for all activities to be conducted in the plant, related to operation, maintenance, inspection and testing.

An administrative procedure - Organisation of Operation Manual - provides the detailed requirements to develop, approve and control all plant procedures. In the case of surveillance procedures required by Technical Specifications or other regulations (ASME Code or KTA rules), another administrative procedure gives instructions in more details for the preparation of field procedures, implementation and control. Each Unit Operation Review Committee (CROU) approves all procedures of the respective unit. The Plant Operation Review Commission (CAON), which oversees both units, analyses and approves all nuclear safety class procedures and those that are related to the Quality Assurance program.

All employees must follow written procedures, and each Department Manager (Operation, Maintenance, Technical Support, Chemistry, Health Physics, etc.), must assure that all tasks done under his/her responsibility are accomplished using the latest revision of the approved procedure. The Quality Assurance Department monitors and controls whether the plant organisation is using approved procedures during operation, maintenance, test and inspection.

The Operation Manual is divided into volumes according to specific areas of activity, such as: Administrative, Operation, Chemistry and Radio Chemistry, Reactor Performance, Nuclear Fuel, Instrumentation, Electrical and Mechanical, Health Physics, Surveillance, Training, Physical Protection, Emergency Procedures, Fire Protection, Environmental Monitoring. Besides the Normal Operation procedures, the Operation volume contains also the Abnormal and Emergency Operation procedures for assisting in abnormal and accident occurrences. The procedures should be revised every 2 years.

In cases where contracted companies (foreign or national) perform work in the plant, a temporary procedure is necessary. For a contracted company which develops its own procedures, a plant expert or an engineer related to the work to be performed, analyses the original procedure and sends it to the Quality Assurance to check if the acceptance criteria are achieved. A cover sheet with an approval form is attached to the procedure.

For other temporary procedures, the author writes the procedure, explains the reason for its temporary nature and establishes a validation period. Temporary procedures can be used only during the validated period stamped in the procedure.

The Work Control Group is responsible for planning all the maintenance, inspection and testing tasks. Inside the work package, procedures, plant modification documents, part lists and other references applicable to the task should be included. Two more steps are necessary for actually starting a task: the discussion at the daily co-ordination meeting and the shift supervisor approval.

Work control process stamps the "Work Permit" with a "Red Line" to identify tasks related to nuclear safety equipment. In this case, quality assurance and maintenance quality control personnel ensure that approved procedures and part lists with traceability are being used. In addition, for equipment that has a "Risk of Scram", an approved procedure must be used and this procedure has a "Red Cover Sheet" to warn workers about risks and cautions to be taken.

During outages, a written and approved outage procedure controls the overall plant safety condition for inspection, testing and refuelling operation.

5.3.3.1. Angra 1 operation

As indicated in section 2.1.1.1 several programs for improvement of safety and reliability are being conducted for the Angra 1 plant.

The main concern at present is the preservation of the 2 Steam Generators (SG) until their replacement, planned for end of 2007. For this purpose extensive testing and tube repair activities are performed at every outage. Following the international experience, Eddy current testing for 100% of the tubes, tube testing by SG secondary side pressurization, tube "in situ" pressure testing as well as tube reinforcement with short and long sleeves and tube plugging are routinely performed at every outage. In the 2003 outage 351 tubes have been fitted with sleeves and 186 tubes have been plugged. To date an average of 15% of the total number of tubes have been plugged. Beginning in 2004, additional mid cycle outages, specifically for SG tube testing may be performed, depending on the previous outage SG evaluation and the cycle length. One of such additional outage was performed in July 2004.

5.3.3.2. Angra 2 operation

For the Angra 2 plant the main concern has been excessive corrosion of the parts of the Plant in contact with salt water (water intake structures, Cooling water and Service systems piping and components, main condensers boxes).

Countermeasures have been taken such as, implementation of corrosion monitoring and cleaning teams, revision of surface treatment and painting specifications and procedures, implementation of corrosion indicators and preparation of the guidelines for establishment of a Corrosion Mitigation Program. The results to date are average.

One highlight relative to follow up of system performance was the implementation in both plants of a color coded indicator system that allows checking of system condition at a glance.

The set of plant safety and performance indicators have also been expanded to a total of 49 indicators, starting with the basic WANO indicators plus additional indicators for safety systems, operation, maintenance, production, radiological protection and chemistry.

A Maintenance Efficiency Programme to check and improve the efficiency of Angra1 plant maintenance was started in the middle of 2001, based on the recommendations of EPRI/NUMARC 93-01- Rev.2. The complete implementation was concluded by the middle of 2002. This methodology allows optimisation of the plant maintenance programme by focusing maintenance work on the items important to safety and availability. It has already been implemented for 2 cycles. On-line information on the efficiency of the actual maintenance programme will be available through an interface with the software used for maintenance work control. The extension of this program to Angra 2 is under consideration, taking into account its specific maintenance program.

At Angra 1, the maintenance risk is evaluated "on line," and controlled through a procedure called "6-week maintenance program". In this procedure maintenance activities are always planned 6 weeks ahead. The equipment unavailability associated to the planned activities are input to the Angra 1 Level 1 PSA model and the resulting risk for the different plant configurations is evaluated. For any configuration that exceeds specified risk limits the corresponding maintenance work has to be re-planned.

Operational safety is monitored by CNEN through the regulatory inspection program and by the routine surveillance carried out by the resident inspector's group. Within ELETRONUCLEAR, corporate auditing is conducted by the Quality Assurance Department, and reviewed by the CAON. In addition, periodical peer review is conducted voluntarily by the operator, through the invitation of international review missions from INPO, WANO and the IAEA (see item 5.3.7, Table 6 for a list of international technical review missions conducted at Angra plant in 2001-2003).

5.3.4. Item iv. Procedures for responding to anticipated operational occurrences and accidents.

As mentioned in item 5.3.3, the Operation Manuals of Angra 1 and Angra 2 contain procedures to respond to anticipated operational occurrences and accidents. For abnormal conditions, procedures are used to return the plant to normal conditions as soon as practical or to bring the plant to a safe state, such as hot shutdown or cold shutdown. For accidents, Emergency Operating Procedures (EOPs) were written in accordance with latest reactor manufacturer guidelines and current international practices.

Although having different formats, both the EOPs for Angra 1 and Angra 2 are based on the same philosophy :

- if an event can be clearly identified, Event Oriented EOPs are used; e.g., for Angra 2, Event Oriented EOPs are provided for control of the following classes of accidents: LOCAs, steam generator tube rupture, secondary side breaks, overcooling transients, external impacts during plant operation with reduced inventory or at refueling .
- if the event can not be clearly identified, Symptom or Safety Function oriented EOPs direct the operator into monitoring and restoration of the set of

fundamental safety functions (Critical Safety Functions). If these safety functions are fulfilled the plant is in a safe state. These Safety Functions are Subcriticality, Core Cooling, Coolant Inventory, Containment Integrity, and Heat Sink.

The EOP structure, taking Angra 2 as example, consists of two levels of detail. The first level includes a diagnose chart, a trends-of-plant-parameters table, an automatic actions flow diagram, a manual actions flow diagram. The second level includes an instrumentation list, detailed instructions for automatic and manual actions, explanatory remarks and diagrams and tables.

These EOPs cover accidents in the Design Basis and Beyond Design Basis up to but not including accidents with core melt. They assume the use of all available systems, even beyond their original design purposes and operating conditions.

Integrated Computerized Systems, added to Angra 1 and Angra 2 after initial design, as a result o HFE evaluations (see section 4.3), assist the operator in monitoring Critical Safety Functions (CSF) and other process variables. When a CSF (Subcriticality, Core Cooling, Coolant Inventory, Containment Integrity, and Heat Sink) is violated or there is a chance to reach the specified limits, there are approved procedures to be used to restore the CSF to normal condition. Colour codes used in the Integrated Computerised System help the operators to act in an anticipated way, to avoid reaching the protection limits. These colours (green - Normal, yellow - Alert, orange - Urgent, red - Emergency) guide the operator to what procedure should be used. In case the Integrated Computerised System is not operable, there is a procedure that must be followed by the operator to confirm that no CSF is in the process of violation or has been already violated.

5.3.5. Item v. Engineering and technical support

Engineering services and technical support are available for the operation of Angra 1 and Angra 2 within the ELETRONUCLEAR organization and supplemented by outside contractors. The technical support groups include all basic engineering disciplines: civil, electrical, mechanical, instrumentation and control, systems and components, safety analysis, stress analysis, reactor physics, and radiation protection. In this respect, the creation of ELETRONUCLEAR, combining FURNAS engineering and technical support groups with NUCLEN design capability, has significantly improved the support services available to both Angra 1 and Angra 2.

This technical staff is involved with the plant safety and operational analysis, evaluation of operational experience feedback and system and component performance, as well as with the design and implementation of the resulting plant modifications. Another source of requirements for modifications is the regulatory body, which normally updates its regulations on the basis of new technological developments, experience feedback and new international practices.

5.3.6. Item vi. Reporting of significant incidents

Reporting requirements during operations are established in regulation CNEN-NE-1.14[9]. Different types of reports are identified, such as periodical reports and reports of abnormal events. Immediate notification is required for events which involve degradation of the plant safety conditions, or exposure to radiation of site personnel or the public to levels above the established limits. Other events should be reported within 24 hours or 30 days, depending on their safety significance.

The International Nuclear Events Scale (INES) is used to classify the safety significance of the events. Only 2 event of INES level 1 has been reported in 2001/2003. Angra 1 reported to CNEN 12 events of INES level 0 in 2001, 14 in 2002 and 9 in 2003. In 2001 a level 1 event involving loss of coolant during reactor heat-up and pressurization has occurred and has been reported to the IAEA – IRS. Angra 2 has reported 17 events of INES level 0 during 2001, 31 in 2002 and 28 in 2003. In 2003 a level 1 event, involving loss of coolant during reactor cooling down and depressurization has occurred and has also been reported to IAEA – IRS.

5.3.7. Item vii. Operating experience feedback

The operational experience feedback process in Brazil comprises two complementary systems: one performed by the utility, processing both in-house and external information, and one performed by CNEN.

At the utility the internal operational experience is collected and processed by specific groups inside the plants. External experience is handled by an Operational Experience Analysis group, belonging to the Plants Support Engineering. This group investigates relevant incidents occurred in the Angra Plants and in similar nuclear installations in order to make recommendations. A program to collect operating experience has been established using several sources of information, such as INPO, WANO and EPRI.

Specially for Angra 2, an agreement has been signed with VGB, the association of large electricity producers in Germany. Through this agreement ELETRONUCLEAR has access to relevant events already processed by a working group. This access can be through normal mail or by on line access to the complete VGB data bank .

In addition, technical exchange visits, technical review missions, observer or expert missions, conducted periodically provide a valuable source of information on other plant experiences. Table 6 provides a list of international technical missions to Angra and Table 7 presents a list of international technical missions from the Angra personnel to other plants during the period 2001/2003

Table 6 . International Technical Missions to Angra Nuclear Power Plant in 2001/2003.

N.	Year	Mission	Subject
1	2001	IAEA	Technical meeting – Cost Management
2	2001	IAEA	Safety Culture workshop for Managers
3	2001	IAEA	Technical Meeting – Cost Reduction in Nuclear Power Plants
4	2002	IAEA	OSART mission to Angra 2
5	2002	IAEA	International Conference on Safety Culture in Nuclear Installations
6	2003	IAEA	OSART mission to Angra 1

Table 7. Technical Missions of ELETRONUCLEAR Personnel to other plants in 2001 / 2003

DATE		LOCATION
2001 (26/03 – 12/04)	WANO	Peer Review – Heyshan 2 – England
2001 (02/04 –07/04)	-	Participation in Neckarwesthein 2 Outage – Germany
2001(17/04 -26/04)	IAEA	Specialist Meeting on Cost Management – Mexico
2001 (02/05 - 06/05	INPO	Participation on "Shift Supervisor Professional Development Seminar"- USA
2001 (30/05 –01/06)	INPO	Participation on "New Operation Manager Seminar" - USA
2001 (11/06 – 15/06)	WANO	Participation on "Plant Managers Workshop & Site Director Meeting"- USA
2001 (24/06 –29/06)	IAEA	Project RLA 4/16 – V Executive Meeting- Mexico
2001 (05/08 – 21/08)	-	Technical Visit – Unterweser - Germany
2001 (03/09 –05/09)	IAEA	Participation on the "International Conference on Topical Issues in Nuclear Safety" – Austria
2001 (08.09 –10.09)	OLADE	OLADE Forum – Equador
2001 (10.09 –21.09)	INPO	Participation on "Maintenance Supervisor Professional Development Seminar – USA
2001 (09/10 –11/10)	IAEA	Participation on the "Advisory Group Meeting on Simulator Training for NPP Personnel" – Austria
2001 (01/11 – 22/11)	IAEA	OSART – Dukovany – Tcheck Republic
2001 (09/11 – 01/12)	WANO	Peer Review – Vandellos – Spain
2001 (13/11 – 18/11)	WANO	WANO Governing Board Meeting – France
2001 (19/11 – 30/11	-	Technical Visits – Trillo, Gronhde and Neckarwestheim 2 – Spain and Germany)
2001 (24/11 – 02/12)	WANO	Peer Review – Vandellos – Spain
2001 (04/12 – 14/12)	-	Participation in the Annual Meeting of German Plant

		Superintendents – France
2001 (26.12 – 17.01)		Participation in the waste resin treatment process in Göesgen – Swiss
2002 (14.01 – 20.01)	INPO	Participation in the "New Operations Manager Seminar "
2002 (23.01 – 26.01)	WANO	Peer Review – Final Meeting- Vandellos – Spain
2002 (26.01 – 16.02)	WANO	Peer Review – Chemistry - Sizewell A – England
2002 (02.02 – 10.03)	INPO	Senior Nuclear Plant Manager Course – USA
2002 (15.02 – 24.02)	INPO	Supervisor Professional Development Seminar - Mexico
2002 (02.03 - 27.03)	Westinghouse	DEHC Course – USA
2002 (14.03 - 22.03)	WANO	Biennial General Meeting – South Korea
2002 (16.03 - 22.03)	IAEA	Technical Meeting on Training NPP Personnel – Austria
2002 (18.03 – 24.03)	EPRI	EPRI- Seminar on Distributed Generation Systems - USA
2002 (24.03 – 30.03)	IAEA	IAEA- Technical Meeting-PRIS-Power Reactor Information System-Austria
2002 (06.04 – 14.04)	IAEA	OSART- Follow up – North Anna – USA
2002 (13.04 – 28.04)	---	Technical Visits – Neckarwestheim-Framatome-Germany/Trillo-Spain
2002 (13.04 – 05.05)	---	Tecnical Visits --- Isar 2-Grafenrheinfeld-Gundremmingen-Siemens-KSB-Sempell-Lisega-Germany
2002 (13.04 – 28.04)	IAEA	Meeting- Convention on Nuclear Safety - Austria
2002 (20.04 – 05.05)	SFEN	International Conference on Water Chemistry in Nuclear Reactor Systems – French Nuclear Energy Society Technical
2002 (27.04 – 11.05)	INPO	Maintenance Supervisor Professional Development Sem.USA
2002 (04.05 – 26.05)	WANO	Peer Review – Fire Protection – Sellafield – England
2002 (10.05 – 19.05)	-----	Technical Visits – Cofrentes e Almaráz – Spain
2002 (18.05 – 26.05)	------	Technical Visits – Trillo – Spain (Outage)
2002(21.05 – 01.06)	IAEA	IAEA – Evaluation mission – Busher-Iran
2002(25.05 – 02.06)	Iberdrola	APS – Technical Discussions
2002 (01.06 – 15.06)	INPO	INPO – Shift Supervisor Professional Development Course
2002 (08.06 – 16.06)	IAEA	IAEA – Follow up OSART – Muhleberg – Swiss
2002(24.06 -- 28.06)	IAEA *	Safety Review – Kozlodoy – Bulgaria
2002(15.06 – 22.06)	INPO-EPRI-	Technical Visit – Comanche Peak- / Turbine Control Seminars –INPO and EPRI
2002(13.07 – 19.07)	INPO	Operation Manager Working Meeting
2002(13.07 – 21.07)	EPRI	10th Nuclear Plant Performance Improvement Seminar
2002(16.07 –30.07)	-------	Technical Visit – Isar 2 – Germany
2002(20.07 – 25.08)	INPO	Senior Plant Manager Course
2002(01.11 – 17.11)	WANO	Technical Support Mission – Maintenance – Calder Hall – England
2002(25.11 – 05.12)	-------	Framatome NPPs Executive Meeting – Technical Visit Isar 2 – Switzerland / Germany.
2002(16.12 – 20.12)	SCART*	Preparation of Guidelines for Safety Culture Assesment Review Team
2003(16.01 – 08.02)	IAEA*	IAEA – OSART – Nogent – sur – Seine – France
2003(02.05 – 25.05)	WANO	Peer Review – Chemistry and Radilogical Protection – Isar 2 – Germany
2003(07.05 – 30.05)	IAEA	IAEA – OSART – Operations – Civaux – France
2003(21.08 – 06.09)	IAEA	IAEA – PROSPER MISSION – Operational Experience - Metsamor – Armenia
2003(16.09 – 12.10)	IAEA	IAEA – OSART – Technical Support – Rovno – Ukrania
2003(16.10 – 08.11)	IAEA	IAEA – OSART – Technical Support – Krsko – Slovenia
2003(30.10 – 21.11)	WANO	Peer Review: Organization and Administration. – Cofrientes, Spain

CNEN itself has its own system for operational experience feedback, analyzing Angra events and participating actively in international organizations to share its own operating experience, such as in the Incident Reporting System (IRS) of the IAEA. To date, Brazil has reported 15 events to IRS. The relevant IRS reports received by CNEN are transferred to the operator for evaluation, thus completing the feedback loop.

5.3.8. Item viii. Radioactive waste and spent fuel

Angra 1 nuclear power plant is equipped with systems for treatment and conditioning of liquid, gaseous and solid wastes. Concentrates from liquid wastes treatment are solidified in concrete and conditioned in $1m^3$ liner. Compressed solid wastes may be conditioned in 200 liter drums and not compressed wastes in special boxes. Gaseous wastes are stored in holdup tanks and may be released from time to time. These tanks have the capacity for long term storage, which eliminates the need for scheduled discharge. For the time being, medium and low level wastes are being stored on site in a separate storage facility.

An overall long term program for reduction of production of new waste and reduction of existing waste in Angra 1 is under way. The main foreseen or in implementation activities comprise :

- Upgrade of the evaporator package for Angra 1
- Installation of the in-drum drying system for treatment of the concentrate
- Acquisition of a super-compactor
- Decontamination of the metallic materials from Angra 1 in the decontamination system of Angra 2.
- Regeneration of the contaminated resins from Angra1 in Angra 2.

Angra 2 nuclear power plant is equipped with systems for treatment, conditioning, disposal and storage of liquid, gaseous and solid radioactive wastes. All Angra 2 waste treatment systems are highly automated to minimize human intervention and reduce operating personnel doses. Liquid wastes are collected in storage tanks for further monitoring and adequate treatment or discharge to the environment. The concentrate resulting from the liquid waste treatment is immobilized in bitumen by means of an extruder-evaporator and the dry concentrate is conditioned in 200 liter drums. Spent resins, non compactable solid waste and filter elements are also immobilized in bitumen and conditioned in 200 liter drums. Compactable solid wastes are conditioned in 200 liter drums. Gaseous wastes are treated in the gaseous waste treatment system, where the radioactive gases are retained in delay beds containing active charcoal to let them decay well below allowable levels, before release into the environment throughout the 150m high plant vent stack. No residues are produced in the gaseous waste treatment system, as all the system's consumables, mainly filter and delay bed fillings, are designed to last for the whole plant lifetime. The drums with waste are initially stored within the plant prior to being transported to the intermediate storage facility still at the plant site.

Generated volume of solid radioactive waste material is kept to a minimum by preventing materials from becoming radioactive, by decontaminating and reusing radioactive materials, by monitoring for radioactivity and separating non-radioactive material prior to conditioning and storage, and by other volume reduction techniques. Procedures, personnel training and quality control checks are used to ensure that radioactive materials are properly packed, labeled and transported to the storage facility.

According to the Brazilian law[25] CNEN is responsible for the final disposal of all radioactive waste generated in the Country.

Since no final radioactive wastes repository is available to date, these wastes are being stored in an initial storage facility located at the Angra site. This repository consists of two hangars, which are submitted to CNEN inspections.

As a result of need for more storage area with the start of operation of Angra 2 the Utility has decided to expand the storage capacity of the existing units and to build a new one. In addition an agreement was signed with CNEN in which CNEN authorizes ELETRONUCLEAR to build an On-Site final repository for low and intermediate level waste. According to planning this repository is to be ready and operational by 2009-2010.

The work for the expansion of the existing units is momentarily stopped because of legal questioning relative to the environmental licensing of the works. For the new unit all environmental licensing requirements have been fulfilled and ELETRONUCLEAR is waiting for the authorization for beginning of construction.

With respect to spent fuel of Angra 1, the spent fuel pool capacity has been expanded by the installation of compact racks to accommodate the spent fuel generated for the expected operational life of the unit.

In the case of Angra 2, the spent fuel pool, which is located inside the steel containment, has two types of racks :

a) region 1 : normal racks with capacity for 264 fuel assemblies, equivalent to one full core plus one reload of fuel of any burnup and with enrichment up to 4.3%;

b) region 2 : high-density storage racks with storage capacity for 820 spent fuel assemblies. The fuel assemblies to be stored in region 2 must have a given minimum burnup, which is a function of the original enrichment. This spent fuel storage capacity is sufficient for about 15 years of operation, which means that additional spent fuel storage space, either of the wet or dry type, will have to be provided in the medium term.

5.3.9. Activities, achievements and concerns regarding the improvement of safety

Activities by CNEN and ELETRONUCLER related to plant operations can be considered as always having a component of safety, and looking for continuous improvement.

As indicated in sections 2.1.1 and 2.1.2 both Plants have been performing well, the average WANO availability factors being about 85% for Angra 1 and 92% for Angra 2, a good performance

Improvements in plant procedures and Plant Technical Specifications can be considered a highlight of this period.

The adoption of a new Maintenance Program, based on the US NRC "Maintenance Rule" can also be singled out.

The excellent safety record, demonstrated by the good set of performance indicators and the low number of reported safety related events, has been also confirmed by the outcome of WANO and IAEA (OSRAT) reviews.

Delays in storage facility capacity expansion, caused by difficult environmental licensing may jeopardize the continuation of plant operation due to lack of radioactive waste storage place.

Chapter 6 – TOPICS RAISED BY THE SUMMARY REPORT OF THE SECOND REVIEW MEETING

During the final discussions of the second review meeting of the Parties of the Convention on Nuclear Safety, held in Vienna in April 2001, several recommendation on improving the information provided in the National Report were made. These recommendations were recorded in the Summary Meeting Report [3] and the Parties were requested to address them in the Third National Report. This chapter addresses these topics, but instead of providing a lengthy explanation, reference is made to the items of the previous chapters were the topic was discussed.

6.1. Deregulation, Maintaining Competence, Lack of Resources

As mentioned in previous Report, following a worldwide tendency, Brazilian electricity market is being de-regulated and privatized. However, due to constitutional requirements, as mentioned in item 1.2, nuclear power generation is and will continue to be a State monopoly. Therefore, privatization is not expected to affect in a direct way the nuclear sector. The main impact will arise from the uncertainties relative to the competitiveness of nuclear energy compared with other sources in a deregulated market. The protection of the nuclear generation from open electricity market variations has been dealt with by the contract arrangements of ELETRONUCLEAR and with the intervention of the Operador Nacional do Sistema (National System Operator – ONS), which is the centralized organization for load dispatch (see item 4.2.1).

Maintaining competence in the nuclear area in Brazil is a key issue, like in other countries. The nuclear programs in Brazilian universities have very few students and the average age of qualified staff is very high (estimated to be above 45 years). A large effort to guarantee adequate replacement for retiring people is being done by ELETRONUCLEAR through its Knowledge Management program, launched in 2001 called "Determination of the Technological Know-how of ELETRONUCLEAR". This program which is already in its 3rd year has the objective of establishing a permanent mechanism for identifying the existing know-how status of the company and allowing for planning to fill in the missing expertise gaps in an organized and timely manner . A summary of the activities performed in the last three years is presented in section 4.2.2. Personnel renewal at reasonable rates is taking place at ELETRONUCLEAR. About 500 new employees have been admitted in period of 2001 to 2003. This was sufficient to offset the loss of people leaving the Company by retirement or other reasons. One unexpected new concern is the relatively large loss of young, well trained and qualified personnel to the oil industry.

To hire new staff, CNEN carried out an admission exam at national level in 1998; another contest was held in 2002 and an additional new contest in will be held in 2004. These efforts also required strong efforts in the initial training of the new staff, which is being carried out in both organizations as described in items 3.2.1 and 4.2.2.

6.2. Status and Position of the Regulatory Body

The status of the Brazilian regulatory body has not changed in the period 2001 -2003. As described in 3.1, a Government structure has been adopted in which CNEN reports to the Ministry of Science and Technology (MCT). It is possible that in the future the Fuel Assembly Fabrication facility mentioned in 1.2 will be removed formally from direct CNEN control, as it is being already observed "de facto."

ELETRONUCLEAR situation has not changed in recent years, but internal reorganization took place, as reported in 4.1.2, to accommodate of the company new work scope (less engineering, more operation) after the end of commissioning of Angra 2.

6.3. Independence of Regulatory Body, de jure and de facto

This topic was discussed in detail for the Brazilian situation during the first and the second review meeting of the Convention on Nuclear Safety. Brazil reaffirms its statement that, with respect to nuclear power generation, CNEN has total independence, de jure and de facto, from ELETRONUCLEAR, as described in item 3.1.

With respect to other facilities not covered by this Convention, such as the research reactors of CNEN's institutes, and some of their pilot fuel cycle facilities, Brazil consider that the existing arrangements, through which the Safety and Radiation Protection Directorate (DRS), licenses and controls the Directorate of Research and Development (DPD) installations, provides the necessary effective separation required to ensure an independent review of design and operation.

With respect to the fuel cycle facilities of INB, CNEN is still evaluating a proposed reorganization through which INB will be formally removed from CNEN control, as it already occurs "de facto", since INB president reports directly to MCT.

6.4. Regulatory Strategies, Prescriptive versus Goal Oriented Regulations

CNEN regulation suffered very little modifications in the period. Most of CNEN regulations are prescriptive in nature, although the main regulation related to nuclear plant operation, CNEN – NE 1.26, adopted a modern risk based approach, which may be considered to be goal oriented, as discussed in item 5.3.3.

The main difficulties experienced, related to regulations, concern the adoption of safety guides and industrial standards from the supplier countries, in a nuclear program which includes suppliers from USA and from Germany. However, as reported in 3.1.1., CNEN regulations form the main basis for the licensing process, and the adoption of foreign guides and standards was dealt with on a case by case basis, without major problems, even in the few cases were American regulatory guides were used in the licensing of the German design Angra 2 plant, as reported in 5.3.2 (Technical Specifications) and 4.3. (Human Factors).

6.5. Use of Technical Support Organizations

CNEN makes no use of external Technical Support Organization, although external consultants may be used in some specific cases. Extensive use is made of the existing man power in CNEN institutes to support the General Coordination Licensing and Control in specialized evaluations. In this cases, some restriction may be imposed, to avoid conflict of interest, since the institutes may also work as consultants for the operating organization.

6.6. Quality Assurance within Regulatory Body

As mentioned in item 4.1.1, CNEN has issued a Quality Assurance Policy [12], and has established a task force to develop and implement a formal Quality Management system for its nuclear safety activities. A member of this task force participated in the IAEA Peer Discussion on Regulatory Practices related to Quality Management of the Regulatory Body. Another member of the task force made a Scientific Visit to Spain to learn about the implementation of Quality Management within the Consejo de Seguridad Nacional.

The task force worked in defining the Quality Management model for CNEN but the implementation phase was not carried out due to lack of support from previous directorate. The current administration has not taken a formal stand with respect to this issues yet.

6.7. Adoption of ICRP60 and Basic Safety Standards (BSS)

In the supplement to the second National Report of Brazil, it was reported that a working group had been formed to adapt the existing Radiation Protection Regulation [19] to the new requirements of the IAEA – Basic Safety Standards (BSS) for Radiation Protection (Safety Series 115).

As mentioned in Section 4.6, the work of the group has proceeded in the period, but a new regulation has not yet been issued, due to the complexity of the proposed modifications and their possible impact on the existing practices.

However, as reported in previous National Reports, some of the new concepts and limits of BSS have already been implemented in practice and through other regulations such as the control of X-Ray installations by the Ministry of Health.

6.8. International Cooperation among Regulators

Brazil has established and maintained strong cooperation both bilaterally and multilaterally.

CNEN is member of the Ibero American Forum of Nuclear Regulators, which includes also Argentina, Cuba, Mexico and Spain, and which is being extended to other Ibero-American countries with other non-nuclear-power activities.

Formal bilateral agreements in the field of nuclear safety are in place also with Argentina, Germany, USA, and Korea. Informal contacts with several other nuclear electricity producing countries are made on a routine basis.

6.9. Safety Improvement Programs

A safety improvements program is a licensing requirement established in CNEN Regulation NE 1.26[10] as mentioned in 5.3.1. Additional details for individual plants are established in the licensing conditions.

Angra 1 has had many modifications, as mentioned in item 2.1.1.1, and the replacement of the 2 steam generators is under planning. Angra 2 has not yet had significant modifications during operation, but, as mentioned in item 2.1.2.1, its design has been upgraded constantly during its long construction period, in accordance with modern German requirements for the reference plant.

6.10. Periodic Safety Review (PSR)

A 10 year PSR is a requirement of Regulation CNEN-NE-1.26[10] as mentioned in Section 4.5. Accordingly, Angra 1 will be the first Brazilian plant to undergo such review in 2004. CNEN and ELETRONUCLEAR defined the basis and scope of the review using the guidance provided by the IAEA Safety Series 50-SG-O12 - Periodical Safety Review of Operational Nuclear Power Plants**.**

As described in section 4.5, ELETRONUCLEAR has already submitted the technical instructions to be used in the elaboration of the Angra 1 Periodic Safety Review Report in order to fulfill the requirements of Regulation CNEN NE 1-26. A preliminary PSR will be submitted to CNEN in the end of 2004. ELETRONUCLEAR has 18 months to conclude this PSR, by July 2005.

6.11. Probabilistic Safety Assessment (PSA)

As mentioned in 4.5, risk management is a requirement of CNEN Regulation NE 1.26[10]. For Angra 1, a preliminary level 1 PSA was performed in the eighties, which supported the decision to add two new Diesel generators. A new detailed level 1 PSA, was completed in 1998, revised in 2002 and since then has been continuously updated.

The revisions 1 of the Angra 1 Level 1 PSA have incorporated the improvements as mentioned in section 4.5, besides others subjects that impact the Core damage Frequency (CDF) quantification. The net effect was a reduction in the CDF of about 3 to 4 times the previous value (Revision 0).

For Angra 2, probabilistic studies have been carried out using the insights of the German Risk Study and models and results of German Plants of the same 1300Mw Standard PWR family, as mentioned in 4.5. An international bidding process is presently under way for the selection of an experienced contractor for performance of an Angra 2 specific Level 1+ PSA, to be concluded in 2007.

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6.12. Containment Function Improvements

Both Angra 1 and Angra 2 have full containment design to withstand the design basis accident (DBA). In addition, both plants have redundant containment spray system, although for Angra 2 it has been demonstrated that the system is not necessary for the plant to cope with the DBA. Both plants have also redundant Hydrogen recombiners for containment atmosphere control under DBA.

Studies are under way with respect to the capacity of the containment to survive beyond design basis accidents (BDBA), but no decision has been reached yet about the necessity to install a filtered containment venting system. Meanwhile, the containment instrumentation of Angra 1 has been upgraded.

6.13. Collective Doses Trends

The collective radiation dose is monitored at the power plant as mentioned in item 4.6, and reported periodically to CNEN. Results of individual doses for the year 2003 are presented also in table 4 of item 4.6.

6.14. Effluent Releases Trends

The effluents of the plant are monitored constantly and reported on a semi-annual basis to CNEN, as described in item 4.6. The result of the environment monitoring program has demonstrated that the impact of these effluents in recent years are negligible.

Recent trends have shown no significant variation of the total amount of radioactive effluents, which remains well bellow permissible limits.

6.15. Emergency Exercises National and International

Emergency exercises are conducted on a periodical basis as described in item 4.7. Brazil has also participated in some international exercises, such as the Joint International Emergency Exercise 1 (JINEX-1), jointly coordinated by the IAEA, NEA and WMO, conducted in May 2001, and is planning to participate in the emergency exercise of the French nuclear power plant Blavais, in December 2004.

Chapter 7. FINAL REMARKS

At the time of the second review meeting of the Nuclear Safety Convention, Brazil had demonstrated that the Brazilian nuclear power program and the related nuclear installations met the objectives of the Convention. During the period of 2001 - 2004, Brazil has continued the operation of Angra 1 and Angra 2 in accordance with the same safety principles.

Based on the safety performance of nuclear installations in Brazil, and considering the information provided in this Third National Report, the Brazilian nuclear organizations consider that its nuclear program has:

- achieved and maintained a high level of nuclear safety in its nuclear installations;

- established and maintained effective defenses in its nuclear installations against potential radiological hazards in order to protect individuals, the society and the environment from harmful effects of ionizing radiation;

- prevented accidents with radiological consequences and is prepared to mitigate such consequences should they occur.

Therefore, Brazil considers that its nuclear program related to nuclear installations has met and continues to meet the objective of the Convention on Nuclear Safety.

REFERENCES

[1] Convention on Nuclear Safety - Legal Series No. 16 - International Atomic Energy Agency - Vienna - 1994.
[2] Guidelines Regarding National Reports under the Convention on Nuclear Safety – INFCIR/572/Rev1 - 1997.04.24. – Revised on 10.06.1999.
[3] Report of the President of the Review Meeting – CSN-RM 2002/03 – Vienna – April 2002.
[4] Second National Report of Brazil – Convention on Nuclear Safety – Rio de Janeiro – September 2001.
[5] Power Reactor Information System - International Atomic Energy Agency (available through the Internet at http://iaea.or.at).
[6] Licensing of Nuclear Installations - CNEN-NE-1.04 - July 1984.
[7] Siting of Nuclear Power Plants - Resolution CNEN 09/69.
[8] Licensing of Nuclear Reactor Operator - CNEN-NN-1.01 - October 1979.
[9] Operational Reporting for Nuclear Power Plants - CNEN-NE-1.14 - 1983.
[10]Operational Safety in Nuclear Power Plants - CNEN-NE-1.26 - October 1997.
[11]Safety Policy of CNEN – Directive n.295 of 23 December 1996.
[12]Quality Assurance Policy of CNEN – Directive n.296 of 23 December 1996.
[13]The Nuclear Power Industry's Aging Workforce and Transfer of Knowledge to the Next Generation (to be published in 2004 by IAEA).
[14]Guidance Document on the Preservation (and Enhancement) of Nuclear Knowledge for NPP's Operating Organizations – (Draft under elaboration by IAEA, 2004).
[15]Magarinos Torres, D.M., Magarinos Torres, M., "Competencies' Tree", COPPE/UFRJ- Universidade Federal do Rio de Janeiro (Brazil), 2002.
[16]Health Requirements for Nuclear Reactor Operators - CNEN-NN.1.06 - 1980
[17]Certification of Qualification of Radiation Protection Supervisors - CNEN-NN-3.03 - October 1997.
[18].Quality Assurance for Safety in Nuclear Power Plants and Other installations - CNEN-NN-1.16 – September 1999.
[19]Basic Radiation Protection Directives - CNEN-NE-3.01 - August 1988.
[20] General Norm for Planning of Response to Emergency Situations – SIPRON – NG–02 - 1996
[21] Directive for the Preparation of Emergency Plans related to the Unit 1 of Almirante Alvaro Alberto Nuclear Power Plant – SIPRON Directiva Angra – 1997.
[22] General Norm for Establishing Public Information Campaigns about Emergency Situations – SIPRON - NG-05 – 1997.
[23] Maintenance of Nuclear Power Plants - CNEN-NE-1.21 - August 1991.
[24]In-service Inspection of Nuclear Power Plants - CNEN-NE-1.25 - September 1996.
[25]Law 10.308 of 2001.11.20 – Rules for the site selection, construction, operation, licensing and control, financing, civil liability and guaranties related to the storage of radioactive wastes.

Annex 1

EXISTING INSTALLATIONS

A.1.1. Angra 1

Thermal power	1876 Mwth
Gross electric power	657 Mwe
Net Electric power	626 Mwe
Type of reactor	PWR
Number of loops	2
Number of turbines	1 (1High Pressure/2Low pressure)
Containment	Dry cylindrical steel shell and external concrete building.
Fuel assemblies	121
Main supplier	Westinghouse El. Co.
Architect Engineer	Gibbs & Hill / Promon Engenharia
Civil Contractor	Construtora Norberto Odebrecht
Mechanical Erection	Empresa Brasileira de Engenharia
Construction start date	March 1972
Core load	20 September 1981
First criticality	13 March 1982
Grid connection	1 April 1982
Commercial operation	1 January 1985

A.1.2. Angra 2

Thermal Power	3765 MWth
Gross electric power	1345 Mwe (as measured during commissioning)
Net electric power	1275 Mwe (as measured during commissioning)
Type of reactor	PWR
Number of loops	4
Number of turbines	1 (1High Pressure/3Low pressure)
Containment	Dry spherical steel shell and external concrete building.
Fuel assemblies	193
Main supplier	Siemens KWU
Architect Engineer	ELETRONUCLEAR/Siemens KWU
Civil Contractor	Construtora Norberto Odebrecht
Mechanical Erection	Unamon
Construction start date	1975
Core load	30 March 2000
First Criticality	14 July 2000
Grid connection	21 July 2000
Commercial operation	January 2001

A.1.3. Angra 3

Thermal Power	3765 MWth
Gross electric power	1309 MWe
Net electric power	1229 MWe
Type of reactor	PWR
Number of loops	4
Number of turbines	1 (1High Pressure/3Low pressure)
Containment	Dry spherical steel shell and external concrete building.
Fuel assemblies	193
Main supplier	Siemens KWU
Architect Engineer	ELETRONUCLEAR/Siemens KWU
Civil Contractor	na
Mechanical Erection	na
Construction start date	1978
Core load	(to be confirmed)
First Criticality	(to be confirmed)
Grid connection	(to be confirmed)
Commercial operation	(to be confirmed)

Annex 2

LIST OF RELEVANT CONVENTIONS, LAWS AND REGULATIONS

A.2.1. Relevant International Conventions of which Brazil is a Party

Convention on Civil Liability for Nuclear Damage (Vienna Convention). Signature: 23/12/1993. Entry into force: 26/06/1993.

Convention on the Physical Protection of Nuclear Material. Signature:15/05/1981. Entry into force: 8/02/1987.

Convention on Early Notification of a Nuclear Accident Signature: 26/09/1986. Entry into force: 4/01/1991.

Convention on Assistance in Case of Nuclear Accident or Radiological Emergency. Signature: 26/09/1986. Entry into force: 4/01/1991.

Convention on Nuclear Safety. Signature: 20/09/1994. Entry into force: 24/04/1997.

Convention n. 115 of the International Labor Organization. Signature: 7/04/1964.

A.2.2. Relevant National Laws

Decree 40.110 of 1956.10.10 - Creates the Brazilian National Commission for Nuclear Energy (CNEN).

Law 4118/62 of 1962.07.27 - Establishes the Nuclear Energy National Policy and reorganizes CNEN.

Law 6189/74 of 1974.12.16 - Creates Nuclebras as a company responsible for nuclear fuel cycle facilities, equipment manufacturing, nuclear power plant construction, and research and development activities.

Law 6.453 of 1977.10.17 - Defines the civil liability for nuclear damages and criminal responsibilities for actions related to nuclear activities

Decree 1809 of 1980.10.07 - Establishes the System for Protection of the Brazilian Nuclear Program (SIPRON).

Law 6938 of 1981.08.31 - Establishes the National Policy for the Environment (PNMA), creates the National System for the Environment (SISNAMA), the Council for the Environment (CONAMA) and Brazilian Institute for the Environment (IBAMA).

Law 7781/89 of 1989.06.27 - Reorganizes the nuclear sectors.

Decree 99.274 of 1990.06.06 - Regulates application of law 6938, establishing the environmental licensing process in 3 steps: pre-licence, installation licence and operation licence.

Decree 2210 of 1997.04.22 - Regulates SIPRON, defines the Secretary for Strategic Affairs (SAE) as the central organization of SIPRON and creates the Coordination of the Protection of the Brazilian Nuclear Program (COPRON).

Law 9.605 of 1998.02.12 – Defines environmental crimes and establishes a system of enforcement and punishment.

Decree 3719 of 1999.09.21 – Regulates the Law 9.605 and establishes the penalties for environmental crimes..

Law 9.765 of 1998.12.17 – Establishes tax and fees for licensing, control and regulatory inspection of nuclear and radioactive materials and installations.

Decree 3833 of 2001.06.05 – Establishes the new structure and staff of the Brazilian Institute for the Environment (IBAMA).

Law 10.308 of 2001.11.20 – Establishes rules for the site selection, construction, operation, licensing and control, financing, civil liability and guaranties related to the storage of radioactive wastes.

A.2.3. CNEN Regulations

NE 1.04 - Licenciamento de instalações nucleares - Resol. CNEN 11/84 - ***(Licensing of nuclear installations).***

NE 1.14 - Relatórios de operação de usinas nucleoelétricas - ***(Operation reports for nuclear power plants).***

NE 1.16 - Garantia de qualidade para a segurança de usinas nucleoelétricas e outras instalações - Resol. 15/99 - ***(Quality assurance for safety of nuclear power plants and other installations).***

NE 1.17 - Qualificação de pessoal e certificação para ensaios não destrutivos em itens de instalações nucleares - ***(Qualification and certification of personnel for non-destructive tests in nuclear power plants components).***

NE 1.18 - Conservação preventiva em usinas nucleoelétricas - ***(Preventive conservation of nuclear power plants).***

NE 1.19 - Qualificação de programas de cálculos para análise de acidentes de perda de refrigerante em reatores a água pressurizada - Resol. CNEN 11/85 - ***(Qualification of calculation programs for the analysis of loss of coolant accidents in pressurized water reactors).***

NE 1.20 - Aceitação de sistemas de resfriamento de emergência do núcleo de reatores a água leve - ***(Acceptance criteria for emergency core cooling system for light water reactors).***

NE 1.21 - Manutenção de usinas nucleoelétricas - ***(Maintenance of nuclear power plants).***

NE 1.22 - Programas de meteorologia de apoio de usinas nucleoelétricas - ***(Meteorological program in support of nuclear power plants).***

NE 1.25 - Inspeção em serviço de usinas nucleoelétricas - ***(In service inspection of nuclear power plants).***

NE 1.26 - Segurança na operação de usinas nucleoelétricas - ***(Operational safety of nuclear power plants).***

NE 1.28 - Qualificação e atuação de órgãos de supervisão técnica independente em usinas nucleoelétricas e outras instalações - Resol. CNEN-CD N^{o}.15/99 de 16/09/1999- **-** ***(Qualification and actuation of independent technical supervisory organizations in nuclear power plants and other installations)***

NN 1.01 - Licenciamento de operadores de reatores nucleares - Resol. CNEN 12/79 - ***(Licensing of nuclear reactor operators).***

NN 1.06 - Requisitos de saúde para operadores de reatores nucleares - Resol. CNEN 03/80 - ***(Health requirements for nuclear reactor operators).***

NN 1.12 - Qualificação de órgãos de supervisão técnica independente em instalações nucleares - Resol. CNEN 16/85 - Revisada em 21/09/1999 ***- (Qualification of independent technical supervisory organizations for nuclear installations).***

NN 1.15 - Supervisão técnica independente em atividades de garantia da qualidade em usinas nucleoelétricas - ***(Independent technical supervision in quality assurance activities in nuclear power plants).***

NE 2.01 - Proteção física de unidades operacionais da área nuclear - Resol. CNEN 07/81 - ***(Physical Protection in operational units of the nuclear area).***

NE 2.03 - Proteção contra incêndio em usinas nucleoelétricas - Resol. CNEN 08/88 - ***(Fire protection in nuclear power plants).***

NE 3.01 - Diretrizes básicas de radioproteção - Resol. CNEN 12/88 - ***(Radiation protection directives).***

NE 3.02 - Serviços de proteção radiológica - ***(Radiation protection services).***

NE 3.03 - Certificação da qualificação de supervisores de radioproteção - Resol. CNEN 09/88 – Revisada em 01/09/95, Modificada em 16/10/97 e 21/09/99 - ***(Certification of the***

qualification of radiation protection supervisors).

NE 5.01 - Transportes de materiais radioativos - Resol. CNEN13/88 - ***(Transport of radioactive materials).***

NE 5.02 - Transporte, recebimento, armazenamento e manuseio de elementos combustíveis de usinas nucleoelétricas - ***(Transport, receiving, storage and handling of fuel elements in nuclear power plants).***

NE 5.03 - Transporte, recebimento, armazenagem e manuseio de ítens de usinas nucleoelétricas - ***(Transport, receiving, storage and handling of items in nuclear power plants).***

NE 6.05 - Gerência de rejeitos radioativos em instalações radioativas - ***(Radioactive waste management in nuclear installations).***

A.2.4. CONAMA Regulations

CONAMA – 01/86 - Estabelece requisitos para execução do Estudo de Impacto Ambiental (EIA) e do Relatório de Impacto Ambiental (RIMA) - ***(Establishes requirements for conducting the environmental study (EIA) and the preparation of the report on environmental impact(RIMA)) -*** (23/01/1986).

CONAMA-28/86 - Determina a FURNAS a elaboração de EIA/RIMA para as usinas nucleares de Angra 2 e 3 - ***(Directs FURNAS to prepare an EIA/RIMA for the Angra 2 and 3 nuclear power plants) -*** (03/12/1986)

CONAMA-09/86 - Regulamenta a questão de audiências públicas - ***(Regulates the matters related to public hearings) -*** (03/12/1987).

CONAMA-06/86 – Institui e aprova modelos para publicação de pedidos de licenciamento - ***(Establishes and approves models for licensing application) -*** (24/01/1986).

CONAMA-06/87 – Dispõe sobre licenciamento ambiental de obras de grande porte e especialmente do setor de geração de energia elétrica - ***(Regulates environmental licensing of large enterprises, specially in the area of electric energy generation) -*** (16/09.1987).

CONAMA-237/97 – Dispõe sobre os procedimentos a serem adotados no licenciamento ambiental de empreendimentos diversos - ***(Establishes procedures for environmental licensing of several types of enterprises) -*** (19/12/1997).

A.2.5. SIPRON Regulations

NG-01 - Norma Geral para o funcionamento da Comissão de Coordenação da Proteção do Programa Nuclear Brasileiro (COPRON) - ***(General norm for the Coordination Commission***

for the Protection of the Brazilian Nuclear Program). Port. SAE 99 of 13.06.1996.

NG-02 - Norma Geral para planejamento de resposta a situações de emergência. ***- (General norm for planning of response to emergency situations).*** Resol. SAE/COPRON 01/96.

NG-03 - Norma Geral sobre a integridade física e situações de emergência nas instalações nucleares - ***(General norm for physical integrity and emergency situations in nuclear installations).*** Resol. SAE/COPRON 01/96.

NG-04 - Norma Geral para situações de emergência nas unidades de transporte - ***(General norm for emergency situations in the transport units).*** Resol. SAE/COPRON 01/96.

NG-05 - Norma Geral para estabelecimento de campanhas de esclarecimento prévio e de informações ao público para situações de emergência - ***(General norm for establishing public information campaigns about emergency situations).*** Port. SAE 150 of 11.12.1997.

NG-06 - Norma Geral para instalação e funcionamento dos centros de resposta a situações de emergência nuclear - ***(General norm for installation and functioning of response center for nuclear emergency situations).*** Port. SAE 27 of 27.03.1997.

NG-07 - Norma Geral para planejamento das comunicações do SIPRON ***(General norm for SIPRON communication planning).*** Port. SAE 37 of 22.04.1997.

NG-08 - Norma Geral sobre o planejamento e a execução da proteção ao conhecimento sigiloso no âmbito do SIPRON ***(General norm for the planning and execution of the protection of the classified knowledge within SIPRON).*** Port. SAE 145 of 07.12.1998.

NI-01 – Norma Interna que dispõe sobre a instalação e o funcionamento do Centro Nacional para o Gerenciamento de uma Emergência Nuclear (***Internal Norm on the installation and operation of the National Center for the Management of a Nuclear Emergency*)**. Port. SAE 001 of 05.21.1997.

Diretriz Angra-1 - Diretriz para elaboração dos planos de emergência relativos a unidade 1 da Central Nuclear Almirante Alvaro Alberto - ***(Directive for the preparation of emergency plans related to Unit 1 of Almirante Alvaro Alberto Nuclear Power Plant - Angra 1).*** Port. SAE 144 of 20.11.1997.

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Ministério de Relações Exteriores (MRE)
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