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SECOND PERIODIC SAFETY REVIEW OF ANGRA NUCLEAR POWER STATION, UNIT 1.

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ABSTRACT

This paper describes the second Periodic Safety Review (PSR2-A1) of Angra Nuclear Power Station, Unit 1, prepared by Eletrobrás Eletronuclear S.A. and Tecnatom do Brasil Engenharia e Serviços Ltda., during Jul.2013-Aug.2014, covering the period of 2004-2013.

The site, in Angra dos Reis-RJ, Brazil, comprises: Unit 1, (640 MWe, Westinghouse PWR, operating), Unit 2 (1300 MWe, KWU/Areva, operating) and Unit 3 (1405 MWe, KWU/Areva, construction).

The PSR2-A1 attends the Standards 1.26-Safety in Operation of Nuclear Power Plants, Brazilian Nuclear Regulatory Commission (CNEN), and IAEA.SSG.25-Periodic Safety Review of Nuclear Power Plants.

Within 18 months after each 10 years operation, the operating organization shall perform a plant safety review, to investigate the evolution consequences of safety code and standards, regarding: Plant design; structure, systems and components behavior; equipment qualification; plant ageing management; deterministic and probabilistic safety analysis; risk analysis; safety performance; operating experience; organization and administration; procedures; human factors; emergency planning; radiation protection and environmental radiological impacts.

The Review included 6 Areas and 14 Safety Parameters, covered by 33 Evaluations.

After document evaluations and discussions with plant staff, it was generated one General and 33 Specific Guide Procedures, 33 Specific and one Final Report, including: Description, Strengths, Deficiencies, Areas for Improvement and Conclusions. An Action Plan was prepared by Electronuclear for the recommendations.

It was concluded that the Unit was operated within safety standards and will attend its designed operational lifetime, including possible life extensions.

The Final Report was submitted to CNEN, as one requisite for renewal of the Unit Permanent Operation License.

1. INTRODUCTION

This paper is a condensed description of the Final Report of the Second Periodic Safety Review of Angra Nuclear Power Station, Unit 1, in Brazil [1], based on the Brazilian Nuclear Regulatory Commission (CNEN) regulation [2] and IAEA safety guide [3].

The contents of this paper were focused more on experience feedback of the review and evaluation methodology, other than plant specific details, once the submitted Final Report [1], is still under evaluation by CNEN.

It was established 6 Evaluation Areas for 14 Safety Factors, covered by 33 Evaluation Reports.

The review, covering the 10 year period from 01.Jan.2004 to 31.Dec.2013, was performed during the period of Jul.2013 to Aug.2014, by a multidisciplinary team of Eletronuclear [4], and Tecnatom do Brasil [5], a subsidiary of Tecnatom Group, hired for this purpose.

The structure of the Final Report was organized as follows: Section 1, describes the review process; Section 2, with a summary of individual evaluations; Section 3, with a global evaluation; Section 5, with References and the Section 5, with the Attachments (Tables, figures and graphs).

The following definitions are applied to this paper:

Strength, when the current practice is equivalent to good practices, that is, recommended for use in other plants, according to current standards.

Improvement Opportunity, based on normative requisites resulting from updates of plant licensing standards, requisites that were not present on the original licensed design basis, industry good practices not yet incorporated and improvement possibilities identified during the review.

Deficiency, when the practice is not equivalent to current codes, standards, and industry practices, or do not comply with the current licensing basis, or are incompatible with approved plant operating procedures. Could also be a process, important for safety, with impediments for its accomplishment or the inexistence of a process important for safety, according to international practice. Based on the classification of the Deficiencies (S1 to S5, in decreasing order of importance for safety), it is verified the individual impact, of each deficiency or deficiencies, for the safe operation of the plant.

The Table 1 presents the abbreviations, acronyms or initials used in this paper:

Table 1: Abbreviations, acronyms and initials

English	Description	Portuguese
BNRC	Brazilian Nuclear Regulatory Commission	CNEN
Eletronuclear	Eletrobrás Termonuclear S.A.	Eletronuclear
FSAR	Final Safety Analysis Report	RFAS
IAEA	International Atomic Energy Agency	AIEA
IFS	Important for Safety	IPS
IOE	Individual Occupationally Exposed	IOE
OSART	Operational Safety Review Team (IAEA)	OSART
P	Eletronuclear, Presidency.	P
POA	Permanent Operation Authorization	AOP
POM	Plant Operations Manual	MOU
PSR	Periodic Safety Review	RPS
PSR1-A1	First Periodic Safety Review of Angra 1	RPS1-A1
PSR1-A2	First Periodic Safety Review of Angra 2	RPS1-A2
PSR2-A1	Second Periodic Safety Review of Angra 1	RPS2-A1
SF	Safety Factor	FS
SSC	Structures, Systems and Components	ESC
Tecnatom	Tecnatom do Brasil Engenharia e Serviços Ltda.	Tecnatom
WANO	World Association of Nuclear Operators	WANO

2. DEVELOPMENT

2.1 Angra 1 periodic safety review evolution and methodology

2.1.1 Second Periodic Safety Review of Angra 1

The Unit 1 of Angra Nuclear Power Station is described in the Abstract. The initial criticality occurred at 20:23 hr. of 13.Mar.1982 and the first synchronism to the Brazilian national electrical grid occurred at 15:26 hr. of 01.Apr.1982. For historical registration that synchronism meant the entrance of Brazil in the era of nuclear electrical generation.

Angra 1 originally belonged, up to Mai.1997, to the electrical utility Furnas Centrais Elétricas S.A. which received from the Brazilian Nuclear Regulatory Commission (CNEN), in Dec.1994, the Permanent Operation Authorization (POA) for a 30 years period, subject to a PSR at each 10 years of operation.

The Angra Power Station ownership was transferred to Eletronuclear, created in May.1997, within the same national holding, Eletrobrás.

In Jul.1997 Eletronuclear granted, from the CNEN, the ratification of the Unit 1 POA, for a 28 years period, subject to a PSR at each 10 years of operation.

The first PSR of Angra 1 covered the period 1994-2003, the first 10 years of operations after the first POA. The review and the reports were done in the period Jan.2004 – Jul.2005.

In the first PSR of Angra 1 there were identified 44 Improvement Opportunities, with no impediments for the continuity of the plant operation. In that review it was adopted the WANO Peer Review and IAEA Operational Safety Review Teams (Osart) criteria which do not discriminate between Deficiency and Improvement Opportunity. This was questioned by CNEN and corrected in this second PSR. The 44 Improvement Opportunities resulted in Action Plans, some implemented and some included in long term duration implementation plans, in agreement with CNEN.

Considering the attendance level of the action plans, CNEN accepted the PSR1-A1 as of 25.Feb.2010.

2.1.2 Objectives of the Second Periodic Safety Review of the Angra 1.

Currently both the Units 1 and 2 are electrically dispatched by “order of merit”, by the National System Operator (ONS), for all levels of operation.

The load programs are periodically evaluated by Eletronuclear and the ONS, considering the long term planning of the nuclear fuel refueling and overall maintenance outages.

Even though demonstrated in the commissioning tests, both Units are qualified for load follow operations, but they are preferably operated in base load, that is, with stable power.

At the end of nuclear fuel cycles both units operate in fuel cycle extension mode and natural power reduction (coast down), for better fuel utilization.

The implementation of Improvement Opportunities identified in the first PSR of the Unit 1 contributed to raise the level of safety in operation of the plant - also the identified strengths contributed positively for the safe operation of the plant.

The PSR is a requirement of the paragraph 21 of CNEN norm CNEN-NE-1.26 – Safety in Operation of Nucleoelectric Power Plants, [2]. It requires that "After the emission of the POA, the operating organization shall conduct, each ten years, a periodic safety review of the Plant, to investigate the consequences of the evolution of norms and standards, of operational practices, of the cumulative effects of plant structures, systems and components, of design modifications, of the operational experience analysis and of the Science and technology developments".

The review is complementary to the auditing and safety evaluations, special and routine, internal (Eletronuclear) and external (Regulatory and Licensing Board) - it can be also included as complementary to the WANO Peer Reviews and IAEA Operational Safety Review Teams (Osarts).

Due to the 10 years period, the PSR permits the identification of global issues that are not normally detected during the short intervals of the routine safety evaluations.

The PSR involves aspects related to the safety of the design, licensing and operation of the Plant, which demands a great volume of work and several specialists and support personnel.

Since it follows internationally accepted standards, the PSR contributes to confirm or to improve the existing design basis and safety analysis.

In the same way as in the PSR1-A1, it was not expected for the PSR2-A1 the identification of unknown deficiencies with important impact on items important for safety.

The level of details employed in the evaluations is compatible with the objectives of the PSR, as previewed in norms, guides, standards, procedures and other documents.

Some of the internal and external evaluations performed during the time covered by the PSR2-A1, were used also as input for this review.

2.1.3 Normative requirements and reference documents

Norm CNEN-NE-1.26 [2], which requires the PSR, establishing a minimum of 11 Safety Parameters to be evaluated and an 18 months period for performance of the review.

Regulation CNEN/PR Nº 087 - of 19.Sep.2010, establishing the requisites and exigencies for performance of the PSR2-A1, and the renewal of the POA of the Plant.

Official Letter CNEN 124/2010, - 09.Oct.2010, for the renewal of the POA of Unit 1, establishing the conditioning terms for the ratification of the POA.

Specific Safety Guide SSG-25 [3], complementary and compatible with CNEN-NE-1.26, considers 14 Safety Factors considered sufficient to cover all safety aspects of the Plant. It provides recom3endations and directions for conduction of the PRS. It is designated to operating organizations, technical support areas, regulating organizations and consulting organizations.

Tec Doc 1643 - Periodic Safety Review of Nuclear Power Plants: Experience of Member States, IAEA, 2010, presents the experience in the performance of PSR in IAEA Member States. The compilation of the experience shows that this methodology for PSR performance

is widely used throughout the world. - The document indicates the scope of PSR performance vary from country to country, but maintaining the methodology and principles.

Report GTS.O-RL-002.2005, Eletronuclear, rev. 01, 16.Sep.2005, presents the results of the First Periodic Safety Review of the Unit 1.

Report SC.O-RL-001/02, Eletronuclear, rev. 0, 30.Nov.2012, presents the results of the First Periodic Safety Review of the Unit 2.

Procedure EQ/1/0236/N 04 222, Eletronuclear, - General Directions for Performance of the First Periodic Safety Review of Angra 1, Rev. 0, 03. Dec.2003.

Procedure *PC-A2-SN-001*, Eletronuclear, , General Directions for Performance of the First Periodic Safety Review of the Unit 2, Rev. 0, 18.Nov.2011

General Circular Letter 054/2013, Eletronuclear, confirming the establishment of the Eletronuclear Coordination Commission for performance of the PSR2-A1, formed by representatives of Eletronuclear Presidency (P), Operations (OD), Technical (TD) and Planning, Management and Environment (GD), 11.Sep.2013.

2.1.4 Procedures and documents utilized for the Review

PC-A1-SN-002 – General Directions for Performance of the Second Periodic Safety Review of Unit 1, Eletronuclear, rev. 0, 16.Oct.2013, confirming the organizational structure for the conduction of the PSR2-A1. By this procedure it was defined the organization and responsibilities, adopted methodology, scope and quality assurance for the PSR2-A1.

Work Instructions or Guide Procedures, Eletronuclear, defining the scope and format of each of the 33 procedures to cope with the 14 Safety Factors, 2013.

2.1.5 Evaluation or review methodology

The Table 2 below represents the list of Areas, Safety Factors and Specific Evaluations:

Table 2: Areas, Safety Factors and Specific Evaluations.

Area	Safety Factor	Nº	Specific Evaluations of the Unit 1
01 – Plant Status	1. Plant Design	01	Design Basis and Licensing of Unit 1.
		02	Design Modifications Process and Implemented Modifications in Unit 1.
02 – Behavior of the Structures, Systems and Components (SSC)	2. Behavior of the (SSC) 3. Equipment Qualification 4. Plant Ageing Management	03	SSC Conditions of the Unit 1.
		04	The Unit 1 Equipment and Components "Q" List.
		05	The Unit 1 Maintenance and Rules (MR) Program.
		06	The Unit 1 In-service Inspection Program.
		07	The Unit 1 Surveillance Program (Periodic Tests and SSC Inspections).
		08	Ageing Management of the Unit 1.
		09	Actuation of the Quality Assurance (QA) Service in the Follow-up of the SSC Behavior of the Unit 1.
03 – Safety Analysis	5. Deterministic Safety Analysis 6. Probabilistic Safety Analysis 7. Hazard (Risk) Analysis	10	Thermal Hydraulic Analysis and Deterministic Safety of the Unit 1 FSAR.
		11	The Unit 1 Probabilistic Safety Analysis (PSA) Program.
		12	The Unit 1 Scope of Risks (Internal and External Risks).
		13	The Unit '1 Risk Analysis (Fire, Internal Flood, External Flood, Line Rupture, Seismic, Pressure Waves, Internal Missiles, External Missiles)
04 – Operational Performance and Experience Feedback	8. Safety Related Performance 9. External Operational Experience Feedback	14	The Unit 1 Operational Performance.
		15	The Unit 1 Internal Operational Experience Feedback (IOEF)
		16	The Unit 1 External Operational Experience Feedback (EOEF)
		17	The Unit 1 Quality Assurance (QA) Evaluation of the Performance and Operational Experience Feedback.
05 – Safety Improvement Projects	10. Organization and Administration 11. Procedures 12. Human Factors 13. Emergency Planning	18	The Company and Unit 1Safety Policy and Safety Culture Improvement Programs.
		19	The Company and the Unit 1 Organizational Changes.
		20	The Unit 1 Documentation Updating Process.
		21	The Unit 1 Quality Assurance Program.
		22	Training Management of the Unit 1 Personnel.
		23	The Unit 1 Self Evaluation and External Evaluation Program.
		24	The Unit 1 Human Performance Program.
		25	The Unit 1 Human Factors Engineering (HFE).
		26	The Unit 1 Operating Manual (OM) Updating and Modernization.
		27	The Unit1 Technical Specifications Improvement Program.
		28	The Unit 1 Severe Accident Management Program.
		29	Local and External Emergency Plans.
06 – Radiation Protection and Environment	14. Radiological Impact on the Environment	30	The Unit 1 Liquid and Gaseous Effluent Release Surveillance Program.
		31	The Unit 1 Occupational Dose Control and ALARA Programs.
		32	The Unit 1 and the Station Environmental Monitoring Program.
		33	The Unit 1 and the Station Solid Waste Management Program.

The Areas were arranged such that the Safety Factors have strong correlations and interfaces. The Table 3 shows the main correlation and interfaces between the Safety Factors:

Table 3: Correlations and interfaces between Safety Factors

Safety Factors Receiving Input Data \ Safety Factors Providing Input Data	SF01	SF02	SF03	SF04	SF05	SF06	SF07	SF08	SF09	SF10	SF11	SF12	SF13	SF14
SF01		X	X	X	X	X	X	X	X			X	X	X
SF02	X		X	X	X			X	X	X				
SF03	X	X		X	X	X	X	X	X	X			X	
SF04	X	X	X		X	X	X	X	X	X	X			
SF05	X	X	X	X		X		X	X		X	X	X	
SF06	X	X	X	X	X		X	X	X		X	X	X	
SF07	X	X	X		X	X		X	X		X	X	X	X
SF08	X	X			X	X	X		X	X	X	X		X
SF09	X									X	X			X
SF10		X			X	X		X	X		X	X		X
SF11	X	X	X	X	X	X	X	X	X	X		X	X	X
SF12	X	X	X	X	X	X	X	X	X	X	X			
SF13	X				X	X	X	X	X		X			
SF14	X	X				X		X	X		X			

Safety Factors	
SF01	Plant Design
SF02	Behavior of the (SSC)
SF03	Equipment Qualification
SF04	Plant Ageing Management
SF05	Deterministic Safety Analysis
SF06	Probabilistic Safety Analysis
SF07	Hazard (Risk) Analyses
SF08	Safety Related Performance
SF09	External Operational Experience Feedback
SF10	Organization and Administration
SF11	Procedures
SF12	Human Factors
SF13	Emergency Planning
SF14	Radiological Protection and Environment

Examples: - The SF01 (Plant Design), to verify the actuality of the normative and the configuration control, has interfaces with all other SF, less SF10. - The SF02 (Behavior of Structures, Systems and Equipment) has interfaces with the SF for Safety Analysis, being input for them.

Global Evaluation: based on the Safety Parameters evaluation results, existence and graduation of Deficiencies, it presents the global Safety Condition of the Unit 1.

The Improvement Opportunities have no direct impact on the safety, as described in the item 1.0 above. The table 4 shows an internal safety classification of Deficiencies:

Table 4: Safety classification of deficiencies

Level	Description
S1	Findings important for safety: - technical specifications violation; non-evaluated safety question violation of requirements of environmental regulatory organizations; deficiency on the physical protection system; deficiency in labor safety; deficiency in the fire protection safety.
S2	Findings which can cause increase in the radiation doses: Additional radiation exposure time due to the needy for observation and equipment maintenance beyond usual; inadequate working conditions. Other findings: Safety related equipment operational but with deviation; pending items on training, procedures and documentation, with impact on safety; lack of safety culture; deterioration on safety of physical protection, environment, labor and fire protection.
S3	Formal findings on internal documentation and training, not directly affecting safety; - formal pending items related to the nuclear and environmental licensing not affecting safety; pending items on the implementation of recommendations resulting from the experience and/or international tendency to improve the design bases, as for example: beyond design events, update of technical specifications, improvement of procedures, etc.
S4	Findings on items of marginal importance for safety.
S5	Not categorized.

2.1.6 Administrative organization for the review

Procedure de PC-A1-SN 002 – General Directions, Eletronuclear, Rev. 1, 2014, confirmed the organization for the PSR2-A1, as follows: 5 general coordinators from higher staff of the company and 6 Area Coordinators from site and engineering managers.

The general coordinators had the responsibility for the conduction of the Review, by the definition of the scope of evaluations, and by the approval of the final report.

The area coordinators had the responsibility for the conduction of the evaluations of the Safety Factors affected to their respective working areas.

The data collection work, evaluation and documentation were attributed to an Eletronuclear multidisciplinary group, all with more than five years' experience in the specific subject.

Tecnatom do Brasil was hired to work together Eletronuclear in this Project, participating in all phases of the PSR2-A1. The Tecnatom team was composed of up to 12 professionals, all with more than 30 years of experience in Administration and Management, Operation, Maintenance, Technical Support Engineering, Reactor Physics and Quality Assurance.

The Final Report was prepared by 7 members of the overall team.

2.2 Evaluations

2.2.1 Area 1: Plant status

2.2.2 The evaluation of this area verifies the adequacy of the plant project as described in the SFAR in the light of evolution of knowledge and the design changes undergone by the plant during the covered period.

The evaluation of this area included the following:

2.2.2.1 Evaluation of design bases for Plant Licensing.

a) This is based on changes on national standards, as well in standards from the country of origin of the project, and their implications in the design and operation of the plant.

b) Verification of the validity and completeness of the information contained in SFAR, considering the changes of hardware and software implemented in the plant over the period.

2.2.1.2 Design Modifications Process evaluation and its incorporation in the documentation of the plant, such as SFAR, Technical Specifications, Procedures, etc.

a) Includes assessing the design modifications implemented in the period, based on their safety classification and safety analysis, in order to ensure that the design bases have been preserved.

2.2.3 Area 2: Behavior of structures, systems and components

The evaluation of this area verifies that the current conditions of Structures, Systems and Components (SSC), important for safety, are appropriate for achieving their design objectives.

It also aims to the assessment of the qualification of equipment important for safety, to perform their functions, throughout the plant lifetime. Also, verifies if there is an effective program to manage equipment aging, to ensure that their safety functions are being preserved. The evaluation of this area comprises the following:

a) Evaluation of the current condition of the SSC important for safety (primary circuit and its components, safety systems, reactor core and nuclear fuel, containment, etc.), based on the results of the in service inspection programs, periodic tests and maintenance programs. Also, should identify the main problems with the SSC occurred in the period, if any, and their solutions implemented or being implemented.

b) Evaluation of Equipment Qualification List (Q List) based on the applicable rules, in order to ensure the identification of components required to perform their duties in adverse environmental conditions, as well as meeting the eligibility requirements. Also, should re-evaluate the processes to ensure the maintenance of such qualifications and qualified spare parts management process.

c) Evaluation of the Maintenance Rules Program (MR), which prioritizes the maintenance of equipment based on their importance to safety and their results.

d) Evaluation of the In-Service Inspection Program, including welds, brackets, valves, pipes, dampers, etc., verifying compliance with the program, the main gaps and their justifications, major deviations and their corrective actions.

e) Evaluation of the In-service Inspections and Periodic Testing Program (Surveillance), established in the Technical Specifications, checking the program compliance with the program, identifying major deviations and corrective actions taken.

f) Evaluation of the Plant aging management program to ensure that aging mechanisms of SSC important for safety are considered in the plant processes. Its scope shall be identified, as well the strategies, results and corrective actions taken or planed for continued Plant operation.

g) Quality Assurance audit assessment of the programs mentioned above, in order to identify if the quality requirements have been met. Major nonconformities and corrective actions taken should be indicated.

2.2.4 Area 3: Safety analysis

The evaluation of the Safety Analysis Area is to verify that the deterministic and probabilistic safety analyses remain valid under the following aspects: status of the plant design, current conditions of the SSC, application of new know-how, safety standards and current analytical methods.

It is also focused in determining the suitability of plant protection against internal and external threats, as well as to verify the proper implementation of the concept of defense in depth:

The revaluation of this Area includes:

a) Verification of the completeness and validity of deterministic safety analysis of incidents and accidents, included in the SFAR. It verifies if the scope of analyses, in the SFAR, corresponds to recent standards and if the data and assumptions used in those analyses are still valid. It verifies also if the methodology remains ensuring conservative results.

b) Evaluation of the scope of threats considered in the plant design, the needy to include other events, resulting, for example, from new know-how, climate change or changes resulting from industrial activities or population growth near the plant, not analyzed in the original project.

c) Evaluation of threat analyses considered in the SFAR: flood, fire, internal and external missiles, high voltage line ruptures, etc., from the point of view of data update, validity of hypothesis and conservatism of the methodology.

~~d)~~ Evaluation of the Probabilistic Safety Analysis program (PSA). Such program enables a quantitative risk analysis for the different operating conditions of the plant. This re-evaluation is focused in the identification of the existing analyses, those under development or planned as well as the existing PSA review process, to ensure that they remain a representative model of the Plant.

2.2.5 Area 4: Operational performance and operational experience feedback

The evaluation of the Performance and Operational Experience Area verifies if the plant collects and evaluates its operational data in a systematic and comprehensive way. It verifies if the plant uses operational, internal and external experience, and the experience of its main

suppliers, the improvement of its processes, procedures, etc. The main objective is to verify the continued improvement of its level of safety throughout the covered period.

The evaluation of this area includes the following:

a) Evaluation of Operational Performance in the period, based on the analysis of plant performance indicators trends in order to verify that plant operation remains as expected, meeting international standards.
b) Evaluation of the Internal Operating Experience (IOE) Process, based on qualitative and quantitative mandatory reporting events in the period, and the implementation of their corrective actions.
c) Evaluation of External Operating Experience (EOE), covering the significant event reports distributed by WANO, INPO, NRC and the IAEA, etc., and communications from the main supplier of the Plant on deficiencies related to their equipment, systems and design. The corrective actions, proposed and implemented, are also evaluated.
d) Evaluation of the Quality Assurance audits applied to the above mentioned programs in order to identify if the quality requirements have been satisfactorily met, identified non-compliances and corrective actions taken.

2.2.6 Area 5: Safety improvement projects

Evaluation of the established programs according to international good practices related to Organization and Management, Human Factors and Procedures. It evaluates the capacity of the Plant in terms of procedures, personnel, facilities and equipment, to control or to mitigate the consequences of severe accidents. It is evaluated also the adequacy of the Plant emergency planning.

The conduct of the evaluation of this area includes the following:

2.2.6.1 Organizational and administrative factors

a) Evaluation of the organizational changes in the plant, to verify the maintenance of competences in the areas Important for the safe operation of the Plant.
b) Evaluation of the Plant External and Self Evaluations Programs and the action plans for solution of possible finds and deficiencies.
c) Evaluation of the Quality Assurance (QA) Program application, including its accomplishment, main findings and corrective actions taken.

2.2.6.2 Human factors:

a) Evaluation of the Training Program for the licensed, non-licensed, management and administrative personnel. It is taken in consideration the applied as compared to the recommended training.

b) Evaluation of Human Performance Improvement Program to minimize human error in implementing the various activities. The evaluation covers the program structure, adequacy of the training and the effectiveness of policies and actions taken.

c) Evaluation of the Safety Policy and the continuous improvement of Safety Culture of Eletronuclear, to strengthen the concept of "safety first" in the different activities in the plant.

d) Evaluation of the Human Factors Engineering (HFE), to verify the adequacy of the Man Machine Interface (MMI) and its compatibility with the recommendations of NUREG 0711 - Human Factors Engineering Program Review Model. It is evaluated the adopted approach, the work performed, and the results obtained.

2.2.5.3 Procedures

a) Evaluation of the control and update process of the Plant main documents, to ensure the continued availability of valid documents, by sampling.

b) Evaluation of the upgrade and modernization of the Plant Operations Manual (OM), focused on the permanent availability of updated and validated procedures with adequate content and format. It is evaluated also the development, validation, approval and change control of the OM procedures.

2.2.5.4 Technical Specification:

Evaluation of the Technical Specifications, including the modifications process changes, control, compilation and classification of modifications, as well as the project of implementation of its version in Portuguese.

2.2.5.5 Emergency planning:

a) Evaluation of the Local and External Emergency Plan, which is focused in the protection of workers and the site neighboring population in case of an emergency. It is utilized the reference US-NUREG 654, [6], as well as the results of the various trainings, simulation scenarios and rehearsals, with findings and respective solutions adopted. It is also assessed the impact of the Fukushima event in the Emergency Plan.

b) Evaluation of the Program for Severe Accident Management being developed for Unit. It is verified the preparation of the Plant to prevent Severe Accident and/or to mitigate their consequences with reference to international practice and the technology supplier country. It is also assessed the implications of the lessons learned from the Fukushima, on the program.

2.2.6 Area 6: Radiation protection and environment protection

The evaluation of this area is to verify the Plant program of control and monitoring of any impact to workers, individuals of the public and the environment, resulting from the operation of the Plant.

The evaluation of this Area includes:

a) Evaluation of the Occupational Dose Control Program, the ALARA program, and their effectiveness in reducing the dose received by the Plant personnel.

b) Evaluation of the process of release of liquid and gaseous effluents, verifying the results such as: tendencies, activities, isotopic compositions, projections of effective dose to the public, etc.

c) Evaluation of the Environmental Monitoring Program, its results and its adaptation to demographic development changes in the area of influence of the Plant.

d) Evaluation of the Waste Management program, indicating the generation rate reduction efforts, storage conditions, ongoing strategies, future perspectives, etc.

3 CONCLUSIONS (GLOBAL EVALUATION)

The Global Evaluation is focused in assessing the impact of the identified Deficiencies, individually or as group, on the safe operation of the Plant during the period. It assesses also the information contained in the Strengths, Improvement Opportunities and Conclusions.

The Second Periodic Safety Review of Angra Nuclear Power Station, Unit 1, was performed in compliance with the item 21 of the Norm CNEN-NE-1.26, [2] supplemented by IAEA Safety Guide SSG-25, [3], in application to the requirement of the Paragraph 16 of the Permanent Operation Authorization of the Unit1, issued by the Order of Regulation CNEN/PR Nº 087 of 17.Sep.2010.

The Table 5 below describes the number and classification of identified Deficiencies.

Table 5 - Conclusion of the Second Periodic Safety Review of Angra Nuclear Power Station, Unit 1

						CONCLUSION	
Area 1	SF01	Topic 01 Topic 02	3 Def. S3	It was verified that the impact of the deficiencies, individually, or per Area of Evaluation did not affect the continuity of the safe operation of the Plant.	It was verified that the group of all the Deficiencies did not affect the continuity of the safe operation of the Plant.	The evaluations concluded that the plant operated in a safe manner and, based on the results, it is able to continue safe operation.	Improvement Opportunities were identified for the 6 areas of evaluation. Being implemented, they can be part of the continuous improvement of the safe operation of the Angra Nuclear Power Station, Unit 1.
Area 2	SF02	Topic 03 Topic 04 Topic 05 Topic 06 Topic 07	1 Def. S2				
	SF03	Topic 08					
	SF04	Topic 09					
Area 3	SF05	Topic 10	5 Def. S3				
	SF06	Topic 11					
	SF07	Topic 12 Topic 13					
Area 4	SF08	Topic 14	4 Def. S3				
	SF09	Topic 15 Topic 16 Topic 17					
Area 5	SF10	Topic 18 Topic 19 Topic 20	1 Def. S4 1 Def. S3				
	SF11	Topic 21 Topic 22 Topic 23					
	SF12	Topic 24 Topic 25 Topic 26 Topic 27					
	SF13	Topic 28 Topic 29					
Area 6	SF14	Topic 30 Topic 31 Topic 32 Topic 33	2 Def. S4				

IMPORTANT NOTICE: The original PSR2-A1 Final Report, [1], is still in analysis by the Brazilian Nuclear Regulatory Commission (CNEN). In this respect, this paper was focused on the evaluation methodology and experience feedback of the review, other than plant specific details.

Notes:

1. The internal classification of deficiencies is defined in the Table 5 above.
2. One Action Plan was prepared by Eletronuclear, to cope specifically with the identified deficiencies.
3. Eletronuclear is to consider the best opportunities to apply the identified Improvement Opportunities.

Further Improvement Opportunities were identified, the implementation of which, along with the maintenance of existing safety related processes, will consolidate aspects related to safety of the Plant.

Action plans were prepared to eliminate the identified Deficiencies, as well as to implement the Improvement Opportunities considered by order of relevance.

During the evaluation period the Unit operated safely and reliably. Identified shortcomings, for which relevant corrective actions have been taken or are in planning, had no direct impact on safety.

Within the Plant general management area it was included the evaluation of the Plant organizational changes to cope with ongoing and future maintenance of important safety operational functions as follows: **Corporate** short term and long term strategies of Eletronuclear and its holding Eletrobrás; **Supply** of nuclear fuel; **Electrical** energy distribution; **Acquisitions** of supplies and services, both national and international; **Training** and human resources programs; **Spent** nuclear fuel storage, both inside the plant and the preparation for construction of the new site interim nuclear fuel storage facility; **Interim** solid waste management center.

The review results showed that, within the evaluated ten years, Angra 1 was operated within the safety standards, and that, maintaining the status of its functions important for the operational safety; it fulfils the operating conditions for its lifetime period, including possible lifetime extensions.

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We also want to dedicate this paper to the memory of Jose Mauro Mendonça, who was part of the Tecnatom´ s team and had provided a valuable contribution to the PSR2-A1 Review and Final Report.

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