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A qualitative approach of the regulation for the life extension of brazilian nuclear power plants

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ABSTRACT

The advantages of Long-Term Operation (LTO) in dealing with the end-of-life-cycle issue of Nuclear Power Plants (NPPs) in operation today, when compared to the creation of new NPPs, have major social and economic implications. The Life Extension process of the Brazilian NPP Angra 1 has already started, and its methodology is well defined in the technical notes NT-CGRC-007/18, (CNEN, 2018a) [1] and NT-CGRC-08/18, (CNEN, 2018b) [2]. This work aims to present a critical analysis of the two technical notes. The technical notes are in an initial version, therefore, the results of their verifications and validations are presented, which were carried out through a qualitative analysis, the factors that can be modified to be adjusted and/or modified to generate improvements for the notes or documents that may replace them.

Keywords: **Long Term Operation, Aging Management, Life Extension, License Renewal.**

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1. INTRODUCTION

On the reports from the International Atomic Energy Agency (IAEA) [3,4], Nuclear Power Plants (NPPs) are highly safe and protected installations, however, they are susceptible to accidents like any other one, that is why, despite the regulation of a NPP and ensuring safety is a national responsibility, IAEA [3,4] assists Member States in fulfilling this responsibility, by establishing international safety standards and examining the application of those standards to all types of nuclear installations throughout their total life cycle.

According to SALDANHA [5], in December 2014, from the 438 nuclear power plants in operation, around 80% had been in service for more than 20 years and, to deal with the issue of the end of the life cycle of their NPPs, many countries have chosen for making use of the Long-Term Operation (LTO).

GREGOR and CHOCKIE [6] have already justified this option based on its advantages, such as the fact that the extension of the life cycle of 104 plants operated in the US is financially equivalent to the construction of 52 new plants, among other one.

Most European States and Japan use Periodic Safety Reviews (PSRs) to obtain authorization for an LTO, but the United States of America practices the License Renew Application (LRA) concept [5].

The nuclear industry and the US Nuclear Regulatory Commission (USNRC) developed license renewal requirements based on the strategy of distinguishing between active and passive systems, structures, and components (SSCs). This distinction has culminated in two important sets of requirements, which are: the Maintenance Rule, 10 CFR 50.65 (USCFR, 2017) [7], that manages the aging of active SSCs, and the License Renewal Rule, 10 CFR Part 54 (USCFR, 2016) [8], responsible for managing the degradation of "passive" SSCs. This process has been adopted by IAEA itself as the model for ensuring safe Life Extension operations [6].

The request for the extension of the Brazilian nuclear power plant life cycle, Angra 1, has already been carried out, and there are two technical documents, developed by the Brazilian National Nuclear Energy Commission (CNEN), NT-CGRC-007/18, (CNEN-2018a) [1], and NT-CGRC-008/18, (CNEN-2018b) [2], which are in force in Brazil, being used, together, as guidelines for the LTO process that is in progress. Technical Note NT-CGRC-07/18 [1] establishes technical

and administrative requirements for operational organizations to demonstrate that a NPP can operate in LTO while maintaining safety functions within the Current Licensing Base (CLB).

The PSR is applied in Brazil every 10 years and its results are used in the LRA, whose concepts originate from the practice adopted by the USNRC and formed the basis of the two Technical Notes [1,2].

Technical Note NT-CGRC-08/18 [2] provides regulatory requirements for operational organizations in developing the implementation and improvement of Aging Management (AM) to maintain the safety functions of the SSCs within the CLB.

Technical Note NT-CGRC-07/18 [1] explains, on its second page, that the regulatory assessment of the Aging Management Review and Long-Term Operation will be made considering the document developed by the USNRC, called USNRC-NUREG-1800, (USNRC, 2010) [9], "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants", and that the use of Technical Note NT-CGRC-07/18 [1] must be done considering Technical Note NT- CGRC-008/2018 [2].

But do the necessary requirements described in those two Technical Notes [1,2] for the Life Extension of the Brazilian NPP Angra 1 correspond, in fact, to those from the American LTO process, adopted by the IAEA as a model to ensure safe Life Extension operations of NPPs?

To verify whether the requirements of the two Technical Notes [1,2] are in accordance with the standards developed by the USNRC, a critical study of them was carried out through a qualitative analysis, examining the points that could be modified and/or improved.

It should be noted that, despite not being available to the public, the two technical documents could be consulted at CNEN. As a participant in the IEN/CNEN, there was the opportunity to evaluate the documents independently from the CNEN technicians, and, if necessary, to contribute to the preparation of technical notes or not.

2. MATERIALS AND METHODS

Two checklists (see Appendix of this work) were prepared, one on Life Extension, to assess Technical Note NT-CGRC-007/18, (CNEN, 2018a) [1], and another on Aging Management, to examine the Technical Note NT-CGRC-008/18, (CNEN, 2018b) [2]. These checklists had, respectively, the License Renewal Rule, 10 CFR Part 54, (USCFR, 2016) [8], and the Maintenance

Rule, 10 CFR 50.65, (USCFR, 2017) [7], as the basis for their developments. Those two last documents mentioned are international ones indicated by the IAEA itself as references in area and based on what they say that are necessary for the LTO process take place, questions asking if those necessary things are included in the Brazilian process were created.

The two checklists are entirely made up of dichotomous Yes/No questions, however, as during data collection it was noticed that certain topics addressed by some questions were not mentioned by the Technical Notes.

The answer "Data Not Found" was also accepted, as well as the answer “Partially Yes”, when it was verified that the Technical Notes dealt with the subjects of some questions, but with a different criterion from what was expected.

The checklist for evaluating Technical Note NT-CGRC-007/18 [1], has 18 questions, and the checklist for reviewing Technical Note NT-CGRC-008/18 [2], contains 32 questions.

The percentage of questions with “yes” answers from each checklist could demonstrate how close to the totality of the Life Extension process requirements, developed by the USNRC, is the current life extension process of the Brazilian NPP Angra 1.

Each question on the checklists is worth 1 (one) point, including those with sub-themes ones. In these questions with sub-themes, all subdivisions have equal percentages, and the sum of all of them is worth 100% (one hundred percent) of the question's score, that is, 1 (one) point. Thus, through simple calculations, the score of each type of answer ("Yes", "No", "Partially Yes" and "Data Not Found") of the sub-themes of the questions with topic subdivisions was determined.

The checklists were also assigned percentages, each worth 100% (one hundred percent). Thus, proportionally, 100% (one hundred percent) of the checklist with 18 questions is 18 points, and 100% (one hundred percent) of the checklist with 32 questions is 32 points. Based on this, also by simple calculations, the percentages of the requirements that are not included in the Technical Notes, and those that are included and need to be attended, were determined; as well as the percentages of those requirements that need to be partially attended, and those that do not need to be attended by the licensee to obtain the license for the Extension of the Life Cycle of the Brazilian NPP, through the answers "Data Not Found", "Yes", "Partially Yes" and "No”, in due order.

3. RESULTS AND DISCUSSION

From the 18 questions that were asked to assess whether Technical Note NT-CGRC-007/18 [1], was in accordance with the License Renewal Rule, 10 CFR Part 54, USCFR (2016) [8], all answers were “Yes”, except the answers to the question 11 and to the sub-item vii of question 14, which were not found in the Technical Note and, therefore, received the answer “Data Not Found”.

Question 11 seeks to know whether NT-CGRC-007/18 [1], requires a more sophisticated asset management tool from the licensee, which considers the lifetime cycle and main capital investments for the plant.

Question 14 asks whether NT-CGRC-007/18 [1], requires the licensee that the application development process involves the following actions: Identification and evaluation of exemptions containing Time-Limited Aging Analysis (TLAA). Although the Technical Note deals with the subject of TLAA, it does not talk about “exemptions” as far as that subject is concerned.

The Table I shows the quantitative data about the answers, which supported the qualitative analysis of Technical Note NT-CGRC-007/18 [1]:

Table 1: Data from Technical Note NT-CGRC-007/18, (CNEN, 2018a) [1]

	Answers for the Technical Note NT-CGRC-007/18, Checklist	
Answers type	**Quantity in unit**	**%**
Yes	16,86	93,67
Partially yes	0,00	0,00
No	0,00	0,00
Data not found	1,14	6,33
Total	**18,00**	**100,00**

From the 32 questions that were asked to assess whether Technical Note NT-CGRC-008/18 [2], was in accordance with the Maintenance Rule, 10 CFR 50.65, (USCFR, 2017) [7], all questions received the answer " Yes”, with the exception of the answers to questions 26 and 30, which were

"Partially Yes," and the answers to questions 6 and 31, which were not found and then received "Data Not Found".

Questions that were not fully answered asked:

(a) If NT-CGRC-008/18 [2], required the licensee to take corrective action and a new and more specific performance criterion (setting goals), if a system could not meet its performance criteria for a period not exceeding 24 months, to demonstrate that the corrective action was effective (question 26); and

(b) If NT-CGRC-008/18 [2], required the licensee to have biannual monitoring activities and system trends, to try to identify precursors or incipient failures that could have occurred in other plants and have implications (…) (question 30).

The answer to the question 26 mentioned in item (a) above was yes, however, NT-CGRC-008/18, (CNEN, 2018b) [2] does not talk about a period not exceeding 24 months.

The answer to the question 30 referred to in item (b) above was also yes, however, NT-CGRC-008/18 [2] does not require the activities to be biannual, but rather that they occur once per cycle.

The questions which data of the subjects were not found investigated whether NT-CGRC-008/18 [2], required the licensee to manage old inaccessible equipment and whether NT-CGRC-008/18 [2], required the licensee to quantify the risk "online" to support the continued operation of the plant.

The Table II shows the quantitative data about the responses, which supported the qualitative analysis of Technical Note NT-CGRC-008/18 [2]:

Table 2: Data from Technical Note NT-CGRC-008/18, (CNEN, 2018b) [2]

	Answers for the Technical Note NT-CGRC-008/18, Checklist	
Answer type	**Quantity in unit**	**%**
Yes	28,00	87,50
Partially yes	2,00	6,25
No	0,00	0,00
Data not found	2,00	6,25
Total	**32,00**	**100,00**

4. CONCLUSION

Technical Note NT-CGRC-007/18 [1], met 93.67% of the guidelines outlined in the License Renewal Rule, 10 CFR Part 54, (USCFR, 2016) as necessary for the process of License Renewal is of acceptable quality, and Technical Note NT-CGRC-008/18 [2], met 87.50% of the guidelines described in the Maintenance Rule, 10 CFR 50.65 (USCFR, 2017) [7], as necessary for the Aging Management process of an NPP has acceptable quality, also.

The approach carried out in this work was limited to verifying through the necessary requirements to be applied in the Life Extension and Aging Management Programs of the NPP in the general aspects available in documents of the international technical literature. However, this limitation proved to be adequate when applied in the verification of programs of a specific NPP.

Based on this understanding, it is possible to state that the percentages of the checklists requirements that were not met do not make the safety level of the Brazilian NPP Life Extension Process low when compared to the process practiced in the USA, as these percentages can be justified by the differences that exist between a Brazilian plant and an American plant, and their consequent differences in demand.

In addition, it is noteworthy that any shortcomings in practices that appear throughout the process can be met during the practical development of Aging Management programs, since those programs are not executed punctually, but rather continuously and that, as long as they do not deviate from regulatory requirements, their practices can be remodeled and adapted to the needs of the reality of the NPP.

Thus, it is concluded that the two Technical Notes, NT-CGRC-007/18 [1], and NT-CGRC-008/18 [2], demonstrated to have standards of requirements for the Life Extension of the Brazilian NPP Angra 1, which not only comply with the standards developed by the USNRC, indicated by the IAEA, but which also guarantee a process that provides high levels of nuclear safety, both for the period of the Life Extension process, and also for the period of operation beyond the original plant life cycle.

It can be said that the quality of the Brazilian process of Life Extension for NPPs is comparable to the quality of international processes accepted as benchmarks of reliable processes by the IAEA. However, for the Brazilian process to become even more complete and rigorous, it is suggested that:

1) the process described by Technical Note NT-CGRC-007/18 [1], deals with the identification and evaluation of exemptions containing time-limited aging analyzes and requires from the licensee a more sophisticated asset management tool, leading into consideration the lifecycle, cycle, and major capital investments for the plant, such as life cycle management (LCM), is that; and,
2) the process described by Technical Note NT-CGRC-008/18 [2], requires the licensee to manage old inaccessible equipment; specify that corrective action and new, more specific performance criteria are required if the system cannot meet its performance criteria for a period not exceeding 24 months; impose that in the process there are biannual monitoring activities and system trends, in order to try to identify precursors or incipient failures that may have occurred in other plants and may have implications; and establish the need to include data on the online risk quantification requirement to support the continued operation of the plant.

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APPENDIX

APPENDIX A: Checklist developed for the collection of data used in the evaluation of Technical Note NT-CGRC-007/18, (CNEN, 2018a).

APPENDIX B: Checklist developed for the collection of data used in the evaluation of Technical Note NT-CGRC-008/18, (CNEN, 2018b).

APPENDIX A

Data collection from Technical Note NT-CGRC-007/18, (CNEN-2018a):

License renewal checklist:

1) Does NT-CGRC-007/18, CNEN, require the licensee to focus on adverse effects of aging rather than on identifying all aging mechanisms, so that identification of individual aging mechanisms is not necessary?
2) Does NT-CGRC-007/18, CNEN, require the licensee to simplify the integrated plant assessment process to make it consistent with the revised focus on the harmful effects of aging?
3) Does NT-CGRC-007/18, CNEN, require the licensee to add a time-limited aging analysis (TLAA) assessment?
4) Does NT-CGRC-007/18, CNEN, require the licensee to only be passive, long-lived structures and components subject to a management review for license renewal, thereby removing active SSCs from license renewal?
5) Does NT-CGRC-007/18, CNEN, require the licensee to focus on safety-critical long-life and passive components rather than all SSCs to justify extended operations? That is, the need is to confirm that the initial ideas of the original design will continue to be valid throughout the extended period of operation, and that the effects of aging will be properly managed, so

that the intended functions of the passive or long life are maintained during extended operation?

6) Does NT-CGRC-007/18, CNEN, requires the licensee, during the regulatory process, to place the focus of the license renewal assessment on the aging management activities of passive and long-term SSCs, excluding structures and components that perform active functions and structures and components that are replaced based on the qualified life or specified period of time?

7) Does NT-CGRC-007/18, CNEN, require the licensee to take measures to address age-related degradation of certain passive and long-lived SSCs, in addition to any other issues that may arise during the extended period of operation?

8) Does NT-CGRC-007/18, CNEN, require the licensee that the plant's licensing base has been maintained, during the license renewal, in the same manner and for the same extension period as during the original licensing?

9) Does NT-CGRC-007/18, CNEN, require the licensee that the plant's licensing base has been maintained, during the license renewal, in the same manner and for the same extension period as during the original licensing?

10) Does NT-CGRC-007/18, CNEN, require the licensee to develop long-term plans to support cost-benefit assessments of major capital projects and formulate a lifetime maintenance strategy for the plants?

11) Does NT-CGRC-007/18, CNEN, requires a more sophisticated asset management tool from the licensee, taking into account the lifecycle, lifecycle and major capital investments for the plant, such as lifecycle management (LCM)?

12) Does NT-CGRC-007/18, CNEN, requires the licensee to have a preventive maintenance program that addresses issues of implementation of the equipment reliability process, based on a rigorous system of work orders, through which maintenance activities are scheduled, implemented and recorded?

13) Is the regulatory process predictable, stable, and does it clearly and unambiguously define regulatory expectations for license renewal?

14) Does NT-CGRC-007/18, CNEN, requires the licensee that the application development process involves the following actions:

i) Identification of SSCs within the scope of the License Renewal Rule?

ii) Identification of the intended roles of SSCs?

iii) Identification of structures and components subject to aging management and intended functions?

iv) Ensuring that the effects of aging are managed?

v) Development and implementation of new aging management and inspection programs?

vi) Identification and resolution of time-limited aging analyses?

vii) Identification and evaluation of exemptions containing time-limited aging review/analysis?

15) Does NT-CGRC-007/18, CNEN, requires the licensee, in the scope phase, to identify, by the licensee, all systems, structures, components and installations related to safety or whose failure may affect the related safety functions, or that are invoked to demonstrate compliance with various USNRC specific regulations, such as fire protection and plant blackout regulations?

16) Does NT-CGRC-007/18, CNEN, require the licensee to have an integrated assessment of the plant?

17) Does NT-CGRC-007/18, CNEN, requires the licensee that the integrated plant assessment (IPA), that is, the demonstration that structures and components requiring aging management (within the scope of the Rule) have been identified and the effects of aging on its functionality will be managed to maintain an acceptable level of security during extended operations so that:

i) be determined which structures and components within the scope of the Rule are passive and enduring?

ii) The technique used to identify and assess the effects of aging any of the approved techniques listed in the NEI guidance document (NEI 95-10)?

iii) During the process, the licensee must demonstrate that the effects of aging will be managed in such a way that the intended functions will be maintained over a long period of operation, i.e. the licensee demonstrates that existing programs provide adequate aging management throughout the period of operation. of extended operation, so that no further

action may be required and that, however, if additional aging management activities are required, the licensee will define them?

iv) There are four general types of aging management programs listed below:

• Prevention, to prevent certain levels of aging degradation from occurring, eg coating programs to prevent external corrosion of a tank?

• Mitigation, to reduce or delay the effects of aging (eg chemistry programs to mitigate internal pipeline corrosion?

• Condition monitoring, to verify the presence and extent of aging effects, eg visual inspection of concrete structures for cracks and ultrasound, and pipe wall measurement for erosion-corrosion induced wall thinning?

• Performance monitoring, to test the ability to perform its function, eg heat exchanger heat balances for the intended heat transfer function of the tubes?

v) The licensee use the generic findings of the GALL report as a technical basis for its plant, subject to applicability verification?

vi) The aging management program, credited for license renewal, meets strict 10-point acceptance criteria, elements and descriptions of which can be seen below:

• Scope of activity: Should the scope of the program/activity include the specific structures and components subject to an aging management review for license renewal?

• Preventive actions: Should preventive actions mitigate or prevent the degradation of aging?

• Detection of aging effects: The detection of aging effects must occur before there is a loss of the component's intended structure or function(s). Does this include aspects such as method or technique (ie visual, volumetric, surface inspection), frequency, sample size, data collection, and timing of new/one-time inspections to ensure timely detection of aging effects?

• Monitored or Inspected Parameters: Should the monitored or inspected parameters be linked to the degradation of the particular structure or intended function(s) of the component?

• Acceptance Criteria: Acceptance criteria, against which the need for corrective action will be assessed, shall ensure that the component's intended structure or functions are maintained under all current licensing-base design conditions during the extended period of the operation?

• Operational experience: Operational experience of the aging management activity, including past corrective actions that result in program improvements or additional programs

or activities, should provide objective evidence to ensure that the effects of aging will be adequately managed so that the structure's intended functions or component is maintained during the period of extended operation?

•□Administrative Controls: Should administrative controls provide a formal review and approval process?

•□Confirmation processes: Should the confirmation processes ensure that preventive actions are adequate and that appropriate corrective actions have been completed and are effective?

vii) Licensees implement the Aging Management Programs (AMPs) series, provided with the GALL report, as part of their maintenance program without much deviation?

18) Does NT-CGRC-007/18, CNEN, require the licensee to identify and update time-limited aging analyses, i.e. the licensee must go back to the original plant design documents and determine if the design criteria included limited specific time and, once identified, should the original calculations or qualification tests be updated for the new extended life?

APPENDIX B

Data collection from Technical Note NT-CGRC-008/18, (CNEN-2018b):

Aging Management Checklist:

1) Does NT-CGRC-008/18, CNEN, requires the licensee to have effective inspection and maintenance practices that allow the life of the installation to be limited only by the economic cost of repairing or replacing any component that does not meet the criteria for specified acceptance?

2) Does NT-CGRC-008/18, CNEN, require the licensee to integrate old management and maintenance requirements, that is, is there careful management to avoid duplication of efforts and ineffective maintenance tasks?

3) Does NT-CGRC-008/18, CNEN, require the licensee to integrate old management and maintenance requirements, that is, is there careful management to avoid duplication of efforts and ineffective maintenance tasks?

4) Does NT-CGRC-008/18, CNEN, require the licensee to reduce component failures, being proactive to identify incipient failures, precursors and age-related degradation?

5) Does NT-CGRC-008/18, CNEN, require the licensee to effectively monitor conditions, improve the application of diagnostic analysis to avoid failures and establish appropriate inspection procedures?

6) Does NT-CGRC-008/18, CNEN, require the licensee to manage inaccessible old equipment (since replacement and repair are generally not an economically viable option)?

7) Does NT-CGRC-008/18, CNEN, require the licensee to adequately quantify the costs resulting from failures in order to support reliable conclusions and justify the implementation of a predictive maintenance strategy and effective aging management?

8) Does NT-CGRC-008/18, CNEN, require the licensee to share experiences by tracking generic failures and monitoring the effectiveness of past management activities?

9) Does NT-CGRC-008/18, CNEN, require the licensee to implement pilot projects to assess the effectiveness of new requirements and processes?

10) Does NT-CGRC-008/18, CNEN, require the licensee that documents developed by the USNRC, which serve for guidance as well as to assist in the development of aging management programs, in the preparation of the renewal application, and in the review of the request, are used to provide clear guidance and support to all parties involved?

11) Does NT-CGRC-008/18, CNEN, require the licensee of the plant to ensure that it is maintained in like-new condition so that there is no reduction in safety margins over the life of the plant?

12) Does NT-CGRC-008/18, CNEN, require the licensee that the professionals involved have the skills and knowledge of all structures, systems and components, as well as the experience to recognize errors and take timely corrective measures for the safety of the plant operation, so as to avoid failures?

13) Does NT-CGRC-008/18, CNEN, require the licensee that the professionals involved have an understanding of the behavior of the materials when they are exposed to certain stressors,

so that attention can be focused on “the right places and at the right time”. right”, so that they can be equipped with the right tools and fundamental information to deal with the degradation situation of aging, and, in this way, produce effective actions to mitigate or prevent problems that affect the safe operations of the plant?

14) Does NT-CGRC-008/18, CNEN, require the licensee to have a scope?

15) Does NT-CGRC-008/18, CNEN, require the licensee to identify critical components and non-critical components?

16) Does NT-CGRC-008/18, CNEN, require the licensee to monitor performance, at the system or component level (reliability and availability) for critical and non-critical components, so that mitigating or corrective actions are carried out before of the component or system exceeds its limits?

i) Does NT-CGRC-008/18, CNEN, require the licensee that, in this performance monitoring, there is a “condition code” process, at the level of performance monitoring manual works, which has three to five levels of equipment condition, from simple observations, to be analyzed by maintenance personnel and recorded in a standard form with the work package to be evaluated by the system engineer, to facilitate the opinion of the condition of the equipment, with the following levels of codes of condition:

• Condition 1: like new,

• Condition 2: meets or exceeds expectations,

• Condition 3: shows signs of acceptable wear/degradation,

• Condition 4: must be scheduled for revision, replacement

• Condition 5: found in fault condition?

ii) Does NT-CGRC-008/18, CNEN, require the licensee to, in this performance monitoring, use the equipment history and corrective action database to perform equipment failure trend for components used in various systems?

iii) Does NT-CGRC-008/18, CNEN, require the licensee that, in this performance monitoring, there are specific alert values for component condition monitoring data?

iv) Does NT-CGRC-008/18, CNEN, require the licensee that, in this performance monitoring, there is a tendency for the condition codes of equipment found to:

• identify degradation patterns by component type and the need to adjust preventive maintenance (PM) tasks or frequencies?

• identify MP discrepancies for further evaluation?

v) Does the performance monitoring use the industry events database (EPIX) to identify trends in components that are being experienced by other plants and take proactive steps to prevent failures?

vi) vi) Does NT-CGRC-008/18, CNEN, require the licensee to identify aging or obsolescence problems in this performance monitoring?

vii) Does NT-CGRC-008/18, CNEN, require the licensee, in this performance monitoring, to evaluate the relationship between the performance of the component and the effect on the functional performance of the system?

viii) Does NT-CGRC-008/18, CNEN, require the licensee that, in this performance monitoring, there is a trend of key data collected in operator rounds?

ix) Does NT-CGRC-008/18, CNEN, require the licensee, in this performance monitoring, to consult non-nuclear sources of information on component failures and parameter/strategy trends?

17) Does NT-CGRC-008/18, CNEN, requires the licensee to take corrective actions, to investigate the reason for the failure and what process should have prevented it from occurring, instead of just repairing it, so that:

i) in the corrective actions, questions about:

• Existing barriers that should have prevented failure (procedure, integrity, implementation of procedures, vessel training, post-maintenance, restoration, identification, use of operational experience, troubleshooting, outage management and human performance)?

• Barriers that should be implemented to prevent recurrence, considering the risk/benefit of the change?

• what other components are susceptible to this failure mechanism? What is extension of this condition?

• if the process of continuous improvement of equipment reliability has been lost?

• could more frequent implementation of existing preventive maintenance actions have prevented recurrence?

• whether the scope of preventive maintenance tasks should be increased?
• is there an aging or obsolescence concern that should be addressed in corrective actions?
• is additional corrective maintenance required?
• is the failing component within the scope of the USNRC maintenance rule or does the failure cause a significant power reduction?
• whether similar components are affected by the same issue?

ii) in corrective actions, questions about:
• Providing training and qualification for the root cause of equipment, including the requirement to participate in a certain number of root cause analyzes per year?
• Developing root cause experts or mentors, with training and experience, in departments that frequently participate in this activity?
• Use of a graduated approach to root cause determination, proportionate to the level of consequences of failure?
• Establishing clear methods to obtain supplier knowledge or increase failure analysis, for equipment failures whose root cause cannot be determined by a team?
• Searching for industry and internal operational experience, including EPIX, to determine if similar failures have occurred?

18) Does NT-CGRC-008/18, CNEN, require the licensee to have equipment reliability, that is, the identification of incipient failures, monitoring of failures in other plants and looking for precursors, to know the locations, the susceptibility to failures and potential degradation and thus effective monitoring methods be used? And so that:
i) the degradation can be monitored by the installed instrumentation?
ii) the degradation can be detected by a predictive maintenance technique such as vibration analysis, oil sampling, thermography or engine signature?
iii) the degradation can be visibly observed during operator or system engineer rounds?
iv) And degradation can be measured by surveillance tests?

19) Does NT-CGRC-008/18, CNEN, require the licensee that representative parameters that can be measured be established for the complete system, and also for all active components, which are normally operating in mechanical and electrical systems?

20) Does NT-CGRC-008/18, CNEN, require the licensee to have rigorous monitoring and reporting of individual system performance parameters?

21) Does NT-CGRC-008/18, CNEN, require the licensee that the scope of the program and the acceptance criteria be defined based on the regulation developed by the USNRC?

22) Does NT-CGRC-008/18, CNEN, require the licensee that the Rule make a significant distinction between important systems that need performance monitored at the system level and those that can be monitored at the plant level?

23) Does NT-CGRC-008/18, CNEN, require the licensee that standby systems be monitored using reliability as a performance parameter?

24) Does NT-CGRC-008/18, CNEN, require the licensee that operating systems be monitored using availability as a measure of performance?

25) Does NT-CGRC-008/18, CNEN, require the licensee to strike an adequate balance between performing preventive maintenance and the need to maintain satisfactory availability and/or reliability?

26) NT-CGRC-008/18, CNEN, requires the licensee to take corrective action and a new and more specific performance criterion (Establishment of Goals) if a system cannot meet its performance criteria for a period not exceeding to 24 months in order to demonstrate that the corrective action was effective?

27) NT-CGRC-008/18, CNEN, requires the licensee to demonstrate that preventive measures in maintenance programs are effective for monitored systems at the plant level, whose performance criteria may include repetitive failures, factory shutdowns , start of security systems and loss of production?

28) Does NT-CGRC-008/18, CNEN, require the licensee that, if the established performance criteria of the systems monitored at the plant level are exceeded, the system must be upgraded to “monitoring at the system level”?

29) Does NT-CGRC-008/18, CNEN, requires the licensee that system-level monitoring requires that a high level of such monitoring continue until it is demonstrated that the system has reached its new level of performance, before the system returns at plant level?

30) Does NT-CGRC-008/18, CNEN, requires the licensee to carry out biannual monitoring activities and system trends, in order to try to identify precursors or incipient failures that may have occurred in other plants and may have implications, which highlight :
i) Performance issues?

ii) Corrective actions taken?
iii) Changes in performance parameters or criteria?
iv) Assessing the balance between maintenance interruptions and system availability?
v) Assessment of the operational experience of the industry?
31) Does NT-CGRC-008/18, CNEN, require the licensee to quantify the risk online to support the continued operation of the plant?
32) Does NT-CGRC-008/18, CNEN, requires the licensee to periodically review the plant to identify failure trends of multiple components, that is, "Repetitive Functional Failure" or "Faults of the same component with identical cause" ?