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Angra 1 NPP in-service inspection and in-service testing programs for operating license and long-term operation

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ABSTRACT

The in-service inspection program of the Angra 1 plant is updated every 10 years, according to applicable standards - designer (American Westinghouse project based on NRC requirements) and CNEN. NRC approves the use of ASME Section XI (In-service Inspection of Nuclear Power Plant Components). To provide this assurance for those components that are subject to the requirements of the ASME Boiler and Pressure Vessel Code presents as requirements a set of rules has been formulated to provide assurance that the functional requirements of the components are available when required. The rules have been arranged to provide appropriate levels of assurance according to the importance of the component in its relationship to plant safety. The classifications that are established during design and manufacturing have been adopted to provide the levels of importance for the components. Nuclear power plants (NPP) have operation license for 40 years. Angra 1 operation license will complete 40 years in 2024. But, according to international standard an NPP can renewal the license for more 20 years. Brazilian standard does not have requirements for license renewal. So, CNEN had prepared two technical notes for License Renewal and Long-term operation for NPP in Brazil - CNEN NT-CGRC-007/18 and NT-CGRC-008/18. Angra 1 had already started the Renewal License and Long-term Operation project and ISI program will need to be on the Aging Management Program form, that require more robust trend analyzes, corrective and preventive actions and others attributes. The main purpose of this article is to show the ASME section XI subsections that are important for the License Renewal and Long-term Operation for Angra 1.

Keywords: **Angra 1 NPP, in-service inspection, ASME Code, License Renewal**

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1. INTRODUCTION

Angra 1 implements the rules of ASME since the preservice inspection (the ISI/IST inspection before operation). Nowadays Angra 1 is in the 4th ISI/IST Interval, so it is applicable ASME Section XI for passive components (ISI – In-service Inspection) and ASME OM (IST – In-service Testing) for active components. The use of ASME is based on the CNEN requirements:

CNEN NE 1.04 [11] - requirements 6.5.1 and 6.5.2: "6.5.1 - The items must be designed, manufactured, assembled, constructed, tested, and inspected according to technical standards compatible with the importance of the safety function to be performed. 6.5.2 - In applying the provisions of item 6.5.1, updated Brazilian codes and standards should be adopted. In the absence of adequate Brazilian standardization, Codes, Guides and Recommendations of the International Atomic Energy Agency and, in the absence thereof, international norms or technically developed countries should be used, provided these standards and regulations are accepted by CNEN."

CNEN NE 1.25 – Requirement 2.2.2. of [11] standard states: "In addition to the requirements of this standard, the implementation of in-service inspection programs shall comply with the standards or codes established by the operating organization in the technical specifications of the Final Report of Safety Analysis, according to the design and approval of the CNEN".

Angra 1 is a Westinghouse project, therefore, it adopts the standards, rules and requirements established by the US NRC (United States Nuclear Regulatory Commission). The in-service inspection program of the Angra 1 plant is updated every 10 years accordingly the 10CFR50.55a [10] requirement: "In-service examination of components and system 120-month inspection intervals must comply with the requirements of the latest edition and addenda of the Code incorporated by reference in paragraph (b) of this section 12 months before the start of the 120-month inspection interval".

The first ISI interval of Angra 1 had started on January 1985, nowadays Angra 1 is in the fourth ISI interval [12]. CNEN had evaluated and approved all the results of the last three ISI intervals of Angra 1. For LTO, CNEN has prepared two technical notes (NT-CGRC-007/18, NT-CGRC-

008/18) [1,2] that approve and describe how to use international standards (10 CFR PART 54, NUREG-1800, NUREG-1801 and Safety Guide NS-G-2.12 [3,4,5]).

To meet the requirements of these technical notes and international standards, Angra 1 developed a Quality Assurance Program and procedures for the project to license renewal and long-term operation. One of the procedures describes how to elaborate the AMP.

The section 2: ASME Section XI – In-Service Inspection Program presents a historical of the ASME section XI and the editions adopted for Angra 1 since the beginning of operation. In section 3: The Aging Management Programs Related to ASME Section XI presents the AMP related to ISI program. In section 4: In-service Testing program presents a historical of ASME OM CODE and the editions adopted for Angra 1 since the beginning of operation and explain how it will for the license renewal and long-term operation. In Section 5 are conclusion of program before and after the license renewal.

2. ASME SECTION XI - IN-SERVICE INSPECTION PROGRAM

The object of In-service inspection of components in nuclear power plants is to provide a continuing assurance that they are safe. To provide this assurance for those components that are subject to the requirements of the ASME Boiler and Pressure Vessel Code, a set of rules has been formulated to provide assurance that the functional requirements of the components are available when required. The rules have been arranged to provide appropriate levels of assurance according to the importance of the component in its relationship to plant safety. The classifications that are established during design and manufacturing have been adopted to provide the levels of importance for the components. The types of components typically found in the various classifications have then been identified and rules formulated for each type. For each type of component in each classification, the functions have been considered and methods of inspecting, testing, or monitoring each component is specified.

These rules include methods of determining the limits of acceptance of the results. Should it be necessary to take corrective action to repair various components, rules have been provided to establish acceptable methods of repair or replacement.

The basis on which the rules were developed is the assumption that a component, as constructed, is acceptable; however, to establish a record of its condition for later comparison, a preoperational (baseline) examination is required. Subsequent examinations are compared to this preoperational examination to determine if there has been a change. The philosophy includes the consideration that similar components, which are subjected to essentially identical service conditions, will behave in a similar manner. For this reason, representative sampling, which is rotated through the similar components, is used to ensure that all components are safe. The percentage of similar components or portions of components examined and the frequency of examination are adjusted in accordance with the classification established by the Owner. The purpose of the rules is to provide a uniform standard to which all nuclear power plants are subjected. By providing such a standard, important areas are not overlooked and unimportant areas are not given unnecessary attention.

The ASME Code BPVC (Boiler & Pressure Vessel Code) is internationally recognized as the technical document providing the necessary information on material specifications, concepts and rules for the design, construction, operation, inspection and maintenance of boilers and vessels including components for the construction of such equipment used in nuclear power plants and other nuclear power plants. Its main objective is to establish technical safety criteria related to the manufacture and periodic inspection of such equipment. In the case of Nuclear Plants, the applicable sections are: II (Materials), III (Construction of Nuclear Plants), V (Non-Destructive Testing), IX (Welding and Brazing) and XI (Inspection in Service) article, the section applied is to XI. In this case, the section XI presented in Table 1, is subdivided into subsections.

Table 1: Subsections of ASME Section XI.

Until 1998 edition	From 1998 edition, adendum 2000
Subsection IWA General Requirements	Subsection IWA General Requirements
Subsection IWB Requirements for Class 1 Components of Light Water-Cooled Plants Subsection	Subsection IWB Requirements for Class 1 Components of Light Water-Cooled Plants Subsection
IWC Requirements for Class 2 Components of Light Water-Cooled Plants	IWC Requirements for Class 2 Components of Light Water-Cooled Plants
Subsection IWD Requirements for Class 3 Components of Components of Light Water-Cooled Plants Light	Subsection IWD Requirements for Class 3 Components of Components of Light Water-Cooled Plants Light
Subsection IWE Requirements for Class MC and Metallic Liners of Class CC Components of Light Water-Cooled Plants	Subsection IWE Requirements for Class MC and Metallic Liners of Class CC Components of Light Water-Cooled Plants
Subsection IWF Requirements for Class 1, 2, 3, and MC Component Supports of Light Water-Cooled Plants	Subsection IWF Requirements for Class 1, 2, 3, and MC Component Supports of Light Water-Cooled Plants
Subsection IWL Requirements for Class CC Concrete Components of Light Water Cooled Plants	Subsection IWL Requirements for Class CC Concrete Components of Light Water Cooled Plants
Subsection IWP Inservice testing of pumps in Nuclear Power plants Subsection	Appendices Mandatory Nonmandatory
IWV Inservice testing of valves in Nuclear Power Plants	
Appendices Mandatory Nonmandatory	

For the components and welds the main changes from the edition 1989 to nowadays were mainly in the qualification requirements for procedure, equipment and personnel performing ultrasonic. This process was introduced in ASME by Appendix VIII. (Performance Demonstration for Ultrasonic Examination). It provides requirements for the demonstration of performance for ultrasonic testing procedures, equipment and personnel for the detection and sizing of flaws. Appendix VIII is divided into 14 (fourteen) supplements, where each supplement is intended to qualify the ultrasonic process (inspector, procedure and equipment) in different components and materials. It should be noted that 10CFR50.55a also introduced a number of changes to the requirements of Appendix VIII.

There were also many changes for the MC class. On 8 August 1996, the NRC published an amendment at 10CFR50.55a. This amendment required the utilities to implement the requirements of ASME Section XI, subsection IWE and IWL, 1992 edition with addition of 1992, as modified by the CFR. These requirements required the utilities to develop a containment examination program and complete the first examination period on September 9th, 2001.

Comparing the ASME section XI IWE subsection it was observed that the subsection IWE of the 1992 and 1995 edition are practically the same, however from the 1998 edition many changes are observed and these changes are maintained. Some categories in the IWE 2500 table have been deleted and some inspections are no longer required. Although the ASME had modifications regarding staff qualification for Visual Examination, the NRC did not recognize the changes and entered in the 10CFR50.55a the qualifications corrections for VT-1 (replacing the detailed examination of the IWE) and VT- 3 (replacing the IWE General examination), ie, the NRC has determined that personnel performing visual containment examination must be qualified and certified according to the requirements of the subsection IWA of section XI of ASME.

Table 2: The applicable editions of ASME section XI for Angra 1.

Interval	Period	Edition
First	01/01/1985 – 31/05/1996	1980
Second	01/06/1996 – 31/05/2006	1989
Third	01/06/2006 – 31/05/2016	2001 Addendum 2002 e 2003
Fourth	01/06/2016 – 31/05/2026	2007 with Addendum 2008

Angra 1 has followed the required ASME Code Section XI examination:

- ✓ Welds ≥ Inch NPS – Visual, Surface and Volumetric;
- ✓ Wild > 1 Inch NPS and < 4 Inch NPS – Visual and Surface (Some Welds Volumetric);
- ✓ Wild ≤ 1 Inch NPS – Visual Only.

For the Third Interval of ISI in Angra 1, the Appendix VIII was applicable for US examination.

When the requirements of ASME can not be attended, Angra 1 can send a relief request, for CNEN, based on a code case or in an operational experience.

In the current interval are applicable some code cases that are approved by CNEN and NRC:

- ✓ Code Case N-648-1: Alternative for Inner Radius Examinations of Class 1 Reactor Vessel Nozzles Section XI, Division 1;
- ✓ Code Case N-770: Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material with or without Application of Listed Mitigation Activities Section XI, Division 1;
- ✓ Code Case N-722: Additional examination for PWR Pressure Retaining Welds in Class 1 Component Fabricated with Alloy 600/82/182 Materials, Section XI, Division 1;
- ✓ Code Case N-729 – Alternative Examination Requirements for PWR Reactor Vessel Upper Heads with Nozzles Having Pressure-Retaining Partial Penetration Welds Section XI, Div.1.

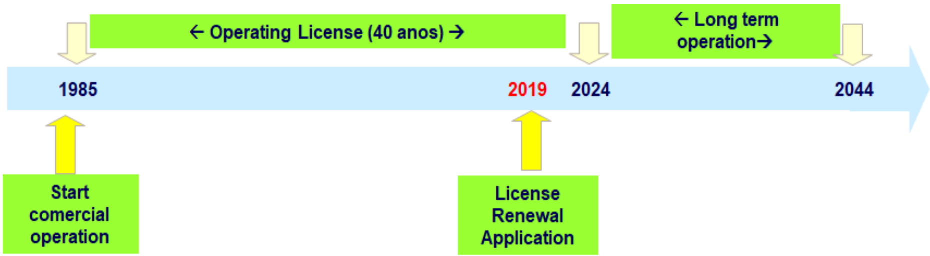
The relief request is a document that Angra 1 explains the problem and describes the alternative inspection. The code case N-648-1, Angra 1 had sent a relief request because according to ASME section XI the Inner Radius of Reactor Vessel Nozzles must be examined by volumetric inspection (ultrasonic according to Appendix VIII-PDI), but because of the geometry of these nozzles is not possible to perform UT-PDI. Based on the international experience, CNEN had approved the relief request.

To install the weld overlay in pressurizer spray nozzle, safety relief nozzle and pressurized surge nozzles (Figure 6), it was necessary to send a relief request to CNEN, because this WOL are based on NRC TI 2515/172 [16].

3. THE AGING MANAGEMENT PROGRAMS RELATED TO ASME SECTION XI

The historical of operation license is according the Figure 1.

Figure 1: *Historical of operation license for Angra 1.*



In October 2019 Angra 1 had sent to CNEN the document "License Renewal Application", that describes how Angra 1 will implement the Aging Management Programs.

The Aging Management Programs is a set of documents, procedures and plans that aim to guarantee the integrity and functional capacity of structures, systems and components important for safety, through actions that control the effects of aging, in such a way that the bases of licensing are maintained for the period of validity of the license for current operation as well as for the intended period of life extension of the plant.

The aging management programs are applicable to passive components/items (For example: welds, pump casing, valves bodies, integral attachments, and pressure retaining bolting, supports, pressure-retaining components of steel and concrete containments). An Aging Management program must present some elements, as shown in Table 3.

Table 3: AMP elements [4].

AMP Element	Description
1. Scope of the Program	The scope of the program should include the specific structures and components subject to an AMR.
2. Preventive Actions	Preventive actions should mitigate or prevent the applicable aging effects.
3. Parameters Monitored or Inspected	Parameters monitored or inspected should be linked to the effects of aging on the intended functions of the particular structure and component.
4. Detection of Aging Effects	Detection of aging effects should occur before there is a loss of any structure and component intended function. This includes aspects such as method or technique (i.e., visual, volumetric, surface inspection), frequency, sample size, data collection, and timing of new/one-time inspections to ensure timely detection of aging effects.

5. Monitoring and Trending	Monitoring and trending should provide for prediction of the extent of the effects of aging and timely corrective or mitigative actions.
6. Acceptance Criteria	Acceptance criteria, against which the need for corrective action will be evaluated, should ensure that the particular structure and component's intended functions are maintained under all current licensing basis (CLB) design conditions during the period of extended operation.
7. Corrective Actions	Corrective actions, including root cause determination and prevention of recurrence, should be timely.
8. Confirmation Process	The confirmation process should ensure that preventive actions are adequate and that appropriate corrective actions have been completed and are effective.
9. Administrative Controls	Administrative controls should provide a formal review and approval process.
10. Operating Experience	Operating experience involving the AMP, including past corrective actions resulting in program enhancements or additional programs, should provide objective evidence to support a determination that the effects of aging will be adequately managed so that the structure and component intended functions will be maintained during the period of extended operation.

Angra 1 had developed a procedure that describes the rules to implement the AMP according to CNEN technical notes and international standard, it is the PA-LG 05 (Procedure to elaborate AMP).

To implement the ISI program in Angra 1 for the license renewal and long-term operation, Angra 1 will need to organize it according the AMP shown on Table 4 and 5.

Table 4: Description of program related to ASME Section XI and status in Angra 1 [4].

GALL Chapter	GALL Program	Description of Program (NUREG 1801)	Status in Angra 1
XI.M1	ASME section XI Inservice Inspection, Subsections IWB, IWC and IWD.	The program consists of periodic volumetric, surface, and/or visual examination of ASME class 1, 2, and 3 pressure retaining components, including welds, pump casing, valves bodies, integral attachments, and pressure retaining bolting for assessment, signs of degradation, and corrective actions.	Angra 1 has procedures for the ISI program according to the ASME section XI Subsections IWB, IWC and IWD. However, it is necessary to organize it according an AMP.
XI.M3	Reactor Head Closure Stud Bolting	This program includes (a) in-service inspection (ISI) in accordance with the	Angra 1 has procedures for the ISI program according

		requirements of the American Society of Mechanical Engineers (ASME) Code, Section XI, Subsection IWB The program also relies on recommendations to address reactor head stud bolting degradation as delineated in NUREG-1339 and Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.65. 1.	to the ASME section XI Subsections IWB. However, it is necessary to organize it according an AMP.
XI.S1	ASME Section XI, Subsection IWE Inservice Inspection (IWE)	The ASME Section XI, Subsection IWE program consists of periodic visual, surface, and volumetric inspection of pressure-retaining components of steel and concrete containments for signs of degradation, assessment of damage, and corrective actions.	Angra 1 has procedures for the ISI program according to the ASME section XI Subsections IWE. However, it is necessary to organize the program according NUREG 1800 – AMP elements.
XI.S3	ASME Section XI, Subsection IWF Inservice inspection (IWF)	This program consists of periodic visual examination of component supports and high-strength structural bolting for signs of degradation, evaluation, and corrective actions. This program is in accordance with ASME Section XI, Subsection IWF.	Angra 1 has procedures for the ISI program according to the ASME section XI Subsections IWB, IWC and IWD. However, it is necessary to organize it according an AMP.

According to table 4, Angra 1 already has the procedures for ISI (since the first interval of 10 years) however, it is not in the form of an AMP. There is a schedule in Angra 1 for the implementation of the ISI program according to an AMP from until 2024.

It is important to describe that there are another AMP, for nuclear class components that are not in ASME section XI, but are related to the Angra 1 ISI program, for example:

Table 5: Other AMP related to the Angra 1 ISI that are not in ASME section XI.

GALL Chapter	GALL Program	Description of Program [NUREG 1801]	Status in Angra 1
XI.M10	Boric Acid Corrosion	To implement of recommendations in NRC Generic Letter (GL) 88-05 to monitor the condition of the reactor coolant pressure boundary for borated water leakage.	Angra 1 has procedures for monitoring boric acid corrosion. However, it is necessary to organize it according an AMP.

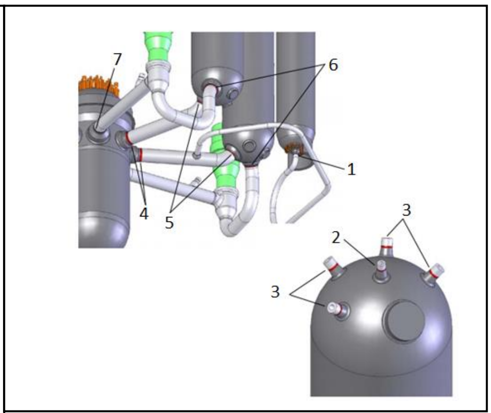
XI.M11B	Cracking of Nickel-Alloy Components and Loss of Material due to Boric Acid-Induced corrosion in reactor coolant pressure boundary components (PWRs Only)	It addresses the issue of cracking of nickel-alloy components and loss of material due to boric acid-induced corrosion in susceptible, safety-related components in the vicinity of nickel-alloy reactor coolant pressure boundary components. Code Cases: (a) N-722 and (b) N-729-1.	The figure 2 shows the typical dissimilar welds for WEC NPP. Angra 1 had already changed some components that are PWR Pressure Retaining Welds in Class 1 Components Fabricated with Alloy 600/82/182 Materials, for example: Steam Generators (Figure 3) and Reactor vessel head (Figure 4); install weld overlay in some welds of primary system (WOL – PZR spray nozzle Safety, relief nozzles and PZR surge nozzles – Figure 5) [IAEA-TECDOC-1852] and is planning to use the mechanical Stress Improvement Process (MSIP) technique on the nozzle of reactor vessel (Figure 6). During the outage of 2016, Angra 1 identified two dissimilar welds on Safety Injection to Reactor vessel (Figure 7). The Reactor Vessel Bottom penetrations are inspected according CC N-722.1 (Figure 8). There are procedures for all inspection – vessel head, steam generator, dissimilar welds and WOL welds. However, it is necessary to organize them according an AMP.
XI.M16A	PWR Internals Vessel	This program relies on implementation of the Electric Power Research Institute (EPRI) Report No. 1016596 (MRP-227) and EPRI Report No. 1016609 (MRP-228) to manage the aging effects on the reactor vessel internal (RVI) components.	There is procedure for this inspection. However, it is necessary to organize it according an AMP.
XI.M17	Flow Accelerated Corrosion (FAC)	The program relies on implementation of the Electric Power Research Institute (EPRI) guidelines in the Nuclear Safety Analysis Center (NSAC)-202L-R2 or R3 for an effective flow accelerated corrosion (FAC) program.	Angra 1 has procedures and a software – COMSY to monitor the FAC. However, it is necessary to organize it according an AMP.
XI.M19	Steam Generator	The Steam Generator program is applicable to managing the aging of steam generator tubes, plugs, sleeves, and secondary	Angra 1 has procedures to SG inspection. However, it is necessary to organize it according an AMP. Angra 1 changed the SG in 2009 because of problems with the

		side components that are contained within the steam generator.	tubes of Inconel 600. The new SG has tubes of Inconel 690 TT.
XI.M35	One-Time Inspection of ASME Code Class 1 Small-Bore Piping	This program is augmented to include piping from NPS 1 to less than NPS 4. For a one-time inspection to detect cracking resulting from thermal and mechanical loading or intergranular stress corrosion of full-penetration welds, the inspection should be a volumetric examination. For a one-time inspection to detect cracking in socket welds, the inspection should be either a volumetric or opportunistic destructive examination.	Angra 1 will inspect all these welds until 2024. The AMP will be prepared.
XI.M37	Flux thimble tube inspection	Flux thimble tubes are subject to loss of material at certain locations in the reactor vessel where flow-induced fretting causes wear at discontinuities in the path from the reactor vessel instrument nozzle to the fuel assembly instrument guide tube.	Angra 1 has procedures to flux thimble tube inspection. However, it is necessary to organize it according an AMP..
XI.S4 10	CFR part 50, Appendix J	Containment leak rate tests (LRT) are required to “assure that (a) leakage through these containments or systems and components penetrating these containments does not exceed allowable leakage rates specified in the technical specifications and (b) integrity of the containment structure is maintained during its service life.”	Angra 1 has procedures LRT. However, it is necessary to organize it according an AMP.

Figure 2: *Typical locations of ALLOY 82/182 Butt Welds in Westinghouse Design Plants.*

Application	Reference Number in Figure Below	Typical Temperature (°F)	Typical ID (inches)	Typ. Number (3 Loop Plant)
Pressurizer				
- Surge Line Nozzle	1	653	10	1
- Spray Nozzle	2		4	1
- Safety/Relief Nozzles	3		5	4
RCS Hot Leg Pipe				
- Reactor Vessel Outlet Nozzles[3]	4	600-620	29	3
- Steam Generator Inlet Nozzles[4]	5		--	--
RCS Cold Leg Pipe				
- Steam Generator Outlet Nozzles[4]	6	550-560	--	--
- Reactor Vessel Inlet Nozzles[3]	7		27.5	3

1. Figures only show locations in pipes greater than 1" NPS and operating at temperatures greater than about 550°F.
2. Plants with original reactor vessel closure heads have CRDM nozzles with Alloy 82/182 nozzle-to-flange butt welds (4" diameter).
3. There are no Alloy 82/182 RPV nozzle welds in Westinghouse 2-loop plants and some early Westinghouse 3-loop and 4-loop plants.
4. One plant has Alloy 82/182 butt welds between the reactor coolant piping and steam generator nozzles.



Source: [13].

Figure 3: Steam generator change in Angra 1 – 2009

Source: [14]

Figure 4: Angra 1 new reactor vessel head.

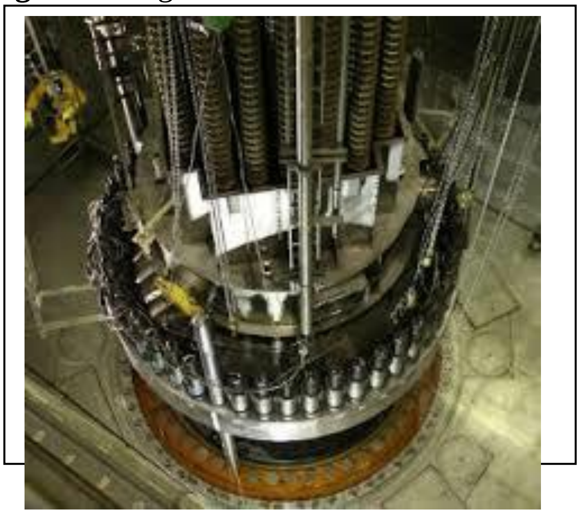
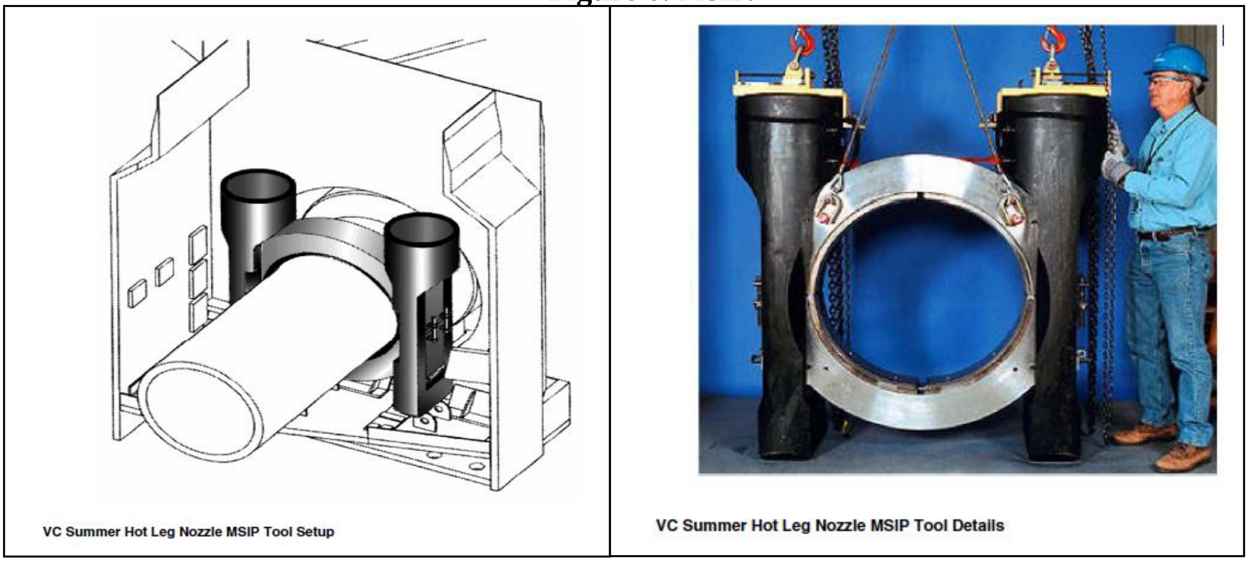


Figure 5: *Picture of an example of Angra 1 WOL - Weld overlay*

Source: ETN Picture.

Figure 6: *MSIP.*



Source: [13].

Figure 7: *Safety Injection to Reactor Vessel.*

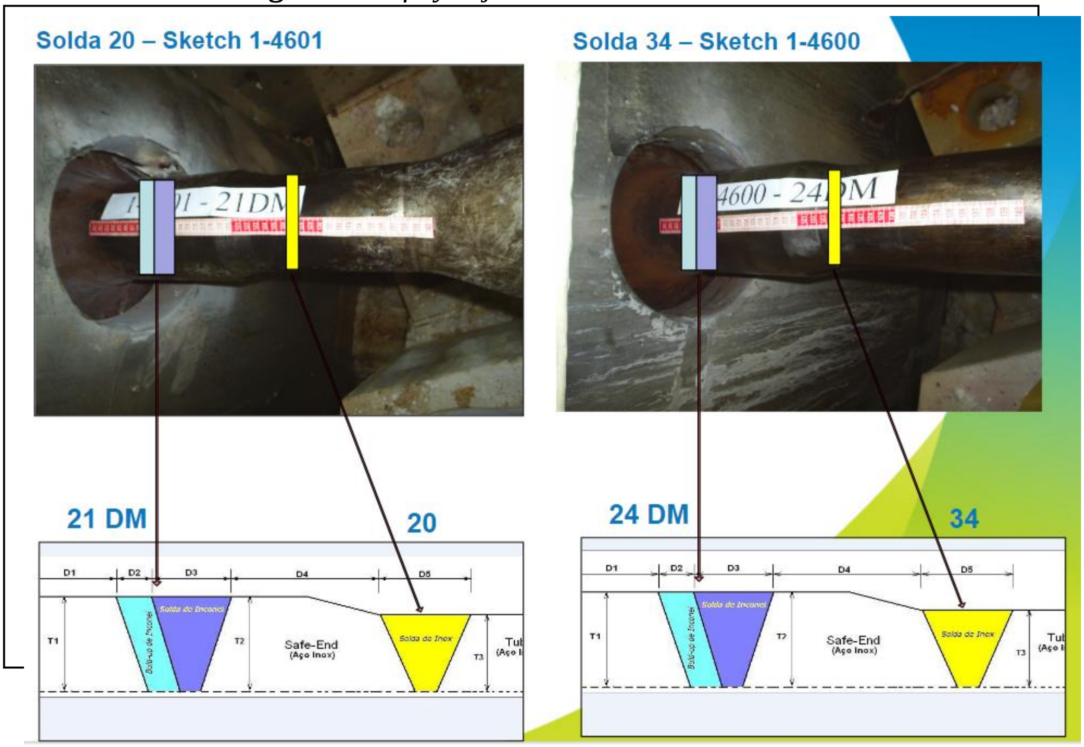


Figure 8: *Angra 1 Reactor Vessel Bottom penetration.*

Source: ETN picture

4. ASME OM CODE: IN-SERVICE TESTING FOR VALVES, PUMPS AND SNUBBERS

Pumps, valves and snubber are active components/items, so these components are monitored according to ASME CODE for Operation and Maintenance of Nuclear power plant and Angra 1 technical specification.

In the 1998 edition addendum 2000, all requirements for testing valves, pumps and snubbers were taken from section XI and transferred to the ASME CODE for Operation and Maintenance of Nuclear power plant. So the IWP and IWV subsections cease to exist in section XI. This is because in Section XI, by definition, there are Inspections that are performed through non-destructive tests (visual, surface and volumetric) and the subsections IWV and IWP deal with Operational Tests, and besides pump and valve test intervals are different from those defined for in-service inspections of Class 1, 2, 3 and MC components defined in section XI.

Table 6 : ASME OM CODE Subsection.

Until OMa-1998	Nowadays	Description
---	ISTA	General requirements
Part 6	ISTB	IST for pumps
Part 10	ISTC	IST for valves
Part 4	ISTD	IST for snubbers
---	Mandatory appendix and non-mandatory appendix	---

Table 7: ASME for pump, valve and snubber – Angra 1 IST program

Interval	Component	ASME	Subsection
First	PUMP	Section XI Edition 1980	IWP
	VALVE		IWV
	SNUBBER		IWF
Second	PUMP	ASME Seção XI	IWP edition 1992 –ASME ANSI OMa 1988 – parte 6
	VALVE	ASME Seção XI	IWV edition 1992 - ASME ANSI OMa 1988 – parte 10
	SNUBBER	ASME Seção XI	IWF-5000 edition 1992 - ASME ANSI OMa 1988 – parte 4

Third	PUMP VALVE SNUBBER	OM CODE Edition 2001 ad 2002 e 2003	ISTA/ISTB ISTA/ISTC ISTA/ISTD
Fourth	PUMP VALVE SNUBBER	OM CODE Edition 2004 ad 2005 e 2006	ISTA/ISTB ISTA/ISTC ISTA/ISTD

Pumps, valves and snubbers are active components, so there is not AMP for them in NUREG 1801. Some active components that are safety related are included on the Monitoring the Effectiveness of Maintenance (PMEM), according the international documents:

- ✓ Regulatory Guide 1.160: “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants” rev. 2 March 1997.
- ✓ NUMARC 93-01 “Industry Guideline for Monitoring the effectiveness of Maintenance at Nuclear Power Plants” rev. 3 July 2000.
- ✓ 10CFR50.65 “Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants”.

However according the technical note NT-007/18 PMEM must follow the AMP form (according the table 3), so Angra 1 had already included the 10 attributes in PMEM. The Active components are in Maintenance Program, so it can be replaced or repaired if they do not meet the test acceptance criteria or show any problems during operation.

5. CONCLUSIONS

The ISI and IST program of Angra 1 has been implemented since the initial commercial operating according CNEN and international standards.

Angra 1 has procedures to ISI and IST program, since the initial commercial operating, however, they are note in AMP form. Angra 1 will need to organize the ISI program as AMP forms until 2024. Angra 1 had already elaborated a procedure to describe how to elaborate an AMP.

The IST program does not need to be in AMP form, but Angra 1 had already included the 10 attributes in PMEM.

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