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STRUCTURAL ASSESSMENT OF PRESSURIZER V-102 OF THE CIRCUIT ORQUÍDEA

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ABSTRACT

The Water Experimental Circuit (CEA) was built in IPEN in eighties and had the aim to perform thermal hydraulic experiments, simulating operational condition of Pressurized Water Reactors and Boiling Water Reactors. The CEA operated until 1984 and since then it was decommissioned. In order to do hydrodynamics tests in MTR fuel type elements of nuclear research reactor, in the years 2015, was conceived an experimental circuit named Orquidea, which shall operate with low pressure and temperature. This paper assess the mechanical and structural suitability of the Pressurizer V-102, that was used in the former Water Experimental Circuit (CEA) aiming reuse this vessel in new the circuit. The methodology applied to evaluate the vessel was based on ASME code, Section VIII, Division 1 & 2.

1. INTRODUCTION

The Experimental Water Circuit (CEA) [1] [2] was built at IPEN in the early eighties to operate at high pressure (≤ 8 N / mm2) and temperature (≤ 285ºC). The CEA enabled the realization of experiments in the area of thermo-hydraulic simulating the conditions of operation of Pressurized Water Reactor and Boiling Water Reactor. It operated almost continuously, interchanging the operating mode with scheduled maintenance shutdowns until 1984. From then on it was rarely put into operation and after 1986 it was inactive.

In 2015, an experimental circuit named Orquidea Circuit was conceived to carry out hydrodynamic tests of fuel elements of the MTR type of research reactors. In the development of the Orquidea project, the possibility of reusing CEA equipment was considered.

This work evaluates the mechanical and structural adequacy of the CEA Pressurizer V-102, applying the analytical method of the ASME code, section VIII, Division 1, and also numerical methods, according to ASME code, Section VIII, Division 2, to verify the possibility of reuse of this equipment in the Orquidea Circuit.

2. CIRCUIT ORQUIDEA DESCRIPTION

The Hydrodynamic Circuit for Testing Fuel Elements named Orquidea Circuit will be a closed experimental circuit which will operate at low pressure (≤ 0.3 N / mm2) and temperature (≤60ºC) which will allow conducting tests to study the hydraulics behavior of fuel elements of the research reactors, for instance, IEA-R1 at IPEN and RMB planned to be built, in normal operation or in extreme conditions.

Figure 1 shows a simplified flowchart of the Orquidea Circuit.

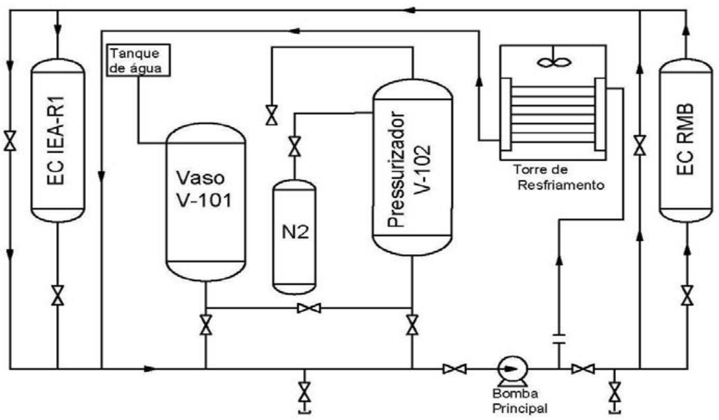


Figure 1: Simplified flowchart of the Orquidea Circuit

In the flowchart above, the operation of the Orquidea Circuit will start with the water being pumped by the main pump to the test section of the RMB or IEA-R1 fuel elements and returning to the main pump suction. The temperature of the circuit will be regulated by cooling part of the water of the primary circuit in the cooling tower.

Process data of the Orquidea Circuit:

- Pressure (P) = 2.0 N/mm^2 and Temperature (T) = 60º C.

3. PRESSURIZER V-102

The Pressurizer V-102 is part of pressure control system of the Orquidea Circuit, see figure 1, compound by the equipment: Pressurizer V-102; Tank N_2; Tank V-101; Pressurized Safety Valve (PSV) and Block Valve. The pressure control system has the main functions:

- To produce pressure in the circuit in order to remove the air of the process water eliminating the possibility of pump and valves cavitation;
- To compensate the water volume variation in the circuit, without great variations of pressure;
- To control the pressure of the circuit.

Pressurizer V-102 is a vertical cylindrical vessel composed of a top plate welded to a cylindrical shell, which has a welded flange to the lower part connected to a blind flange, provided with a nozzle for connection with the pipe closing the vessel. Inside the vessel and located at the top there is a sprinkler that will come into operation in conjunction with a PSV valve to control for eventual increase in the pressure.

The Pressurizer V-102 was designed [3] like a pressure vessel, according to the design requirements of ASME code, Section VIII, division 1 [4]. Figure 2 shows 3D drawing of the Pressurizer V-102 developed using the computer program SOLIDWORKS [5].

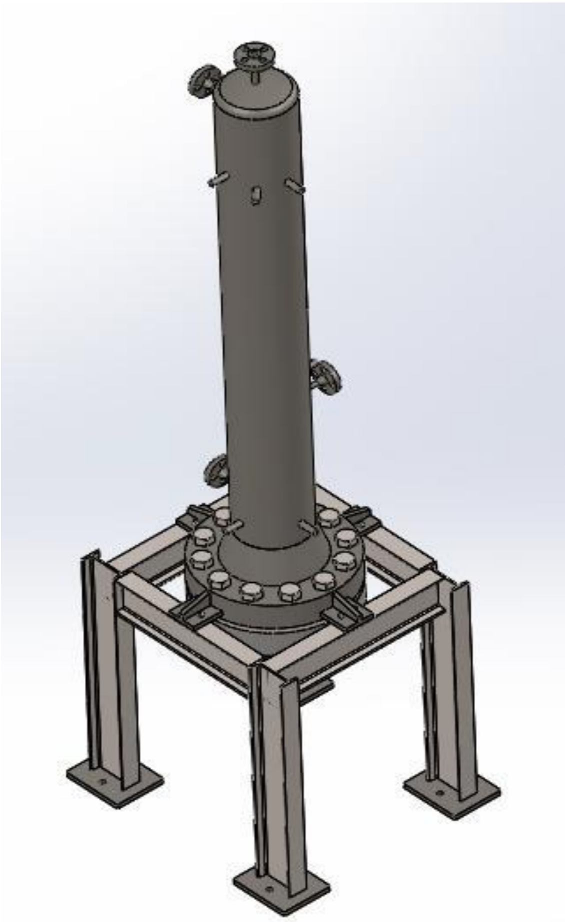


Figure 2: Pressurizer V-102

The sketch of the V-102 pressurizer including general dimensions and the positioning of the nozzles and flanges is shown in figure 3 and table 1.

Flange and screw data [6] are shown in Table 2. The mechanical properties of the materials of the mechanical parts of the pressurizer V-102 [3] [7] [8], the joint data applied on flange sealing and process data are shown in Table 3.

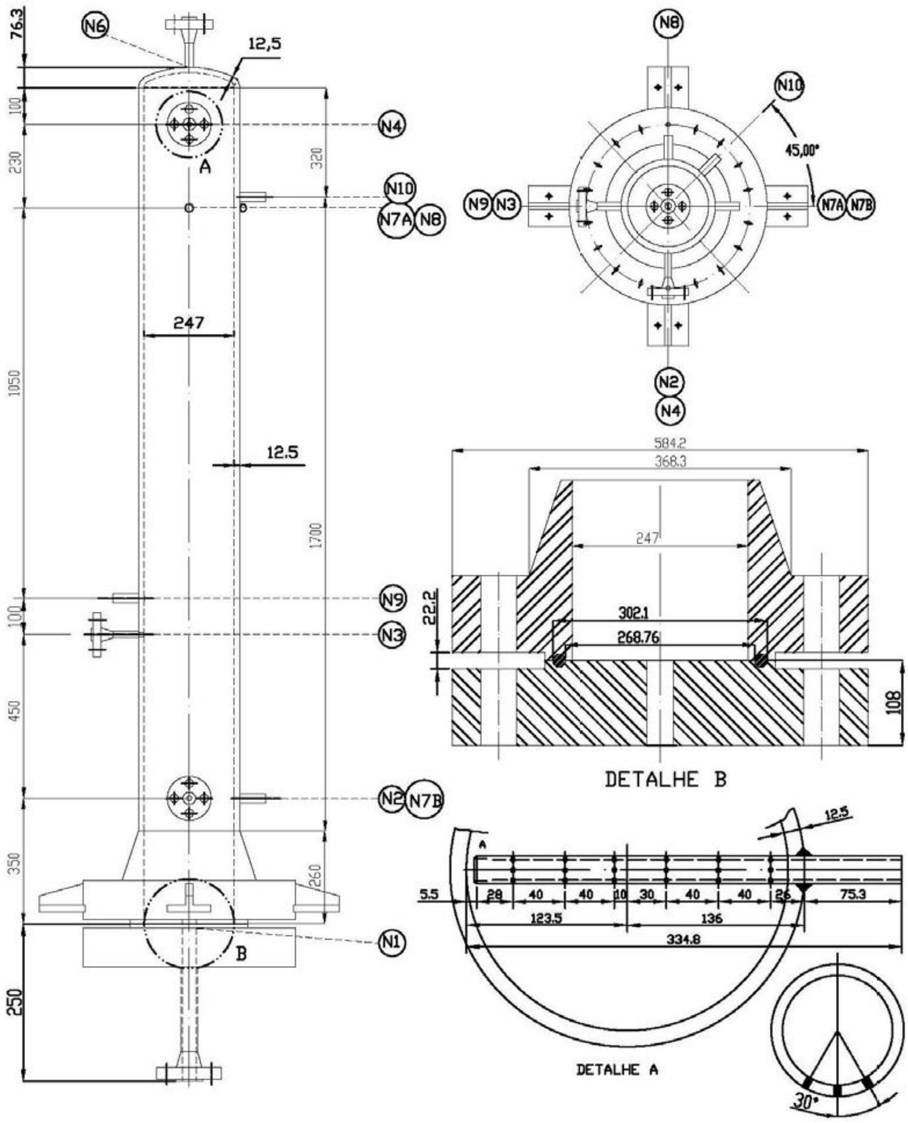


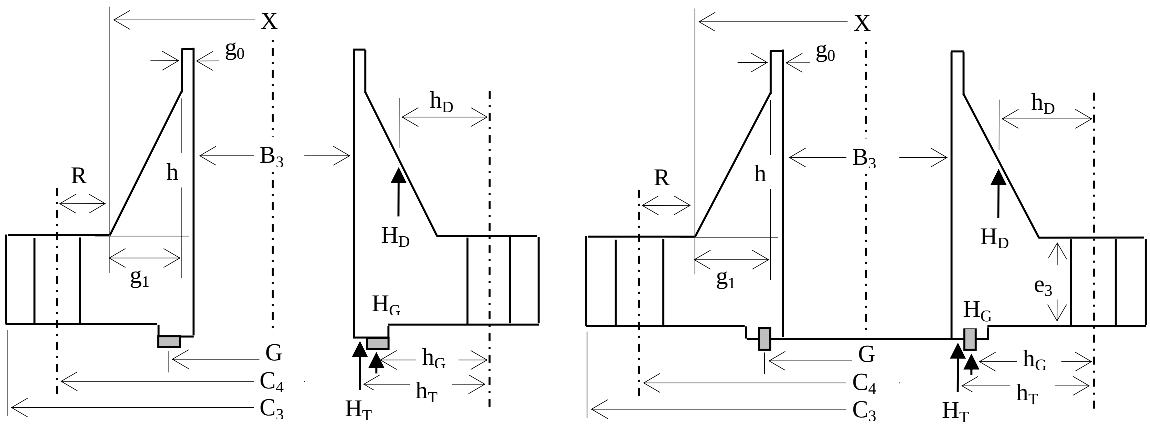
Figure 3: Schematic Drawing of the Pressurizer V-102

Table 1 – General dimensions of nozzles (mm)

Description	Number	Diameter			Thickness (e_2)	Length (h_2)
		Nominal (D_N)	External (C_2)	Internal (B_2)		
Inlet / Outlet	N1	$1^{1/2}$”	48.3	40.9	3.7	145.0
Inlet	N2	1/2”	21.3	15.7	2.8	75.3
Outlet	N3	1/2”	21.3	15.7	2.8	75.3
Inlet (Spray)	N4	1/2”	21.3	15.7	2.8	75.3
P.S.V.	N6	3/4"	26.7	20.9	2.9	47.5
L.G.	N7A: N7B	-	36.0	23.0	6.5	51.2
P.I.	N8	-	36.0	23.0	6.5	51.2
T.I.C.	N9: N10	-	36.0	23.0	6.5	51.2

Table 2- General dimensions of flanges (mm)

Flanges (Class → 1500#)							Bolts		
D_N	C_3	B_3	C_4	G	X	e_3	D_{Np}	NºP	A_p
1/2"	120.7	15.7	82.6	35.1	38.1	22.4	3/4"	4	215.4
3/4"	130.1	20.9	88.9	42.9	44.5	25.4	3/4”	4	215.4
1 1/2”	177.8	40.9	124.0	73.2	69.9	31.8	1”	4	391,0
10”	584.2	247.0	482.6	323.9	368.3	108.0	13/4””	12	1125.0



a) Flanges sketch 1/2” to 1 1/2” **b) Flange sketch 10”**

[D_{Np} : NºP : A_p] – [nominal diameter: number: cross-sectional area] of bolts.

Table 3: General data

Materials Properties (N/mm²)				
Item	Steel	Stress: Yield (S_Y)	Stress: Allowable (25ºC) (S_C)	Stress: Allowable (60ºC) (S_H)
Shell	SA240 TP304		S_{C1} = 138.0	S_{H1} = 130.0
Nozzles	SA312 TP304	205.0	S_{C2} = 138.0	S_{H2} = 138.0
Flanges	SA182 F304	205.0	S_{C3} = 138.0	S_{H3} = 134.0
Bolt	SA193 B7	725.0	S_{C4} = 172.0	S_{H4} = 172.0

Properties of Flanges Gaskets				
D_N	Type	m	y (MPa)	b
½” - 1½”	Spiral wound metal, asbestos filled	2.5	69.0	N/2
10”	Ring Joint	6.5	180.0	N/8

[m : y : N : b] – gasket [factor : seating load : width : effective width].

The combinations between the loads to simulate the design and operating conditions of the V-102 pressurizer are:

Design condition : Pre-Tension + Deadweight + Design Pressure
Operating condition Pre-Tension + Deadweight + Design Pressure + Thermal

4. METHODOLOGY

4.1 – ASME code, Section VIII, division 1 – Analytical Procedure

The ASME code, Section VIII, Division 1 defines the methodology for the calculation of pressurized parts of a vessel pressure: cylindrical shell, bottom and top caps, nozzles and flanges, applying paragraphs containing equations, recommendations and the definition of permissible limits. The most relevant paragraphs are described below.

- **Minimum Thickness and Maximum Allowable Working Pressure (MAWP)**

The equations that define The Minimum Thickness and Maximum Allowable Working Pressure of the Pressurizer V-102 are showed in table 5. The MAWP to the mechanical design shall be the least value found among computed values of all pressurized parts of the Pressurizer V-102.

Table 5- Minimum Thickness & MAWP

	Paragraph	**Cylindrical Shell and Nozzles**	**Ellipsoidal Head**
Minimum Thickness (e_m)	UG-27	$\frac{P.R}{S_H.E-0{,}6.P}$	$\frac{P.B.K}{2.S_H.E-0{,}2.P}$
Maximum Allowable Working Pressure (MAWP)	UG-98	$\frac{S_H.E.e_m}{R+0{,}6.e_m}$	$\frac{2.S_H.E.e_m}{K.B+0{,}2.e_m}$

K - factor depending on the head proportion ($\frac{B}{2.h}$) and Table 1-4.1 of the ASME code, Section VIII, Division 1 Appendix 1;
h – inside length of the ellipsoidal head measured from the tangent line, see figure 3;
R - inside radius; B – inside diameter; E – joint efficiency;

- **Minimum Distance between Nozzles**

When a nozzle is installed in a pressure vessel cause geometric discontinuity of the vessel wall, as a consequence occurs changes in the stress distribution in the pressure vessel region near the borehole. These stresses tension increase or decrease their value as they approach or depart from the hole in the vessel wall, and from a certain distance they disappear. The distance on the pressure vessel wall from the edge of the borehole, and moving away from it to a point on the wall where there is no further influence of the localized stresses, is given by the limit of the reinforcement on the pressure vessel wall: "$\mathbf{L_V}$"

To install more than one nozzle in a pressure vessel, the minimum distance between the center lines of two adjacent nozzles should meet the condition shown in figure 4:

$$L_V \text{ (nozzle 1)} + L_V \text{ (nozzle 2)} \geq d_{MIN}.$$

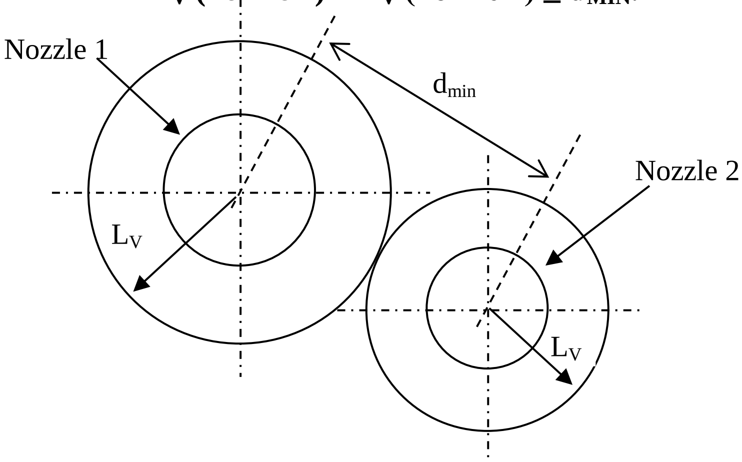
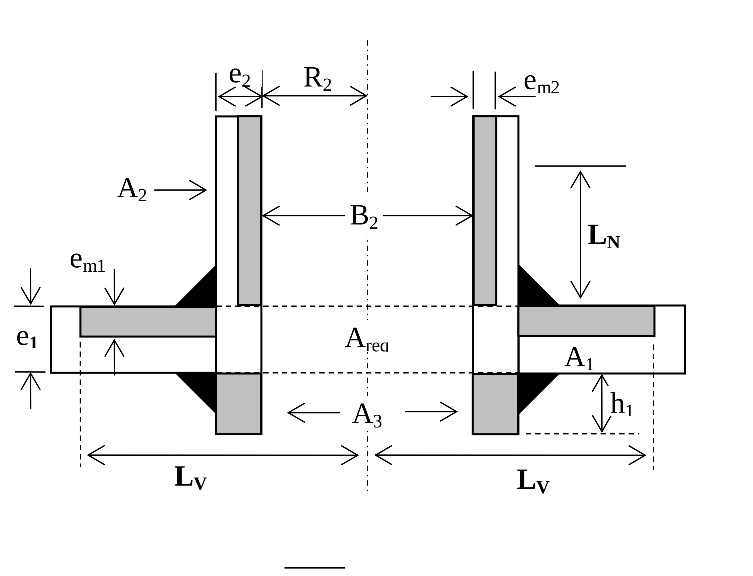


Figure 4: Schematic Drawing of the Distance between Nozzles

- **Nozzle Reinforcement Areas**

The ASME code define a constructive method based on cross-sectional area compensation for the region next to the hole in the wall of the pressure vessel, i.e., the amount of material removed from the wall of the pressure vessel to engage a nozzle, should be compensated in the walls of the vessel and the nozzle. Paragraphs UG-37 and UG-40 recommend the circular geometry for the nozzle and the method of calculating the required and available areas.

Figure 5 shows how the required areas are calculated and available for nozzle reinforcement. At the bottom of figure 5, the condition of whether or not the nozzle is reinforced is defined.



Area Required:

$$A_{req} = B_2 \times e_1$$

Area Available

$$A_{disp} = A_1 + A_2 + A_3$$

$$A_1 = 2 \times (L_V - R_2 - e_2) \times (e_1 - e_{m1})$$

$$A_2 = 2 \times L_N \times (e_2 - e_{m2})$$

$$A_3 \text{ (minor value)} \begin{cases} 5 \times e_1 \times e_2 \times f_{r2} \\ 5 \times e_2 \times e_2 \times f_{r2} \\ 2 \times h_1 \times e_2 \times f_{r2} \end{cases}$$

where $\rightarrow$ $f_{r2} = S_{c2} / S_{c1} = 1.0$

Condition:

$A_{req} \leq A_{disp} \rightarrow$ OK

$A_{req} > A_{disp} \rightarrow$ needs reinforcement

Figure 5 – Schematic Drawing of the Pressurizer Nozzles

- **Verification of the Flanges**

The flanges were built according to the ASME code B16.5 [6] and their structural integrity computed with ASME code, Section VIII, division 1, applying the paragraphs UG-11, UG-44 and Mandatory Appendix 2. The equations and parameters necessary to the computation of a flange are showed, in a simplified way, in table 6 and table 2.

Table 6 – Flange Analytical Method

Flange Design Bolt Load (W)			
$W = [(A_m+A_b) \times S_{H4}]/2$ where: $\begin{cases} A_m = \text{greater value } [A_{m1}: A_{m2}] \text{ where } \begin{cases} A_{m1} = W_{m1} / S_{H4} \\ A_{m2} = W_{m2} / S_{C4} \end{cases} \\ W_{m1} = H + H_P \text{ where } \begin{cases} H = (\mathbf{p} \times G^2 \times P) / 4 \\ H_P = 2 \times b \times \mathbf{p} \times G \times m \times P \end{cases} \\ W_{m2} = b \times \mathbf{p} \times G \times P \end{cases}$			
Flange Moment			
<u>Moment</u>	**<u>Pre-tension</u>**		**<u>Operating</u>**
$M_D = H_{D} \times h_D$	$H_D = 0.0 \rightarrow M_D = 0.0$	$H_D = (\mathbf{p} \times B_3^2 \times P)/4$	$\rightarrow M_D = (\mathbf{p} \times B_3^2 \times P)/4 \times h_D$
$M_G = H_{G} \times h_G$	$H_G = W \rightarrow M_G = W \times h_G$	$H_G = W_{m1} - H$	$\rightarrow M_G = 2 \times b \times \mathbf{p} \times G \times m \times P \times h_G$
$M_T = H_{T} \times h_T$	$H_T = 0.0 \rightarrow M_T = 0.0$	$H_T = H - H_D$	$\rightarrow M_T = (G^2 - B_3^2) \mathbf{p} \times P)/4 \times h_T$
$M_O = M_D + M_G + M_T$			
Bolt and Flange Stresses			
<u>Bolt</u>	**<u>Flange</u>**		
-	(Longitudinal)	(Radial)	(Tangential)
$\sigma_P = \dfrac{W}{A_b}$	$\sigma_H = \dfrac{f\,Mo}{L\,g_1^2 B_3}$	$\boldsymbol{\sigma_R = \dfrac{(1.33\, e_3\, e + 1)\, Mo}{L\, e_3^2 B_3}}$	$\sigma_T = \dfrac{Y\,Mo}{e_3^2 B_3} - Z\,\sigma_R$
Bolt and Flange Limit Stresses			
<u>Bolt</u>	**<u>Flange</u>**		
-	(Longitudinal)	(Radial)	(Tangential)
$\sigma_P \leq S_{H4}$	$\sigma_H \leq 1.5 \times S_{H3}$	$\sigma_R \leq S_{H3}$	$\sigma_T \leq S_{H3}$

$\mathbf{H_D}$ – hydrostatic end force on area inside flange;
$\mathbf{H_G}$ – gasket load (difference between flange design bolt load and total hydrostatic end force);
$\mathbf{H_T}$ – difference between total hydrostatic end force and hydrostatic end force on area inside flange;
$\mathbf{A_b}$ – bolting area ($A_b = \text{N}^{\text{o}}P \times A_p$);

Parameters:

$\mathbf{L} = \left(\frac{e_3\,e+1}{T}\right) + \left(\frac{e_3^3}{d}\right)$; Where $\left(e = \frac{F}{h_0}\right)$ and $\left(d = \left(\frac{U}{V}\right) h_0 g_0^2\right)$ and $\left(h_0 = \sqrt{B_3\, g_0}\right)$

T, U, Y, Z – extracted from Figure 2-7.1 (function of K): where $\left(K = \frac{C_3}{B_3}\right)$

F – extracted from Figure 2-7.2 (function of $\left(\frac{g_1}{g_0}\right)$); where $\left(g_1 = \left(\frac{X - B_3}{2}\right) - g_0\right)$

V – extracted from Figure 2-7.3 (function of $\left(\frac{g_1}{g_0}\right)$);

f – extracted from Figure 2-7.6 (function of $\left(\frac{g_1}{g_0}\right)$).

The Figures 2-7.1, 2-7.2, 2-7.3 and 2-7.6 is referenced on the Mandatory Appendix 2 of the ASME code, Section VIII, Division 1.

4.2 - ASME VIII division 2 – Numerical Procedure

The ASME code, Section VIII, Division 2 [9] allows the stress analysis to be performed through numerical simulation with computer programs for structural analysis using the Finite Elements Method. The ANSYS computer program was used for the stress analysis of the Pressurizer V-102 [10].

Equivalent Stress can be calculated, according to the theory of maximum distortion energy or the criterion of "Von Mises", in regions of the component and compared to allowable stress, to verify that the component meets the defined design conditions. The Table 7 shows the associated categorization and equivalent stress limits.

Table 7 –Stresses – Categorization & Limits

Categorization	Limits
General Primary Membrane Stress – P_m	$P_m \leq S_H$
Local Primary Membrane Stress – P_L	$P_L \leq 1.5\ S_H$ and/or $P_L + P_B \leq 1.5\ S_H$
Primary Bending Stress – P_B	$P_L + P_B + Q \leq 3.0\ S_H$
Secondary Stress - Q	

In conservative way, the maximum equivalent stresses resulting from the numerical simulation of the V-102 pressurizer calculation model under the design and operating conditions will be classified as General Primary Membrane Stress – P_m.

The values of the maximum equivalent stress, classified as $\mathbf{P_m}$, shall meet the limit ($\mathbf{P_m \leq S_H}$), see table 7, prescribed by ASME code, Section VIII, Division 2 to avoid plastic collapse.

5. RESULTS

5.1 – ASME code, Section VIII, Division 1 – Analytical Methods

The Pressurizer V-102 was analyzed by applying the methodology described in ASME code, Section VIII, Division 1, for the calculation of: Minimum Thickness, Maximum Allowable Working Pressure, Nozzle Reinforcement Areas, Minimum Distance between Nozzles; Stress flanges, and the results are summarized in table 8.

Table 8 –Analytical Methods - Results

Minimum Thickness & MAWP

Description	Thickness (mm)		MAWP (N/mm^2)	Description (Nozzles)	Thickness (mm)		MAWP (N/mm^2)
	Nominal	Minimum			Nominal	Minimum	
Shell	12.5	1.92	12.4	N1	3.7	0.30	21.2
Upper Head	12.5	1.90	10.8	N2: N3: N4	2.8	0.12	38.1
Blind Flange	108.0	83.4	5.8	N6	2.9	0.15	30.9
				N7A: N7B:	6.5	0.17	54.8
				N8:N9:N10	6.5		

Nozzle Reinforcement Areas

Nozzle	Area (mm^2) Required	Area (mm^2) Available	Obs.
N1: N4	-	-	**The ASME code, Section VIII, Division 1 does not present a methodology for the evaluation of N1 nozzle configurations and N4 nozzle.**
N2: N3	196.3	270.6	
N6	261.3	331.2	
N7A:N7B:N8:N9:N10	287.5	622.5	

Nozzle Distance

Nozzle	Distance		Nozzle	Distance	
	Real	Minimum		Real	Minimum
N2 x N7B	175.0	57.3	N8 x N7A	175.0	72.0
N3 x N9	100.0	57.3	N8 x N10	80.0	72.0
N4 x N6	159.0	48.0	N10 x N7A	88.0	72.0

Flanges Stresses (N/mm^2)

	D_N	Flange Normal Calculate	Flange Normal Limit	Flange Radial Calc.	Flange Radial Limit	Flange Tangential Calc.	Flange Tangential Limit	Bolt Calc.	Bolt Limit
Pre-tension	1/2"	144.5	201.0	112.4	138.0	122.2	138.0	18.9	172.0
	3/4"	106.6		69.9		89.1		23.8	
	11/2”	113.5		61.7		70.8		23.6	
	10”	63.6		44.4		45.2		24.9	
Operating	1/2"	6.9	201.0	5.4	138.0	5.9	138.0	4.4	172.0
	3/4"	7.0		4.6		5.9		6.1	
	11/2”	10.7		5.8		6.7		8.1	
	10”	8.1		5.6		5.7		13.1	
Obs.	**The ASME code, Section VIII, Division 1 does not provide methodology for the calculation of blind flange with a passing hole.**								

In general, it is noted in table 8 that the limits prescribed by ASME code, Section VIII, Division 1 have been met. It is also established that the MAWP for the V-102 Pressurizer is:

$$\mathbf{MAWP = 5.8\ N/mm^2.}$$

The ASME code, Section VIII, Division 1 does not present a methodology for evaluating the configurations:

- Blind hole flange with N1 Nozzle installed;

- N4 nozzle with extension inside pressure vessel

Thus, the blind flange and the N1 and N4 nozzles will be analyzed by applying the ASME code, Section VIII, Division 2 methodology, based on numerical methods.

5.2 - ASME VIII – Division 2 – Numerical Methods

The ASME code, Section VIII, Division 1 allows that in the absence of methods for structural evaluation other methodologies may be adopted as long as they are as reliable and safe as those of Division 1. The V-102 pressurizer presents mechanical configurations not foreseen in Division 1 of the ASME code.

The following configurations will be evaluated by conducting a stress analysis of the V-102 Pressurizer, according to the requirements of ASME code, Section VIII, Division 2, applying the elastic stress analysis method:

- The bolted blind flange located in the lower part of the V-102 with a hole for the installation of a nozzle;
- The N1 nozzle which is installed in the blind flange;
- The N4 nozzle which is installed in the upper part of the vessel V-102 whose extension to the interior of the vessel has the shower function.

The stress analysis is developed using the Finite Element Method with the computer program for structural analysis ANSYS ref. [10], and consists of the following steps

- To develop the design of Tank V-102, with solid 3D model, see figure 6 (a);
- To Apply the finite element with 20 nodes and 3 GDL (displacements Ux, Uy and Uz) per node;
- To search for a finite element mesh suitable for analysis, see Figure 6 (b);
- To apply the boundary conditions to the calculation model simulating the bond of Tank V-102 with the metallic platform in the CEN building;
- To perform the numerical simulation with the ANSYS program for the following load cases:
    - Pre-tension; Deadweight; Design Pressure; Operating Temperature
- To post-processing to give the stresses resulting of the combinations:
    - Design Condition: [Pre-tension + Deadweight + Design Pressure];
    - Operating Condition: [Pre-tension + Deadweight + Design Pressure + Thermal]

a) Solid Model | **b) Finite Element Mesh**

Figure 6 – Pressurizer V-102

The maximum equivalent stresses resulting from the numerical simulation for the blind flange, nozzles N1, and N4 under the design and operating conditions of the V-102 Pressurizer are shown in table 9. These stresses were categorized as General Primary Membrane Stress – Pm which must meet the limit (Pm ≤ SH) to avoid plastic collapse.

As can be seen in table 9 and figures 7 to 9, the maximum equivalent stresses calculated for the blind flange, and the nozzles N1 and N4 meet the limits prescribed by the ASME code, Section VIII, Division 2.

Table 9 – Numerical Methods– Results (N/mm²)

Description	Design		Operating	
	Calculate	Limit	Calculate	Limit
Blind Flange (figure 7)				
Near to the bolt	101.0		56.0	
Near the channel of the metallic ring	89.0	134.0	125.0	134.0
Near the hole in the center of the flange	78.0		111.0	
Nozzle N1 (figure 8)	119.5	138.0	114.1	138.0
Nozzle N4 (figure 9)				
Near to the nozzle attachment in the vessel	39.1	138.0	40.6	138.0
Inside the vessel	8.6		9.0	

Figure 7 shows the distributions of equivalent stresses on the blind flange, in the Design and Operating condition. The tensions were analyzed in the following regions:

- Near to the drilling of the bolts;
- Near to the channel to accommodate the metal ring;
- In the center of the flange, near the hole for the installation of the N1 nozzle.

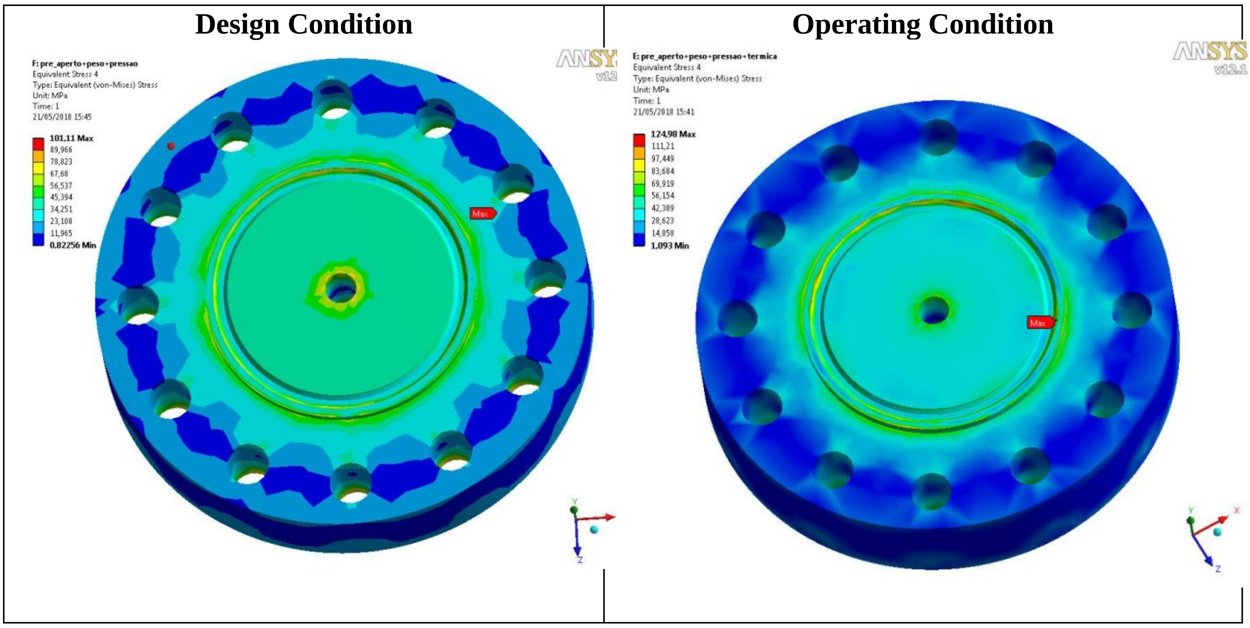


Figure 7 –Equivalent Stresses in Blind Flange (N/mm²)

Figure 8 shows the distributions of the equivalent stresses in the N1 nozzle in the Design, and Operating condition.

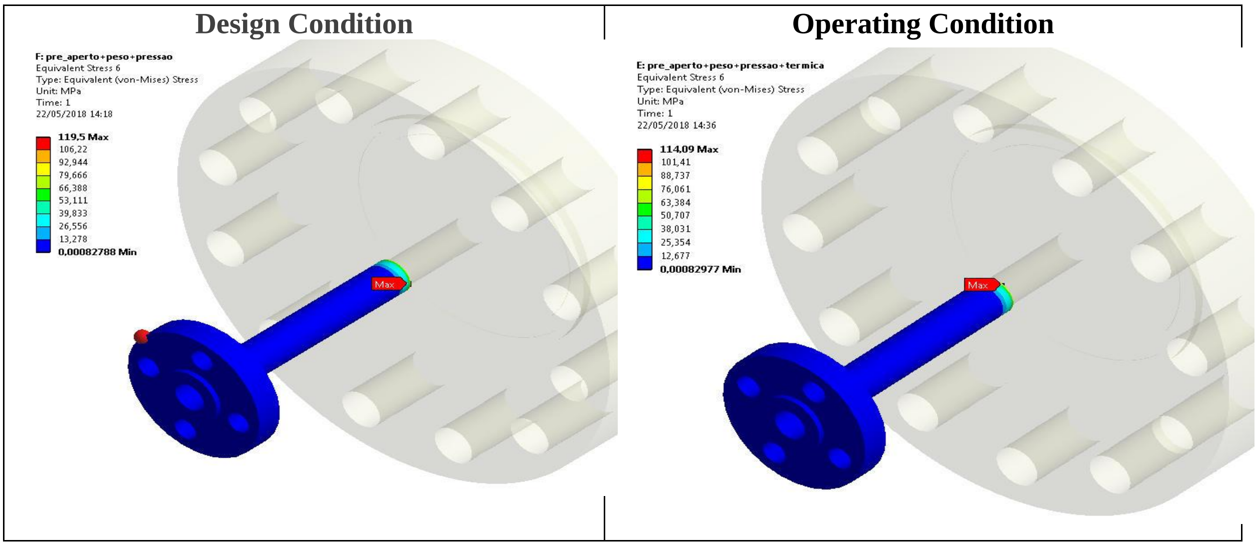


Figure 8 - Equivalent Stresses in Nozzle N1 (N/mm²)

Figure 9 shows the distributions of equivalent stresses in the N4 nozzle, in the Design and Operating condition. The tensions were analyzed in the following regions:

- Next to the nozzle attachment in the vessel;
- Internal to the vessel.

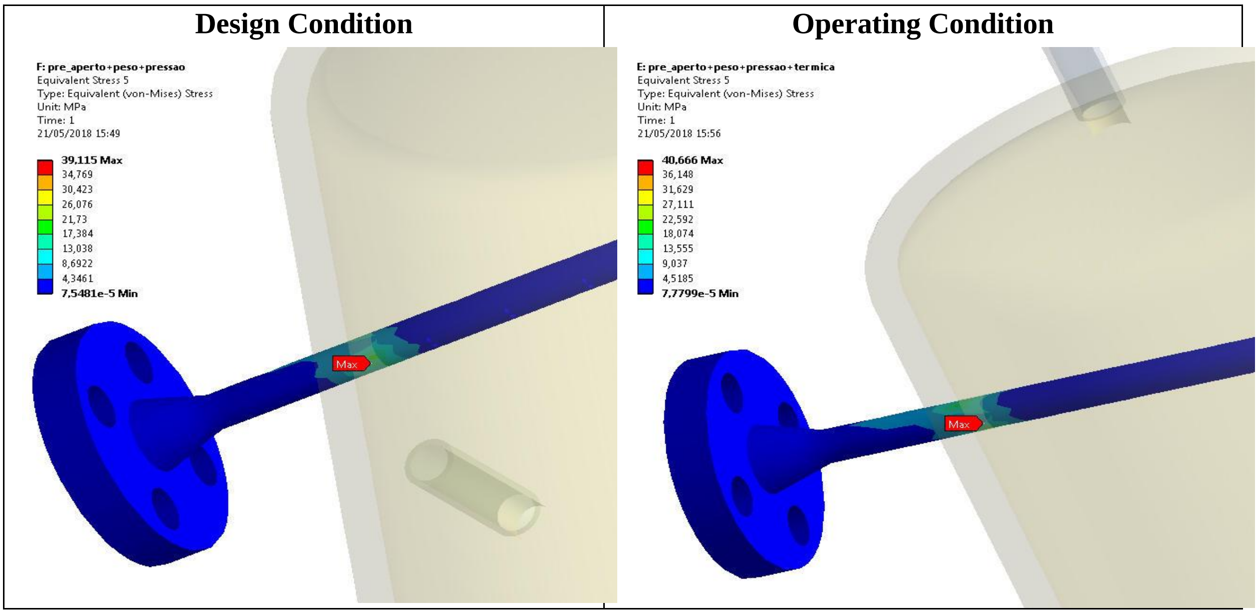


Figure 9 - Equivalent Stresses in Nozzle N4 (N/mm²)

6. CONCLUSIONS

The Pressurizer V-102 was designed and built with the ASME code, Section VIII, division 1 in 1977 to operate on the Experimental Water Circuit (CEA). It was evaluated at the present time through the structural analysis of the internal and external mechanical parts, applying the code of the original design, i.e., ASME code, Section VIII, division 1 to verify the possibility of its reuse in the Orquidea Circuit.

The results of the evaluation can be summarized as described below:

- Wall thickness of pressurized mechanical parts meet minimum thickness requirements;
- The maximum working pressure (MAWP) is 5,8 N/mm2
- Espessura de parede das partes mecânicas pressurizadas atendem os requisitos de espessura mínima;
- The nozzles require no reinforcement. The nozzles: N1 installed in a blind flange, and N4 extended into the V-102 vessel are structural configurations not provided for by ASME code, Section VIII, Division 1;
- The distance between nozzles meets the criterion of minimum distance;
- The stresses in the flange ½ ", ¾", 1½", and 10" meets the permissible limits. The blind flange 10" with a nozzle installed is a structural configuration not provided for by ASME code, Section, VIII, Division 1;
- No reference, report or document has been found that reports any in-service inspection performed on the mechanical parts of the V-102 Pressurizer since the start of its operation in 1977.

Therefore, a stress analysis of the blind flange N1 nozzle and N4 nozzle applying the elastic stress method was performed with the ANSYS finite element program in the Design and Operating Condition. The calculated stresses comply with the limits prescribed by ASME code, Section VIII, division 2.

To sum up, the mechanical and structural suitability of the mechanical parts of the V-102 Pressurizer is documented.

However, the reuse of the V-102 Pressurizer in the Orquidea Circuit must obey the following conditions:

- Not exceed Maximum Allowable Working Pressure (MAWP) $\leq$ 5.8 N/mm^2;
- Obligatory Internal and external visual inspection of the mechanical parts of the V-102 Pressurizer.

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