LEUPA

Type B(U) Package for Fissile Materials

VERIFICATION OF LIFTING POINTS OF THE LEUPA PACKAGE

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CONTENTS

1 PURPOSE

1. Structural verification of lifting points of the LEUPA package.

2 SCOPE

1. Calculations for the welding and lifting shall be made manually. The verification of the bridging shall be performed through finite elements (ANSYS).

3 REFERENCES

[1] 0908-LE01-3ASIN-010 “LEUPA – Main Body”.

4 MATERIALS

1. All parts verified in the package are ASTM A-240 Gr 304L. The properties are as follows:

Tabla 1: Properties of A-240 Gr 304L

A-240 Gr 304L	
Young Module [E]	195 GPa
Poisson's Ratio [n]	0.3
Tensile Strength [σu]	482 MPa
Yield strength [σy]	172 MPa
Admissible Strength[1] [σi]	115 MPa

5 RESULTS

5.1 Lifting

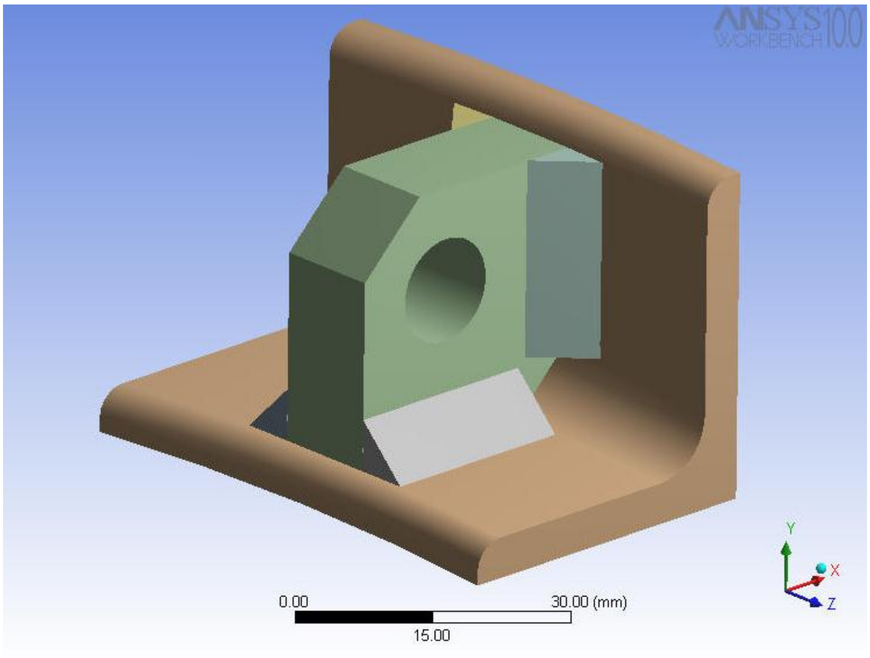
1. Verification of shackle support on crushing and cutting. The package has four shackles. Conservatively, for calculation purposes, only two are considered. The gross weight of the container is 430 kg. Stresses are low and below admissible values. The calculation can be seen in Appendix I.

5.2 Lifting Method

1. The lifting method is represented in the following figure. Two are used for the lifting, but we only present the calculations for one.

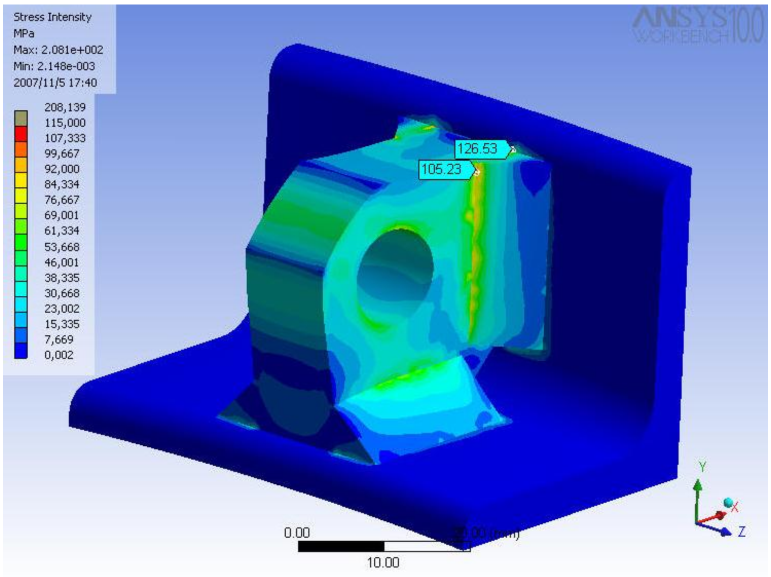
[1] Admissible stress, ASME II Part D, Table 1A.

Figure 1: Lifting



2. A finite elements model is prepared, with the welding beads. The assumed weight of the container is 500 kg. A coefficient of 2 for dynamic load is assumed for the calculation. The case of 30° lifting is analyzed first for the horizontal position and then for pure vertical load.
3. Admissible stress is taken from ASME II Part D, SA-240 304L, “Stress Intensity” 115 MPa. For stress concentrations, ASME VIII Div. 2 contemplates an admissible value of up to three times the abovementioned value.
4. The following figure shows "intensity" stresses for the case of 30°. The maximum deformation is less than seven tenths of a millimeter. The deformation is amplified to appreciate it.

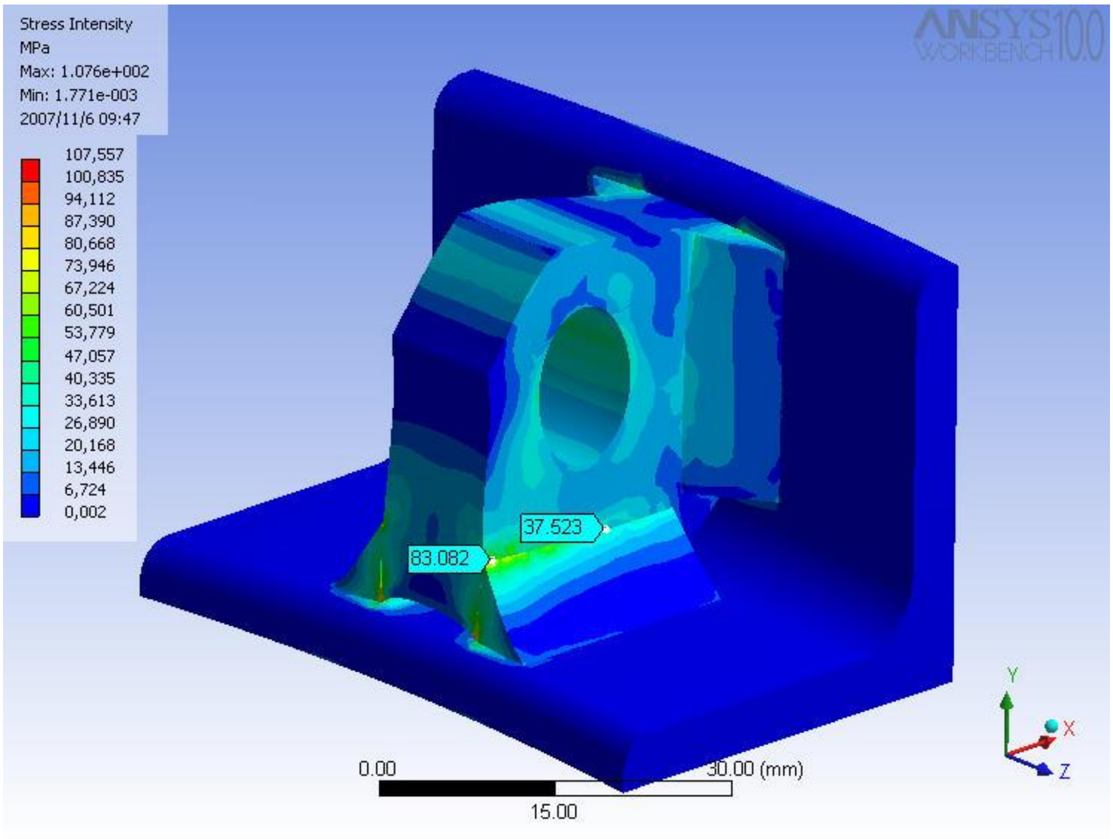
Figure 2: Stresses (angle = 30°)



5. The stresses in the part and the welding appear almost fully below the admissible stress value. Higher stresses relate to highly localized concentrations.

6. Then, the case of vertical load alone is analyzed. The requirement is lower than in the first case. The following figure shows "intensity" stresses.

Figure 3: Vertical load stresses



5.3 Bridgings

1. The bridging/sling system to restrain the specimen during transport can be seen in Technical Specification 0908-LE01-3BSIN-025 – Analysis of Restrain for Transport.

6 CONCLUSIONS

1. Admissible stresses are met for all load conditions, proving proper structural design of the supports of the LEUPA package.
2. Given the low stresses shown in calculations and taking into consideration the security coefficient adopted, it is considered that the requirements in paragraph 608 of Standard AR 10.16.1 Rev. 2 *Transport of Radioactive Materials*, are met.
3. The latter shall also be proved during field tests, since the lifting for drops would be using only one of the slings.

7 APPENDIX I

$P = 430\ kg \cdot g$			Gross Weight of the Package

Crushing

$D_p = 8\ mm$ $l_a = 10.67\ mm$	$A_{ap} = D_p \cdot l_a$	Crushing Area
$N_b = 2$		Number of Lifting Points
$\sigma_{ap} = \dfrac{P}{A_{ap} \cdot N_b}$	$\sigma_{ap} = 24.7\ MPa$	Crushing Stress

Cut

$l_1 = 9.34\ mm$ $d_1 = 4.76\ mm$	$A_c = l_1 \cdot d_1$	Cut Area
$N_a = 2$		Number of Cut Areas
$\tau = \dfrac{P}{N_a \cdot N_b \cdot A_c}$	$\tau = 23.712\ MPa$	Cut Stress

8 APPENDIX II

Bridging Welding

$T_{ar} = 2625\ kg$		Maximum Bridging Stress
$N_O = 4$		Number of Bridgings
$\theta_{iz} = 45°$		Lifting Angle
$d_y = 25\ mm$		
$d_z = 30\ mm$		
$F_O = \dfrac{T_{ar} \cdot g}{N_O}$	$F_O = 6.436\ kN$	Total Force by Bridging

Forces and Moments in the Bridging Base

$F_x = 0$	$M_x = F_O \cdot \left(\cos(\theta_{iz}) \cdot d_y - \sin(\theta_{iz}) \cdot d_z\right)$	Horizontal and Flexion Cut
$F_y = F_O \cdot \sin(\theta_{iz})$	$M_y = 0$	Vertical and Flexion Cut
$F_z = F_O \cdot \cos(\theta_{iz})$	$M_z = 0$	Stress and Torque

Welding Data

$E = 0.6$	Welding Efficiency
$\sigma_{ad} = 68.8\ MPa$	Admissible Strength

Welding Lines: Base *b* and Height *d*

$$b = 60\ mm$$

$$d = 50\ mm$$

Welding Properties

$L_f = 2b$	$L_f = 120\ mm$	Length of Welded Fillet
$Z_{wx} = bd$	$Z_{wx} = 3 \times 10^3 mm^2$	Flexion Module (axis x – x)

Force by Length Unit

$f_{1x} = \frac{M_x}{Z_{wx}}$	$f_{1x} = -7.584\ {}^{N}/_{mm}$	Flexion
$f_{2y} = \frac{F_y}{L_f}$	$f_{2y} = 37.922\ {}^{N}/_{mm}$	Cut
$f_{2z} = \frac{F_z}{L_f}$	$f_{2z} = 37.922\ {}^{N}/_{mm}$	Stress

Composition of Forces

$$f = \frac{\sqrt{\left(\sqrt{{f_{1x}}^2 + {f_{2z}}^2}\right)^2}}{+\left(\sqrt{{f_{2y}}^2}\right)^2} \qquad f = 54.164\ {}^{N}/_{mm}$$

$$f_w = \cos 45° \cdot E \cdot \sigma_{ad}$$

Width of Welding Used

$$w = \frac{f}{f_w} \qquad w = 2.498\ mm$$