NAKUJA 4 SOLIDS TEAM

WEEK 2 PROGRESS REPORT

THIS WEEK’S OBJECTIVES:

1. Analysis and research of the previous static test
2. Preparation of the tensile test workpieces
3. Conducted the tensile test on the specimens.
4. Developing calculations for the new casing.
5. Searching for suppliers of the new casing.
6. Cutting of the bulkhead material.
7. Re-making of the liner.

1.Results from the analysis

- Calculated working pressure was found to be equal to the simulated motor pressure.
- The liner acted as an insulating layer and ablative layer where pyrolysis occurred.

2.Preparation of the tensile test work pieces

Using hacksaws,square files and round file a work piece was made from the aluminium casing according to the ASTM B557M Standard.

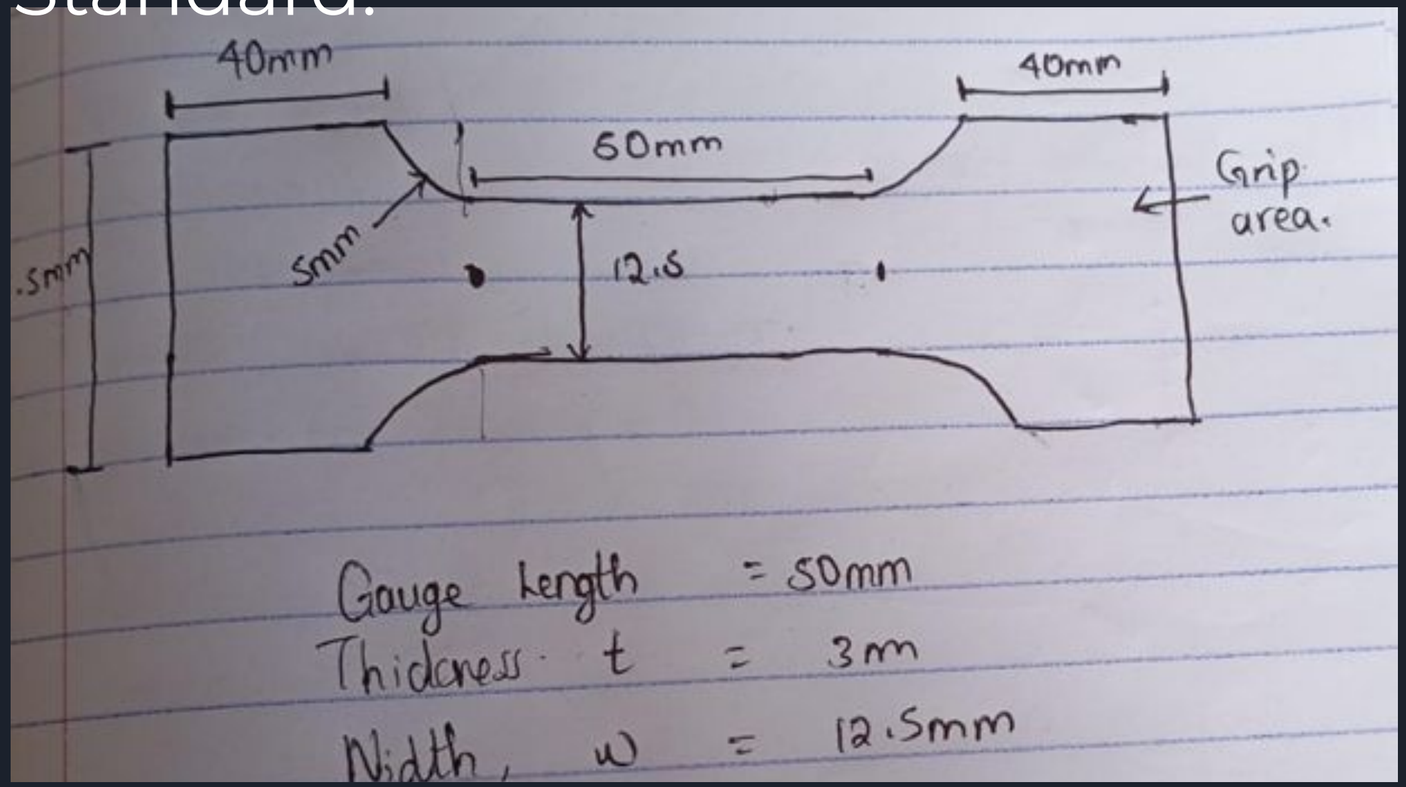


Fig 1: Dimensions of work piece with standards

Photo of the activity.

Fig 2. Workpiece preparation

Fig 3. Workpieces after activity

3.Tensile testing

The specimen were tested using a Shimadzu universal tensile testing machine.

The method was customised within the Trapeziumx software and the batch number specified. The specimen was loaded onto the jaws of the machine and loading began.

Fig 4. Tensile test setup

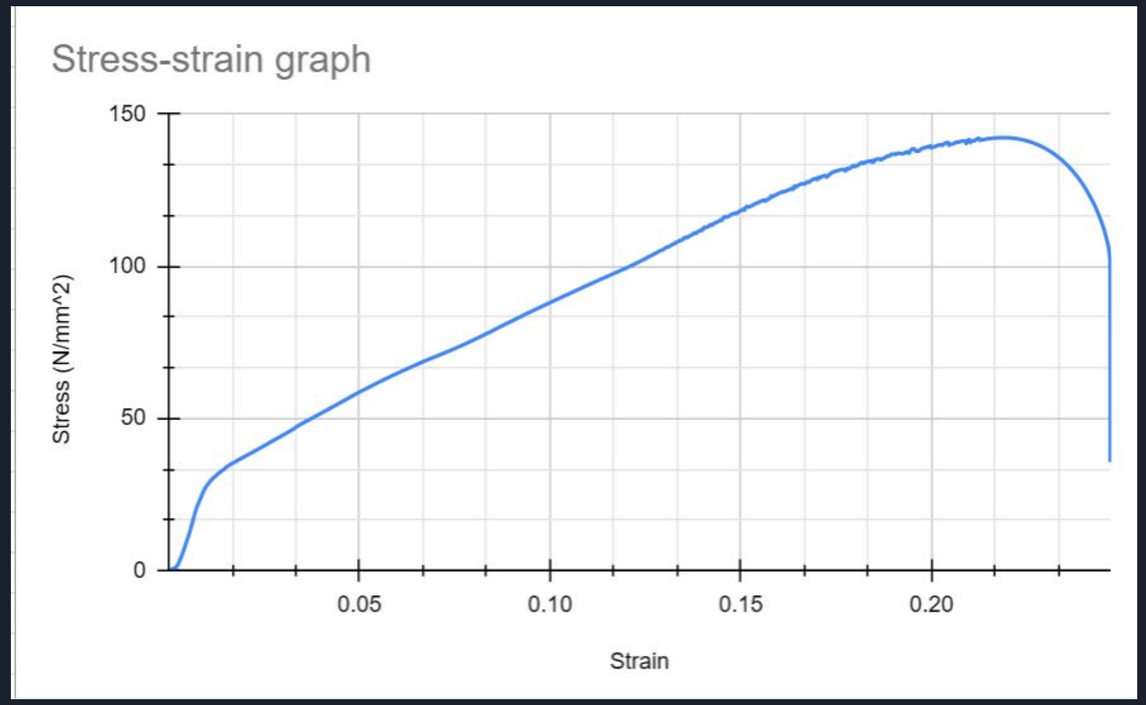
Fig 5. Workpiece in machine

Results of the tensile test

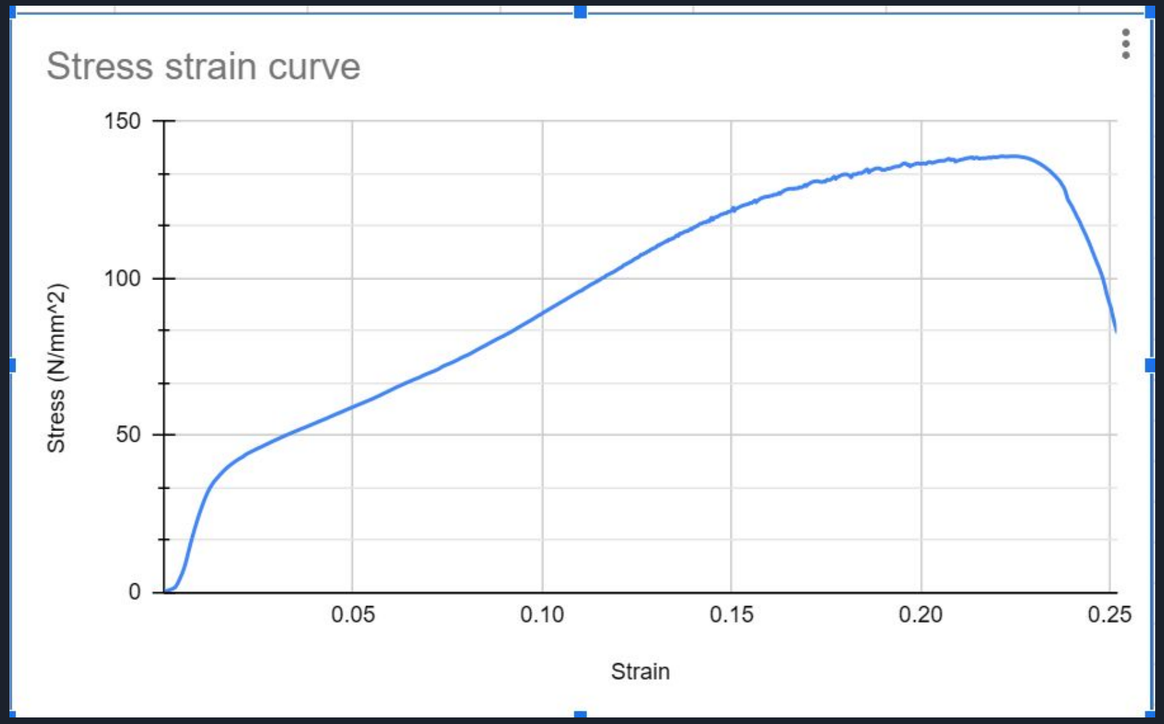
Name	YP(%FS)_Force	YP(%FS)_Stress	YP(%FS)_Stroke	YP(%FS)_Stroke_Strain
Parameters	0.1 %	0.1 %	0.1 %	0.1 %
Unit	N	N/mm2	mm	%
1 _ 1	4949.61	123.125	8.97683	17.9537
1 _ 2	5496.29	119.433	7.23260	14.4652
Average	5222.95	121.279	8.10472	16.2095
Standard Deviation	386.561	2.61064	1.23336	2.46674
Range	546.680	3.69200	1.74423	3.48850

Name	Max_Force	Max_Stress	Max_Stroke	Max_Stroke_Strain
Parameters	Calc. at Entire Areas	Calc. at Entire Areas	Calc. at Entire Areas	Calc. at Entire Areas
Unit	N	N/mm2	mm	%
1 _ 1	5291.45	131.628	10.9368	21.8736
1 _ 2	6396.05	138.984	11.0643	22.1285
Average	5843.75	135.306	11.0006	22.0011
Standard Deviation	781.070	5.20147	0.09016	0.18024
Range	1104.60	7.35599	0.12750	0.25490

Excel analysis of the results



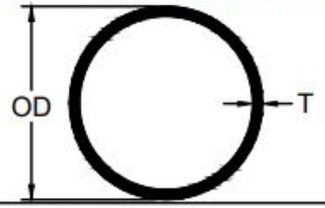
Sample 1 stress-strain curve



Sample 2 stress-strain curve

Mechanical properties from the supplier

CIRCULAR TUBE



CIRCULAR TUBE

No.	NEW CODE	OD	ID	T	Kg/M
23	105-0509	100.00	94.00	3.00	2.60

MECHANICAL PROPERTIES		Al 6063	
Properties	Unit	T5	T6
Ultimate Tensile Strength	N/mm²	150	250
0.2 % Proof Stress	N/mm²	110	160
Hardness (Brinell)	BHN	55	65
Ult. Shear Strength	N/mm²	155	
Elongation on 50 mm	%	8	
Density	g/cm3	2.7	
Melting Range	g/cm3	600-500	
Coefficient on Linear Expansion	X10-²Deg °C	23	
Modulus Of Elasticity	N/mm²	67000	
Fatigue Strength (50*10⁶) Cycle	N/mm²	75	

Conclusion of the test

From the tensile test, it is evident that the Yield stress from the supplier was concurrent with yield stress of the test. The same is true for the Ultimate tensile stress

Material properties of different Al alloys

Physical Properties	Metric	English
Density	2.7 g/cc	0.0975 lb/in³
Mechanical Properties		
Hardness, Brinell	60	60
Hardness, Knoop	83	83
Hardness, Vickers	70	70
Ultimate Tensile Strength	186 MPa	27000 psi
Tensile Yield Strength	145 MPa	21000 psi
Elongation at Break	12 %	12 %
Modulus of Elasticity	68.9 GPa	10000 ksi
Poisson's Ratio	0.33	0.33
Fatigue Strength	68.9 MPa	10000 psi

Al 6063
T5

Physical Properties	Metric	English
Density	2.7 g/cc	0.0975 lb/in³
Mechanical Properties		
Hardness, Brinell	95	95
Hardness, Knoop	120	120
Hardness, Rockwell A	40	40
Hardness, Rockwell B	60	60
Hardness, Vickers	107	107
Ultimate Tensile Strength	310 MPa	45000 psi
Tensile Yield Strength	276 MPa	40000 psi
Elongation at Break	12 %	12 %
Elongation at Break	17 %	17 %
Modulus of Elasticity	68.9 GPa	10000 ksi

Al 6061
T6

4.Calculation of the casing

Casing Dimensions and Design Factors

Do =	100	in. (mm)	Diameter, outside
t =	3	in. (mm)	wall thickness
S_D =	1.5		Design Safety factor

Material Properties

Fty =	110	ksi (MPa)	Yield Strength
Ftu =	150	ksi (MPa)	Ultimate Strength
E =	68900	Msi (MPa)	Modulus of Elasticity
ν =	0.33		Poisson Ratio
β =	0.733		Fty/Ftu
B =	1.474		Burst factor

Design and Burst Pressures

P_D =	**4400**	psi (kPa)	**Design pressure**
P_U =	**9727**	psi (kPa)	**Burst pressure**
S_U =	**2.21**		**Burst Safety Factor**

Elastic Deformation under Pressure *

ΔD =	**0.00009**	in. (m.)	**Change in casing diameter, at P_D**
Δc =	**0.00028**	in. (m.)	**Change in casing circumference, at P_D**

Fig 12. Casing calculations for AL 6063 T5

Casing Dimensions and Design Factors

Do =	100	in. (mm)	Diameter, outside
t =	3	in. (mm)	wall thickness
S_D =	1.5		Design Safety factor

Material Properties

Fty =	276	ksi (MPa)	Yield Strength
Ftu =	310	ksi (MPa)	Ultimate Strength
E =	68900	Msi (MPa)	Modulus of Elasticity
ν =	0.33		Poisson Ratio
β =	0.890		Fty/Ftu
B =	1.266		Burst factor

Design and Burst Pressures

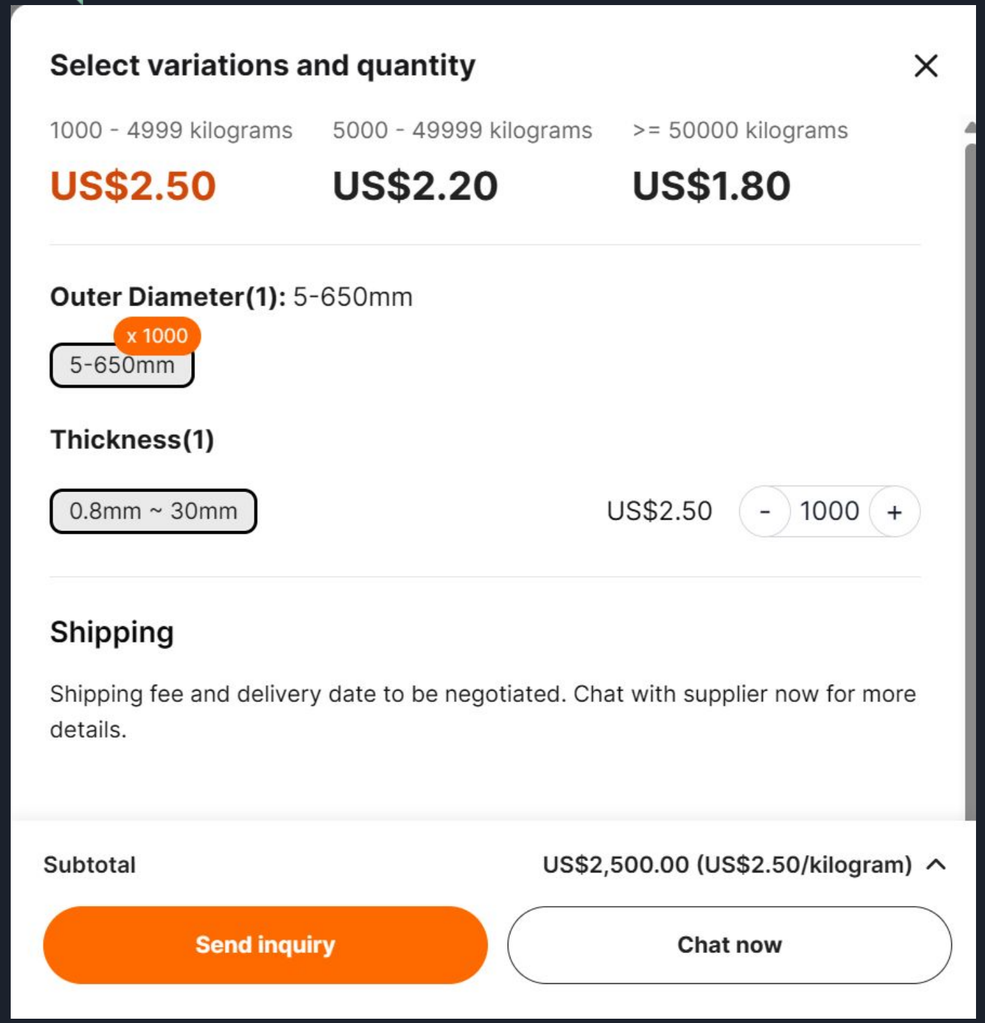
P_D =	**11040**	psi (kPa)	**Design pressure**
P_U =	**20959**	psi (kPa)	**Burst pressure**
S_U =	**1.90**		**Burst Safety Factor**

Elastic Deformation under Pressure *

ΔD =	**0.00022**	in. (m.)	**Change in casing diameter, at P_D**
Δc =	**0.00070**	in. (m.)	**Change in casing circumference, at P_D**

Fig 12. Casing calculations for AL 6061 T6

5.Suppliers from the internet



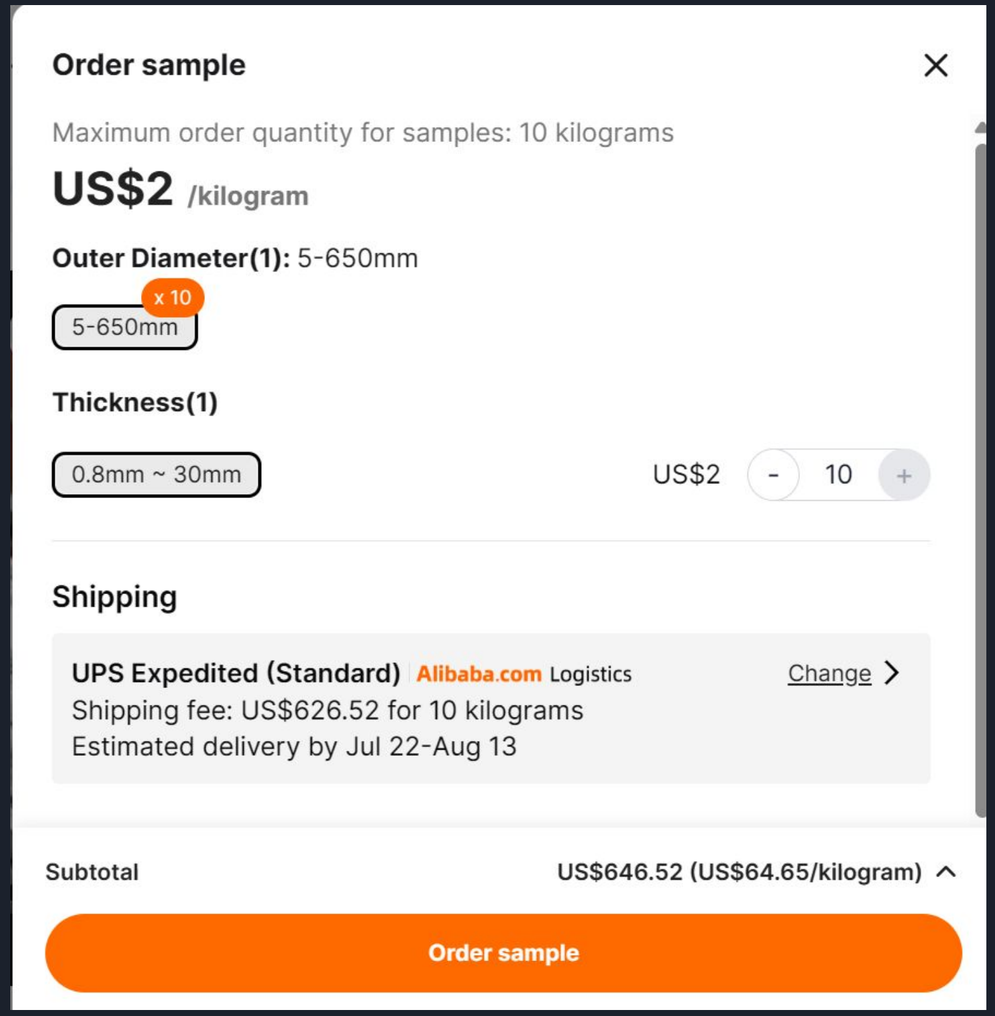


Fig 14&15. Alibaba supplier

6. Cutting of the bulkhead to specific size.

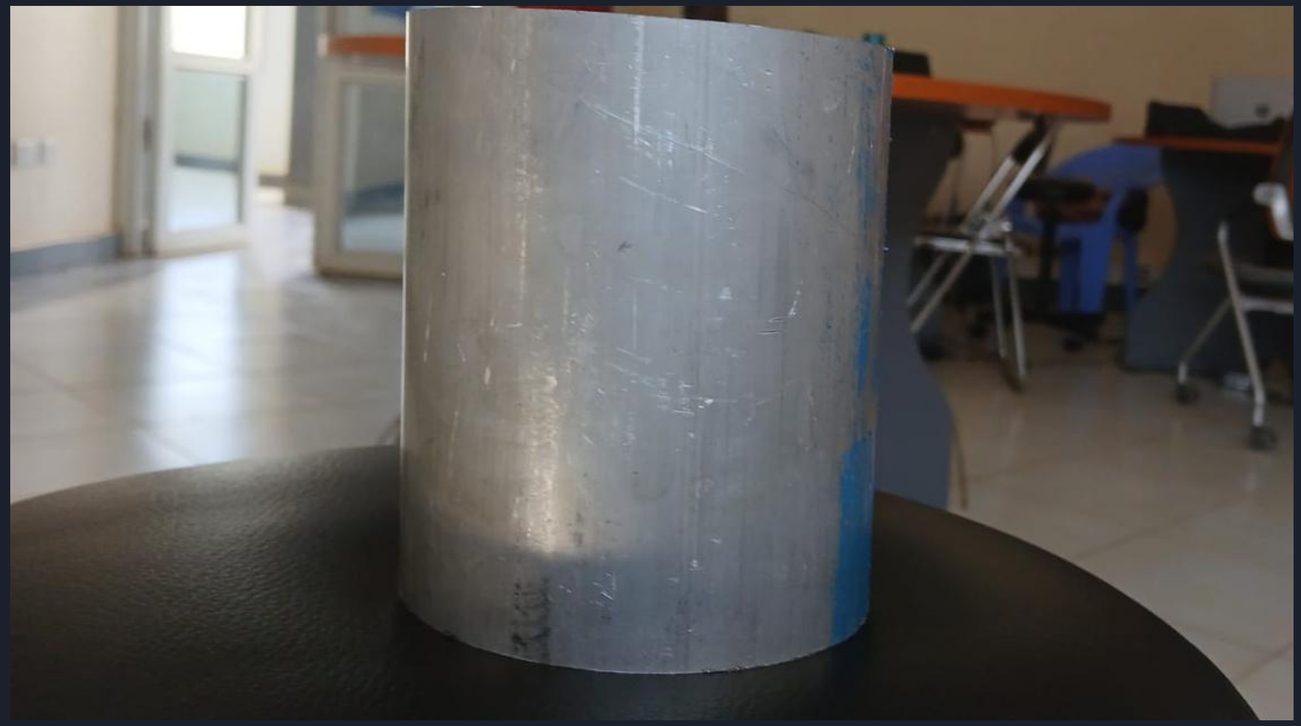


Fig 16. Bulkhead material cut to dimension

Re-making of the Liner according to the new casing dimensions

Fig 16. Liner made to 94mm dimension

NEXT WEEK'S OBJECTIVES

1. Simulating of the new casing performance in Ansys
2. Machining of the bulkheads to be used in the hydrostatic test **(consult on how to conduct our own pressure test during hot fires - piping system connection**)
3. Conducting the hydrostatic test
4. Obtaining Sorbitol and Potassium Nitrate
5. Cooking of the grains

THANK YOU

N4 SOLIDS TEAM