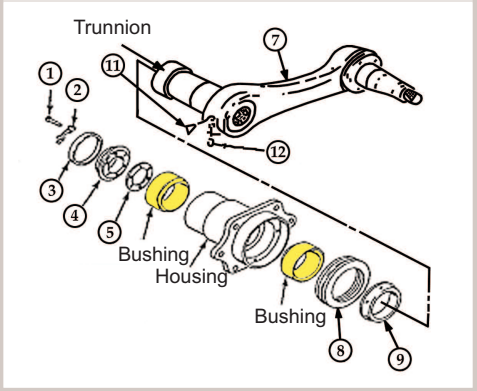
M113-Support Arm Bushing Upgrade

Support Arm Assembly



Rebuilt Support Arm prior to installation

CASE STUDY

The ADF (Australian Defence Force) was in search of a material that would not wear down or damage the support arm trunnion of the M113 armored personnel carrier, as its current material was causing excessive wear and frequent vehicle repairs. The M113s needed to take heavier loading, tolerate higher speed and last more than 10,000 km (the vehicles need to remain in service until 2020).

CHALLENGE

Over the years the ADF's M113 fleet has used several different materials for their support arm bushings, including fabric-based, oil-lubricated, bronze bearings and plastic bearings. Not only did the bearings experience an excessively high wear rate, but most of the trunnions on the support arm were damaged. Some details on the M113 follow below:

- Vehicle weight under normal operation: approx. 10 to 13 metric tons for all variations
- Maximum combat laden weight: 13 metric tons
- Vehicle speed: max at 75 km/hr on open road
- Number of roadwheels: 10
- Temperature: -40°F to 302°F (-40°C to 150°C)
- Life requirement: >10,000 km

RECOMMENDATION

We recommended Arlon® 1555, a proprietary blend of thermoplastic material (lubricated and carbon filled), because it had been battle tested as roadarm bushings on the Bionix (25 ton infantry fighting vehicle) and the AMX 13 SM1 (17 ton light tank), clocking over 6,500 km in service.

Arlon 1555 is self-lubricating, making it virtually maintenance free once fitted. The bushing only needs to be packed with grease during installation. The material can tolerate dirt ingress much better than other PTFE-based materials.

Arlon 1555 bearings do not experience failures normally associated with roller bearings like "Brinelling" or "Fretting." Additionally, they will not fail catastrophically and cause secondary damage, nor will they wear out or damage mating metal parts like the trunnion.

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EVALUATION BY THE ADF

A total of six different bushings were selected for trials on two M113 vehicles in Victoria, Australia. The bushings included:

- The original bushing as a basis for comparison (Reinforced Tetrafluoroethylene)
- A bronze bushing
- Arlon® 1555
- Three other different plastic materials

The evaluation was divided into two phases: the first phase (initial evaluation) ended after the vehicles clocked between 1,000 to 1,500 km, and the second phase ended after they clocked 5,400 km. Arlon 1555 was one of only three bushings left after the first phase. The bushings were still serviceable at the end of testing, and the trunnions were in almost perfect condition. Using the total distance traveled (5,424 km), the wear rate for the Arlon bushing can be estimated at between 0.026 mm/1000 km and 0.067 mm/1000 km. From the results, we estimated that the bushings can last for at least 20,000 km before replacement.

Based on these results, the ADF put the bushings through a more extreme trial in Darwin, Australia. At the trial, five support arm assemblies were fitted with Arlon 1555 bushings and put through operations in the field until failure.

The trials performed by the ADF highlight the capabilities of Arlon 1555 in extremely harsh environments. Arlon 1555 delivers strength and wear properties critical for the hostile conditions prevalent in the defense arena.

Lancer Systems is a world-class team of engineers and manufacturing experts committed to providing engineered lightweight and harsh environment solutions to our customers. We support our customers by developing and delivering innovative designs that enable them to effectively complete their missions.

Arlon 1555 Typical Properties

Physical Properties	ASTM Method	Typical Value
Color		Black
Specific Gravity	D792	1.46
Hardness, Shore D, Points	D2240	87
Hardness, Rockwell M, Points	D785	98
Elongation, %	D638	2.2
Tensile Break Strength, psi	D638	21,200
Tensile 0.5% Secant Modulus, psi	D638	1,650,000
Compressive Strength @ Break, psi	D695	24,600
Deformation Under Load, %	D621	0.10
Flexural Strength, psi	D790	33,000
Flexural 0.5% Secant Modulus, psi	D790	1,400,000
Shear Strength, Axial, psi	D732	13,000
Shear Strength, Transverse, psi	D732	10,000
Heat Deflection Temperature @ 264 psi, ºF	D648	>600
Coefficient of Thermal Expansion < 300ºF, 10^{-6} in./(inºF)	D696	8
Coefficient of Thermal Expansion > 300ºF, 10^{-6} in./(inºF)	D696	17
Coefficient of Dynamic Friction, PV = 12,600 psi-ft/min	G77	0.17
Wear Factor, 10^{-10} in.3-min./(lb.-ft.-hr.)	G77	65

Note: Properties of Arlon 1555 are anisotropic. The published properties, unless otherwise noted, are measured in the axial flow direction of molded test specimens. Strength and stiffness, therefore, are at a maximum, while elongation and thermal coefficient of expansion are at a minimum.

Statements and recommendations in this publication are based on our experience and knowledge of typical applications for this product and shall not constitute a guarantee or warranty of performance nor a modification or alteration of our standard product warranty which shall be applicable to such products.

www.lancer-systems.com
sales@lancer-systems.com

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