

UNCLASSIFIED

AD NUMBER

ADB008723

LIMITATION CHANGES

TO:

Approved for public release; distribution is unlimited. Document partially illegible.

FROM:

Distribution authorized to U.S. Gov't. agencies only; Test and Evaluation; JUL 1975. Other requests shall be referred to Army Tank and Automotive Command, Attn: AMSTA-RKMC, Warren, MI.

AUTHORITY

tadc, d/a ltr, 10 jun 1976

THIS PAGE IS UNCLASSIFIED

**Best Available
Copy
for all Pictures**

THIS REPORT HAS BEEN DELIMITED
AND CLEARED FOR PUBLIC RELEASE
UNDER DOD DIRECTIVE 5200.20 AND
NO RESTRICTIONS ARE IMPOSED UPON
ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

① ✓

⑬ ~~RDTE PROJECT NO. / FSN NOT AVAILABLE~~
TECOM ~~PROJECT NO.~~ 1-VC-087-060-008
⑭ REPORT NO. APG-MT-4689
TEST SPONSOR US ARMY TANK-AUTOMOTIVE
COMMAND
TRADOC AC NO. NONE



AD B 008723

⑥ PRODUCT IMPROVEMENT TEST OF
HARD-COATED ALUMINUM T142 TRACK FOR
M60 SERIES TANKS -

⑨ FINAL LETTER REPORT, 10 Jul 74 - 27 May 75

BY

⑩ ARTHUR L. CUMMINGS

⑪ JUL 1975

⑫ 57P.

DDC
RECEIVED
JAN 26 1976
A

DISTRIBUTION LIMITED TO U. S. GOVERNMENT AGENCIES ONLY; TEST AND
EVALUATION; JULY 1975. OTHER REQUESTS FOR THIS DOCUMENT MUST BE
REFERRED TO TACOM, ATTN: AMSTA-RKMC.

AD No. _____
DDC FILE COPY

US ARMY ABERDEEN PROVING GROUND ✓
ABERDEEN PROVING GROUND, MARYLAND

1473
An

404 062

REPRODUCTION LIMITATIONS

See DD-1473

Reproduction of this document in whole or in part is prohibited
except with the permission of Commander, US Army Tank-
Automotive Command, ATTN: AMSTA-RKMC.

*DIC is authorized to reproduce this document for United States
Government purposes.*

DISPOSITION INSTRUCTIONS

Destroy this report in accordance with appropriate regulations
when no longer needed. Do not return it to the originator.

DISCLAIMER

The findings in this report are not to be construed as an official
Department of the Army position, unless so designated by other
authorized documents issued and approved by the Department of the
Army.

ACCESSION for	
HTIS	White Section <input type="checkbox"/>
DOC	Self Section <input checked="" type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
BY.....	
DISTRIBUTION/AVAILABILITY CODE	
SRL: ADL, and/or STC/LA	
<i>B</i>	



DEPARTMENT OF THE ARMY
ABERDEEN PROVING GROUND Mr. A. L. Cummings/dgm/283-2237
ABERDEEN PROVING GROUND, MARYLAND 21005

18 JUL 1975

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

Commander
US Army Tank Automotive Command
ATTN: AMSTA-RKMC
Warren, Michigan 48090

1. REFERENCES:

- a. Letter, AMSTA-RHT, TACOM, subj: Test of T142 Aluminum Track, with 1 Inclosure, 6 June 1974.
- b. Letter, AMSTA-BB, TECOM, subj: Customer Test Directive: Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, 13 June 1974.
- c. Adler, R, First Partial Report on Product Improvement Test of Hard-Coated Aluminum Track Shoes and Hard-Coated Road Wheels for M60 Series Tank. TECOM Project No. 1-VC-087-060-005. Aberdeen Proving Ground. Report No. APG-MT-4273, May 1973.
- d. Wilkie, R, Product Improvement Test of Hard-Coated Aluminum Track Shoes and Hard-Coated Road Wheels for M60 Series Tank (T142 Aluminum Track). TECOM Project No. 1-VC-087-060-005. Aberdeen Proving Ground. Report No. APG-MT-4435, April, 1974.

- e. TM 9-2630-200-14, Identification, Inspection, Classification, Maintenance, Storage, Disposition, and Issue of Solid Rubber Tires and Track Components, June 1972.

2. BACKGROUND:

- a. This test was authorized by reference 1b.
- b. The standard T142 steel track for the M60 series tank as compared to T97E2 track offers the advantage of longer overall life; however, the track weight is increased by approximately 25%. This results in a heavier

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

vehicle with higher unsprung weight, greater power losses, and higher fuel consumption. A track of the T142 design made with aluminum would reduce weight and power losses and improve fuel consumption. An experimental aluminum track with T142 shoe design was provided to obtain endurance and performance characteristics for comparison with the steel T142 track.

c. The test track was identical to standard T142 track, except the track blocks were constructed of an aluminum alloy instead of steel. The use of aluminum reduced the T142 track weight per pitch length from 76.6 lb (34.75 kg) to 59.9 lb (27.17 kg), which compares favorable with the 61.3 lb (27.80 kg) weight of the T97E2 Track.

d. Prior to this test, the track had, in part, completed 5000 miles (8045 km) of endurance operations consisting of paved, gravel, and cross-country at Aberdeen Proving Ground, under TECOM Project No. 1-VC-087-060-005.

e. During this test program, performance tests were conducted on standard T142 steel track, installed on the same vehicle, in order to obtain comparable data. These engineering tests consisted of drawbar pull, acceleration and fuel consumption. The 2,000 mile (3218 km) scheduled endurance test was conducted over paved, gravel and level and hilly cross-country courses. Data were obtained on wear of rubber and metal components of the track and the maintenance required over the 2000 miles (3218 km) of operation. Upon completion of the planned 2000 miles (3218 km) it was determined that additional testing was desirable since the track condition remained serviceable and a trend of component failure had not been established. The test was extended an additional 1545 miles (2486 km) until the track assemblies were generally worn far beyond serviceable limits.

f. Materiel Testing Directorate conducted the test at US Army Aberdeen Proving Ground from 10 July 1974 to 27 May 1975.

3. OBJECTIVE

The test objective was to determine the performance and endurance characteristics of the aluminum T142 track in order to compare the results with previous tests of steel T142 track.

4. SUMMARY OF RESULTS:

a. The test items consisted of two strands of T142 hard-coated aluminum track shoes previously tested under TECOM Project No. 1-VC-087-060-005.

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECCOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

The left strand contained 76 shoes and the right strand 60 shoes of the previously tested track. Twenty shoes had been shipped to AMSTA-RKMC for evaluation at the conclusion of the previous test and four shoes were replaced due to center guide interference.

At the start of this program the two test track strands consisted of shoes with test mileage as shown in Table 1.

Table 1. Initial Track Shoe Mileage

No. of Shoes	Left Track		No. of Shoes	Right Track	
	Mileage Completed	Kilometers		Mileage Completed	Kilometers
4	0	0	20	0	0
10	1230	1979	9	1230	1979
8	3421	5504	2	3000	4827
58	5000	8045	49	5000	8045
Total	80		80		

b. Prior to test start, the pads, center guides, and end connectors in both strands were replaced with new items procured through supply channels. Numerous track blocks had shifted on the pins toward the center guides, to the extent that these blocks were contacting the sides of the guides (Inclosure 1, Figure 1). Center guide removal from the shoes was extremely difficult due to the interference between the center guide pinhole flanges and track block end plates.

In order to assemble the required eighty shoe strands, it was necessary to add a total of twenty four new aluminum shoes from the project spare stock. Twenty shoes were installed in the right track as replacements for those forwarded for TACOM evaluation and four left shoes were replaced since the severity of the block to center guide interference made guide removal unfeasible. This interference problem also necessitated grinding down the pinhole flanges of 8 right and 16 left new replacement center guides in order to provide adequate clearance for installation. The fasteners were torqued as follows: pad nuts 190 lb-ft (258 Nm); end connector wedge nuts 160 lb-ft (217 Nm); and center guide nuts 320 lb-ft (434 Nm). The track tension was adjusted to that prescribed for the T97E2 and T142 steel track. All shoes were stamped with an identifying number prior to test start.

The test support vehicle, M60A1 Tank, USA Registration No. 09A03872, with 4810 (7739 Km) previous test miles was obtained from the MTD fleet. This vehicle was inspected to ensure that performance was acceptable and that all suspension components met or exceeded condition Code B criteria as prescribed by TM 9-2630-200-14, June 1972. Those components failing to meet the condition criteria were replaced with new items prior to testing.

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

The M60A1, with the test track installed, was loaded to a gross vehicle weight of 107,300 pounds (48671 kg). The M60A1 was equipped with the Maintenance Indicator Panel (MIP-Mark III) which was undergoing Engineering Design testing under TECOM Project No. 7-ES-595-000-031.

c. The test tracks were subjected to 50 miles (81 km) preliminary operation over the gravel course to ensure the proper seating of the new connecting hardware and to break-in the new track pads prior to endurance testing. The preliminary operation was accomplished in accordance with Table II.

Table II. Preliminary Operation Schedule

<u>Speed, MPH</u>	<u>Km/h</u>	<u>Distance, Miles</u>	<u>Km</u>
10	16	15	24
15	24	15	24
20	32	20	32
		TOTAL	80

All track fasteners were retightened to specified torque and track tension was readjusted following the preliminary operation.

d. Acceleration, drawbar pull, and fuel consumption tests were conducted on the M60A1 vehicle equipped with standard T142 steel track and repeated with the test track. The objective of these tests was to determine the vehicle performance characteristics when equipped with each track in order to obtain comparable data. The steel track used was new T142 production track which had completed 50 miles (80 km) of preliminary operation, while the test track shoes had completed from 50 (80 km) to 5000 miles (8045 km) of test operation.

Information was not available to define the degree of influence, if any, that this mileage difference had upon comparing track performance characteristics.

e. The M60A1 tank was accelerated from rest to maximum road speed on a smooth, dry, paved road. Both a calibrated fifth wheel and a bank of stopwatches were used to collect the data.

The use of aluminum track improved the acceleration performance of the M60A1 by 10 percent in the 0-10 mph (9-16 km/h) speed range, 20 percent in the 0-20 mph (0-32 km/h) range, and 29 percent in the 0-30 mph (0-48 km/h) range. Average time intervals required to accelerate to various road speeds are presented in Table III.

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

Table III - Acceleration Characteristics

Speed Range		Average Time - Sec	
(MPH)	(km/h)	W/T142 Aluminum	W/T142 Steel
0-10	0-16	4.5	5.0
0-20	0-32	14.0	17.5
0-30	0-48	40.0	56.5

Complete acceleration characteristics are presented in Inclosure 2, Page 1.

f. Drawbar performance tests were conducted on smooth- dry, level pavement, utilizing a mobile dynamometer and associated instrumentation.

The data collected indicated that the use of aluminum track had no significant effect upon the low transmission range drawbar performance of the M60A1 tank. However, high range drawbar pull attained with the aluminum track was increased by approximately 1700 pounds, 7562N, (23 hp) at 5 mph (8 km/h) to 3200 pounds, 14234N (188 hp) at 22 mph (35 km/h) over that obtained with steel tracks. This progressive improvement in high range drawbar performance obtained with the aluminum track over the entire speed range indicates that track and suspension power losses were significantly higher when using the steel track. Complete drawbar pull and horsepower curves are presented in Inclosure 2, Pages 2 through 4.

g. The standard course fuel consumption test was performed at various road speeds selected to span the normal service speeds of the M60A1 tank. The standard fuel course, designed to be representative of service conditions, is a loop of graded gravel and paved road with ascending and descending slopes having gradients up to 30 percent. Data were collected by use of a calibrated fuel burette and stopwatches.

Over the road speed range of 10 to 23 mph (16 to 37 km/h), fuel consumption of the M60A1 ranged from 0.60 to 0.67 mpg (0.26 to 0.29 km/l) when equipped with the aluminum tracks, and from 0.60 to 0.64 mpg (0.26 to 0.27 km/l) when equipped with the T142 steel tracks. Standard course fuel consumption for the M60A1 was not significantly different when either track set was used. Standard course fuel consumption data are presented in Inclosure 2, Page 5.

h. The endurance test mileage was divided between paved, gravel, level and hilly cross-country courses in increments to closely equal the 7000 mile (11263 km) endurance testing of the acceptance T142 steel track tested under TECOM Project No. 1-4-2170-30. Hilly cross-country testing was eliminated from the 1545 miles (2486 km) in excess of the

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

originally planned 2000 miles (3218 km), since safety considerations precluded the travel over a public highway to reach the hilly cross-country site. No restrictions were imposed during the test relative to speed limitations or elimination of operation on any test course, other than those required to satisfy safety procedures. Table IV shows mileage distribution and average vehicle speeds.

Table IV - Operational Summary

<u>Course</u>	<u>Miles</u>	<u>Kilometers</u>	<u>Percent</u>	<u>Average Speed MPH</u>	<u>Km/h</u>
Paved	742	1194	21	23.4	37.7
Gravel	1183	1904	33	20.9	33.6
Cross-Country					
Perryman No. 2, 3, and 4	601	967	17	10.9	17.5
Churchville (Hilly)	1019	1640	29	12.7	20.4
TOTAL	3545	5704	100	15.8	25.4

Fuel and oil consumption data are included as Inclosure 2, Page 6. The adjustment of track tension was accomplished periodically during the test as indicated by daily operator inspection. Each track was adjusted a total of nine times during the test with an average of 394 miles (634 km) between adjustments. These adjustments were made as prescribed in TO 9-2350-215-10 to a clearance of $\frac{1}{4}$ (6.4 mm) to $\frac{5}{16}$ - inch (7.9 mm).

The tracks were separated during the test for the purposes of performing maintenance and reversing the direction of track travel. The left strand was separated six times, at 199 (320 km), 1928 (3102 km), 2317 (3728 km), 2404 (3868 km), 2805 (4513 km) and 3025 test miles. The right track was separated seven times, at 199 (320 km), 453 (729 mm), 1391 (2238 km), 2404 (3868 km), 2805 (4513 km), 2909 (4681 km), and 3025 miles (4867 km). Both tracks were reversed after 2404 test miles (3868 km), resulting in 2404 miles (3868 km) operation against one driving face of the end connectors, and 1141 miles (1836 km) against the other.

A total of 16 track shoes were replaced during the test. Table V summarizes these shoe replacements.

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

Table V - Track Shoe Replacements

<u>Mileage</u>	<u>Kilometers</u>	<u>Quantity</u>	<u>Location</u>	<u>Cause</u>
1928	3102	2	Left	Pin bushing failure
2625	4224	1	Left	Pin bushing failure
2625	4224	1	Right	Pin bushing failure
2805	4513	1	Right	Pin bushing failure
2805	4513	1	Left	Fractured pin tube
2909	4681	1	Right	Pin bushing failure
3025	4867	2	Right	Track pin wear
3025	4867	5	Left	Track pin wear
3467	5578	2	Right	Road wheel path rubber failure

Two pin tube fractures, as shown in Inclosure 1, Figures 2 and 3, were the only failures of the aluminum track bodies detected. One tube fracture occurred in a left inboard block at 2805 miles (4513 km) and the other was detected in a right inboard block at final inspection. The cause of these failures was undetermined.

Six track shoes were replaced during the test due to pin bushings that were worn to the extent that the pins were contacting the bushing bore of the blocks. The cause of these failures was undetermined.

Seven track shoes, two right and five left, were replaced at 3025 test miles (4867 km) as a result of conditions created by the shifting of the track shoes on the pins. This shifting caused pronounced wear of both the inner and outer track block end plates, thus reducing the effective width of the blocks. When the block width was reduced, the pins of the affected shoes shifted to the extent that the sprockets contacted and caused heavy wear to the track pins inboard of the end connector. It was this track pin wear that necessitated replacement of the seven shoes in order to maintain a safe track condition.

The breakdown and splitting of the road wheel path rubber over the binoculars, reported during the earlier 5000 miles (8045 km) of testing, developed into a severe condition in 34 shoes after 3467 miles (5578 km). Of these 34 shoes 15 were in the left track and 19 in the right. As the initial breakdown of the rubber continued, mud worked into the cracks and a pumping action was created by the passage of the road wheels, causing greater separation until it had progressed to the binocular tube, finally forcing the rubber away from a bond with the tube. The foreign material trapped between the remaining rubber and binocular tube, caused an abrasive action which resulted in tube wear to the extent that large holes were

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

worn through the tube into the pin bushing bore as shown in Inclosure 1, Figure 4. At 3467 miles (5578 km) it was necessary to replace 2 right track shoes that represented the most extreme case of the condition, in order to maintain track integrity.

Track pad replacement was performed during the test only upon the loss of a pad. A total of 15 pads were lost due to the pad nut wearing through the web section of the aluminum block. These failures occurred when the pad loosened causing the washer to become bell shaped; finally the nut fretted through the web section of the track block resulting in the loss of the pad. Replacement pads were installed using a locally fabricated 1/4-in (6.4 mm) mild steel plate in place of the washer to secure the pad. No incidents of pad loosening were noted following the installation of these plates, which were identical to those used during the previous testing of this track. Table VI shows the location and mileage of pad loss due to the block web damage condition.

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

Table VI Pad Loss Due to Web Damage

<u>Test Mileage</u>	<u>Kilometers</u>	<u>Location</u>			
		<u>Left Track</u>		<u>Right Track</u>	
		<u>Inboard</u>	<u>Outboard</u>	<u>Inboard</u>	<u>Outboard</u>
1106	1780	1			1
1342	2159	1			
1552	2497	1			
2404	3868	1		1	2
2481	3992	2			
2487	4002	2			
2909	4681	2			1

In addition to the above losses, three pads separated from the backing plates due to an apparent bonding failure. These bonding type failures occurred at 112 test miles (180 km) in a right inside track position, at 1737 miles (2795 km) in a left inside position, and after 2481 miles (3992 km) in a left outside position.

Track pads lost during the test were replaced with new standard items reduced in height to approximately that of the pads in the track at the time of replacement, to minimize vibration.

Inspection and tightening of the end connector wedges and center guides was considered a function of daily operator maintenance. Infrequent tightening of individual wedge bolts was required during the first 3000 test miles (4827 km), became more frequent after 3000 miles (4827 km), until immediately prior to test termination tightening of a small number of wedges became a daily requirement. The occasional loss of a loosened wedge was experienced after 1520 test miles (2446 km) with a total of 18 lost throughout the test. In addition, one center guide was lost at 1552 miles (2497 km) due to an undetermined cause. The frequency of connecting hardware maintenance was not deemed excessive when consideration was given to the relatively high track mileage. End connector wedge losses are summarized in Table VII.

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

Table VII Wedges Lost

Test Mileage	Kilometers	Left Track		Right Track	
		Inboard	Outboard	Inboard	Outboard
1520	2446		1		
1930	3105		1		
2317	3728	1			
2805	4513				1
2909	4681	2	1	2	1
3114	5010		1		
3512	5651	1	2	1	2
3515	5656				1

At the time of the pretest inspection it was noted that many end track pin bushings were extruding from the blocks. These bushings were torn from the pins and lost during the test. The bushing loss apparently had no detrimental effect upon the life of the track generally, but may have reduced the test life of the track bushings that failed.

Endurance testing was terminated upon completion of 3545 test miles (5704 km), or 8545 total miles (13749 km) for the test item, when the track assemblies were considered unserviceable. The integrity of the aluminum track blocks remained satisfactory with the exception of one block which contained a pin tube fracture. Upon test termination the two test track strands were comprised of shoes with overall test mileage as shown in Table VIII.

Table VIII Track Shoe Mileage at Test Termination

Left Track			Right Track		
No. of Shoes	Mileage Completed	Kilometers	No. of Shoes	Mileage Completed	Kilometers
5	520	837	2	78	126
1	740	1191	2	520	837
1	920	1480	1	636	1023
2	1617	2602	1	740	1191
4	3545	5704	1	920	1480
10	4775	7683	20	3545	5704
8	6966	11208	9	4775	7683
49	8545	13749	2	6545	10531
Total 80			42	8545	13749
			Total 80		

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

i. While vehicle maintenance may not be directly related to the testing of track, each item contributes to the environment of the other especially in the track to suspension relationship. Vehicle maintenance and service data are, therefore, summarized to provide evidence of the effect the use of aluminum track had upon vehicle maintenance requirements. The vehicle suspension was lubricated an average of every 295 miles (475 km) during the test. Other scheduled maintenance and lubrication services were performed in accordance with the vehicle technical manuals. Unscheduled suspension maintenance actions required to provide a satisfactory environment for the test item were as indicated:

(1) The sprockets were new at the start of test, reversed at 2404 miles (3687 km), and replaced at 3025 miles (4867 km).

(2) Four road wheels were replaced due to tire separation from the wheel; No. 3 right inside at 1573 test miles (2531 km), No. 4 left outside at 2092 miles (3366 km), No. 3 right inside at 2531 miles (4072 km), and No. 1 right inside after 2983 miles (4800 km).

(3) Two support rollers were replaced due to tire separation; No. 3 right outside at 1573 test miles (2531 km) and No. 3 left outside at 3470 miles (5583 km).

(4) Three track support roller wear plates were replaced due to severe wear; No. 1 left inside at 1737 test miles (2795 km), No. 1 left outside at 2092 miles (3366 km), and No. 1 right outside at 2404 miles (3868 km).

(5) Three road wheel hub bearings failed causing damage that, in each incident, necessitated replacement of the road arm assembly. These failures occurred at the No. 1 right, No. 4 left, and No. 2 left positions, after 453 (729 km), 1890 (3041 km), and 2092 test miles (3366 km), respectively.

(6) Three shock absorbers failed; No. 1 left at 453 test miles (729 km), and after 2909 test miles (4681 km) No. 2 right and No. 1 left.

(7) Nine shock absorber mounting pins were lost from various positions throughout the test and one lower shock absorber bushing was replaced due to wear.

(8) At 2317 test miles (3728 km) No. 1 left torsion bar and No. 1 and 3 left volute springs failed.

The rate of suspension maintenance was considered normal for the M60A1, indicating that the T142 aluminum track did not adversely affect suspension component life.

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

j. A summary of general vehicle unscheduled maintenance is presented for information purposes; again there was no indication that the use of aluminum track was detrimental to component life.

(1) At 199 test miles (320 km) both final drive assemblies were replaced due to a worn condition.

(2) The engine rear fan tower seal was replaced to correct a severe oil leak at 557 miles (896 km).

(3) The throttle bell crank bearings at the fuel injector pump became inoperative and were replaced at 557 test miles (896 km).

(4) At 3025 (4867 km) several engine oil leaks were repaired and a worn pinion bearing in the right final drive was replaced.

(5) Between 3052 (4911 km) and 3470 miles (5583 km) three engine assemblies were replaced. This excessive replacement rate was not related to the track or vehicle, rather it was attributed to depot rebuilt engines that were defective as received.

k. Upon termination of endurance testing a final inspection was conducted to determine the condition of the track and the extent of wear on the track components.

(1) As previously noted in para h, the pin tube of one right inboard block contained two longitudinal fractures approximately 4-inches (102 mm) in length as shown in Inclosure 1, Figure 3. The cause of the failure was undetermined.

(2) A total of 118 block end plates, 62 in the left track and 56 in the right, were severely worn due to the shifting of the blocks on the pins, which was first reported during the preceding test of this track. This same problem resulted in severe center guide interference at initial service, and track pin wear during the endurance test necessitating the replacement of a total of 11 shoes. Throughout this test an overall total of 129 track shoes were affected by this block shifting condition. This shifting occurred in both directions, first toward the center guide causing the center guide pin flange to wear into the end plate of the aluminum track block (Inclosure 1, Figure 5), and secondly toward the end connector resulting in severe wear of the outer end plate as it was contacted by the sides of the sprocket teeth (Inclosure 1, Figure 6). In some instances a

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

migration type activity was observed when several individual blocks moved from a condition of contacting the center guide to contacting the end connector or the reverse of this action, within a two hour period of vehicle operation. Although the connecting hardware remained properly secured, the shifting of the blocks caused the pins, center guides, and end-connectors to become misaligned with resultant accelerated and irregular wear of the track and suspension components.

(3) This block movement problem was originally considered a product of the use of the aluminum material since it was first detected in this test track. Recent testing, however, has disclosed a similar condition in the steel T142 track, thus indicating that the problem may relate to the T142 configuration and manufacturing processes rather than the use of aluminum blocks. Reportedly the degree of block movement in the case of the steel track is not as extreme as with the aluminum, possibly due to the lower wear rate of the steel track body material. The cause of this problem remains undetermined.

(4) The average grouser height was reduced to 0.38-in (9.6 mm) from the original height of 1.38-in (35.1 mm).

(5) The road wheel path rubber was breaking down and had progressed to the point of separation from the binoculars of 15 left and 17 right track blocks.

(6) The outer portion of the track pin bushings were missing from most of the track shoes, having extruded from the track block and been torn from the pin during endurance testing.

(7) The end connectors, center guides, and track pads were heavily worn, far in excess of serviceable limits. These items normally would have been replaced earlier; however, when the wear limits were reached late in the test, replacement was not considered feasible due to the generally poor condition of the trackshoes. Accurate definition of the degree of end connector and center guide wear was difficult due to the extreme irregularity of the wear patterns. The material remaining on the driving face of individual end connectors varied from a maximum of 0.25-in (6.4 mm) to a minimum of 0. Remaining center guide thickness, as measured 1.5-in (38.1 mm) from the top, varied between guides from a maximum of 1.38-in (35.1 mm) to a minimum of 0.75 in (19.1 mm) as compared to a new thickness of 1.5-in (38.1 mm). Many guides were worn only on one side due to the condition of track blocks shifting on the pins.

(8) The track pads were worn to grouser height, and therefore provided little cushioning during operation on hard surfaced roads.

STEAP-MT-U

SUBJECT: Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks, TECOM Project No. 1-VC-087-060-008, Report No. APG-MT-4680

At the conclusion of the final inspection forty test track shoes representative of the various problems related in this report were forwarded to TACOM for evaluation. The remaining items were placed in storage pending disposition instructions.

5. CONCLUSIONS

It is concluded that:

a. The use of aluminum T142 track improved the acceleration and drawbar pull performance of the M60A1 tank as compared to the steel T142.

b. The aluminum track successfully completed the 3545 miles (5704 km) of endurance testing.

c. The integrity of the aluminum block was satisfactory during 8545 miles (13749 km) of service.

d. Track shoe reinforcement is required under the track pad securing nut.

e. The endurance test results were compromised by conditions caused by the track block movement on the pins.

6. RECOMMENDATIONS

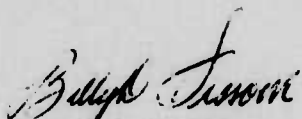
It is recommended that:

a. Action be taken to correct the problem of the T142 blocks moving laterally on the track pins.

b. Further tests should be conducted on the T142 track using blocks made of this aluminum alloy, in order to obtain additional performance and endurance data.

FOR THE COMMANDER:

3 Incls
1. Photographs
2. Test Data
3. DD Form 1473



BILLY D. SISSOM
Associate Director
Materiel Testing Directorate

14

CF:
Cdr, TECOM, ATTN: AMSTE-AR - 1 cy
Cdr, TACOM, ATTN: AMSTA-RHT- 20 cys

Secondary distribution control by Cdr, USATACOM, ATTN: AMSTA-RHT

STEAP-MT-U

SUBJECT: Final Letter Report of Product Improvement Test of Hard-Coated
Aluminum T142 Track, TECOM Project No. 1-VC-087-060-008,
Report No. APG-MTD-4680



Figure 1. Arrows Denote Center Guides Trapped
Between the Track Blocks Due to Block
Movement Toward the Center of the Shoe.

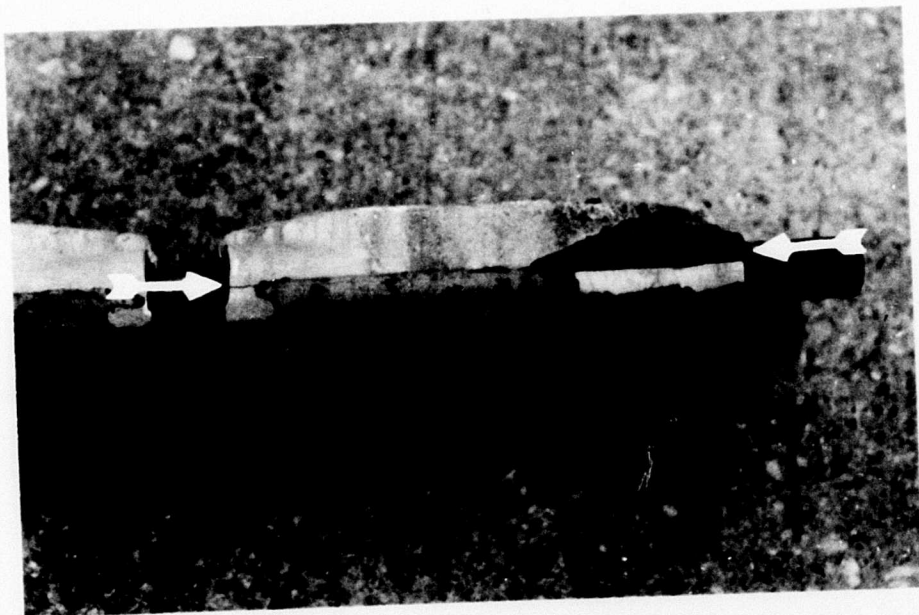


Figure 2. Arrows Denote Aluminum Block Fracture
Along Pin Tube at 2805 Test Miles (4513 Km).

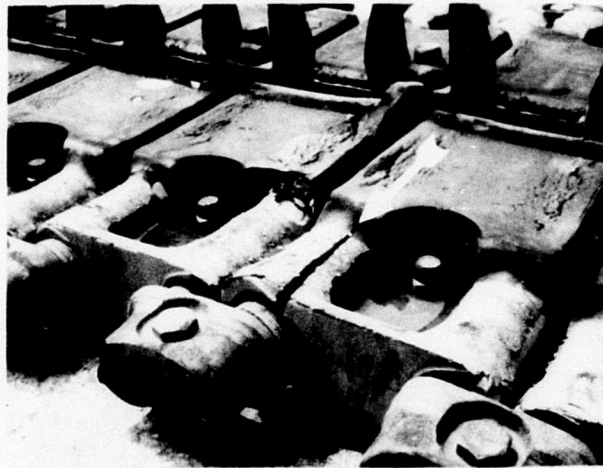


Figure 3. Arrow Denotes Pin Tube Fracture
Detected At Final Inspection



Figure 4. Arrow Denotes Pin Tube Wear Due to
Failure of Road Wheel Path Rubber

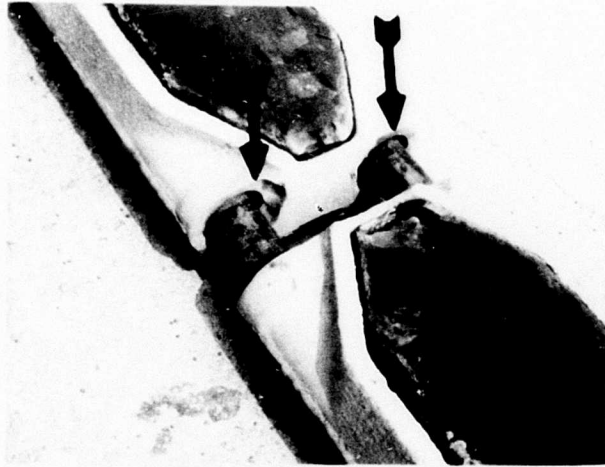


Figure 5. Arrows Denote Track Block End Plate Wear Caused by Center Guide Pin Flange Contact As The Blocks Moved Toward The Guides

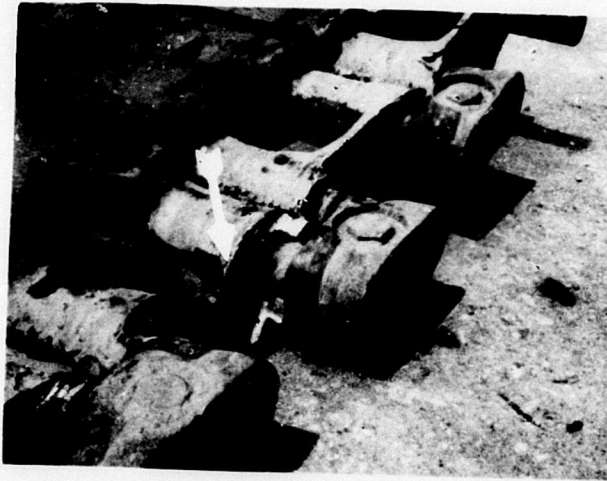


Figure 6. Arrow Denotes Severity of End Plate Wear Resulting From The Blocks Contacting The Sides of The Sprocket Teeth

SECTION 3. APPENDICES

APPENDIX A - TEST DATA

TANK, COMBAT, FULL-TRACKED, 105MM GUN, M60A1, USA REG. NO. 90A03872

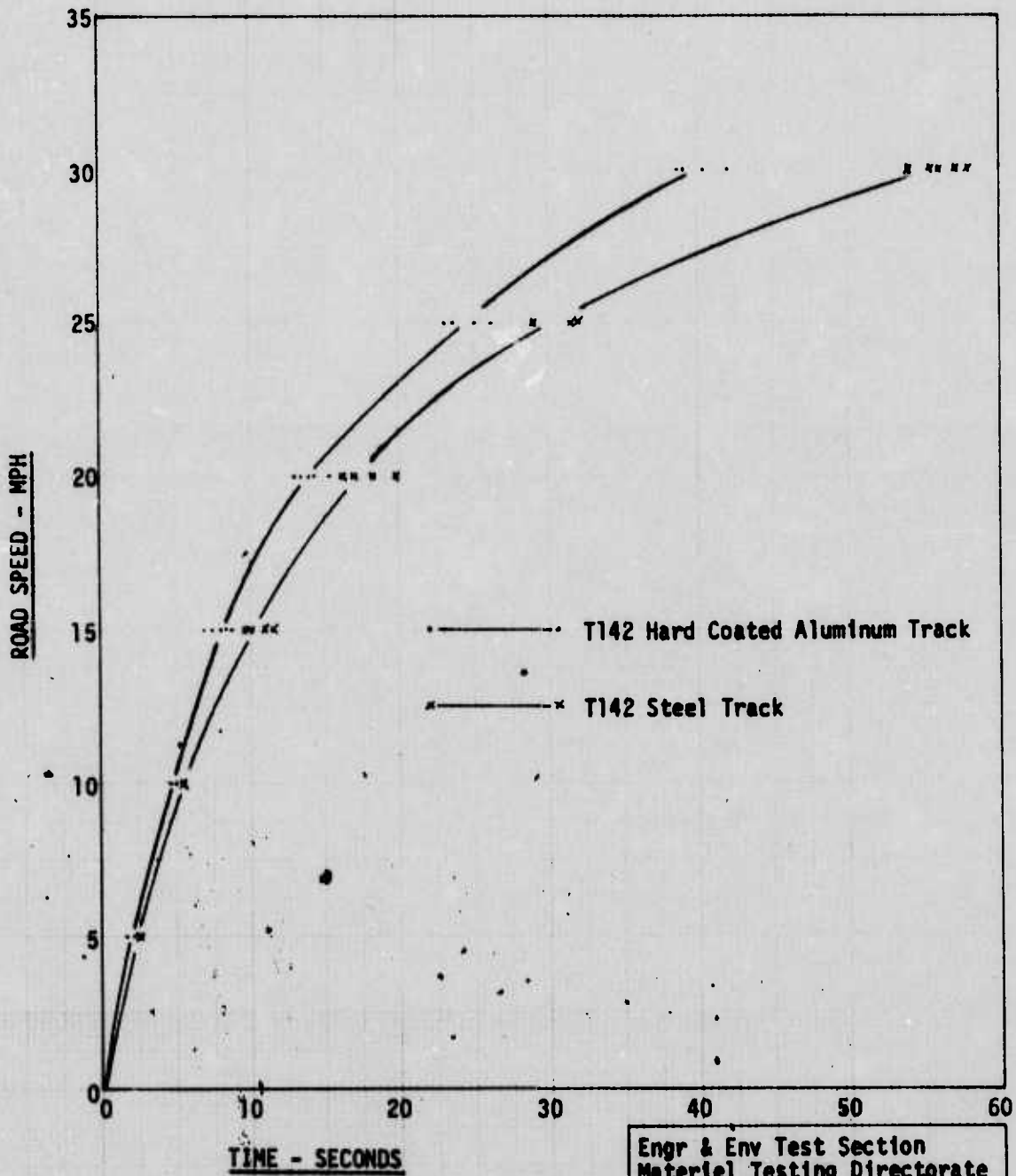
ACCELERATION (TIME-VELOCITY) CHARACTERISTICS

Engine: Model AVDS-1790-2

Transmission: Model CD-850-6

Vehicle Weight: 107,300 Lb with T142 Aluminum Track

109,450 Lb with T142 Steel Track



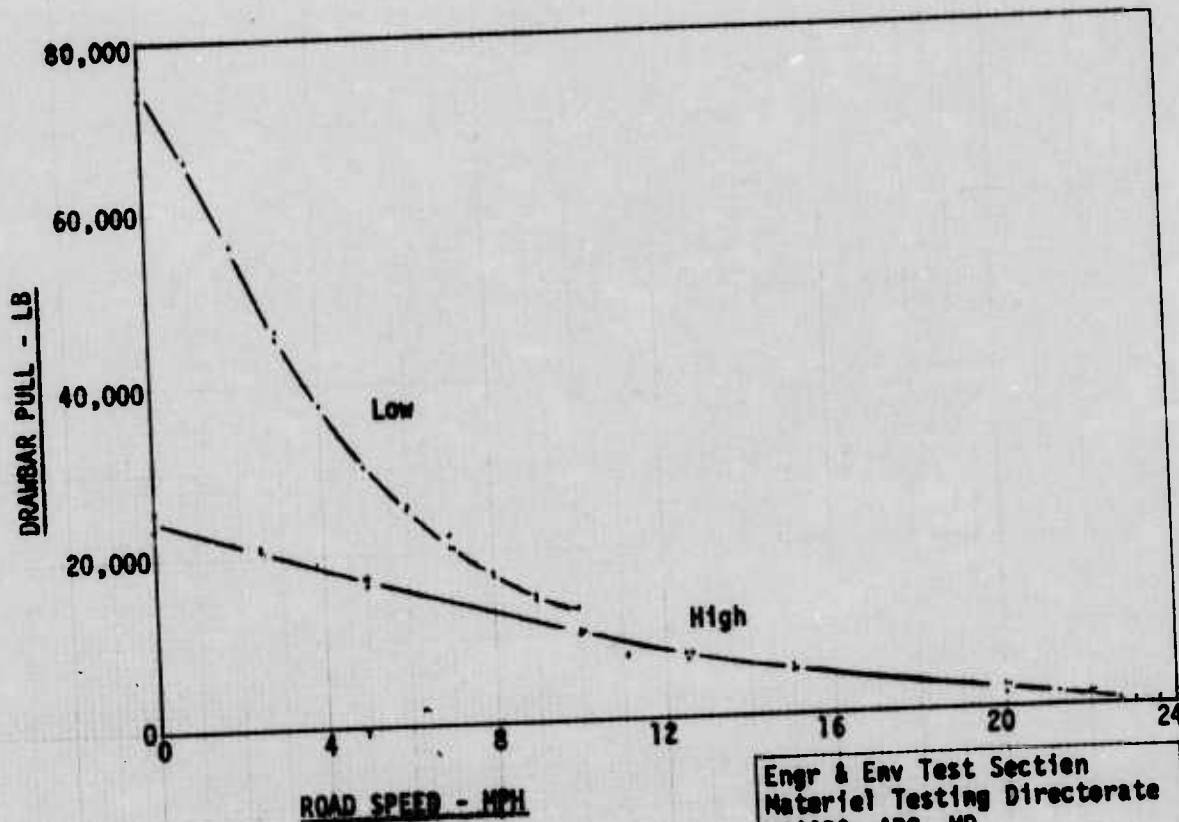
Engr & Env Test Section
Materiel Testing Directorate
USAAPG, APG, MD
JRouse/mp/2 Oct 74

A-1

TANK, COMBAT, FULL-TRACKED, 105MM, M60A1, USA REG. NO. 09A03872

DRAMBAR PULL CHARACTERISTICS - WITH T142 STEEL TRACK

Engine: Model AVDS-1790-2
Transmission: Model CD-850-6
Vehicle Weight: 109,450 Lb
Date of Test: 8 and 9 August 1974



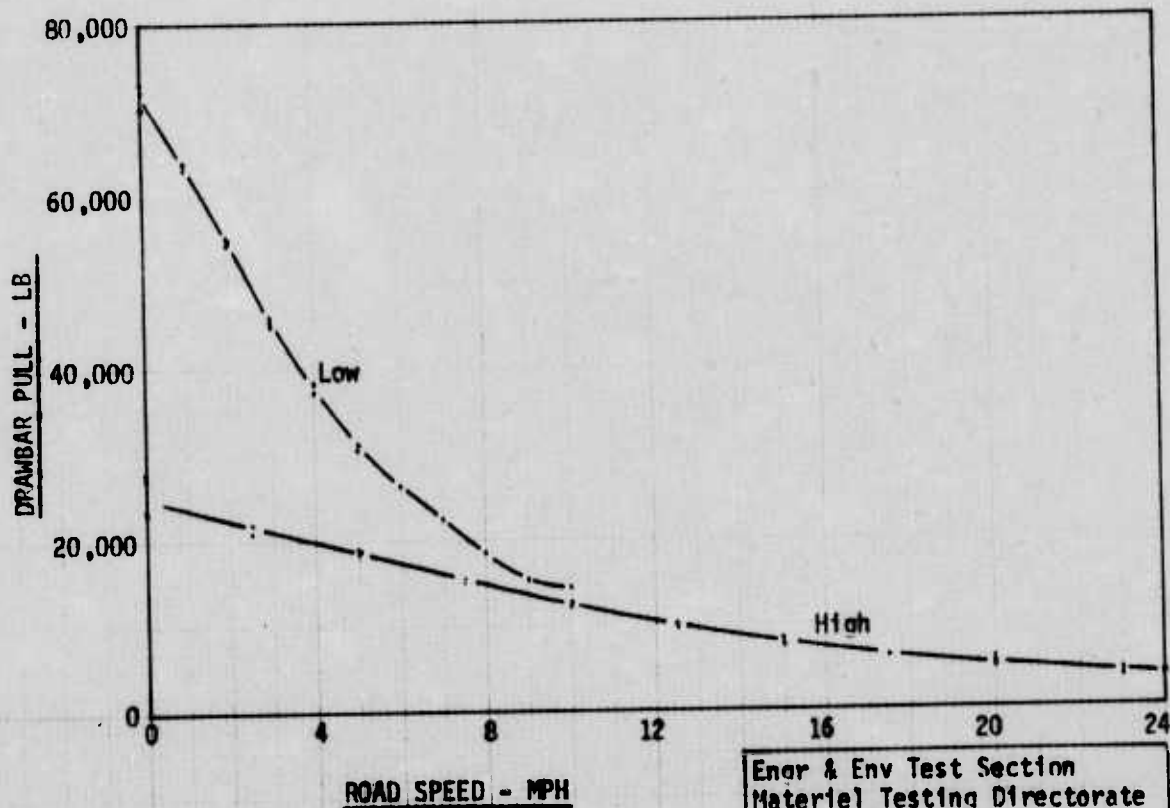
Engr & Env Test Section
Material Testing Directorate
USAAPG, APG, MD
JRobso/mp/72 Oct 74

A-2

TANK, COMBAT, FULL-TRACKED, 105MM, M60A1, USA REG. NO. 09A03872

DRAWBAR PULL CHARACTERISTICS - WITH T142 ALUMINUM TRACK

Engine: Model AVDS-1790-2
Transmission: Model CD-850-6
Vehicle Weight: 107,300 Lb
Date of Test: 16 August 1974



Eng & Env Test Section
Materiel Testing Directorate
USAAPG, APG, MD
JRouse/ds/3 Oct 74

A-3

TANK, COMBAT, FULL-TRACKED, 105MM GUN, M60A1, USA REG. NO. 09A03872

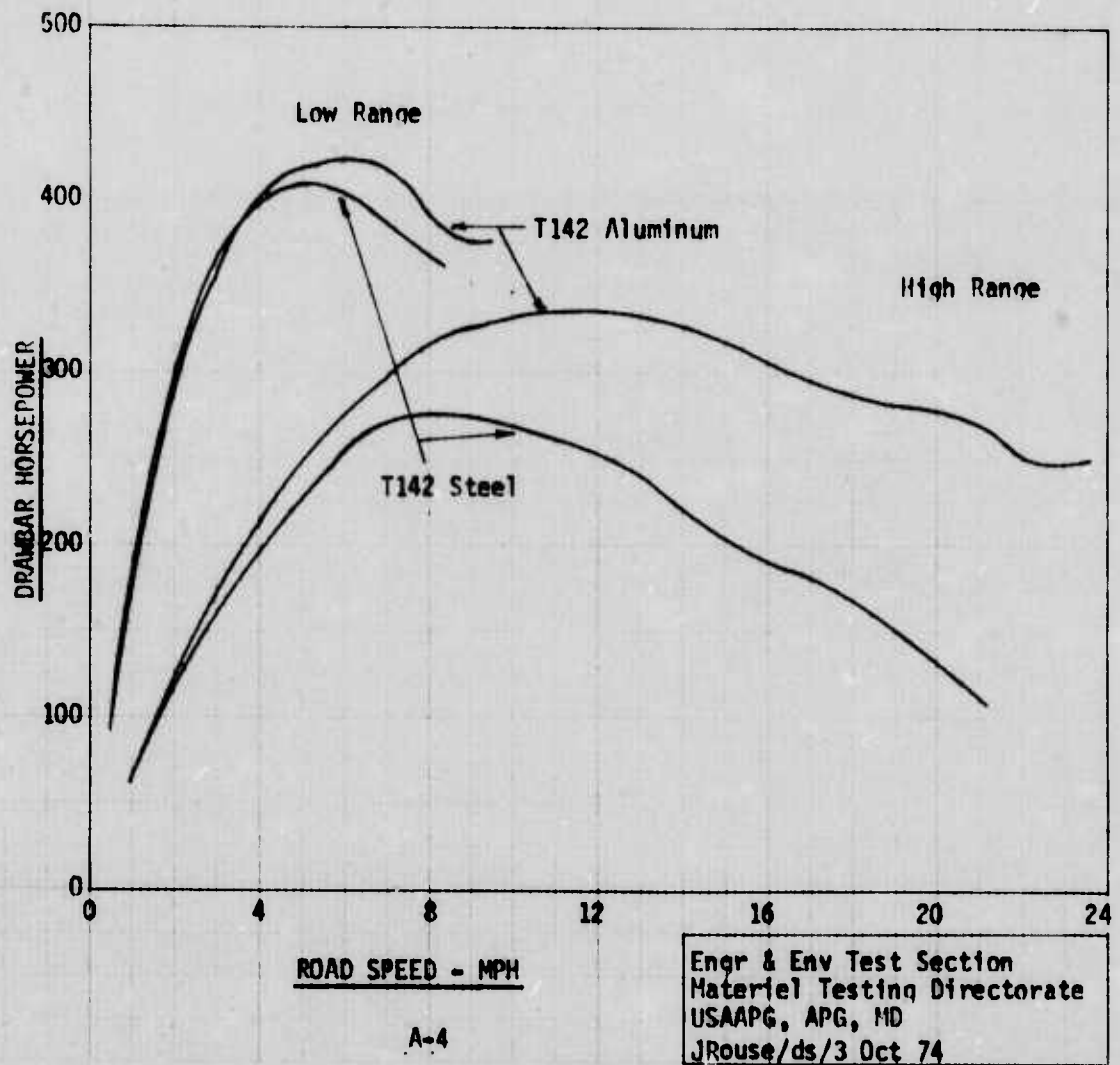
DRAWBAR HORSEPOWER CHARACTERISTICS

Engine: Model AVDS-1790-2

Transmission: Model CD-850-6

Vehicle Weight: W/T142 Steel Track - 109,450 Lb

W/T142 Aluminum Track - 107,300 Lb



TANK, COMBAT, FULL-TRACKED, 105MM, M60A1, USA REG. NO. 09A03872

STANDARD COURSE FUEL CONSUMPTION CHARACTERISTICS

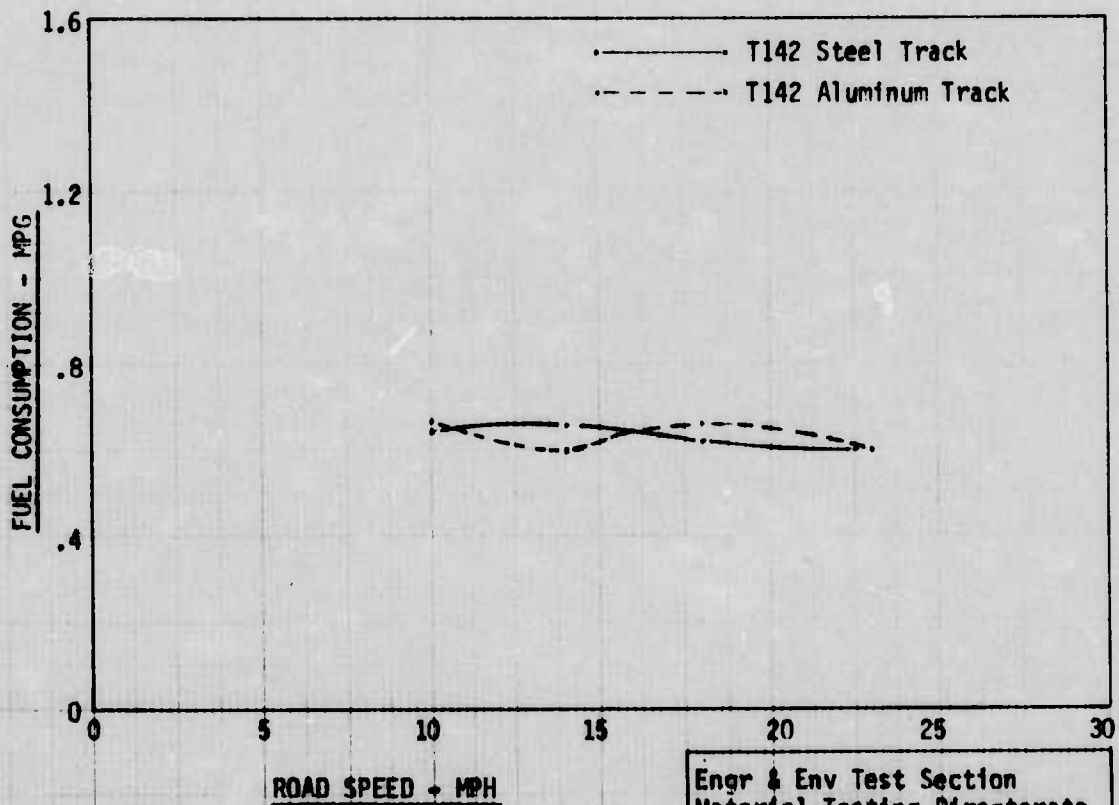
Engine: Model AVDS-1790-2

Transmission: Model CD-850-6

Vehicle Weight: W/T142 Steel Track - 109,450 Lb

W/T142 Aluminum Track - 107,300 Lb

Dates of Test: 2 & 19-21 August 1974



ROAD SPEED - MPH

A-5

Engr & Env Test Section
Materiel Testing Directorate
USAAPG, APG, MD
JRouse/ds/3 Oct 74

VEHICLE FUEL AND OIL CONSUMPTION
 Product Improvement Test of Aluminum T142 Vehicle M60A1 Tank
 Vehicle No. 09A03872, Diesel Fuel Spec: VV-F-800, Oil Spec: MIL-L-2104B
 Engine: AVDS-1790-2A, Transmission: CD 850-6A

Course Condition	Date		Miles	Kilo-meters	Operating Hours	Speed		Type	Gallons	Liters	MPG	l/100km	Type	Engine Oil		km/l	
	Begin	End				mph	km/hr							Quarts	Liters		MPQ
Paved/Dry	8-16-74		566	1072	28.4	23.4	37.7	DF-2	829.2	3139	0.80	293	OE50	10	9.5	66.6	112.8
Gravel/Dry			716	1152	34.9	20.5	33.0	"	1105.1	4183	0.65	363	"	20	18.9	35.8	60.7
Gravel/Wet			304	489	14.0	21.7	34.9	"	489.6	1853	0.62	379	"	12	11.4	25.3	42.9
Level/Cross Country/Dry			256	412	25.3	10.1	16.3	"	532.6	2016	0.48	490	"	6	5.7	42.7	72.3
Level Cross Country/Mud			218	351	18.2	12.0	19.3	"	455.0	1722	0.48	490	"	22	20.8	9.9	16.9
Hilly Cross Country/Dry			914	1471	68.8	13.3	21.4	"	1826.3	6913	0.50	470	"	16	15.1	57.1	97.4
Hilly Cross Country/Mud	5-20-74		105	169	11.6	9.1	14.6	"	225.0	852	0.47	504	"	0	0	-----	-----
Totals			3179	5116	201.2	15.8	25.4		5462.8	20678	0.58	404		86	81.4	37.0	62.9

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPRDT NUMBER APG-MT-4680 ✓	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Product Improvement Test of Hard-Coated Aluminum T142 Track For M60 Series Tanks	5. TYPE OF REPORT & PERIOD COVERED Letter, 10 July 1974 to 27 May 1975	
	6. PERFORMING ORG. REPORT NUMBER None	
7. AUTHOR(s) Arthur L. Cummings	8. CONTRACT OR GRANT NUMBER(s) None	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Materiel Testing Directorate ✓ Aberdeen Proving Ground, Maryland 21005	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS TECOM Project No. 1-VC-087-060-008 ✓	
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPRDT DATE July 1975	
	13. NUMBER OF PAGES	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Commander, US Army Tank-Automotive Command Warren, Michigan 48090 ATTN: AMSTA-RKMC	15. SECURITY CLASS. (of this report) UNCLASSIFIED	
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE None	
16. DISTRIBUTION STATEMENT (of this Report) Distribution limited to U. S. Government Agencies only; Test and Evaluation. Other requests for this document must be referred to Commander, US Army Tank- Automotive Command, ATTN: AMSTA-RKMC.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) None		
18. SUPPLEMENTARY NOTES None		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Shoe, Track, M60 Tank Aluminum Track for Tanks		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A product improvement test of T142 Track blocks made of Aluminum Alloy was con- ducted by Materiel Testing Directorate at Aberdeen Proving Ground, Maryland from 10 July 1974 to 27 May 1975. The purpose of the test was to determine the performance and endurance characteristics of the Aluminum T142 track in order to compare the results with previous tests of steel T142. Performance testing was conducted with both the aluminum and steel T142 track to obtain comparable data. Endurance testing consisted of 3545 miles (5604Km) conducted over paved, gravel, level and hilly cross-country courses. Acceleration and drawbar pull performance		

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

20. characteristics of the M60A1 tank were improved by the use of the aluminum alloy track. Fuel consumption for the M60A1 was not significantly changed by the use of the aluminum track. The test item successfully completed the 3545 miles (5404Km) of endurance testing. The endurance test results were compromised by conditions caused by the lateral movement of the blocks on the track pins. This aluminum alloy should be considered for use in making track blocks for use on the M60 series tanks.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)