



DEPARTMENT OF THE ARMY
ABERDEEN PROVING GROUND C. W. Wilson/pmf/3475
ABERDEEN PROVING GROUND, MARYLAND 21005

STEAP-MT-U

SUBJECT: Final Letter Report of Product Improvement Test of Truck
Utility, 1/4 Ton, 4X4, M151A1 (Rear Suspension Retrofit).
USATECOM ~~Project No. 1-VG-120-151-055~~ USAADC AG No. N/A,
Report No. APG-MT-4087

Distribution limited to U.S. Gov't. agencies only;
Test and Evaluation; *May 72*. Other requests

Commanding General this document must be referred to

US Army Tank-Automotive Command

ATTN: AMSTA-REB

Warren, Michigan 48090

*Final letter rept.
27 Jan - 9 May 72*

1. References:

a. Letter, TECOM, AMSTE-BB, Customer Test Directive, Truck,
Utility: 1/4 Ton, 4X4, M151A1 Rear Suspension Retrofit/Product Improve-
ment Test, TECOM Project Nos. 1-VG-120-151-055/-056, 19 January 1972.

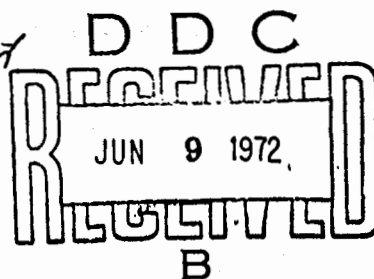
b. Letter, TACOM, AMSTA-REB, M151A1 Rear Suspension Retrofit/
Product Improvement Program, 29 December 1971.

2. Background

The present M151A1 rear suspension has not been totally acceptable under all driving conditions because of oversteer characteristics and lack of driver feel under dynamic steering conditions, primarily during highway operations. The M151A2 rear suspension system which is a trailing-arm design is being considered for retrofit of M151A1 vehicles now in service, in addition to other retrofit items such as front wheel brake cylinders, M151A2 brake shoe assemblies, and added rear wheel tire chain clearance. This report includes testing performed at APG from 27 January to 8 May 1972. Two vehicles, USA Registration Nos. 02CV5569 and 02CW0769 (hereafter referred to as V55 and W07) were tested.

3. Objectives:

a. To determine the endurance of the proposed retrofit kit consisting of:



404 062

1473
mk

AD 894871

FILE COPY

STEAP-MT-U

SUBJECT: Final Letter Report of Product Improvement Test of Truck,
Utility, 1/4 Ton, 4X4, M151A1 (Rear Suspension Retrofit),
USATECOM Project No. 1-VG-120-151-055, USA CDC AC No. N/A,
Report No. AFG-MT-4087

(1) M151A2 rear suspension arms with associated brackets and hardware.

(2) One inch diameter front wheel brake cylinders.

(3) M151A2 brake shoe assembly configuration (14 rivets for fastening shoe lining material).

(4) Increased rear wheel tire chain clearance.

b. To determine the endurance of items being considered for potential release during future production of the M151A2 series vehicles, consisting of:

(1) Dual brake master cylinder.

(2) Stick-on plastic reflectors.

(3) Plastic wiring harness clamps.

(4) Sintered iron pistons in wheel cylinders.

(5) Banded wheel cylinder boots.

(6) Experimental brake shoes.

c. To determine the endurance of certain product improvement items including:

(1) Transfer output snap ring retainer.

(2) Pre-lubed universal joints.

(3) Clutch linings from a new supplier.

(4) Turn signal controller from a new supplier.

(5) Igniter and coil.

(6) Front suspension arm bushings.

(7) Rear suspension arm solid bushings.

ACCESSION 12	WHITE SECTION
FSTI	BUFF SECTION
DOC	
UNANNOUNCED	
JUSTIFICATION	
BY	
DISTRIBUTION/AVAILABILITY CODES	
BIST.	AVAIL. and/or SPECIAL
B	

STEAP-MT-U

SUBJECT: Final Letter Report of Product Improvement Test of Truck,
Utility, 1/4 Ton, 4X4, M151A1 (Rear Suspension Retrofit),
USATECOM Project No. 1-VG-120-151-055, USACDC AC No. N/A,
Report No. APG-MT-4087

(8) Experimental transmission.

d. To determine the effectiveness of the service brakes.

4. Summary of Results:

Several of the rear suspension fasteners on suspension arm hangers, pivots, and shock absorber mounts required adjustment during initial inspection to conform to torque values prescribed by TACOM (para. 2.2).

The two inner pivot nuts on vehicle No. W07 were found to be stripped during initial inspection. New nuts were installed on all pivot bolts on both vehicles and adjusted to 60 lb-ft of torque (para. 2.2).

The average stopping distance from 20 mph was 20 feet for vehicle No. V55 and the service brakes were capable of holding the vehicle on the 60% slope (para. 2.4).

No problems were experienced with the M151A2 rear suspension arms with associated brackets and hardware (para. 2.5). No problems were experienced with the one-inch diameter front wheel brake cylinders.

No major problems were experienced with the M151A2 brake shoe configuration. The only problem was fracturing of the lining on one secondary shoe at the rivets (para. 2.5).

Comparison measurements indicate that the increased rear wheel chain clearance is equivalent to that provided on the M151A2 vehicle (para. 2.5).

No problems were experienced with the items being considered for potential release except for the sintered iron wheel cylinder pistons on the rear of vehicle No. V55. They were severely corroded and seized and one of the pistons had broken (para. 2.5).

Endurance testing was insufficient to permit complete evaluation of the two experimental brake linings. However, substantial wear was indicated in the limited mileage attained (para. 2.5).

No major problems were experienced with the product improvement items except for the pre-lubed universal joints. There were six universal joint failures; two were attributed to seal failures and contamination, three were caused by fractured bearing caps and loss of needle bearings, and one was caused by brinelling of the needle bearings and journals (Para. 2.5).

STEAP-MT-U

SUBJECT: Final Letter Report of Product Improvement Test of Truck,
Utility, 1/4 Ton, 4X4, M151A1 (Rear Suspension Retrofit),
USATECOM Project No. 1-VG-120-151-055, USACDC AC No. N/A,
Report No. APG-MT-4087

Insufficient endurance test miles precluded evaluation of the experimental transmission.

5. Conclusions:

It is concluded that:

a. The M151A2 rear suspension retrofit kit is satisfactory (para. 2.5).

b. The items being considered for potential release are satisfactory except for the sintered iron pistons in the rear wheel cylinders. Endurance testing with the experimental brake linings was of insufficient duration to permit thorough evaluation; however, substantial wear was indicated during the limited mileage achieved (para. 2.5).

c. The product improvement items are considered satisfactory except for the pre-lubed universal joints (six failures) and the experimental transmission with which there was insufficient endurance testing to permit evaluation (para. 2.5).

d. Stopping distance and hill-holding capability of the service brakes are satisfactory (para. 2.4).

6. Recommendations:

Not applicable.

FOR THE COMMANDER:

3 Incls

1. Details of Test
2. Photographs
3. Distribution List



R. P. WITT
Associate Director
Materiel Testing Directorate

2. DETAILS OF TEST

2.1 INTRODUCTION

The vehicles, V55 and W07, were received and after a limited initial inspection and lubrication were subjected to 500 miles of break-in operation without payload or towed load. Payloads were prepared and installed in each vehicle and endurance tests were initiated. Engineering performance tests were conducted on the service brakes of one vehicle.

2.2 INITIAL INSPECTION

2.2.1 Objectives

To determine that the vehicles were in satisfactory condition for test and that the various fasteners on the M151A2 rear suspension members such as hanger bolts, pivot arm bolts, and shock absorber bolts were adjusted to prescribed torque values before test operations began.

2.2.2 Criteria

a. The rear suspension bolts shall be adjusted to 40-50 lb-ft of torque.

b. The rear suspension pivot bolts shall be adjusted to 60-70 lb-ft of torque.

c. The rear shock absorber mounting bolts shall be adjusted to 110-150 lb-ft of torque.

2.2.3 Method

A limited technical inspection was performed on each of the two vehicles to determine the general condition of the vehicle, to measure the torque values of the rear suspension fasteners, and to record major component serial numbers. The lubricant levels of all fluid systems were checked and the engine coolant was checked for anti-freeze protection.

2.2.4 Results

Discrepancies noted and corrected during initial inspection were as follows:

a. On vehicle V55:

(1) One of the screws which secure the personnel heater bracket to the vehicle was sheared and was replaced.

(2) The handle used to lift the wire filter screen from the air cleaner was detached from the element and was rewelded in place.

(3) The clamp which secures the tailpipe to the muffler was loose and was tightened.

(4) No hand tools or manuals were received with the vehicle.

(5) Three of the tire valve caps were missing and were replaced.

(6) The mounting bolts on the rear shock absorbers were at 80 to 90 lb-ft torque and were tightened to the specified 110 lb-ft.

(7) Three of the rear suspension hanger bolts were at 40-45 lb-ft torque, and nine 55 lb-ft. All were torqued to 40 lb-ft.

(8) Two of the rear suspension pivot bolts were at 50, one was at 55, and one was at 70 lb-ft torque. All were torqued to specified 60 lb-ft.

b. On vehicle W07:

(1) Front wheel caster was out of adjustment and was reset to $+1/2^{\circ}$.

(2) One wrench was missing from the tool kit and no manuals were received with the vehicle.

(3) Nine of the rear suspension hanger bolts were at 50 and three were at 38 lb-ft torque. All were reset to 40 lb-ft as specified.

(4) The two outer pivot bolts on the rear suspension were at 55 lb-ft torque and the two inner pivot nuts were found to be stripped. The two stripped pivot nuts were replaced and all rear suspension fasteners were reset to the 60 lb-ft torque value specified.

The major vehicle component serial numbers are contained in Table 2.2.I.

2.2.I - Major Component Serial Numbers

<u>Vehicle</u>	<u>Engine</u>	<u>Transmission</u>	<u>Differentials</u>	
			<u>Front</u>	<u>Rear</u>
V55	H228287	822373	B107012	B107008 B107006
W07	H228823	822402	B107005	B107009

2.2.5 Analysis

After the necessary corrections and adjustments had been made, the vehicles were considered to be in satisfactory condition for testing.

2.3 VEHICLE CHARACTERISTICS

2.3.1 Objective

To determine the weight distribution at curb, cross-country, and highway payload conditions.

2.3.2 Criteria

a. The payload including crew shall be 800 pounds for cross-country and 1200 pounds for highway operation.

b. The gross towed load shall be 1070 pounds for cross-country and 1320 pounds for highway operation.

2.3.3 Method

The weight distributions of the two vehicles and the two trailers to be used for towed load were measured by means of electronic loadometers located under each of the four vehicle wheels and under each trailer wheel and under the trailer lunette (using a suitable spacer to simulate the proper vehicle pintle height).

2.3.4 Results

Vehicle weights and weight distributions are shown in Table 2.3-I

Table 2.3-I. Weight Distribution of M151A1
Vehicles, Lb.

<u>Wheel Position</u>	<u>Vehicle No.</u>					
	<u>V55</u>			<u>W07</u>		
	<u>Curb</u>	<u>^aCross-Country</u>	<u>^aHighway</u>	<u>Curb</u>	<u>^aCross-Country</u>	<u>^aHighway</u>
Left front	711	790	809	702	786	805
Right front	662	750	757	608	750	753
Left rear	576	883	1073	569	865	1064
Right rear	<u>607</u>	<u>918</u>	<u>1117</u>	<u>591</u>	<u>901</u>	<u>1096</u>
Total	2556	3341	3756	2470	3302	3718
Payload	0	785	1200	0	832	1248

^aIncludes 175 lb simulated driver weight.

Trailer weights and weight distributions are shown in Table 2.3-II.

Table 2.3-II. Weight Distribution of M416 Trailers

<u>Position</u>	<u>Trailer Registration No.</u>					
	<u>6T5773</u>		<u>6T5774</u>		<u>6T5775</u>	
	<u>Cross-</u> <u>country</u>	<u>Highway</u>	<u>Cross-</u> <u>country</u>	<u>Highway</u>	<u>Cross-</u> <u>country</u>	<u>Highway</u>
Left wheel	487	587	482	598	480	597
Right wheel	502	597	497	589	479	562
Lunette	<u>a</u> <u>82</u>	<u>b</u> <u>137</u>	<u>a</u> <u>89</u>	<u>b</u> <u>127</u>	<u>a</u> <u>89</u>	<u>b</u> <u>132</u>
Total	1071	1321	1068	1314	1048	1291

^aPintle height = 20-1/16 in.

^bPintle height = 18-3/4 in.

2.3.5 Analysis

The variation in payloads and towed loads were in all cases within 4% of the prescribed values.

2.4 BRAKE TESTS

2.4.1 Objectives

a. To determine the stopping distance of the vehicle with rated highway payload, but without towed load.

b. To determine the ability of the service brakes to hold the vehicle with rated highway payload on longitudinal slopes.

2.4.2 Criteria:

a. The service brakes shall be capable of stopping the vehicle with rated highway payload and without towed load within 30 feet from a speed of 20 mph.

b. The service brakes shall be capable of holding the vehicle with rated highway payload and without towed load on a 60% longitudinal slope.

2.4.3 Method

Stopping distance from a road speed of 20 mph was determined on a level, dry, hard-surfaced road, using a pousometer and trailing fifth wheel to measure the distance the vehicle traveled from the point of brake application to a complete stop.

Slope-holding ability of the service brakes was determined by applying the service brakes in both the ascending and descending vehicle attitudes on the 60% slope.

2.4.4 Results

a. The average stopping distance of vehicle No. V55 from 20 mph was 20 feet.

b. The service brakes on vehicle No. V55 successfully held the vehicle in both the ascending and descending attitudes on the 60% longitudinal slope.

2.4.5 Analysis

The service brakes met the requirements stated in the criteria.

2.5 ENDURANCE TESTS

2.5.1 Objectives

a. To evaluate the endurance of the proposed rear suspension retrofit kit for the M151A1 series trucks during 20,000 miles of endurance testing. Figure I-1 shows the rear suspension retrofit kit installed on the vehicle.

b. To determine during testing, the endurance of several test components being considered for potential release.

2.5.2 Method

Each of the two vehicles were to be tested for 20,000 miles by completing the 5000 mile cycle (Table 2.5-I) four times. A towed load was used during the second and fourth cycles. The towed load was an M416 trailer with a gross weight of approximately 1320 pounds for highway and 1070 pounds for cross-country operation. The vehicles were tested with rated payload, including driver, of approximately 1200 pounds for highway and 800 pounds for cross-country operation. Four-wheel drive was used when towing a trailer on secondary road and for all operations on Belgian Block and cross-country courses.

Table 2.5-I. Endurance Mileage Cycle, Miles

<u>Course</u>	<u>Miles</u>
Paved	1500
Gravel	650
Belgian block	150
Perryman A	1200
Perryman No. 1	700
Churchville B	<u>800</u>
Total	5000

^aThe 500-mile break-in run was counted in the paved 1500-mile first cycle, the first 100 miles at 35 mph and the remaining 400-miles at speeds of not more than 50 mph. Break-in was accomplished without payload or trailer.

Tire pressures (cold) maintained during tests were as prescribed in TM9-2320-210-10 manual. Vehicle maintenance and servicing were performed in accordance with maintenance manuals.

2.5.3 Results

An aggregate of 32,014 test miles was attained with the two vehicles. Tests were terminated on vehicle No. W07 after 12,007 miles as requested by TACOM. Vehicle No. V55 completed 20,007 miles of endurance testing.

Table 2.5-II shows mileage break downs for each vehicle. Table 2.5-III shows overall fuel consumption for each vehicle. Table 2.5-IV shows overall fuel consumption averages by test course.

Table 2.5-II. Total Test Miles By Course

<u>Course</u>	Vehicle	
	<u>V55</u>	<u>W07</u>
Paved without trailer	3062	1531
Paved with trailer	2950	1518
Gravel without trailer	1279	1246
Gravel with trailer	1297	648
Belgian block without trailer	321	355
Belgian block with trailer	299	151
Perryman A without trailer	2314	1558
Perryman A with trailer	2400	1200
Perryman No. 1 without trailer	1486	700
Perryman No. 1 with trailer	1400	700
Churchville B without trailer	1600	1600
Churchville B with trailer	<u>1599</u>	<u>800</u>
Total	20007	12007

Table 2.5-III. Over-all Fuel Consumption

<u>Characteristic</u>	<u>V55</u>	<u>W07</u>
Total test miles	20007	12007
Total Operating hours	721.1	459.8
Total Fuel, gallons	1264.5	752.5
Total oil, quarts	0.75	2.5
Average fuel consumption:		
Miles per gallon	15.8	16.0
Gallons per hour	1.75	1.64
Average oil consumption:		
Miles per quart	26,676.0	4802.8

Table 2.5-IV. Speed and Fuel Consumption Averages by Test Course

<u>Course</u>	<u>Avg Speed (mph)</u>	<u>Miles per gal.</u>	<u>Avg Speed (mph)</u>	<u>Miles per gal.</u>
Paved	37.3	17.3	37.8	17.3
Gravel	29.4	16.5	29.4	13.3
Belgian block	22.3	15.7	25.0	17.5
Perryman A	26.6	17.0	23.8	15.9
Perryman 1	29.4	15.6	22.4	14.9
Churchville B	21.6	11.7	21.9	13.7

Discrepancies, not associated with the modification or retrofit components under test are as follows:

a. On vehicle V55:

(1) The carburetor control linkage, and idle and air controls required adjustment at 5003 test miles.

(2) The radiator fins were bent and clogged with debris at 6002 test miles and the fins were straightened and the core was cleaned.

(3) The tab securing the radiator cap safety chain to the radiator has separated from the radiator and was refastened.

(4) The starter switch would not release after 502 test miles and was replaced.

(5) The metallic, braided loom on numbers three and four spark plugs leads were frayed adjacent to the distributor cap connectors and were taped at 5045 test miles.

(6) The valve cover gasket on the engine cracked and was leaking lubricant after 11,999 test miles.

(7) The manifold to muffler exhaust pipe was damaged by a fractured front propeller shaft at 11,312 test miles.

(8) The fan belts were loose and slipping after 18,001 test miles.

(9) The test switch for the master cylinder warning light seized and would not actuate the light at 9486 test miles.

(10) The fuel level transmitter failed after 9486 test miles.

(11) The coil spring contactor at the spark plug end of the electrical lead to No. 1 cylinder broke at 11,312 test miles and those on Nos. 3 and 4 failed at 11,478 test miles.

(12) The annular bearing on the rear output shaft of the transfer assembly failed at 19,197 test miles (Figure I-5, 6, 7, and 8).

(13) Two front propeller shafts fractured, one at 5954 test miles and the second at 15,220 test miles (9266 part life miles) (Figure I-2).

(14) The outer U-joint on the left front drive axle had excessive free play after 11,999 test miles due to seal failure allowing loss of lubricant and contamination of the journals and needle bearings.

(15) The short side gear shaft in the rear differential failed at 1378 test miles (Figure I-3).

(16) The inner U-joint on the left rear drive axle failed after 2615 test miles due to fracture of the two journal caps (Figure I-4).

(17) The outer U-joint on the right rear drive axle failed after 11,312 test miles.

(18) The right rear inner, right rear outer, and left rear inner wheel bearings were rusted and seized at 11,999 test miles.

(19) The inner U-joint on the left rear drive axle failed at 14,317 test miles (11,702 part miles) due to fracture of the yoke journal cap and loss of needles.

(20) The lining on the secondary brake shoe of the left front wheel fractured at the second set of rivets from the anchor end and felloff and the lining was cracked at the third set of rivets after 11,999 test miles.

(21) All tires were worn to service limits and required replacement after 11,999 test miles.

(22) The right rear shock absorber failed at 6188 test miles (5672 part miles), the left rear, at 8247 test miles, the right rear, at 11,737 test miles (5549 part miles), and the left rear, at 17,209 test miles (6144 part miles). In each case there was loss of damping and the shock was running cold.

b. On Vehicle W07:

(1) There was excessive free play in the clutch after 6003 test miles. Clutch free play initially was 1-1/4 inches.

(2) The carburetor control linkage, idle screw, and air metering screw required adjustment after 6003 test miles.

(3) The fan belts required tightening after 5900 test miles.

(4) The radiator fins were bent and clogged after 6003 test miles.

(5) The oil pressure gage failed after 2116 test miles.

(6) The distributor point gap was too close and required re-setting after 6003 test miles.

(7) The braided shielding on the leads to number one and two spark plugs was frayed and required replacement after 10,510 test miles.

(8) Oil was being pumped up the speedometer cable after 162 test miles and a fiber washer was installed.

(9) The transmission failed after 6801 test miles due to fracture of teeth on the third speed set of gears.

(10) Lubricant was leaking past the transfer thrust washer rivets after 6523 test miles. Silastic RTV compound was used to correct the problem.

(11) The front propeller shaft was severely distorted after 6264 test miles and was replaced (Figure I-9).

(12) The inner wheel bearing and seal on the right front wheel required replacement after 12,008 test miles. The bearing was rusty and the seal was scored.

(13) The pivot shaft on the left front lower suspension arm was bent and the suspension crossmember was damaged after 6523 test miles installed (Figures I-11 and I-12).

(14) The outer universal joint on the right rear axle had excessive lost motion due to brinelling of the needle bearings and journals after 9833 test miles.

(15) There was excessive free play in the right rear wheel bearing after 9833 test miles.

(16) The shock absorber brackets on the right rear suspension arm were grooved on the inner surfaces around the shock absorber mounting bolt holes due to milling action of the shock absorber bushing after 10,065 test miles (Figures I-13 and I-14). The surfaces were rebuilt with weld and filed to size.

(17) The inner wheel bearing on the right rear wheel was rusted and chipped after 10,066 test miles. The seals and the axle flange were also scored and required replacement.

(18) The inner universal joint on the left rear axle required replacement after 10,808 test miles due to failure of the yoke cap and loss of needles. The outer universal joint flange cap was also cracked necessitating replacement of the axle assembly.

(19) Both wheel bearings in the left rear wheel were rusted and seized after 12,008 test miles, both seals were damaged and the axle flange was scored.

(20) The service brakes required adjustment after 5768 test miles.

(21) The secondary brake shoe on the left front wheel failed after 6264 test miles and the backing plate anchor pin and wheel cylinder were damaged (Figures I-15 and I-16).

(22) The left front brake drum was scored and required replacement after 6523 test miles.

(23) The PT-651 linings on the secondary brake shoes on both rear wheels exhibited extensive wear after 1932 test miles.

(24) The right rear tire was worn to limit at 10,065 part miles, the left rear at 9,878 part miles, and the two front tires at 10,803 part miles.

(25) Both rear shock absorbers were leaking and running cold after 10,065 test miles.

As a part of the 6000 mile and 12,000 maintenance and inspections, the rear suspension fastener torques were checked as requested by TACOM at 50% of the lower value of the specified torques:

<u>Item</u>	<u>Torque Range, 16-Ft</u>	<u>Lower, lb-ft</u>
Hanger bolts	40 to 50	20
Pivot bolts	60 to 70	30
Shock absorber mounting nuts	110 to 150	55

No evidence of cracks, weld failures, or other damage was detected. All fasteners on both vehicles were at or above the 50% torque values with the exception of the inner bolt on the inner hanger bracket of the left outer pair which was found to be at 10 lb-ft on vehicle W07 after 12,007 test miles.

The rear suspension fastener torques were checked on vehicle No. V55 after 20,007 test miles to determine whether the minimum torque values, to which the fasteners had been adjusted initially, had changed. Results are as follows:

<u>Location</u>	<u>Initial Torque, lb.-ft</u>	<u>Veh. No.</u>	
		<u>^aW07</u>	<u>V55</u>
		<u>Final Torque, lb.-ft.</u>	<u>Final Torque, lb.-ft.</u>
Left outer pivot bolt	60	57	60
Left inner pivot bolt	60	57	60
Right inner pivot bolt	60	46	60
Right outer pivot bolt	60	60	60
Left outer hanger inner bracket	40-40-40	32-40-10	40-40-40
Left inner hanger inner bracket	40-40-40	26-40-32	40-40-40
Right inner hanger inner bracket	40-40-40	40-37-40	40-40-40
Right outer hanger inner bracket	40-40-40	40-28-20	40-40-40
Left rear shock bolt upper	110	110	110
Left rear shock bolt lower	110	110	110
Right rear shock bolt upper	110	110	50
Right rear shock bolt lower	110	110	110

^aFinal measurements at 12,007 test miles.

No problems were encountered with the rear suspension retrofit kit on vehicle No. W07 during 12,007 miles of endurance testing or on vehicle No. V55 during 20,007 miles of endurance testing except for loosening of one hanger bracket bolt on vehicle W07 and one shock absorber bolt on vehicle V55.

The rear suspension assembly on vehicle No. V55 was carefully inspected at the end of 20,007 test miles for evidence of cracks, weld failures, or distortion. Dye penetrant check of the critical areas on the vehicle rails, outer box numbers, crossmember, and hanger brackets revealed no evidence of any distress (Figures I-19 and I-20). There also was no evidence of any damage to the rear suspension assembly on vehicle No. W07 after 12,007 test miles.

No problems were experienced with the one inch front wheel cylinders. The only problem experienced with the M151A2 brake shoe configuration (14 rivets) was fracturing of one lining at the rivets on a front wheel secondary shoe (Figure I-21).

Although no chains were received for determination of adequate rear wheel clearance, measurements of clearance between the fender wells and tires on Vehicle No. V55 indicate that the flattening of the projection would provide clearance equivalent to that on an M151A2 vehicle which has approximately 1-7/16 inches. The left rear of V55 had 1-7/16 inches clearance and the right rear had 7/8 inch clearance indicating that the right side needed additional flattening of the hump.

No problems were experienced with the additional items being considered for potential release consisting of dual brake master cylinder, stick-on plastic reflectors or plastic wiring harness clamps.

The sintered iron wheel cylinder pistons on the left wheels of vehicle No. W07 were in good condition after 12,007 test miles as were the standard pistons on the right wheels.

The sintered iron wheel cylinder pistons on the left rear wheel on vehicle No. V55 were severely corroded and seized after 20,007 test miles and the front piston was broken into two cylindrical sections (Figure I-18). The aluminum pistons on the right rear wheel were also severely corroded and seized (Figure I-18). The one inch pistons on the front wheels (iron on the left and aluminum on the right) were in good condition (Figure I-17).

The banded wheel cylinder boots on vehicle No. W07 were in excellent condition after 12,007 test miles.

No problems were experienced during 30,014 endurance test miles with the product improvement items consisting of transfer output shaft snap ring retainer (inspected after 19,197 test miles on vehicle No. V55 during replacement of failed transfer bearing), clutch lining, turn signal controller, igniter and coil, front suspension arm bushings, and rear suspension arm solid bushings. All of these items except the snap ring retainer were inspected after 20,007 endurance test miles on vehicle No. V55.

There were six U-joint failures. Two were caused by seal failures and subsequent contamination, and rusting of bearings, three were caused by fractured bearing caps and loss of needle bearings, and one was caused by brinelling of needle bearings and grooving of the journals.

Insufficient endurance test miles (1941 miles) were attained with the experimental transmission in vehicle No. W07 to permit evaluation.

The PT-651 brake linings on vehicle No. W07 were subjected to only 1941 test miles which was insufficient to permit a thorough evaluation. However, it was noted that the linings on the secondary shoes on both rear wheels were worn appreciably.

Measurements made of the thickness of the lining material above the rivets heads were as follows:

<u>Location</u>	<u>Lining to rivet head, ins.</u>					
	<u>Primary</u>			<u>Secondary</u>		
	<u>Anchor</u>	<u>Center</u>	<u>Heel</u>	<u>Anchor</u>	<u>Center</u>	<u>Heel</u>
Left front	0.133	0.131	0.139	0.122	0.134	0.134
Right front	.133	.134	.135	.135	.133	.127
Left rear	.086	.096	.128	.056	.016	.063
Right rear	.092	.118	.126	.086	.061	.102
Std. new shoe assy.	.144	.162	.131	.146	.160	.128

The WB-12-20 experimental brake lining material installed on vehicle No. V55 was subjected to only 5593 endurance test miles. Final measurements were made of the thickness of the lining material at the anchor end, at the center of the shoe, and at the heel of the shoe. Unfortunately measurements were not made at the start of the test. Measurements were made of the lining material on a set of new shoes from standard stock for comparison purposes. Measurements were as follows:

<u>Location</u>	<u>Lining Thickness, inches</u>					
	<u>Primary</u>			<u>Secondary</u>		
	<u>Anchor</u>	<u>Center</u>	<u>Heel</u>	<u>Anchor</u>	<u>Center</u>	<u>Heel</u>
Left front	0.216	0.220	0.212	0.214	0.220	0.223
Right front	.221	.214	.217	.193	.195	.195
Left rear	.223	.221	.213	.235	.294	.230
Right rear	.245	.245	.233	.230	.230	.239
New shoe	.251	.261	.234	.257	.269	.234

2.5.4 Analysis

Failure of the three front propeller shafts is attributed to increased torque forces imposed by drive line wrap up during operation on secondary roads and Belgian block in four-wheel drive and to shock forces imposed by service brake lock-up reported by drivers of both vehicles on several occasions.

Drive axle U-joint failures were caused by seal deterioration and by fracturing of needle bearing caps which may have been brought on by excessive friction due to loss of lubricant.

The several wheel bearing failures and rapid wear of brake linings are attributed to contamination of brake drums and wheel cavities indicating the need for better brake sealing.

The improved condition of the rear wheel cylinder pistons on vehicle No. W07 to those on vehicle No. V55 is attributed in part to the success of the banded wheel cylinder boots in preventing cylinder contamination.

Although the standard wheel cylinder boots were not severely cracked or split, it is felt that contamination of the rear wheel cylinders on vehicle No. V55 occurred in view of the condition of the pistons on this vehicle.

There were no adverse driver's comments on the stability of the two vehicles equipped with the rear suspension retrofit which provides the M151A1 vehicles with the trailing-arm configuration.



Figure I-1: Rear Suspension Retrofit Mounted on M151A1, 1/4 Ton Truck.



Figure I-2: Front Prop Shaft of Vehicle 02CV5569, 5954 Miles.



Figure I-3: Rear Differential Short Side Gear of Vehicle 02CV5569, 1378 Miles. Fracture Approximately 3-7/16" Inboard from Left Axle Drive Flange Surface.

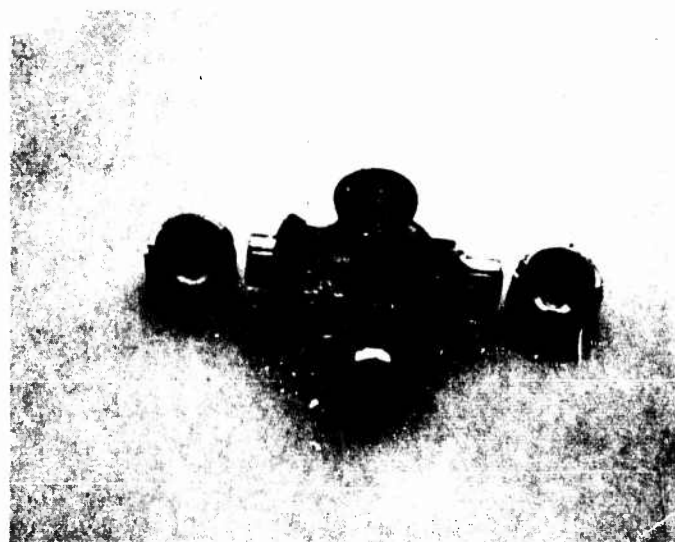


Figure I-4: Left Rear Inner U-Joint of Vehicle 02CV5569, 2615 Miles. Journal Caps in Yoke Chipped Allowing Needles to Escape.



Figure I-5: Transfer Case Rear Output Shaft Bearing Failure on Veh. No. V55 at 19,197 Test Miles.



Figure I-6: Roller Bearings Lodged in Transfer Shifter Linkage.



Figure I-7: Damage to Gear Teeth in Transfer Case Due to Rearing Failure.

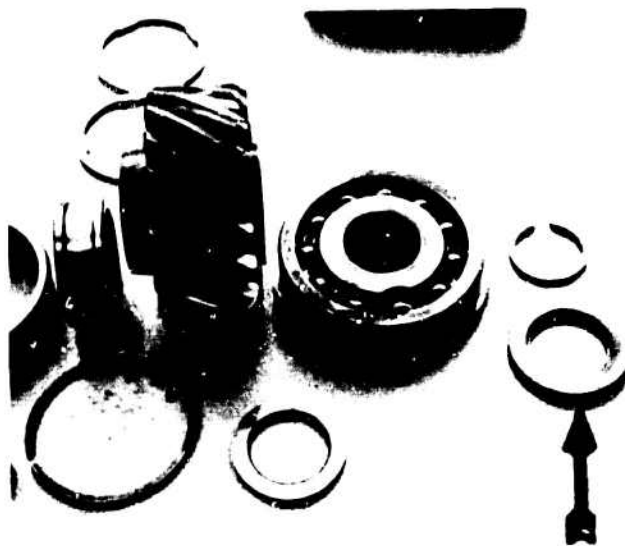


Figure I-8: Transfer Output Shaft Snap Ring Retainer after 19,197 Part Life Miles (Veh. No. V55).

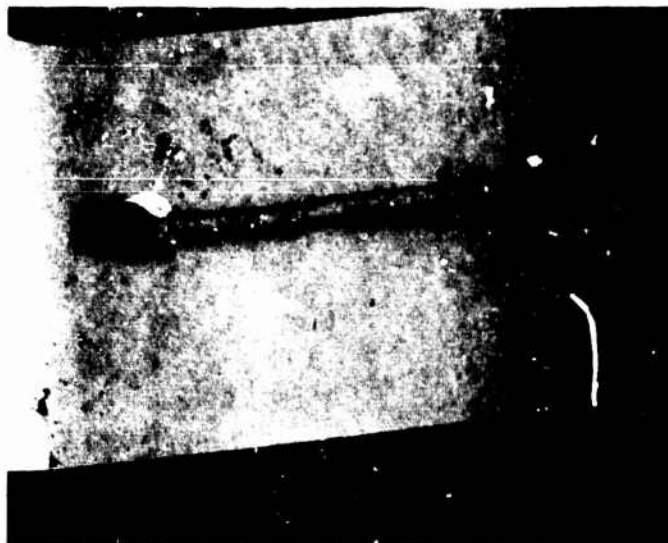


Figure I-9: Failed Front Propellor Shaft on Veh. No. W07 after 6264 Test Miles (Possible Cause - Brake Grabbing).



Figure I-10: Typical Axle Drive Shaft U-Joint Journal Wear Caused by Seal Failure and Lack of Lubricant.



Figure I-11: Bent Pivot Rod on Left Front Suspension Arm of Veh. No. W07 after 6523 Test Miles.



Figure I-12: New Front Suspension Arm Shown for Comparison to Damaged Ass'y in Figure I-10, Above.



Figure I-13: Right Rear Shock Absorber on Veh. No. W07 after 10,065 Test Miles (Note Excessive Bushing Wear and Loss of Serrated Faces of Bushing).



Figure I-14: Damage to Right Rear Suspension Arm Shock Absorber Brackets on Veh. No. W07 after 10,065 Test Miles Caused by Shock Absorber Bushing Failure.

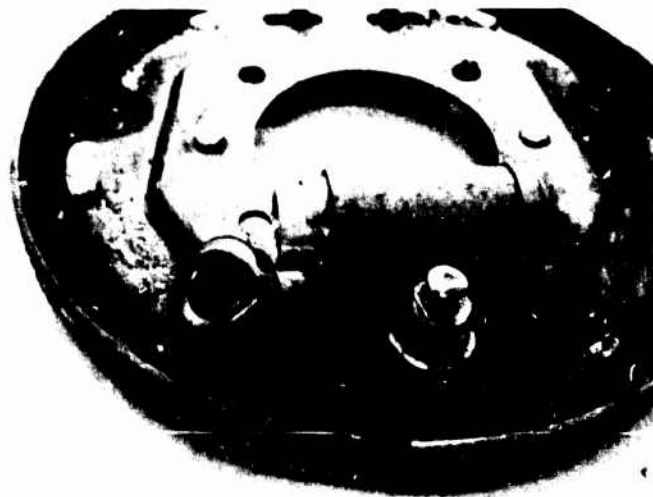


Figure I-15: Broken Wheel Cylinder and Damaged Anchor Pin on Veh. No. W07 after 6234 Test Miles (Caused by Shoe Failure Shown in Figure I-13 Below).



Figure I-16: Shoe Failure on Left Front Wheel of Veh. No. W07 after 6234 Test Miles (Arrow Indicates Failure of Weld Securing Shoe Web to Platform).



Figure I-17: Front Brake Cylinder Pistons on Veh. No. V55 after 20,000 Test Miles (Left Wheel Iron Pistons on Left, Right Wheel Aluminum Pistons on Right).



Figure I-18: Rear Wheel Cylinder Pistons on Veh. No. V55 after 20,000 Test Miles (Left Wheel Iron Pistons on Left, Right Wheel Aluminum Pistons on Right).



Figure I-19: Vehicle Rail, Outer Box Frame, and Crossmember on Right Rear Suspension of Veh. No. V55 after 20,000 Test Miles (Dye Check Disclosed no evidence of cracks or Weld Failures).



Figure I-20: Vehicle Rail, Outer Box Frame, and Crossmember on Left Rear Suspension of Veh. No. V55 after 20,000 Test Miles (Dye Check Disclosed no Evidence of Cracks or Weld Failures).

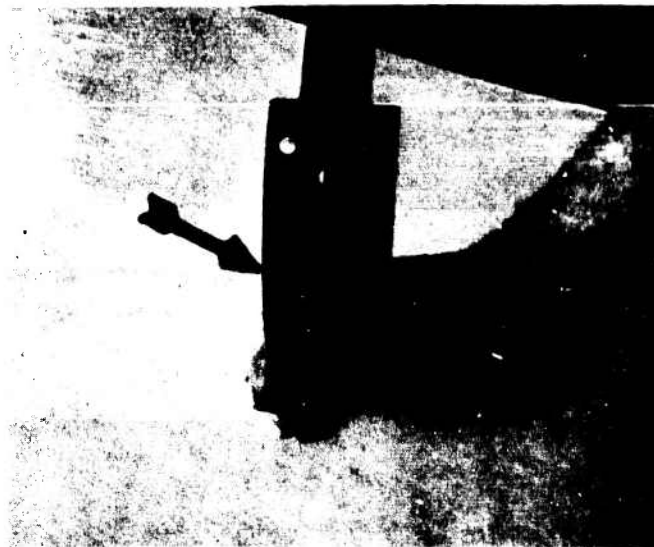


Figure I-21: Fracture of Lining on Secondary Brake Shoe on Left Front Wheel of Veh. No. V55 after 11,999 Test Miles. (Note Cracked Lining at Third Set of Rivets).

Distribution
Nat Shot



DEPARTMENT OF THE ARMY Mr McNeil/mj/5264
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-BB

19 JAN 1972

SUBJECT: Customer Test Directive: Truck, Utility: 1/4 Ton, 4x4,
M151A1 Rear Suspension Retrofit/Product Improvement Test,
TECOM Project Nos. 1-VG-120-151-055/-056

Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-MT-D,
Aberdeen Proving Ground, Maryland 21005
President, U. S. Army Armor and Engineer Board, ATTN: STEBB-TD-MG,
Fort Knox, Kentucky 40121

1. Reference: Letter, AMSTA-REB, TACOM, 29 Dec 71, subject: M151A1 Rear Suspension Retrofit/Product Improvement Program, copy attached.
2. Subject testing is assigned for accomplishment in accordance with above reference. TECOM priority code 20 applies. Direct coordination with the sponsor is authorized concerning test details.
3. STE forms 1188 and 1189, reflecting test entry and schedule into the active TRMS master file, are inclosed.
4. This directive will be immediately reviewed and processed in accordance with the provisions of paragraph 2-2b of TECOM Regulation 70-8.
5. Special Instructions: Since the primary purpose of this test is to evaluate the durability of the proposed rear suspension retrofit kit (para 3, referenced letter) no maintenance evaluation data are required. However, significant and unusual maintenance requirements will be recorded. The interim and final reports will be letter reports concerned with the modifications or their affect on other components. To accommodate the separate reporting requirements cited at paragraph 4, referenced letter, the two different groups will be identified and discussed as follows:
 - Component Group A - Retrofit Kit
 - Component Group B - Miscellaneous

19 JAN 1972

AMSTE-BB

SUBJECT: Customer Test Directive: Truck, Utility: 1/4 Ton, 4x4,
M151A1 Rear Suspension Retrofit/Product Improvement Test,
TECOM Project Nos. 1-VG-120-151-055/-056


Both groups may be included in the same interim and final reports.
Headquarters, Test and Evaluation Command, ATTN: AMSTE-BB will be
included in the distribution of all reports.

FOR THE COMMANDER:

2 Incl

1. Ltr, 29 Dec 71
2. TRMS Forms

Copy furnished: w/o incl
CG, TACOM, ATTN: AMSTA-REB


ABRAM V. RINEARSON III
Colonel, GS
Dir, Arm Mat Test Dir

AMSTA-RES

29 December 1971

SUBJECT: M151A1 Rear Suspension Retrofit/Product Improvement Program

Commanding General
U.S. Army Test & Evaluation Command
ATTN: AMSTE-TO
Aberdeen, Maryland 21005

1. Reference USATACOM PRON EN-1-82444-01-EN-K2, dated 6/18/71 for \$130,000.00.
2. It is requested that a CUSTOMER Durability Test be established and a TCOM project number be assigned for four M151A1 trucks modified with the M151A2 rear suspension system and associated hardware (two vehicles for Fort Knox and two vehicles for APG). These four pilot vehicles will contain the following hardware changes which are being proposed as a retrofit kit:
 - a. M151A2 rear suspension arms with associated brackets and attaching hardware.
 - b. One inch front wheel brake cylinders.
 - c. M151A2 brake shoe assembly configuration (14 rivets for fastening shoe lining material).
 - d. Rear wheel tire chain clearance.
3. The primary purpose of this test is to evaluate the durability of the proposed rear suspension retrofit kit for the M151A1 series truck.
4. Additional test components contained on these vehicles are as follows:
 - a. Dual brake master cylinder.
 - b. Stick-on plastic reflectors.
 - c. Plastic wiring harness clamps.
 - d. Sintered iron pistons in wheel cylinders.

AMSTA-REB

29 December 1971

SUBJECT: M151A1 Rear Suspension Retrofit/Product Improvement Program

e. Banded wheel cylinder boots

These components are not part of the proposed retrofit program and should not be considered as a part of the durability test for the retrofit kit. They are components that may be released for future production of the M151A2 series truck and preliminary durability testing is essential for potential release. The durability characteristics on the above components should be reported separately from the retrofit kit.

5. Each of the four pilot vehicles will be subjected to 20,000 miles of durability testing in accordance with the attached test outline. The pilot vehicles are scheduled to be shipped to APG and Fort Knox the week of 3 Jan 1972.

6. Spare parts for all of the test items and standard components not readily available in the supply system will be made available for the test. However, standard components that are readily available will be expected to be furnished by the different testing agencies.

7. In order that the milestones are met as proposed by this command and accepted by AMC it is essential that the testing be completed and a final report published by 1 June 1972.

8. If additional information pertinent to this program is received, contact Mr. Edward Woessner of this command on SCAN 2731357 or 2732323.

FOR THE COMMANDER:

- 2 Incl
1. Test Outline
2. Dist. List

JOHN GILIBERTO
Chief, Transport Vehicle Branch
Systems Development Division
Rsch, Dev & Engr Dir
Mobility Systems Laboratory

CF:

WANTECOM, AMSTE-BB

STRAF-MT-TU

Test Outline

1. The following test procedures are applicable to both APG and Fort Knox test agencies:

- a. Vehicle Inspection - TOP/MTP 02-2-502
- b. Preliminary Operation - TOP/MTP 02-2-505
- c. Load Distribution - TOP/MTP 02-2-801
- d. The payload with driver and towed load for the vehicles are as follows:

Rated Payload

Truck

Highway	1200 lbs.
Cross-country	800 lbs.

Towed Load (GTW)

Highway	1320 lbs.
Cross-Country	1070 lbs.

2. The following test cycle should be repeated four times for a total of 20,000 miles on each pilot vehicle:

Test Cycle

- a. 1500 miles on paved roads either concrete or asphalt or any combination of the two.
- b. 1850 miles on secondary roads (4 wheel drive shall be used when towing a trailer)
- c. 1500 miles on cross-country terrain. (vehicle shall be in 4 wheel drive)
- d. 150 miles on Belgian block or equivalent (vehicle shall be in 4 wheel drive)

NOTE: Fifty percent of the vehicle operations over each course shall be performed with a towed load. Each vehicle shall be subjected to a 500 mile break-in run. This mileage shall be counted as part of the paved road mileage requirement. The first 100 miles shall be accumulated at speeds of not more than 35 mph. The remaining 400 miles shall be accumulated at speeds of not more than 50 mph. The break-in run shall be accomplished with driver, and without pay load and trailer.

Inclosure 1

3. A sufficient number of brake stops will be made to demonstrate that the service brakes shall stop a fully equipped vehicle, including highway payload, but excluding towed load, within 30 feet from a speed of 20 mph, on dry, hard, relatively level, smooth road, free from loose material. Service brakes shall be able to stop and hold the vehicle on a 60 percent incline.

4. Reporting of test results:

a. Problems of difficulty will be reported as they occur by telephone to Mr. Edward Woessner or Mr. John Karkosak (SCAN 2731857 or 2732323) and Equipment Performance Reports.

b. Interim Reports will be forwarded to USATACOM, ATTN: AMSTA-MPT on the progress of the testing after completion of 6,000 and 12,000 miles of test. (Distribution list is attached).

c. A formal report will be published at the conclusion of the test (distribution list is attached).

5. The shipping address for the hardware is: Ford Motor Company, Special Purpose Vehicle Operation, ATTN: Frank Plush, 2001 Beech Daly Road, Dearborn Heights, Michigan 48121. It is requested that component failures affecting the design of the vehicle be returned as they occur. In addition, all failed components, spare parts and test trucks should be returned to the above address after completion of the retrofit/product improvement program.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Materiel Testing Directorate Aberdeen Proving Ground, Maryland 21005		2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
		2b. GROUP	
3. REPORT TITLE Product Improvement Test of Truck, Utility, 1/4 Ton, 4X4, M151A1			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Final Letter Report 27 January to 9 May 1972			
5. AUTHOR(S) (First name, middle initial, last name) Charles W. Wilson			
6. REPORT DATE May 1972		7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
8a. CONTRACT OR GRANT NO. Not applicable		8b. ORIGINATOR'S REPORT NUMBER(S) APG-MT-4087	
a. PROJECT NO. TECOM Project No. 1-VG-120-151-055		8b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
c.			
d.			
10. DISTRIBUTION STATEMENT Distributed limited to US Government Agencies only; Test and Evaluation; May 1972. Other requests for this document must be referred to CG, USATAC, ATTN: AMSTA-REB			
11. SUPPLEMENTARY NOTES None		12. SPONSORING MILITARY ACTIVITY TACOM	
13. ABSTRACT Product Improvement Tests were conducted on the M151A1, 1/4 ton, 4x4, utility truck from 27 January to 9 May 1972. Two vehicles were subjected to 32,014 aggregate miles of endurance testing to evaluate the effectiveness of a proposed retrofit kit consisting of M151A2 rear suspension arms with associated brackets and hardware, one-inch diameter front wheel brake cylinders, M151A2 brake shoe assembly configuration, and increased rear wheel chain clearance. The endurance of items being considered for potential release was also evaluated. These included dual brake master cylinder, stick-on plastic reflectors, plastic wiring harness clamps, sintered iron wheel cylinder pistons, and banded wheel cylinder boots. Tests were conducted in accordance with appropriate Test Operation Procedures/Materiel Test Procedures. No problems were experienced with the rear suspension retrofit kit, one inch diameter front wheel brake cylinders, M151A2 brake shoe assemblies, or the increased rear wheel tire chain clearance. No problems were experienced with any of the items being considered for potential release except for the sintered iron pistons in the rear wheel cylinders on one vehicle which were severely corroded and seized, one of the pistons was broken into two cylindrical sections. An experimental transmission and two sets of experimental brake linings were installed too late for sufficient endurance testing to permit evaluation.			

DD FORM 1473

REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED

Security Classification

UNCLASSIFIED

Security Classification

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Truck, Utility, M151A1 Truck, 1/4 Ton Product Improvement Test, Truck, M151A1 Rear Suspension Retrofit						

UNCLASSIFIED

Security Classification