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Report No. APG-MT-3186

FINAL REPORT ON INITIAL PRODUCTION TEST OF MARGINAL TERRAIN ASSAULT BRIDGE WITH APC LAUNCHER

BY

H. WADE BYERS, JR.
EDWARD C. KOTRAS

MAY 1969

JUN 27 1969

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ABERDEEN PROVING GROUND

ABERDEEN PROVING GROUND, MARYLAND

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DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-GE 5 JUN 1969

SUBJECT: Final Reports on Initial Production Test of Marginal Terrain Assault Bridge with M113A1 Launcher, Contract No. DAAK02-68-C-0226, USATECOM Project No. 7-8-1018-05/06

Commanding General
U. S. Army Mobility Equipment Command
ATTN: AMSME-QRT
4300 Goodfellow Boulevard
St. Louis, Missouri 63120

1. References:

a. Final Report on Initial Production Test of Marginal Terrain Assault Bridge with M113A1 Launcher (DAAK02-68-C-0226), USATECOM Project No. 7-8-1018-06, U. S. Army Armor and Engineer Board, 6 May 1969. (Incl 1)

b. Final Report on Initial Production Test of Marginal Terrain Assault Bridge with APC Launcher, USATECOM Project No. 7-8-1018-05, Aberdeen Proving Ground, May 1969. (Incl 2)

c. Letter, AMSME-QRT, USAMECOM, 7 January 1969, subject: "Marginal Terrain Assault Bridge, M113 Launcher; Contract No. DAAK02-68-C-0226, ENSURE 84, USATECOM Project No. 7-8-1018-05/06."

d. Letter, AMSTE-GE, USATECOM, 7 February 1969, subject: "Initial Production Test of Marginal Terrain Assault Bridge with M113 Launcher, Contract No. DAAK02-68-C-0226, ENSURE 84, USATECOM Project No. 7-8-1018-05/06."

e. Message DA 899062, ACSFOR, Department of the Army, 27 February 1969, subject: "Marginal Terrain Assault Bridge-Launched M113A1 Armored Personnel Carrier (ENSURE Nr. 84)."

2. Approval Statement: The subject final reports, references 1a and 1b, are approved except as noted herein.

3. Background of Test: The test item consists of two basic components - the bridge, a class 12 capacity aluminum bridge with a 33-foot length of

span; and the launcher, a modified M113A1 Armored Personnel Carrier (APC). The following tests were conducted under intermediate climatic conditions to contribute to the overall evaluation of suitability for release of the assault bridge:

a. Initial production test was conducted by Aberdeen Proving Ground from 20 August 1968 to 11 February 1969 to determine compliance with the initial production requirements of the purchase descriptions, and to determine the capabilities of the bridge to meet the essential requirements of the proposed Small Development Requirement.

b. Initial production test was conducted by U. S. Army Armor and Engineer Board from August 1968 to February 1969 to determine the degree to which the performance, reliability and maintainability of the assault bridge met user requirements.

4. Test Results:

a. The results of testing indicate that the item met 32 of the 45 essential performance requirements. It failed to meet 11 of the requirements and two requirements were not tested because of test termination. This test was initiated in August 1968 and numerous product failures were reported. On 30-31 December 1968, modifications intended to correct most of the problems were made to one test item at each test agency. Operation following these modifications indicated that the item was still unsatisfactory. The test item fails to meet essential requirements in the following respects:

(1) The weight of launcher and bridge in travel position exceeds the weight of the combat-loaded current APC by 1900 pounds.

(2) The evacuation of the crew from the test item is more difficult than from a standard APC. The driver's hatch cannot fully open and the cargo hatch cannot be opened with the bridge in travel position.

(3) Because of its narrow tread width, a ¼-ton truck has extreme difficulty crossing the bridge, and when the bridge is wet or covered with mud, it is treacherous to cross due to lack of curbs. The non-skid surface will not prevent a vehicle from sliding off the bridge.

(4) Placing the bridge without exposing the crew is difficult and crossing the bridge without a guide is considered hazardous. Exposure of a crew member is required to remount the bridge on the vehicle.

(5) The launcher will not retrieve a mud-laden bridge. The mud must be removed before recovery and requires an excessive amount of time.

(6) The equipment, as tested, does not possess sufficient ruggedness in design to withstand military service without requiring major overhaul or replacement for 750 kilometers or 500 launching cycles.

(7) The mean time between failures before modification was 54.24 kilometers and 44.63 launchings and after modification was 221.1 kilometers and 175 launchings. The requirement is for 240 kilometers or 240 launchings.

(8) The inherent availability was .953 before modification and .90 after modification, against a requirement of .925.

(9) The achieved availability was .894 before modification and .884 after modification, against a requirement of .90.

(10) Organizational maintenance of the launcher per 10 launchings before modification was .61 manhours and after modification was 0.08 manhours, against a requirement of .25. The manhour requirements for the bridge per 100 crossings was .30 manhours before modification and .72 manhours after modification, against a requirement of .33. In addition, the organization cannot weld the bridge with present instructions and requires a pressure gage, FSN 6685-581-5186, for diagnosis of the hydraulic system, which is not included in the maintenance package.

(11) The mean down time per 750 kilometers was 51.5 hours and the mean down time per 500 launchings was 34.2 hours during test, against a requirement of 2.0 hours in each case.

b. In general, the modifications made on 30-31 December were corrections to the component deficiencies reported in Appendix III of both reports. Since the testing was terminated after only limited testing of these modifications, the failures still appear as deficiencies in the reports. This headquarters believes that the modifications appear to be adequate and that the bridge will provide relatively maintenance-free operation for the first 150 to 200 launching cycles. Therefore, this headquarters agrees with the findings of the subject reports except for the classification of deficiencies listed in Appendix III of each report.

(1) Reference 1a, Appendix III, lists 16 deficiencies and 15 shortcomings. Fifteen of the deficiencies are reclassified as follows:

(a) The failure of the link beam flanges, paragraph 1.1; cylinder beam, paragraph 1.2; vertical braces, paragraph 1.3; tensile link, paragraph 1.6; link beam mounts, paragraph 1.11; rotating beam retaining bolts, paragraph 1.13; and sliding link, paragraph 1.15 are the result of the binding of the bridge hinge pins. These components were modified, which improved the bridge but did not correct the deficiency in the design of the bridge hinge. The binding of the hinge pins caused primarily by the vehicle crossing the bridge is considered to be the major component deficiency in the bridge.

(b) The failure of the hydraulic handles cotter pin, paragraph 1.5 and the hydraulic handles, paragraph 1.9 are related to the inadequate design in the handles. The handle design is considered to be deficient because it will not withstand the force applied by the operator during bridge launching.

(c) The lower surfboard mount failed because of insufficient strength. New mounts made from low alloy, high strength steel were installed. This, therefore, as indicated in the APG report, is a corrected deficiency.

(d) The hose retractors failed, paragraph 1.8, because they were bent and damaged, due to misalignment during retrieving operations. The redesigned quick disconnects and improved mounting are considered satisfactory. This, therefore, as indicated in the APG report, is a corrected deficiency.

(e) The failure of the hydraulic pump, paragraph 1.10 and the hydraulic system, paragraph 1.14, were caused by quality control and engineering problems, which caused premature pump wear. Modified pumps were installed and, although limited testing was conducted, the pumps are apparently satisfactory. Therefore, this deficiency is reclassified as a corrected deficiency.

(f) The failure of the launching cylinder was the result of leakage by threads and may have been due to a loose end connection. This failure only occurred on one cylinder out of seven tested. This, therefore, is considered to be a random failure.

(2) Reference 1b, Appendix III, lists three deficiencies and 19 shortcomings. The deficiencies are reclassified as follows:

(a) Control handle failure (paragraph 2) is the same as paragraph 4b (1)(b) above and is considered to be a deficiency in the design of the handle.

AMSTE-GE

5 JUN 1969

SUBJECT: Final Reports on Initial Production Test of Marginal Terrain Assault Bridge with M113A1 Launcher, Contract No. DAAK02-68-C-0226, USATECOM Project No. 7-8-1018-05/06

(b) Cracks appeared in the ramps (paragraph 2) is the same as paragraph 4b(1)(a) above and is considered to be a deficiency in the design of the bridge hinge.

(c) Front universal joint failure. This failure only occurred on the unit at APG. USAARENBD did not experience a similar difficulty, and since this is a standard part in the M113A1, this is considered to be a random failure.

(3) In summary, there remained three deficiencies at the time of test termination. These were the binding of the bridge hinge, the design failure of the hydraulic control handles, and the unsafe operating conditions during vehicle swimming.

5. Comments: Per request, reference 1c, and based on the fact that the item failed to meet the requirements indicated above, USATECOM, on 7 February, provided USAMECOM with a statement that the subject bridge was considered unsuitable for issue and took action to terminate the test (reference 1d). USATECOM also recommended that, in view of the urgent requirements, the customer be advised of the performance of the subject bridge and release of the item be contingent on customer reaction. In message, reference 1e, Department of the Army pointed out the problems encountered in testing the bridge and actions taken to preclude unsatisfactory performance. Message requested that user concur in DA proposal to deploy items for field evaluation. The user concurred in deployment of the items and items were released.

6. Conclusions: The conclusion made at the time of test termination, reference 1d, is reiterated at this time. Based on the fact that the item failed to meet requirements established, this headquarters considers the subject bridge unsuitable for release.

FOR THE COMMANDER:

2 Incls
as

WILLIAM H. HUBBARD
Colonel, GS
Deputy Chief of Staff

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AMCMS CODE NO. 4750.824.719.M.K2

USATECOM PROJECT NO. 7-8-1018-05

CONTRACT NO. DAAK 02-68-C-0226

INITIAL PRODUCTION TEST OF MARGINAL-TERRAIN ASSAULT BRIDGE WITH APC LAUNCHER

FINAL REPORT

BY

H. WADE BYERS, JR.
EDWARD C. KOTRAS

MAY 1969

ABERDEEN PROVING GROUND
ABERDEEN PROVING GROUND, MARYLAND
21005

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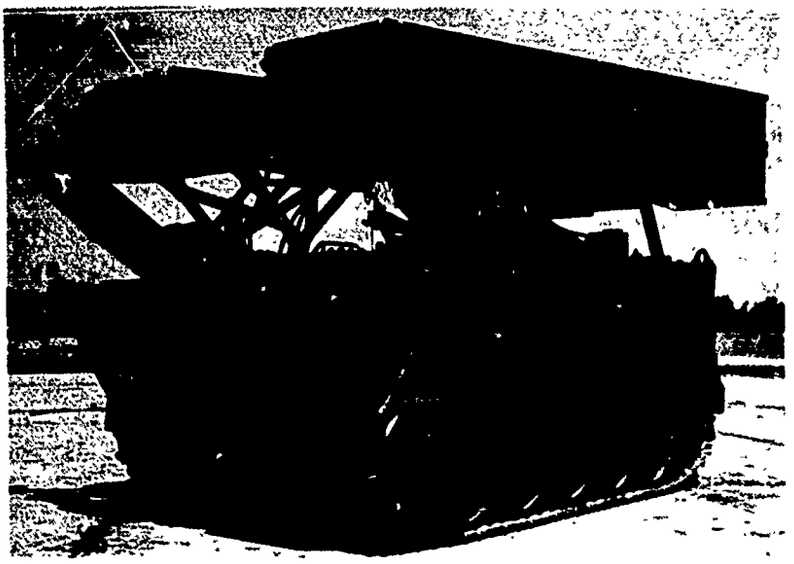
ABSTRACT

The marginal terrain assault bridge with APC launcher was subjected to various engineering tests as well as endurance operations. Under most conditions, the test vehicle was able to meet the performance requirements of specification MIL-C-46782A(MO) for the standard M113A1 vehicle. However, while swimming, the vehicle has excessive list and trim forward and to the right which adversely affect vehicle turning ability. The vehicle was operated for 1051 miles on various test terrain and for 441 launches with 15 vehicle crossings per launch. Various weld failures occurred in the braces and beams for the bridge because of insufficient strength. In addition failures of the rotating beam to hinge pin bolts resulted in other failures. Redesigned components were installed after 320 launches; however, the limited operation thereafter provided insufficient testing as to the suitability of these components. It was concluded that certain operating conditions, such as swimming and bridge launching present operational hazards that can be detrimental to the vehicle and its operating personnel. Also, that the assault bridge failed to meet the Proposed Small Development Requirement for maintainability and reliability.

FOREWORD

Materiel Test Directorate was responsible for preparing the plan of test, conducting the test, and preparing the test report.



MARGINAL-TERRAIN ASSAULT BRIDGE WITH APC LAUNCHER

PHYSICAL DATA

Weight	
Without bridge	21750 lb
With bridge and driver	24900 lb
Length	
Without bridge	208-1/8 in.
With bridge	248-7/8 in.
Width	
Without bridge	123-5/8 in.
With bridge	123-5/8 in.
Height	
Without bridge	108-3/4 in.
With bridge	134-3/8 in.
Ground clearance	16-1/8 in.
Angle of approach	
Without bridge	19°
With bridge	19-1/2°
Angle of departure	
Without bridge	18°
With bridge	16-1/2°

POWER PLANT

Engine	
Type	Model 6V53
Displacement	318 cu in.
BHP	216 at 2800 rpm
Fuel	Diesel, DF-2
Fuel capacity	95 gal
Horsepower per ton	17.3

POWER TRAIN

Transmission	Model TX-100-1, automatic, 3 speeds forward, 1 speed reverse.
Transfer gear case	1:1.286 ratio

BODY/HULL

Type	Welded aluminum plate
Cargo floor size	None
Crew	Driver, 2 Crewmen

SUSPENSION

Type, torsion bar	
Tracks	Type T120, singlepin with detachable rubber pads, 15 in. wide.
Road wheels	20 (10 duals)
Ground pressure	
Without bridge	6.8 psi
With bridge and driver	7.7 psi
Tread width	85 in.

STEERING

Type	Controlled differential; pivot-steer brakes for low-speed steering.
Turning diameter, wall to wall	
Without bridge	46 ft
With bridge	50 ft
Turning diameter, swimming	
With bridge	152.5 ft (left) 40 ft (right)

ELECTRICAL SYSTEM

Type, 6 TN battery, 24 volts

ARMAMENT

Machine gun	Cal .50, M2
Rifle	7.62-mm, M14(2)

AMMUNITION

200 rounds, cal .50

FIRE-CONTROL AND VIEWING DEVICES

Periscope, M17	
Driver's hatch	4
Commander's cupola	5
Spare (stowed)	1
Periscope, M19	
Stowed	1
Spare (stowed)	1

PERFORMANCE (WITH BRIDGE)

Maximum speed (land)	42 mph
Maximum speed (water)	3.2 mph
Maximum gradeability	60%, 2.3 mph
Side slope	30%
Fording depth	amphibious
Vertical step	24 in.
Trench crossing	72 in.
Cruising range	200 mi

AUXILIARY EQUIPMENT

Radio, AN/VRC 15

BRIDGE-LAUNCHER

Surfboards, polyurethane foam	2
Bridge class	12
Span	33 ft
Hydraulic pump flow rate	3300 psi at 1800 rpm
Hydraulic tank	
Capacity	14 gal
Type fluid	OES
Bridge dimensions	
Length (total)	438 in.
Width (total)	105-5/8 in.
Width of surface tracks	35 in.
Weight	2750 lb
Material	Aluminum Alloy

Data Compiled: March 1969

Characteristic Photograph

ABERDEEN PROVING GROUND
ABERDEEN PROVING GROUND, MARYLAND 21005

USATECOM PROJECT NO. 7-8-1018-05

FINAL REPORT ON INITIAL PRODUCTION TEST OF MARGINAL-TERRAIN ASSAULT BRIDGE WITH APC LAUNCHER

19 JULY 1968 to 10 MARCH 1969

SECTION 1. INTRODUCTION

1.1 BACKGROUND

An urgent request was made during late 1965 for a light assault bridge to be utilized with the carrier, personnel, full-tracked, armored, M113. A deck bridge was developed from standard equipment and this expedient bridge was satisfactorily used in the field.

However, operational requirements, and studies of the general problem resulted in the development of a light bridge structure, which was launched and retrieved by an M113 vehicle. This new bridge was designed to permit emplacement without troop exposure to small-arms fire, and to support vehicles up to 12 tons, gross weight, in combat operations in marginal-terrain environments over dry and wet gaps.

The assembly described in this report is the first sample submitted from production by Code A under Contract No. DAAK 02-68-C-0226.

1.2 DESCRIPTION OF MATERIEL

The marginal-terrain assault bridge consists of two major components: the bridge, a class 12 aluminum structure, and the launcher, mounted on a modified M113A1 armored personnel carrier.

Two ramp assemblies attached to each other with a centrally located noneccentric hinge provide a clear span of 33 feet, a roadway width of 8 feet 10 inches, and a load carrying ability of 12 tons. Each ramp consists of two aluminum sections formed into modified open boxes with composite decks 18 feet long, 2 feet 11 inches wide, and connected by vertical and horizontal braces.

A hydraulic cylinder, which is supported in the bridge by a rotating link, and cross-member beams, is used to fold and unfold the bridge. Additional components of the bridge hydraulic system include valves,

lines, and fittings designed to operate at 3500 psi and provide for adequate operation of the bridge. Quick-disconnect plugs and sockets are located at the cylinder and the pickup points at each end of the bridge.

The bridge-launching mechanism, which is pin-connected to weldments on the APC, consists of a locking cylinder, two launching cylinders, and necessary hydraulic lines and control valves. The hydraulic pump, which is the power source for the hydraulic system, is driven by a shaft from the engine power take-off. A hydraulic reservoir and the launcher-operating controls are located at the commander's position behind the engine compartment bulkhead. Detailed characteristics of the marginal-terrain assault bridge with launcher are presented in the frontispiece. Additional views are in Appendix I.

The full-tracked armored personnel carrier, M113A1 is a lightweight, low-silhouette vehicle capable of amphibious operation, and high-speed operation on improved roads. It has a power train consisting of a diesel engine, transfer gear case, automatic transmission, steering-control differential, and final drives. Ten pairs of torsion-bar-mounted road wheels support the vehicle which travels on rubber-backed steel tracks with detachable highway pads. Additional information regarding the vehicle can be found in TM 9-2300-224-10/2/1, September 1964.

1.3 TEST OBJECTIVES

The test objectives are:

a. To determine the capabilities of the marginal-terrain assault bridge with current APC launcher to meet the essential requirements of the Proposed Small Development Requirement when employed in marginal terrains or climates.

b. To determine the capabilities of the launcher to meet the pertinent requirements of the purchase description.

c. To determine the capabilities of the bridge to meet the pertinent requirements of the purchase description.

d. To conduct such additional engineering testing required to assure that the test item is suitable for issue to troops under provisions of AMCR 700-34.

1.4 SUMMARY OF RESULTS

1.4.1 Bridge

The bridge did not meet purchase description requirements because of recurring failures to the beams and braces in the bridge, the hose retractors, the ramps, and the rotating beam-to-hinge pin bolts.

Redesigned components were installed after 868 miles and 320 launches. The limited operation thereafter (121 launches and 183 miles) provided insufficient data as to the suitability of these components.

1.4.2 Launcher

Failures occurred early in the test period to the hydraulic reservoir. The reservoir was replaced with a redesigned reservoir, and no further problems were encountered.

The hydraulic pump was replaced after 868 miles and 320 launches. Termination of testing occurred before conclusive test results concerning the hydraulic pump could be obtained.

1.4.3 Marginal-Terrain Assault Bridge with APC Launcher

During swimming operations, the test item had excessive trim, and list forward and to the right, respectively, which adversely affected the turning ability of the vehicle.

The test item was operated for 1051 miles on various terrains. The bridge was launched and recovered 441 times, with 15 vehicle crossings per launch.

The test item weighed 24,900 lb, 820 lb over the 24,080 lb for a current standard M113A1 APC.

The vehicle system required 1.34 maintenance man-hours per operating hour and 11.41 maintenance man-hours per 100 miles of operation.

Visibility about the vehicle from either the driver's or the bridge operator's positions was materially reduced when the bridge was in the transport position.

Continuous full-load operation in a +120°F ambient temperature at a converter speed ratio of 0.4 or above provided satisfactory cooling.

All equipment performance reports are summarized in Appendix III.

1.5 CONCLUSIONS

It is concluded that:

a. The assault bridge with APC launcher failed to meet the essential Proposed Small Development Requirement for weight, maintainability, and reliability (ref par. 2.18.4 and Appendix II).

b. The launcher was generally satisfactory and met the pertinent purchase description requirements for the 441 launches and 1051 miles accrued prior to test termination (ref Appendix II, Part II).

c. The bridge failed to meet the pertinent requirements of the purchase description (ref Appendix II, Part III).

d. Certain operating conditions, such as swimming, bridge launching, and vehicle crossings, present operational hazards that can be detrimental to the vehicle and its operating personnel (ref pars. 2.5.4 and 2.20.4).

1.6 RECOMMENDATIONS

Not applicable.

SECTION 2. DETAILS OF TEST

2.1 INTRODUCTION

The tests conducted were designed to measure the performance of the marginal-terrain assault bridge and APC launcher in temperate climate conditions in different marginal-terrains. These tests were intended to provide sufficient data, not only to satisfy the initial production test objectives, but to also assure suitability of the test item for issue to the troops.

All fuel and lubricants were standard military types, normally available to operating units and used in accordance with the appropriate lubrication orders.

2.2 INITIAL INSPECTION AND SERVICING

2.2.1 Objectives

The objectives are:

a. To assure that the bridge and launcher are in good mechanical condition and that major component serial numbers and pretest data are recorded prior to the start of the test program.

b. To note any discrepancies incurred during shipment.

2.2.2 Criteria

Appropriate Department of the Army technical manuals and lubrication orders will be used to assure good condition and adequate lubrication.

2.2.3 Method

Perform limited technical inspections, record major component serial numbers, note initial condition of components and other pretest observations (MTP 2-2-502).

Assure that all fluid systems and lubrication points are fully serviced with the proper fuels, lubricants, and fluids; purge if necessary. Inaccessibility, special tools required, extremely long drain periods, capacities, and other pertinent data are recorded.

2.2.4 Results

Serial numbers are listed in Table 2.2-I.

Table 2.2-I. Serial Nos. for Major Components

Component	Serial No.
Engine	6D-37149
Transmission	7T-1864
Transfer case	3878
Differential	5138

The voltage regulator was controlling system voltage at 25.5 volts. The regulator was inspected and found to be damaged internally. A replacement was installed, and the voltage output was 27.5 volts.

The launcher system seriously impaired accessibility to the engine compartment, particularly the power-plant door on the front of the vehicle and the engine-access door in the interior of the vehicle.

If the power plant is inoperable, the launcher cannot be lowered to service the engine. The power-plant door on the front of the vehicle cannot be opened with the launching mechanism in the transport positon.

The cargo hatch cover will not open completely, because the bridge seat on the rear of the vehicle interferes with the hatch cover. This situation compromises accessibility to the cargo hatch.

The fire extinguishers were found to be adequate.

The hydraulic-oil reservoir dipstick fell out of the cap prior to vehicle receipt and was located in the bottom of the reservoir. The dipstick was reinstalled in the cap and welded.

The total fuel capacity was 95 gallons. The usable fuel capacity was not tested.

2.2.5 Analysis

The bridge and launcher were in suitable test condition except for the hydraulic oil-reservoir dipstick and the generator voltage regulator which could not be adjusted above 25.5 volts. However, the limited accessibility to the engine compartment because of the launcher system, and the cargo hatch cover partial opening due to interference with the bridge seat provided evidences of possible problem areas during vehicle usage.

2.3 VEHICLE CHARACTERISTICS

2.3.1 Objective

The objective is to record basic dimensions, data, and characteristics of the bridge and launcher.

2.3.2 Criteria

Reference Appendix II, Part I, pars. 1.3 and 1.4.

2.3.3 Method (MTP 2-2-500)

The specified dimensions are obtained and recorded upon receipt of the vehicle.

A complete list of pertinent characteristics of each component or major component group is prepared.

General-view photographs are taken and the characteristics photograph is made incorporating significant components and data.

Performance data are obtained from results of engineering tests and recorded as performance characteristics.

2.3.4 Results

Basic dimensions of the bridge and the vehicle were as shown in Tables 2.3-I and 2.3-II.

Table 2.3-I. Assault Bridge Dimensions

Characteristics	Measurement, in.
Length (over-all)	438
Width (over-all)	105-5/8
Width of ramp surface	35

Table 2.3-II. Vehicle Dimensions

Characteristics	Measurements		
	Without, Bridge	With, Bridge	Standard M113A1
Height	108-3/4 in.	134-3/8 in.	[a] 86-1/2 in. [b] 79-1/2 in.
Width	123-5/8 in.	123-5/8 in.	106 in.
Length	208-1/8 in.	248-7/8 in.	191-1/2 in.
Angle of approach	19°	19-1/2°	-
Angle of departure	18°	16-1/2°	-

[a]Maximum; to top of machine gun pintle.
[b]Minimum; to top of antenna guard.

Pursuant to the dimensional and payload limits of standard aircraft as presented in AR 705-35, the vehicle would be capable of being transported in C-5, C-124, and C-133 aircraft.

In order to clear the American Association of Railroads profile, the bridge would have to be removed from the vehicle. The bridge would have to be removed and the launching mechanism lowered so that the vehicle would clear the Berne International profile.

2.3.5 Analysis

Installation of the bridge and the launcher on the M113A1 APC significantly increases the over-all length, width, and height of the vehicle. These dimensional changes degrade vehicle transportability via air, sea, and land as compared to the standard M113A1 APC.

2.4 PRELIMINARY OPERATIONS

2.4.1 Objective

The objective is to assure proper break-in of the various components and provide a period of familiarization for the operator prior to conducting additional tests. Stress operations that will make inherent hazards or weaknesses apparent.

2.4.2 Criteria

Criteria are as follows:

a. Special training and familiarization of trained, professional drivers not required.

b. Proper and suitable functioning of all components.

c. Satisfactory control of vehicle operating functions.

2.4.3 Method

The bridge and launcher will be operated for 50 miles and with five launches as follows:

a. Fifty miles.

1) Fifteen miles at 8 to 10 mph.

2) Fifteen miles at 12 to 15 mph.

3) Twenty miles at 20 to 25 mph.

b. Five launches.

2.4.4 Results

No special training or familiarization was required by the test drivers to operate the launching device. The drivers read the operating instructions and safety precautions preceding test operation.

No special operating requirements were necessary since the test vehicle had operational capabilities of a standard M113A1 armored personnel carrier.

The driver effort was equal to the effort required to operate a standard M113A1 with one exception. The test drivers reported difficulty when inserting the quick-disconnect plug on the bridge into the quick-disconnect socket on the launcher because of pressure buildup. Unless this pressure was first bled off, the crew member effort necessary to perform this operation was extremely uncomfortable since excessive strain was placed on the upper arms.

No maintenance was required following the break-in period.

2.4.5 Analysis

Not applicable.

2.5 SAFETY

2.5.1 Objective

The objective is to determine the suitability of the launcher and bridge with regard to personnel safety, operational hazards, and safeguards to prevent accidents during use of the vehicle and to effect a safety release statement early in the test and provide a more complete safety evaluation later in the test.

2.5.2 Criteria

Test directive (Reference 6).

2.5.3 Method

Safety evaluation tests are conducted, on an expedited basis, as soon as possible after the test item is delivered. The following tests are performed to the degree required to determine if any safety hazards exist:

a. Center of gravity (ref par. 2.11).

b. Steering (ref par. 2.12).

c. Maximum speeds (ref par. 2.13).

d. Braking (ref par. 2.15).

e. Gradeability (ref par. 2.7).

f. Side slopes (ref par. 2.8).

g. Floating and swimming (ref par. 2.9).

h. Human factors (ref par. 2.19).

i. Limits of vision (ref par. 2.14).

j. Launcher performance (ref par. 2.16).

In addition, an inspection is made to determine if the vehicle possesses such necessary safety devices as the following:

a. Accessible engine shutdown.

b. Adequate fire extinguisher systems.

c. Hydraulic pressure release valves.

2.5.4 Results

With the bridge in transport position, the freeboard with the vehicle in calm water is extremely limited. Therefore, when crossing (swimming) bodies of water, care must be exercised that the vehicle is not operated in rough waters or in such a manner to cause the vehicle to be swamped. In addition, prior to attempting a water crossing, the surfboards must be checked to insure that all mountings and attaching devices are in satisfactory condition. Loss of either surfboard could cause the vehicle to sink during water crossings.

Whenever the bridge is to be raised from the carrying position, the locking pins must be engaged, otherwise the bridge is uncontrollable and will fall back on top of the vehicle. This could result in injuries to operating personnel and damage to the bridge or the vehicle.

Under certain operating conditions, the bridge ramps become coated with mud, and vehicles that are crossing the bridge can slide off the ramps and become immobilized. This, then, requires that the immobilized vehicle be retrieved before other vehicles can use the bridge or the bridge can be relocated.

The launcher and braking system functioned satisfactorily on longitudinal slopes up to 60% and side slopes to 30%.

2.5.5 Analysis

The marginal-terrain assault bridge with launcher, in general, has no greater operating hazards under normal operating conditions than has the basic M113A1 vehicle. Certain operating conditions, such as swimming, and bridge launching, present hazards that could be detrimental to the vehicle and its operating personnel.

2.6 STANDARD OBSTACLES

2.6.1 Objective

The objective is to determine the ability and specify limitations of the vehicle to negotiate the following obstacles (determine center of gravity before running):

a. Vertical wall.

b. Trench crossing.

c. Bridging.

1) With bridge on launcher.

2) Without bridge on launcher.

d. Six-inch washboard.

2.6.2 Criteria

Reference 21, par. 3.6 and Appendix II, Part I, par. 3j.

2.6.3 Method (MTP 2-2-611)

Operate the vehicle over the obstacles outlined in paragraph 2.6.1. Establish the limitations over the obstacles. In some cases, it may be necessary to operate in reverse to negotiate the obstacle.

2.6.4 Results

The vehicle satisfactorily negotiated the 18- and 24-inch vertical walls in the reverse and forward directions, respectively. With and without the bridge, the vehicle crossed a 72-inch span and the prepared concrete trench without difficulty or interference.

During operation on the 6-inch washboard course, the vehicle rode unevenly up to eight mph where it levelled out and remained constant up to 22.5 mph at the end of the washboard course.

2.6.5 Analysis

Installation of the bridge did not degrade the ability of the vehicle to cross the various standard obstacles as outlined in the applicable paragraphs of specification MIL-C-46782A(MO).

Mobility was equivalent to that of the standard M113A1 over these obstacles.

2.7 GRADEABILITY

2.7.1 Objective

The objective is to determine the capability of the vehicle to comply with the following combat vehicle requirements (with and without bridge):

a. Slope. Vehicle with or without bridge must be capable of ascending and descending a 60% dry slope without difficulty.

b. The service brake shall be capable of stopping and controlling and the parking brake capable of holding the vehicle at gross weight on 60% slope.

c. A sustained speed of 15 mph must be maintained on a 10% slope.

The engine shall start and perform satisfactorily throughout the speed range of the engine in each direction on the 60% slope. All components shall operate without faulty lubrication, cooling, fuel supply, leakage, or other malfunctions.

2.7.2 Criteria

Reference 21, pars. 3.6.6 and 3.6.7 and Appendix II, Part I, par. 3.

2.7.3 Method (MTP 2-2-610)

Operations are conducted on the paved slopes in the Munson test area up to and including the 60% slope. Surface conditions are dry during the test. Service and parking brakes are used on 60% slope.

Observations are made on the angle of approach and departure at the bottom of the slope and the effect of weight transfer on steering.

2.7.4 Results

Maximum sustained road and engine speeds were as shown in Table 2.7-I.

Table 2.7-I. Maximum Grade and Engine Speeds

	Without Bridge			With Bridge		
Slope, %	Gear	Mph	Rpm	Gear	Mph	Rpm
5	2-LU	22.0	2970	2-LU	22.0	2960
10	2-LU	17.5	2330	2-LU	14.2	2000
15	1-LU	10.7	2960	1-LU	10.6	2940
20	1-LU	9.8	2730	1-LU	9.2	2530
30	1-LU	6.5	1780	1-C	5.6	2210
40	1-C	4.6	2120	1-C	4.1	2110
50	1-C	3.9	2080	1-C	3.1	2070
60	1-C	3.1	2060	1-C	2.3	2050

Engine idling performance characteristics and hull inclination on the 60% longitudinal slope were as shown in Table 2.7-II.

Table 2.7-II. Engine Performance Characteristics, 60% Grade

	Without Bridge		With Bridge	
	Ascending	Descending	Ascending	Descending
Engine speed, rpm	725	700	720	700
Fuel pressure, psi	30	32	31	32
Oil pressure, psi	30	26	32	24
Hull inclination, degrees	32.5	39	34.5	40

Engine idling and restarting ability were satisfactory; weight transfer had no noticeable effect on vehicle steering in either direction on the 60% grade. Angles of approach and departure were satisfactory on all grades from 5 to 60%.

Reference specification MIL-C-46782A(MO), standard M113A1 vehicles meet the requirements for engine starting on grades and side slopes, (par. 3.6.6) and for brake holding on the 60% grade (par. 3.6.7.2).

Representative M113A1 performance characteristics on the various prepared longitudinal grades from 5 to 60% are presented in Appendix I.

2.7.5 Analysis

The vehicle, with and without bridge, met the various requirements of specification MIL-C-46782A(MO) in regards to brake holding, slope climbing, engine idling and restarting ability on the 60% grade. Without the bridge, the vehicle can maintain a sustained speed in excess of 15 mph on the 10% longitudinal grade; however, with the bridge installed, vehicle sustained speed on this grade is only 14.2 mph instead of the required 15 mph. This slight difference in sustained speed on the 10% grade with the bridge installed is considered inconsequential.

2.8 SIDE SLOPES

2.8.1 Objective

The objective is to check for lateral stability and proper engine operation and vehicle performance on side slopes up to 30%.

2.8.2 Criteria

Reference 21, par. 3.6.6 and Appendix II, Part I, par. 3.

2.8.3 Method (MTP 2-2-610)

Calculate or measure the static tipping angle for safety prior to actual operation.

Operation is conducted on the 30% side slope in both directions. Under static conditions, the suspension deflections and maximum vehicle inclination of the body are noted. Behavior of the vehicle is noted at speeds up to 5 mph, particularly while steering up and down the slope.

All components should be capable of operation without faulty lubrication, cooling, fuel supply, leakage, or other malfunctions.

2.8.4 Results

There were no indications of adverse effects on steering during operation up to five mph in a sine wave pattern on the 30% side slope. Vehicle stability, engine restarting ability, and performance were satisfactory in both directions on the side slope course.

Engine performance characteristics at idle on the 30% side slope were as shown in Table 2.8-I.

Table 2.8-I. Engine Performance Characteristics, 30% Side Slope, Hull Inclination, 18°

Conditions	Left Side Up	Right Side Up
Engine speed, rpm	710	720
Fuel pressure, psig	33	34
Oil pressure, psig	27	29

2.8.5 Analysis

Vehicle performance was satisfactory on the 30% side slope and compares with the basic vehicle side slope performance requirements of specification MIL-C-46782A(MO).

2.9 SWIMMING

2.9.1 Objective

The objective is to determine if the swimming ability of the basic vehicle has been adversely affected by the installation of the assault bridge.

2.9.2 Criteria

Reference 21, par. 3.6.9 and Appendix II, Part I, par. 3.

2.9.3 Method (MTP 2-2-501)

Preliminary operation is conducted in the fording basin, general amphibious operating characteristics are observed in Spesutie Narrows.

Freeboard, list, and trim measurements are recorded under both static and dynamic conditions. Stability is observed while static and maneuvering, and limitations on speed and steering are noted. Vehicle water speed is measured to reflect propulsive characteristics in water having minimum current velocity. The vehicle trim versus speed relationship is obtained.

Evaluation of maneuverability consists of determining if the vehicle holds a straight course, evaluating turning response, and measuring circle diameter. Performance, when entering and leaving the water, is investigated.

2.9.4 Results

Average maximum water speed was 3.2 mph at 1980 rpm in 1-2 gear range.

Turning diameters of the initial turn and the average of two turns thereafter with the vehicle operating at full throttle in 1-2 gear range were as shown in Table 2.9-I.

Table 2.9-I. Turning Diameter

Direction	Initial, ft	Average, ft
Left	155	152.5
Right	49	40

Vehicle stability and entering and exiting performance was satisfactory throughout the test. It is capable of operating within 30 foot corridor when crossing calm, open water, although it continuously drifts . . the right. Water leakage into the hull was negligible.

Freeboard measurements are shown in Table 2.9-II.

Table 2.9-II. Freeboard Measurements

Position	Static, in.	Dynamic, in.
Left front	10	14
Right front	4	10
Left rear	17	9
Right rear	14	8

List and trim measurements are shown in Table 2.9-III.

Table 2.9-III. List and Trim Measurements

Conditions	Static, in.	Dynamic, in.
List	2.5° right	3.0° right
Trim	4° forward	2° forward

Static freeboard measurements (inches) on standard M113 vehicles are shown in Table 2.9-IV.

Table 2.9-IV. Static Freeboard Measurements, M113 Vehicles

Position	Static, in.
Left front	10-3/4
Right front	10-1/2
Left rear	11-1/2
Right rear	10-3/4

Water speeds for standard M113 vehicles ranged from 3.0 to 3.6 mph during tests at APG.

2.9.5 Analysis

Left turning diameter was adversely affected by the vehicle list to starboard under static and dynamic conditions. Improvements in the surfboards to raise the right front of the vehicle, when in water, would reduce vehicle turning diameter and would improve over-all water performance.

2.10 LOAD DISTRIBUTION AND GROUND PRESSURE

2.10.1 Objective

The objective is to determine the vehicle gross weight and weight distribution with and without bridge and provide a loading that will properly simulate the normal combat loading of the vehicle.

2.10.2 Criteria

Comparison with the basic M113A1 vehicle (References 15 and 16 and Appendix II, Part I, par. 3).

2.10.3 Method (MTP 2-2-801)

2.10.3.1 Weight. The vehicle is weighed on a platform scale with designated payload including OVE, full fuel tank, personnel, bridge, and weapons. This weight is compared with the gross weight of the standard M113 vehicle.

2.10.3.2 Weight Distribution. The weight distribution is checked in the conditions noted in paragraph 2.10.3.1 by sequential weighings across a platform scale.

2.10.3.3 Ground Pressure. The ground pressure is computed for the described conditions using total vehicle weights and projected area of the track.

2.10.4 Results

Vehicle load distribution characteristics, gross weight and nominal ground pressure were as presented in Table 2.10-I.

Table 2.10-I. Load Distribution Developments

	Load Distribution, lb					
	Without Bridge		With Bridge		Bridge Extended	
Road Wheel	Left	Right	Left	Right	Left	Right
Sprocket	-	-	-	-	1275	2850
1	2800	2525	2500	2625	8000	6600
2	2525	2850	3000	3000	3200	2975
3	2275	2275	2775	2800	0	200
4	1950	2000	2550	2650	0	0

Table 2.10-I (Cont'd)

Road Wheel	Load Distribution, lb					
	Without Bridge		With Bridge		Bridge Extended	
	Left	Right	Left	Right	Left	Right
5	1275	1275	1500	1500	0	0
Total	10,825	10,925	12,325	12,575	12,475	12,625
Gross weight	21,750		[a]24,900		[b]25,100	
Nominal ground pressure, psi	6.8		7.7		11.3	

[a]Includes driver.
[b]Includes driver and launcher operator.

A representative M113A1 vehicle, with a simulated combat load, driver, and full fuel tank had a nominal ground pressure of 7.5 psi at a weight of 23,425 lb. Load-distribution characteristics for this vehicle are shown in Appendix I.

2.10.5 Analysis

Weight distribution is greater on the Nos. 1 and 2 positions with the bridge in the carrying position than for a comparable M113A1 APC.

Current combat loaded weight of a standard M113A1 carrier is 24,080 pounds, with a ground pressure of 7.6 psi. The launcher with bridge exceeded this weight by 820 pounds.

2.11 CENTER OF GRAVITY

2.11.1 Objective

The objective is to determine the center of gravity of the vehicle, with and without bridge, in three planes. The vehicle is fitted with OVE and full fuel tanks.

2.11.2 Criteria

Comparison with the basic M113A1, APC vehicle (References 15 and 16 and Appendix II, Part I, par. 3).

2.11.3 Method (MTP 2-2-800)

The location of the center of gravity on the lateral axis is determined by using load-reaction data (ref par. 2.10). The location of the center of gravity along the vertical and longitudinal axes is obtained by the suspension method.

2.11.4 Results

The center of gravity of the vehicle was located as shown in Table 2.11-I.

Table 2.11-I. Center of Gravity Locations

Direction	With Bridge	Without Bridge
Longitudinal		
To centerline of drive sprocket, in.	74-1/4	71
Vertical		
To ground, in.	51-1/4	43-1/2
Centerline of drive sprocket to ground, in.	20-11/16	19-1/2
Lateral		
To the right of vertical centerline, in.	5/8	1/4

Vertical and longitudinal center-of-gravity locations for a standard M113A1 vehicle are shown in Appendix I.

2.11.5 Analysis

Center-of-gravity locations are further forward and higher on the vehicle with the complete installation and with only the launcher than on the standard M113A1 vehicle. This change in center-of-gravity location had no discernible adverse effects on vehicle operation on the 30% side slope and the 60% longitudinal grade. Under certain other operating conditions, the marginal-terrain assault bridge with APC launcher may be somewhat less stable than is a standard M113A1 vehicle.

2.12 STEERING

2.12.1 Objective

The objective is to determine vehicle steer response and effort, minimum turning radius, and general characteristics of turning.

2.12.2 Criteria

Reference 21, par. 3.6.8 and Appendix II, Part I, par. 3.

2.12.3 Method (MTP 2-2-609)

The minimum turning circle is measured on a level, dry, paved surface.

2.12.4 Results

Minimum turning diameters were as shown in Table 2.12-I.

Table 2.12-I. Minimum Turning Diameters, Ft

	With Bridge		Without Bridge	
Type Steer	Left	Right	Left	Right
Pivot	29.6	29.3	25.5	25.5
Differential	50.3	49.7	45.9	45.9

Reference par. 3.6.8 of specification MIL-C-46782A(MO), M113A1 vehicles are to complete full 360° turns with differential steer in 50-foot-diameter circles and with pivot steer in 28-foot-diameter circles.

Turning diameters for a representative M113A1 vehicle were shown in Table 2.12-II.

Table 2.12-II. Turning Diameters, M113A1, Ft

Type Steer	Left	Right
Differential	44.6	44.2
Pivot	23.9	24.2

2.12.5 Analysis

The marginal-terrain bridge with launcher fails to meet the requirement for 360° turns in pivot steer within 28-foot-diameter circles and for differential steer (left) within 50-foot-diameter circles because of increased weight from the bridge installation. Since the vehicle without the bridge readily meets the pivot- and differential-steer requirements, the slight degradation in turning performance, with the bridge installed, should not adversely affect vehicle capabilities.

2.13 MAXIMUM AND MINIMUM SPEEDS, ACCELERATION

2.13.1 Objectives

The objectives are:

a. To determine the maximum road speed obtainable on level, paved surface without exceeding the maximum rated engine speed.

b. To determine minimum sustained speed in the lowest forward gear range without rough or irregular operation.

c. To determine acceleration characteristics. Also, to assure that sufficient power and gear ratios are provided and that gear changes can be accomplished easily and quickly to accelerate the vehicle to top road speed in the shortest time and allow ready acceleration from minimum to maximum sustained speed in the highest gear range.

2.13.2 Criteria

Criteria are as follows:

a. Reference 21, pars. 3.6.4 and 3.6.5.

b. Comparison with basic M113A1, APC vehicle (References 15 and 16.

2.13.3 Method

All operations are conducted over a level, paved road. Maximum and minimum sustained speeds are measured with rated payload.

Data and curves indicate the engine and vehicle speeds, time, and gear combinations. Delays due to initial or subsequent shifting and unusual shock conditions imposed on the power train are noted.

2.13.4 Results

Maximum and minimum speeds were 42.0 mph at 2820 rpm and 1.4 mph at 700 rpm, respectively.

The average time required for the vehicle to accelerate from 0 to 20 mph and 0 to maximum speed was 9.3 and 134.3 seconds, respectively. Complete acceleration characteristics are located in Figure 2.13-I.

Transmission selector in 1-2-3 position.

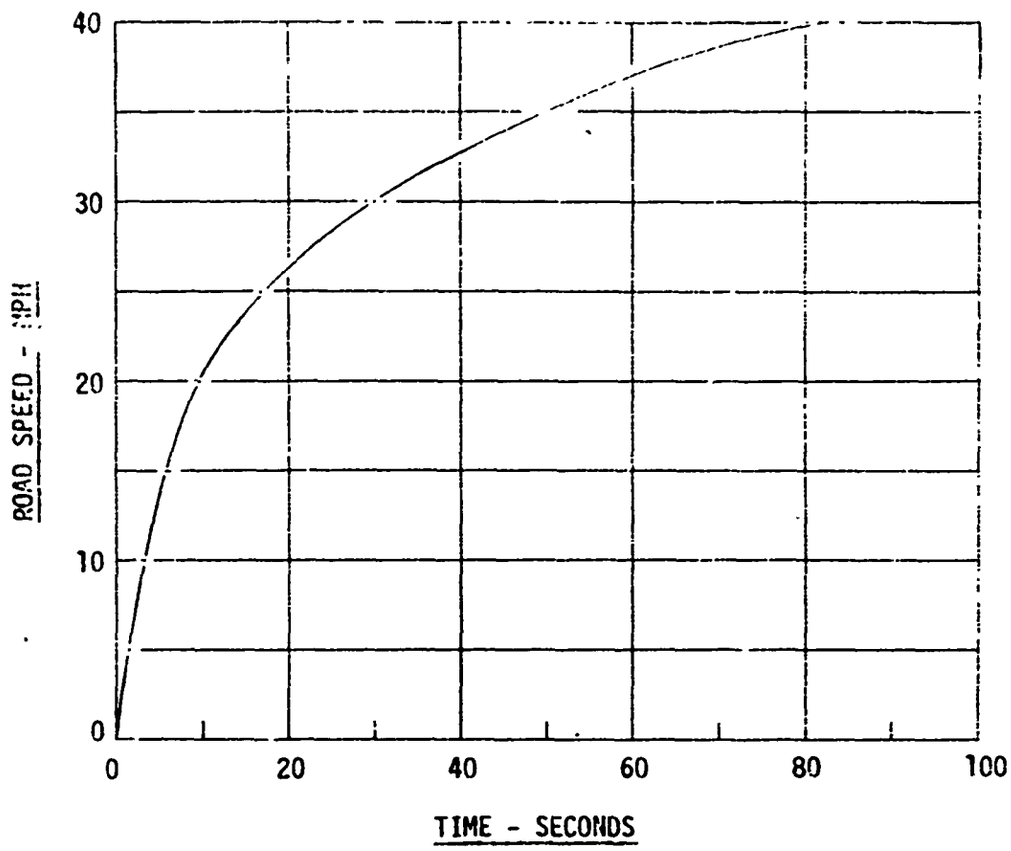


Figure 2.13-I: Acceleration (Time-Velocity) Characteristics.

Maximum and minimum speeds for a representative M113A1 vehicle were 42.0 mph at 2825 rpm and 0.9 mph at 585 rpm.

This vehicle met the acceleration requirements of par. 3.6.5 of specification MIL-C-46782A(MO) by accelerating from 0 to 20 mph in 8.2 seconds on a smooth level, hard-surfaced road. Full-throttle acceleration characteristics for this representative M113A1 vehicle are shown in Appendix I.

2.13.5 Analysis

The marginal-terrain assault bridge with APC launcher meets the acceleration requirements, 0 to 20 mph in not more than 11 seconds, of specification MIL-C-46782A(MO). However, more time is required for this vehicle to attain maximum speed than for a standard M113A1 vehicle.

2.14 LIMITS OF VISION

2.14.1 Objective

The objective is to determine the visual limitations imposed on the M113 with the bridge and launcher installed.

2.14.2 Criteria

Reference 19 par. 3b, Proposed Small Development Requirement and Appendix II, Part I, par. 3.

2.14.3 Method

The vehicle will be parked at the center of a level concrete circle graduated in degrees. Recordings will be made of the angle of vision from each position in horizontal and vertical planes. Interferences are noted.

2.14.4 Results

Limits of vision at the driver's and the launcher operator's positions are shown in Figures 2.14-I thru 2.14-III.

When the bridge is resting on the ground, the guide pins and rear end of the bridge extend 86 and 32 inches, respectively, to the front of the vehicle. Therefore, neither the driver nor the bridge operator can see these points when coupling or uncoupling the bridge.

Representative limits of vision for a standard M113 vehicle are shown in Appendix I.

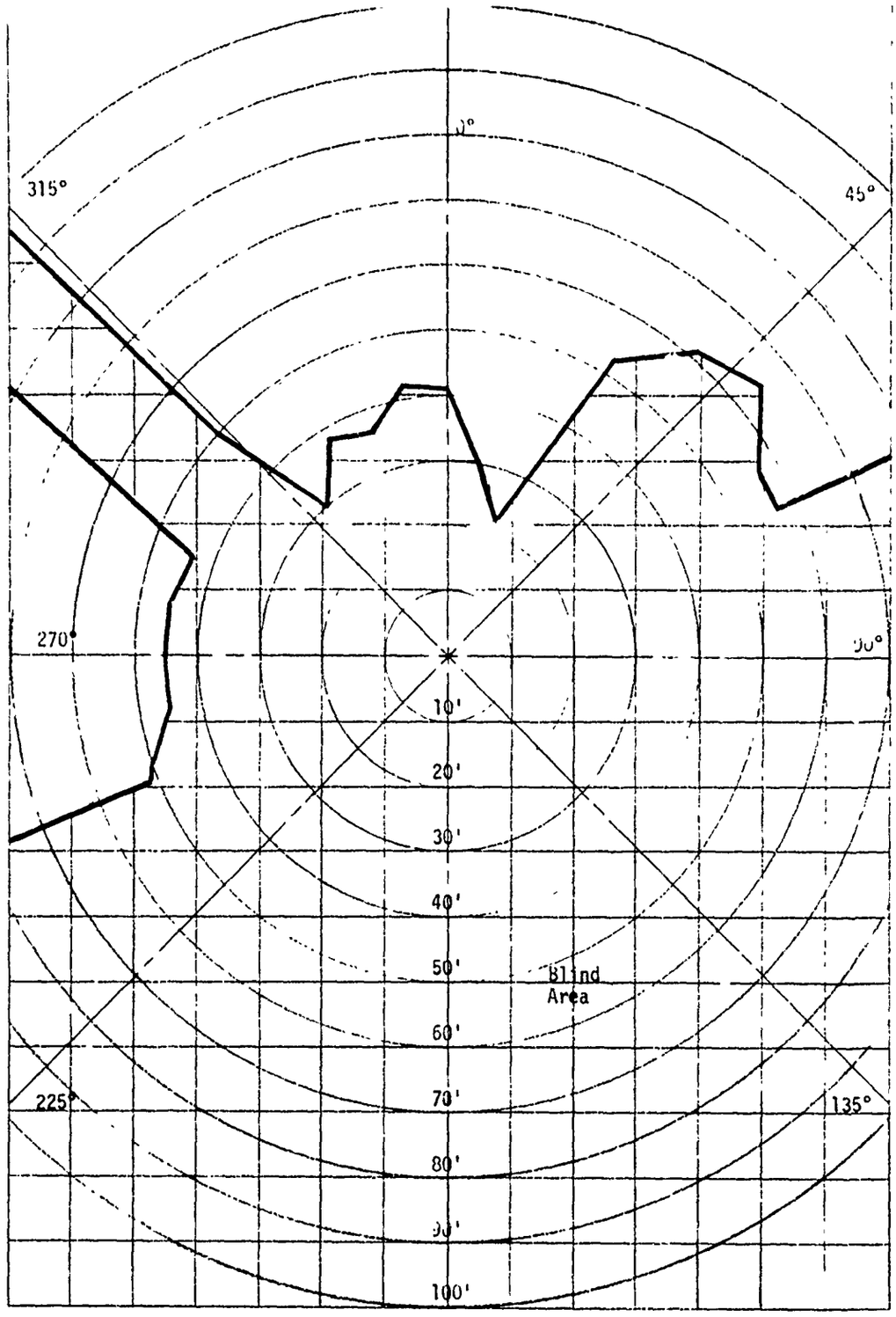


Figure 2.14-I: Limits of Vision, Driver's Station.

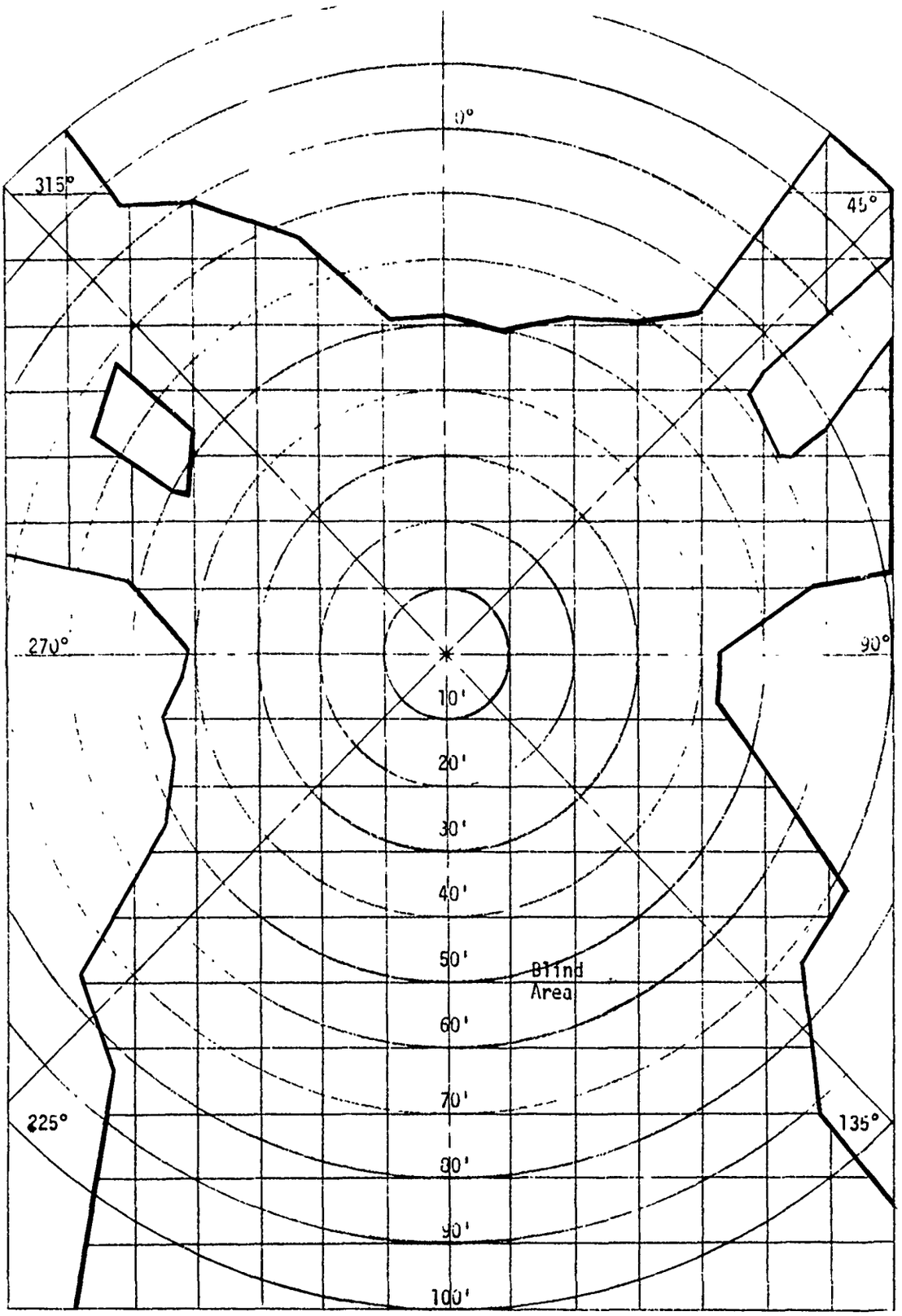


Figure 2.14-2: Limits of Vision, Turret Station.

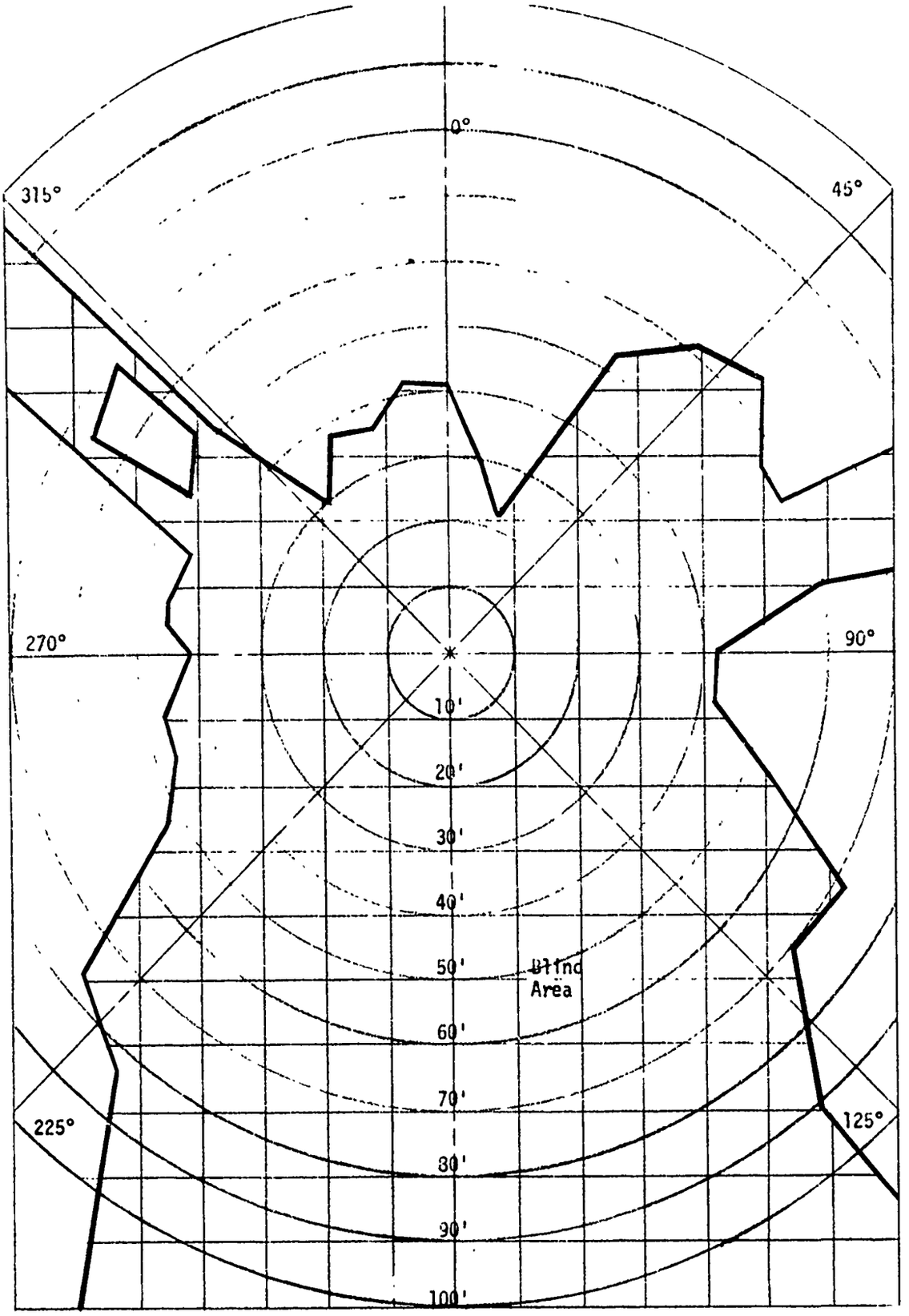


Figure 2.14-3: Limits of Vision, Total All Vision Blocks.

2.14.5 Analysis

Installation of the bridge and launcher reduces the visibility about the vehicle from either the driver's or the bridge operator's positions especially when the bridge is in transport position.

2.15 BRAKING

2.15.1 Objective

The objectives are:

a. To determine the ability of the vehicle to make a complete, safe, stable stop on a level, paved road from varying speeds up to 30 mph.

b. To determine if the brakes will safely hold the vehicle (parked) in both directions on a 60% longitudinal slope.

2.15.2 Criteria

Reference 21, par. 3.6.7.

2.15.3 Method (MTP 2-2-608)

Stopping distances from 10, 20, and 30 mph on a dry, bituminous concrete roadway, from point of application until the vehicle has been halted with maximum braking effort, are measured. The holding ability on the 60% slope is determined during gradeability tests.

2.15.4 Results

Average stopping distance from 20 mph, with the bridge installed, was 32.7 feet. Similar stopping distance for a representative M113A1 was 28 feet; specification MIL-C-46782A(MO) requires that the M113A1 vehicle shall stop within a distance of 40 feet from point of brake application at 20 mph on smooth, level, hard-surfaced roads.

The vehicle service and parking brakes safely held the vehicle (parked) on the prepared 60% grade in the ascending and descending attitudes as required by specification MIL-C-46782A(MO).

Safe stable stops were made at speeds up to 35 mph. Stopping distances at various speeds are shown in Figure 2.15-I.

Engine: Model No. 6V53
Transmission: Model No. TX-100-1
Fuel: VV-F-800, Diesel Fuel DF-2
Vehicle Weight: 24,900 Lb
Date of Test: 27 September 1968

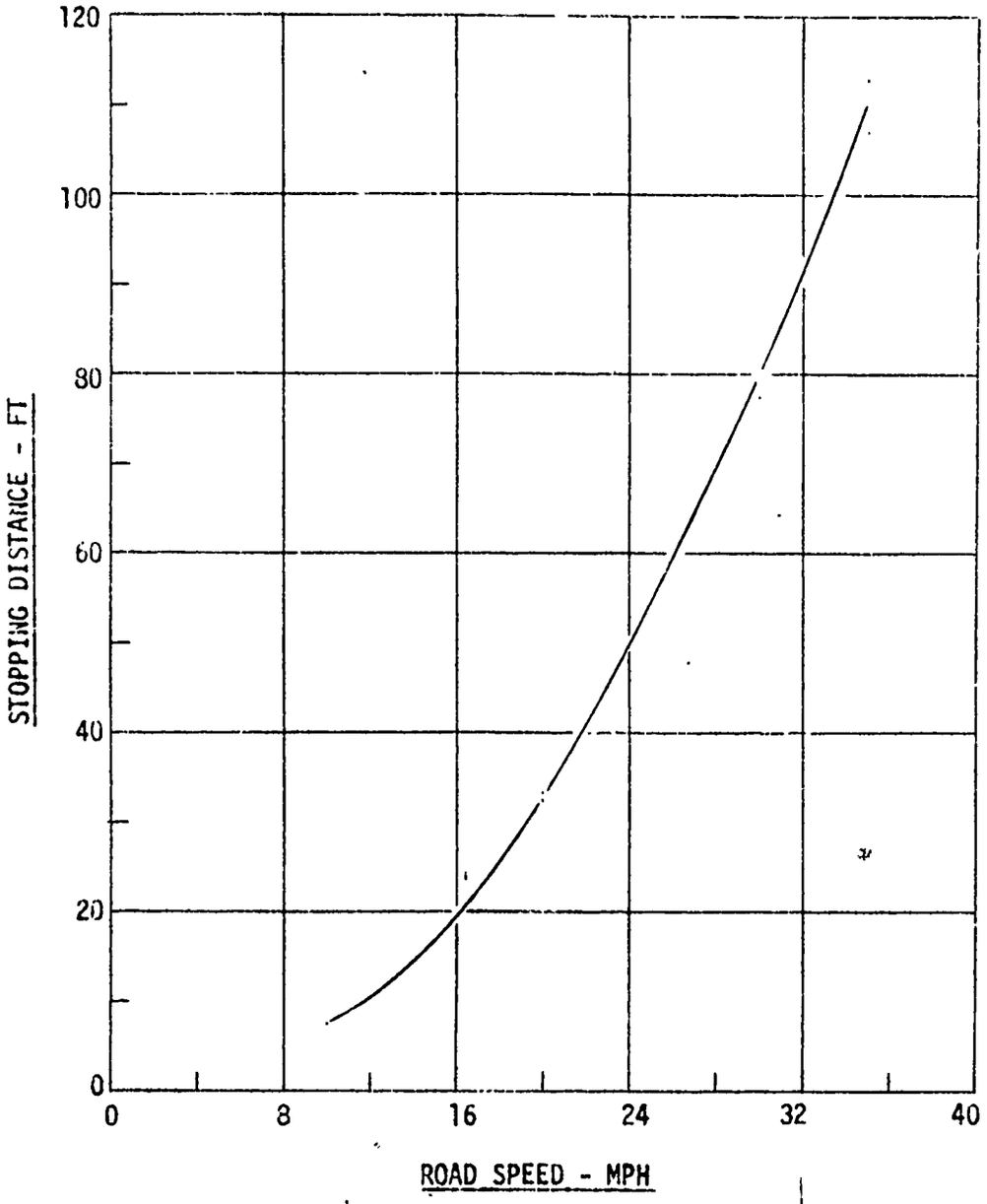


Figure 2.15-I: Braking Characteristics.

2.15.5 Analysis

Installation of the bridge and launcher did not adversely affect vehicle braking characteristics and holding capabilities.

2.16 LAUNCHER PERFORMANCE AND COOLING

2.16.1 Objectives

The objectives are:

a. To determine performance of the test vehicle over different terrain configurations.

b. To determine if the vehicle will operate at 120°F ambient air temperature without any component exceeding its critical temperature limit.

2.16.2 Criteria

Reference Appendix II, Part I, pars. 2, 3, 8, 9, 10, 12, 14, 15, 16 and Part II, pars. 1 through 4.

2.16.3 Method

2.16.3.1 Launch and Recovery. Complete launch and recover the bridge 500 times. The launchings and recoveries will be made with the launcher on varying slopes as follows:

a. Two hundred and fifty launchings and recoveries with launcher on level ground. During this test, the lock cylinder shall be used to disconnect the bridge for 50 of the launchings when the bridge is unfolded. Conduct 50% of these launchings and recoveries with the launcher at each end of the 33-foot span bridge.

b. One hundred and fifty launchings and recoveries with launcher on a slope: 75 launchings at an upward slope of 15% and 75 launchings at a downward slope of 15%. Conduct 50% of the launchings and recoveries with the launcher at each end of the 33-foot span bridge.

c. One hundred launchings and recoveries with launcher on a transverse side slope of 8%. Conduct 50% of the launchings and recoveries with the launcher at each end of the 33-foot span bridge.

During these tests, the bridge and launcher components shall be lubricated as specified. During all stages of the test, the launcher shall be examined for conformance to the purchase description. This portion is to be conducted in conjunction with durability (par. 2.17).

2.16.3.2 Land Performance. Operate the launcher, with the bridge stowed in the transport position, for a minimum distance of 100 miles equally divided on paved and graded roads, and level and hilly cross-country terrain. Ten per cent of the level road operation shall be at maximum speed. Speed for other test conditions shall be dictated by the type of terrain.

2.16.3.3 Water Performance. The launcher with the bridge in the stow position shall be driven into and out of the water a total of 20 cycles. The type of bank conditions shall vary as those typical of stream banks on small inland rivers. The launcher with bridge shall be operated in the water for a total of ten hours.

2.16.3.4 Cooling Performance. The vehicle, loaded to its maximum gross vehicle weight, is operated at full load (WOT) at road speeds from a minimum equal to the maximum at which the full loaded vehicle will ascend a 60% slope to approximately 20 mph and throughout the usable engine speed and gear ranges appropriate for a given road speed. Approximately 12 runs are made. The full load is applied by a field dynamometer at the particular speeds until a critical component temperature is reached or until component temperatures stabilize (Interim Pamphlet 60-95).

The cooling test is conducted at an ambient temperature of not less than +95°F and temperatures recorded are extrapolated to an ambient temperature of +120°F by adding a degree to the recorded temperature per degree of ambient temperature below +120°F.

Temperature limits for the vehicle will be as follows, subject to manufacturer's recommendations:

a. Engine coolant, not to exceed boiling temperature of water at 3000 feet above MSL with maximum system pressure.

b. Engine oil sump, +275°F.

c. Transmission and other gear boxes, +300°F.

d. Driver and crew compartment, +135°F.

2.16.4 Results

Launcher performance test results are included in par. 2.17. Water performance test results are included in par. 2.9.

Cooling data are presented in Figure 2.16-I, and pertinent maximum stabilized temperatures (°F) when extrapolated to +120°F ambient temperature are shown in Table 2.16-I.

Table 2.16-I. Maximum Stabilized Temperatures, °F

Condition	Converter Speed Ratio	Water to Radiator	Eng Oil Sump	Trans. Oil to Cooler	Diff Oil to Cooler
Second converter					
5.0 mph at 2120 rpm	0.31	228	266	322	218
6.4 mph at 2110 rpm	.40	221	261	296	212
9.0 mph at 2130 rpm	.56	215	258	272	207
12.0 mph at 2270 rpm	.70	217	261	283	209
First lock-up					
10.0 mph at 2780 rpm		204	253	222	198
Road load					
42.0 mph at 2820 rpm		217	259	239	242

Temperatures were extrapolated based on a 1-degree rise in component temperature per degree rise in ambient temperature.

Maximum drawbar pull was 17,700 pounds at 1.0 mph in first converter and was limited by track slippage. Maximum drawbar horsepower was 138 in first lock-up at 9.6 mph.

Cooling characteristics and drawbar pull and horsepower curves are shown in Appendix I.

Vehicle crossings under muddy conditions were made with an M35A1, 2-1/2 ton truck, an M54A2, 5-ton truck, and with the M113A1 APC launch vehicle.

The bridge was capable of being launched with no crew members exposed. It was capable of being recovered with only one crew member exposed. It was capable of being launched and recovered by a 2-man crew. Recovery time was improved when a 3-man crew was employed, however. This time improvement occurred because, with two men, one man must exit the vehicle to hook up the folding cylinder hydraulic-line quick-disconnects, and then return into the vehicle to either the driver's seat or the operator's seat to perform the tasks necessary for bridge recovery.

The only terrain configuration used was from a level launch base to a level far bank. This was because of poor weather, with either muddy or frozen course conditions prevailing.

The bridge was capable of being crossed 15 times by an M113A1 APC, an M35A1 truck and an M54A2 truck in a 15-minute time interval. This capability was noted under all test conditions.

2.16.5 Analysis

Continuous full-load operation in a +120°F ambient temperature at a speed which yields a converter speed ratio of 0.4 or above would be satisfactory. Paragraph 3.6.2.2 of specification MIL-C-46782A(MO) states, "with the vehicle operating in ambient temperature up to 115°F, the transmission lubricant cooling system shall maintain lubricant temperature at no more than 300°F measured out of transmission into cooler, except at torque converter speed ratios less than 4/10."

Drawbar-pull and horsepower characteristics were not degraded because of the bridge and launcher installation.

2.17 DURABILITY

2.17.1 Objective

The objective is to determine the durability characteristics and reliability of the bridge and launcher during 750 miles of test operation and 500 launches divided evenly between the swamp and Perryman cross-country courses.

2.17.2 Criteria

Reference Appendix II, Part I, pars. 3, 6, 7 and 19 to 22 and Part III, pars. 1 to 3.

2.17.3 Method

The scheduled endurance operation with a minimum objective of 750 miles and 500 launches is divided into cycles as follows (750 miles divided equally on swamp and Perryman cross-country courses):

a. Drive vehicle and bridge 0.6 miles.

b. Launch bridge.

c. Make 15 bridge crossings (in 15 minutes) with a Class 12 load.

d. Recover bridge.

2.17.4 Results

A total of 441 launches were made, with 15 vehicle crossings for each launch. The 15-minute time limit for the 15 crossings was met under all conditions. Of the 441 launches, 320 were completed on the Perryman cross-country course, and 121 launches were completed in a swamp area.

In conjunction with the 441 launch cycles, the vehicle was operated 1051 miles over paved, gravel, swamp, water and cross-country courses.

The mileage breakdown for operation over each course is shown in Table 2.17-I.

Table 2.17-I. Operations Summary

Test Course	Miles
Paved	431
Gravel	290
Level cross-country	101
Swamp	217
Water	12
Total	1051

The vehicle used 717.3 gallons of DF-2 fuel and 25 quarts of OE-30 engine oil. The average fuel consumption was 1.47 miles per gallon. Fuel economy and oil consumption for the vehicle are summarized in Table 2.17-II.

Table 2.17-II. Fuel and Oil Consumption

Fuel or Oil	Amount Used	Grade
Fuel	717.3 gal	DF-2
Engine oil	25 qt	OE-30
Transmission	10 qt	OE-10
Transfer case	2-1/2 qt	OE-30
Final drives	0	OE-30
Steer differential	0	OE-30

At odometer 220, after repairs to the transmission, a leak was noted at the bottom of the hydraulic oil reservoir. This reservoir was replaced with a new reservoir incorporating improved mountings. Inspection of the original reservoir revealed a crack approximately three inches long adjacent to a weld on the bottom of the reservoir. Additional cracks were also developing in other welds in the reservoir.

Failures of the braces, 11545-20-4, which support the valve bank for launching and retrieving the bridge occurred at odometer 325 miles. The braces fractured in the threads behind the first locking nuts on the braces.

At odometer 344, the vertical brace, 11546-9-3, developed cracks in the attaching lugs to the upper connection to the female ramp. A crack also developed at the lug on the female ramp for the lower connection for the vertical brace.

The durability testing was initiated at odometer 527.

After 15 launches and 534 miles, failures occurred in several braces and beams of the bridge half without the hydraulic cylinder. These failures were at the welds in the vertical brace at the connection of the female ramp, in the hose retractor beam at the female ramp, and in the vertical brace connection to the male ramp.

Two hose retractors failed after 17 launches and 536 miles because the screws which hold the retainer plate inside of the beam sheared. Additional failures of the hose retractors occurred after 61 and 132 launches. Modified hose retractors were installed after 320 launches.

On the bridge half with the hydraulic cylinder, weld failures similar to those experienced on the other half of the bridge after 15 launches, were incurred after 19 launches and 539 miles had been completed. These failures resulted from inadequate design of the various braces and beams which couple the ramp sections together to form the bridge.

After 681 miles and 191 launches, the cross-country test area became very muddy because of excessive rainfall. An accumulation of mud developed on the bridge surfaces because of vehicle crossings and the bridge could not be lifted and retrieved. When the mud was scraped off by operating personnel, the bridge could be retrieved normally.

A check was made of the hydraulic system after 811 miles and 286 launches by attaching a pressure gage to the output line of the hydraulic pump. Four successive cycles were run with the bridge surface free of mud and other foreign materiel. During launching, the maximum pressure range was 1100 to 1200 psi, while during retrieving, the maximum pressure range was 2800 to 2950 psi.

Two sandbags (less than 200 pounds total weight) were then placed on the extended ramps. The system was unable to retrieve the bridge with a maximum pressure range of 3000 to 3200 psi and operating-oil temperature at ambient.

The pump-control handle is connected to an arm which moves the yoke within the pump to the position required for normal pump operation. Since there is no positive indexing between the arm and the yoke, the arm can be improperly connected and satisfactory pump operation will not occur. Operating pressures and flow rates will be below the necessary requirements for proper bridge launching and retrieving unless the arm and yoke are correctly aligned.

After 827 miles and 291 launches, one rotating beam-to-hinge pin bolt failed and this allowed the hinge pin to move out of the rotating beam. The rotating beam then did not maintain its proper position during retrieving operations, and the two struts which secure the rotating beam to the folding hydraulic cylinder and the tensile link were bent. Bending of the struts resulted in failures of the attaching welds to the rotating beam. These weld failures were repaired by welding.

During the first 320 launches, 16 failures of the rotating beam-to-hinge pin bolts occurred. These 1/4 in. by 3 in. bolts were underdesigned and were unable to withstand the shearing loads imposed during bridge launching and retrieving. Failures of these bolts allow the hinge pins to work out of the rotating beam and allow the beam to slip out of its proper position.

A failure of one of these bolts after 320 launches and 868 miles resulted in failure of the tensile link where it attaches to the link beam. When the bolt failed, the rotating beam became misaligned and the tensile link was pulled apart where it connects to the link beam.

After the completion of 320 launches, modifications were performed on the bridge to correct several deficiencies. These modifications included:

a. Installation of a refurbished hydraulic pump.

b. Installation of a redesigned tensile link.

c. Rework of the rotating beam.

d. Installation of larger diameter bolts and nuts which secure the rotating beam to the hinge pins.

e. Installation of a redesigned link beam.

f. Rework of the hose-retractor beams, and installation of redesigned hose-retractor beam mounts on the ramps.

g. Installation of redesigned hose retractors.

h. Installation of six redesigned hinge pins, castellated nuts, and cotter pins.

i. Installation of two redesigned hinge pins for the rotating beam.

j. Installation of a redesigned clevis pin, castellated nut, and cotter pin.

k. Installation of a redesigned cylinder-beam pin, castellated nut, and cotter pin.

l. Installation of a redesigned link-beam pin, castellated nut, and cotter pin.

m. Installation of redesigned tensile and sliding link spacers, used with the clevis pin in item j.

n. Welding all cracks in the beams, braces and ramps.

o. Reworking and welding the mounting bosses for the folding hydraulic cylinder on the cylinder beam.

p. Installation of redesigned surfboard lower mounts.

After the modifications were made, only one incident involving the modified items occurred.

When the bridge was being launched after 1083 miles and 441 launches, the two struts, which are attached to the rotating beam and form a sliding link with the folding hydraulic cylinder and the tensile link, failed. This failure prevented proper launching and retrieving of the bridge.

Since only 121 launch cycles were completed after the modifications were made, their success cannot be fully determined. However, the components appeared to be withstanding the testing quite well.

Photographs of various test incidents are included in Appendix I. Seventy-two incidents, including 15 deficiencies and 57 shortcomings, were observed during this test and are listed in Appendix III.

2.17.5 Analysis

Most of the test incidents pertaining to the bridge and the launcher occurred prior to the application of the extensive modifications. Primary cause of most of the failures to the bridge and the launcher components was insufficient strength.

There were no indications that any of the failures to the basic vehicle were directly attributable to the bridge and launcher installation.

2.18 MAINTENANCE EVALUATION

2.18.1 Objectives

The objectives are:

a. To evaluate the practicability, the ease of performance, use of standard tools, man-hour requirements for scheduled and unscheduled maintenance, and adequacy of the maintenance package with regard to direct support and general support.

b. To determine the suitability of special tools provided with the bridge.

2.18.2 Criteria

Reference 21, pars. 3.2.1; Appendix II, Part I, pars. 10, 11, and 14 through 22; Part II, par. 4; and Part III, pars. 2 and 3.

2.18.3 Method

Scheduled maintenance is conducted in accordance with instructions supplied with the vehicle.

Maintenance and analysis are developed by identifying and recording all maintenance time required during testing. The evaluation should provide suitable judgment in the cancellation or adjustment of the data on failures of components that are known to have been corrected before the conclusion of test.

Maintenance analysis is based on maintenance man-hours, ratio of man-hours to total operating hours, maintenance time, and ratio of maintenance time to operating hours.

2.18.4 Results

The over-all maintenance man-hour requirement per operating hour was 1.34 of which 0.36 hour was scheduled and 0.98 hour was unscheduled. The maintenance man-hour requirement per operating hour (less driver daily checks) was 1.16.

Vehicle downtime (time in unscheduled maintenance) was 60.50 hours or 0.68 hour per hour of operation. PSDR par. 6b (5) states that the mean downtime per 1000 miles or 500 launches shall not exceed 2.0 hours for all unscheduled organization and direct-support maintenance.

Scheduled maintenance required 32.42 man-hours and unscheduled maintenance required 87.50 man-hours of which 19.17 were for direct support. The 119.92 man-hours of scheduled and unscheduled maintenance greatly exceeded the PSDR requirement, par. 6b (4)(a)(2), that scheduled and unscheduled organizational maintenance shall not exceed 25 man-hours per 1000 miles or 500 launches for the launcher and two man-hours per 500 crossings of class 12 loads for the bridge.

The basic vehicle required 14.62 man-hours of scheduled and 31.1 man-hours of unscheduled maintenance of which 11.1 man-hours were for direct support. Most of the unscheduled and all of the direct-support maintenance man-hours were required because of transmission malfunctions and/or failures.

Scheduled maintenance for the launcher was 8.9 man-hours and unscheduled maintenance totalled 19.9 man-hours with 1.7 man-hours for direct support.

The bridge required 9.0 man-hours for scheduled maintenance and 17.3 man-hours for unscheduled maintenance with 6.3 man-hours for direct support.

Over-all maintenance, scheduled and unscheduled, are listed per operating hour, mile of operation, and launch in Table 2.18-I.

The maintenance package was adequate. Spare parts and a maintenance manual were furnished and no special tools were required.

Table 2.18-I. Maintenance Data Summary

1.	Velocity:	11.74
2.	Reliability (Vehicle Hours)	
	a. Time in use and maintenance 100%	179.92
	b. Time in use	89.50
	c. % of time in use	50%
	d. Time in use and scheduled maintenance	119.42
	e. % of time in use and scheduled maintenance	66%
	f. Unscheduled maintenance	60.50
	g. % of time in unscheduled maintenance	34%
	h. Mean time between failures:	
	(1) Organizational	2.56
	(2) Field	6.88
	i. Mean time between sched maint:	
	(1) Organizational (driver)	[a]**0.82**
	(2) Organizational (other)	9.94
3.	Amount of Maintenance (man-hours)	
	a. Maintenance man-hours per operating hours	1.34
	(1) Organizational (driver)	**0.18**
	(2) Organizational scheduled	**0.18**
	(3) Organizational unscheduled	**0.76**
	(4) Direct and general support	.22
	b. Maintenance man-hours per 100 miles	11.41
	c. Maintenance man-hours per mile of operation	**0.11**
	(1) Organizational (driver)	.01
	(2) Organizational scheduled	.02
	(3) Organizational unscheduled	.06
	(4) Direct or General Support	.02
	d. Maintenance man-hours per launch	.27
	(1) Organizational (driver)	.04
	(2) Organizational scheduled	.04
	(3) Organizational unscheduled	.15
	(4) Direct or General Support	.04
	e. Mean time to repair	
	(1) Organizational unscheduled	1.95
	(2) Direct or General Support	1.47

[a]**Accomplishment of the test plan prescribed operating cycle** required more frequent than normal driver/crew preventative maintenance checks. This in combination with the low overall operation time (89.50 hours) caused the mean time of .82 hours between organizational (driver) maintenance to be abnormally low.

Table 2.18-I (Cont'd)

4. Maintainability (Vehicle Hrs)
   a. Average length of each stoppage:
      (1) Organizational (driver) .15
      (2) Organizational scheduled 1.56
      (3) Organizational unscheduled 1.34
      (4) Direct and general support 1.05
   b. Total vehicle downtime per oper hour .68
   c. Total vehicle maint hrs per operating hour 1.01
      (not to be confused with maintenance man-hours)

5. Test Course Mileage

Paved	431
Gravel	290
Level cross-country	101
Swamp	217
Water	12
TOTAL	1051

The 87.50 man-hours of unscheduled maintenance were due to the various incidents listed in Table 2.18-II. Incidents are separated as to the basic vehicle, launcher, and bridge.

Table 2.18-II. Summary of Incidents, Unscheduled Maintenance

M113A1 Basic Vehicle	Test Miles at Time of Repair	Launches at time of repair	Vehicle Hours	Maintenance Man-Hours	Direct or General Support Maintenance
[a]Replaced transmission high clutch, turbine shaft seals, control valve body and oil transfer plate.	188	0	5.7	7.7	3.7 D.S.
Adjusted the differential steer brakes.	460	0	.3	.7	
Replaced left sealed beam unit.	537	58	.2	.2	
Replaced two track adjuster bracket bolts, track adjuster, shock absorber and three track shoe assemblies. (right side).	641	201	2.0	4.0	
Replaced the transmission, No 1 right lower shock absorber washer and seals and one track shoe assembly (right track).	883	364	7.0	10.3	3.7 D.S.

Table 2.18-II (Cont'd)

Replaced engine low oil pressure sending unit.	990	425	.5	.5	
Replaced the transmission.	1026	440	5.7	7.7	3.7 D.S.
Launcher Components:					
Hydraulic reservoir leaking at bottom seam. Removed, steam cleaned, welded and re-installed.	115	0	8.2	7.3	.8 D.S.
Replaced hydraulic reservoir and mounting kit.	167	0	8.5	8.5	
Repaired right surfboard retaining brackets by welding. (broken during fording test).	452	0	.3		.3 D.S.
Repaired broken launching cylinder lever by welding.	653	216	.3		.3 D.S.
Repaired broken launching cylinder lever by welding.	799	311	.3		.3 D.S.
Replaced the bridge control valve body braces.	863	338	1.0	1.0	
Replaced the launching cylinder lever.	879	360	.2	.2	
Tightened the bridge seat mounting bolts.	905	378	.2	.2	
Left and right launching beam pins binding. Removed pins, cleaned, greased, and reinstalled.	917	380	1.3	2.7	
Bridge Components:					
Replaced two quick disconnect pipe nipples (end w/hydraulic cylinder).	524	4	.5	.5	
Repaired cracks in the horizontal brace (end w/hydraulic cylinder) and both hose retractor beams by welding. Replaced the vertical braces.	487	19	5.7	10.0	.7 D.S.
Replaced one rotating beam retaining bolt.	496	19	.3	.3	
Replaced two quick disconnect pipe nipples. (end w/hydraulic cylinder).	521	24	.5	.5	

Table 2.18-II (Cont'd)

	Test Miles at Time of Repair	Launches at time of Repair	Vehicle Hours	Maintenance Man-Hours	Direct or General Support Maintenance
Tightened the horizontal brace retaining bolts (end w/o hydraulic cylinder).	545	65	.3	.3	
Tightened hydraulic cylinder lines.	552	74	.2	.2	
Tightened ramp pickup socket bolts and the hydraulic lines on the folding and locking cylinders.	563	95	.5	.5	
Repaired the hose retractors by welding (end w/hydraulic cylinder).	574	107	.3		.3 D.S.
Repaired the hose retractors by welding (end w/o hydraulic cylinder).	590	130	.3		.3 D.S.
Replaced one rotating beam retaining bolt and tightened the pickup socket bolts.	616	170	.7	.7	
Repaired cracks in the hose retractor beam and the hydraulic cylinder cross beam mounting pads.	641	201	.8		.8 D.S.
Replaced two rotating beam retaining bolts.	673	228	.5	.5	
Repaired cracks in the hose retractor beam, vertical end brace mounting pad and replaced two rotating beam retaining bolts.	720	263	2.0	.5	1.5 D.S.
Replaced one rotating beam retaining bolt.	730	279	.3	.3	
Replaced one rotating beam retaining bolt.	759	286	.3	.3	
Replaced left sealed beam unit.	761	291	.2	.2	

Table 2.18-II (Cont'd)

	Test Miles at time of repair	Launches at time of repair	Vehicle Hours	Maintenance Man-Hours	Direct or General Support Maint.
Rotating beam retaining bolt broke allowing retaining pin to work out. Installed the pin and replaced one rotating beam retaining bolt.	775	292	1.2	1.2	
Replaced two rotating beam retaining bolts.	785	297	.5	.5	
Replaced one rotating beam retaining bolt.	801	314	.3	.3	
Replaced the tensile link. Welded cracks in the mounting bosses for the hydraulic cylinder and bridge ramps.	815	320	2.5	.5	2.0 D.S.
Repaired cracks in the vertical brace (end w/o hydraulic cylinder).	840	323	.7		.7 D.S.

[a]Normally in the field, failed major components are replaced by organizational or direct support maintenance and the vehicle is returned to use; consequently, only that time required for replacement is considered in this report.

Figure 2.18-1 graphically illustrates the ratio of total maintenance man-hours to hours of operation. A curve of the ratio of maintenance man-hours (less driver daily checks) to operational hours is also shown in Figure 2.18-1.

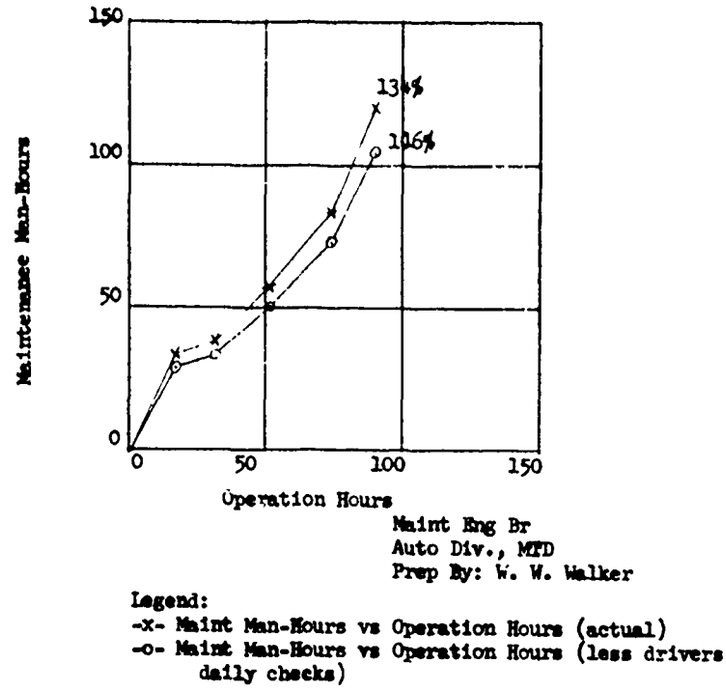


Figure 2.18-1: Maintenance versus Operation.

2.18.5 Analysis

The basic vehicle failed to meet the operational capabilities of specification MIL-C-46782A(MO) as to the following:

a. Vehicle shall require only organizational maintenance (first and second echelon) during 2000 miles of normal operation since direct support was required for transmission replacement.

b. Vehicle shall require no replacement or major overhaul of any major automotive component during 4000 miles of normal operation because of transmission failures.

Underdesign of the bridge components and various launcher components resulted in various failures with the subsequent unscheduled maintenance required. Insufficient operation (121 launches and 183 miles) was accumulated on the redesigned bridge and launcher components to provide dependable information as to reliability, availability, and failure rate.

2.19 HUMAN FACTORS

2.19.1 Objective

The objective is to determine the suitability of the seating, visibility, arrangement of controls, instrument displays, entry and exit for all personnel, and general comfort to include noise level, vibration response, and vehicle pitch, bounce, and stability.

2.19.2 Criteria

Reference Appendix II, Part I, par. 3.

2.19.3 Method (MTP 2-2-803)

A human-factors review of the vehicle is made under both static and dynamic conditions, with primary emphasis on the bridge and launching equipment. This review is integrated as much as possible with planned testing. Specific items considered with human safety, comfort, efficiency, and ease of operation include the following:

a. Space requirement for ease of operation and maintenance.

b. Control display relationships.

c. Work-space layout.

d. Safety in operation and maintenance.

e. Environmental factors such as temperature, humidity, dust, noise, and vibration.

f. Communication.

g. Readability of such items as dials and meters.

h. Comfort, which may significantly affect efficiency of operation and personnel.

i. An accumulation of nauseous and irritating fumes in an amount that has an effect on personnel.

Instrumentation is used to the extent necessary to obtain an objective analysis of problems.

2.19.4 Results

During vehicle test, a human-factors review indicated that operating personnel generally had suitable work space and personal comfort to adequately operate the launcher and the bridge. Under normal operating conditions, there were no nauseous and irritating exhaust fumes from the vehicle engine. Exhaust fumes could blow into the launcher operator's station if the vehicle was not correctly oriented with prevailing winds. Environmental factors, such as temperature, humidity, dust, noise, etc are identical for the marginal-terrain assault bridge and standard M113A1 APC vehicles.

2.19.5 Analysis

Not applicable.

2.20 FINAL INSPECTION

2.20.1 Objectives

The objectives are:

a. To determine the condition of the vehicle and bridge components at the end of test.

b. To predict, to some degree, the ability of the vehicle and bridge to continue in service.

2.20.2 Criteria

Appropriate Department of the Army Technical Manuals and prints are used to ascertain vehicle condition.

2.20.3 Method (MTP 2-2-505)

Visual and possible magnaflux inspections are made of vehicle components. Particular attention is given to the hull and other components in the areas of bridge installation points. A complete teardown of the bridge is made to determine wear and damage to its parts.

Measurements taken and data recorded before test are repeated to determine significant changes during test.

2.20.4 Results

A final inspection was not accomplished because of test termination, and the immediate return of the vehicle to USAMERDC, as requested. In addition, failures of the two struts, which form a sliding link on the rotating beam with the folding hydraulic cylinder and the tensile link, precluded ready movement of the bridge assembly. These failures were the only visible damage, except for minor weld failures and loss of the nonskid paint, of the bridge assembly. There were no indications of failures or excessive wear in the launcher assembly.

2.20.5 Analysis

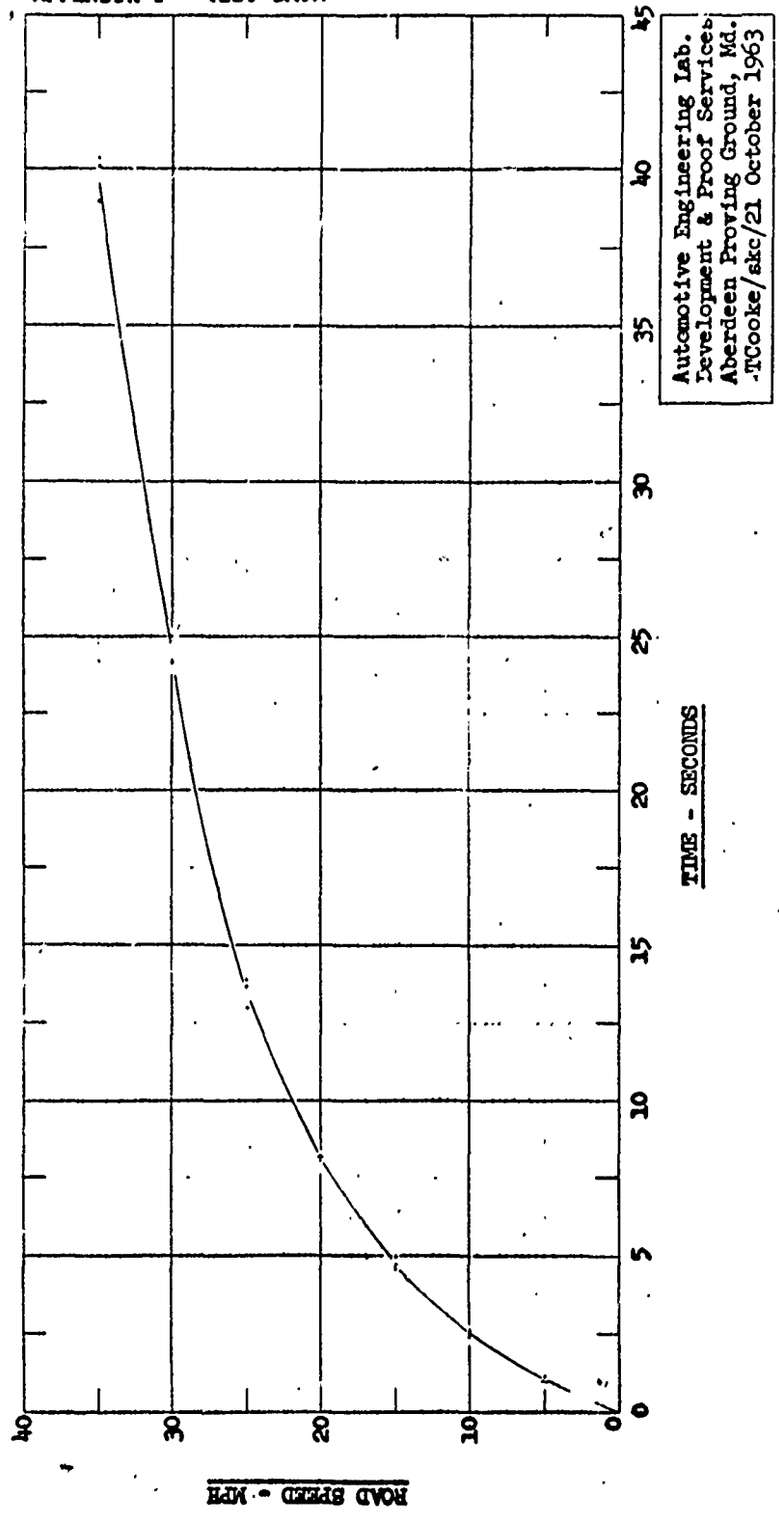
Many of the improvement items that had been added to the bridge - launcher system had received insufficient testing for evaluation as to wear and damage at the termination of testing. The limited test operation, 1051 miles also did not provide a sufficient basis for evaluation of the basic vehicle components.

APPENDIX I - TEST DATA

CARRIER, PERSONNEL, FULL-TRACKED, ARMORED, M113A1, USA REG. NO. 12CS88

FULL THROTTLE ACCELERATION (TIME-VELOCITY) CHARACTERISTICS WITH VV-F-800, DF-2 FUEL

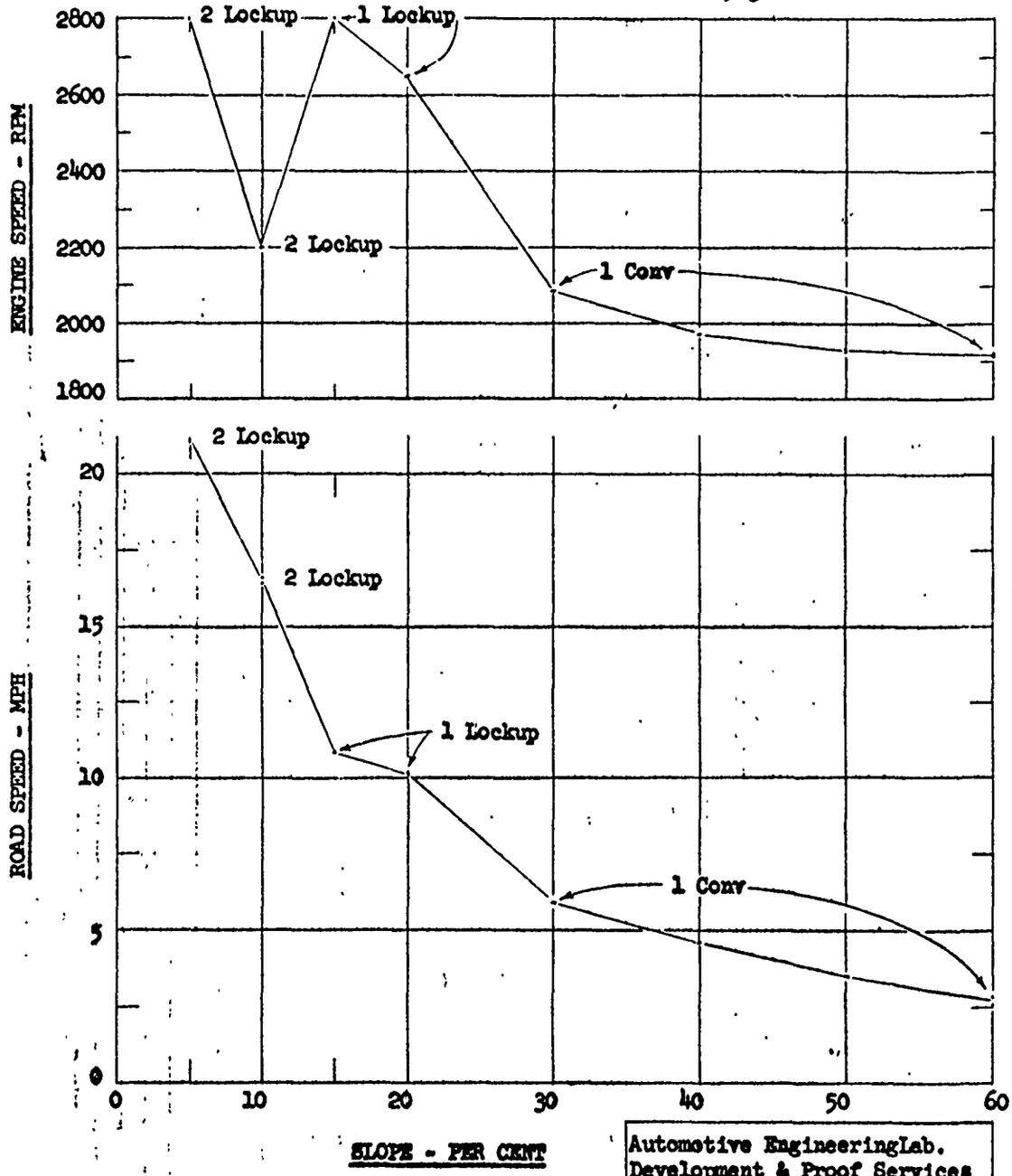
Engine: Model No. 6V53
Transmission: Model No. TX-100-1
Steer Unit: Model No. DS-200
Track: T130
Vehicle Weight: 23,625 Lbs
Date of Test: 16 October 1963



SLOPE PERFORMANCE CHARACTERISTICS WITH VV-F-800, DF-2 FUEL

Engine: Model No. 6V53
Transmission: Model No. TX-100-1
Steer Unit: Model No. DS-200
Track: T130
Vehicle Weight: 23,625 Lbs

Dates of Test: 11 and 16 October 1963



Automotive EngineeringLab.
Development & Proof Services
Aberdeen Proving Ground, Md.
TCooke/sko/21 October 1963

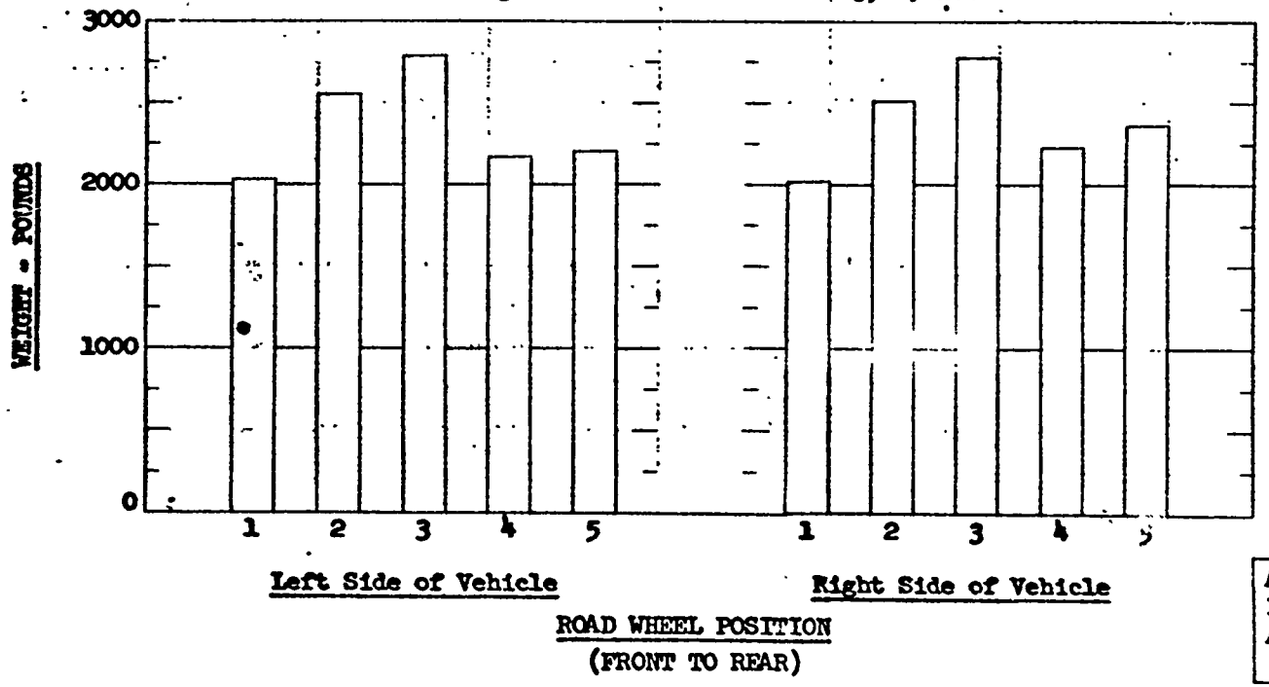
63-188-7

STATIC WEIGHT DISTRIBUTION

Test Conditions: W/Full Fuel Tank
W/Driver
W/Payload

Date of Test: 8 October 1963

Total Vehicle Weight on Platform Scale - 23,425 Lbs



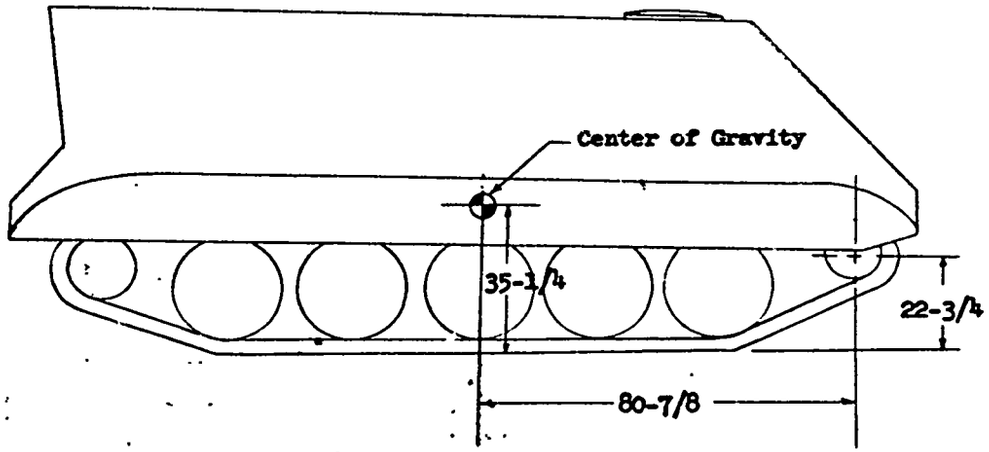
Automotive Engineering Lab.
Development & Proof Services
Aberdeen Proving Ground, Md.
TCooke/kc/11 October 1963

CARRIER, PERSONNEL, FULL-TRACKED, ARMORED, M113A1,

USA REG. NO. 12CS88

CENTER OF GRAVITY LOCATION

Vehicle Weight: 23,275 Lbs
Date of Test: 8 October 1963



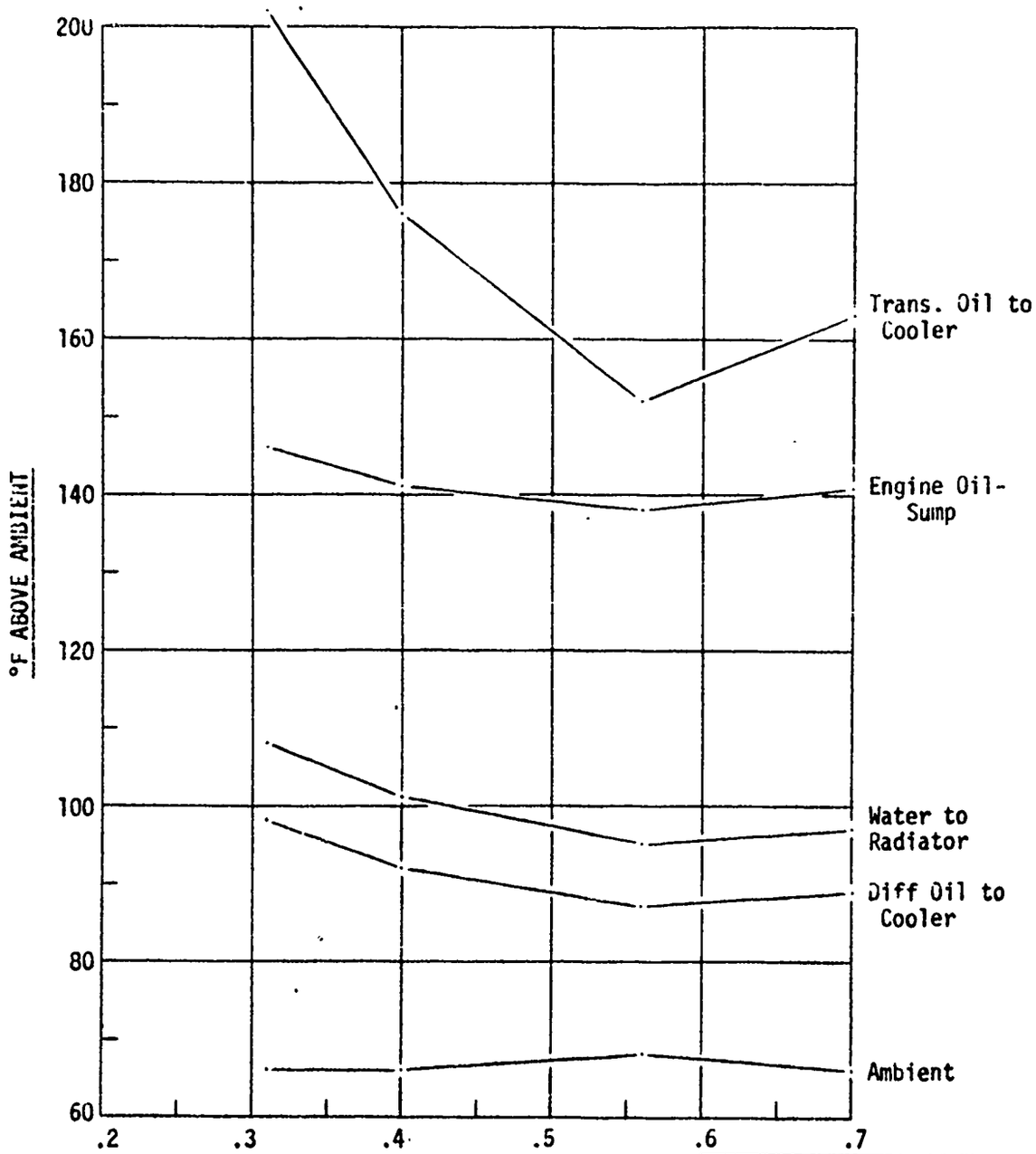
NOTES: 1. Dimensions are given in inches
2. Payload consisted of armor plating attached to personnel compartment floor.

Automotive Engineering Lab.
Development & Proof Services
Aberdeen Proving Ground, Md.
TCooke/akc/11 October 1963

MARGINAL TERRAIN ASSAULT BRIDGE W/APC LAUNCHER, USA REG. NO. 12HU76

COOLING CHARACTERISTICS

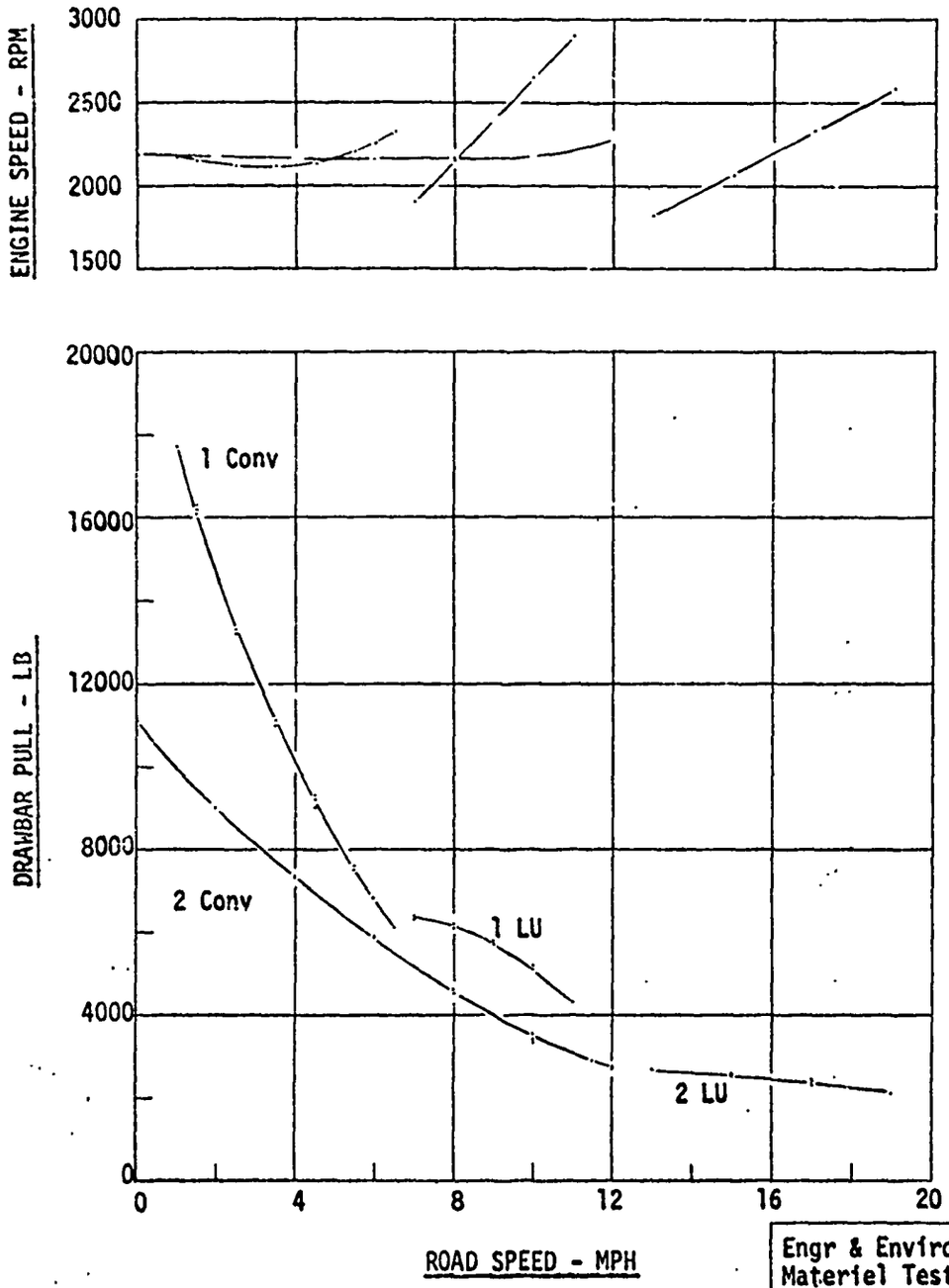
Engine: Model No. 6V53
Transmission: Model No. TX-100-1
Fuel: VV-F-800, Diesel Fuel DF-2
Vehicle Weight: 24,900 LB
Dates of Test: 11 and 14 October 1968



Engr & Environmental Test Sec
Materiel Test Directorate
Aberdeen Proving Ground, Md.
PGross/skc/12 November 1968

DRAWBAR PULL CHARACTERISTICS

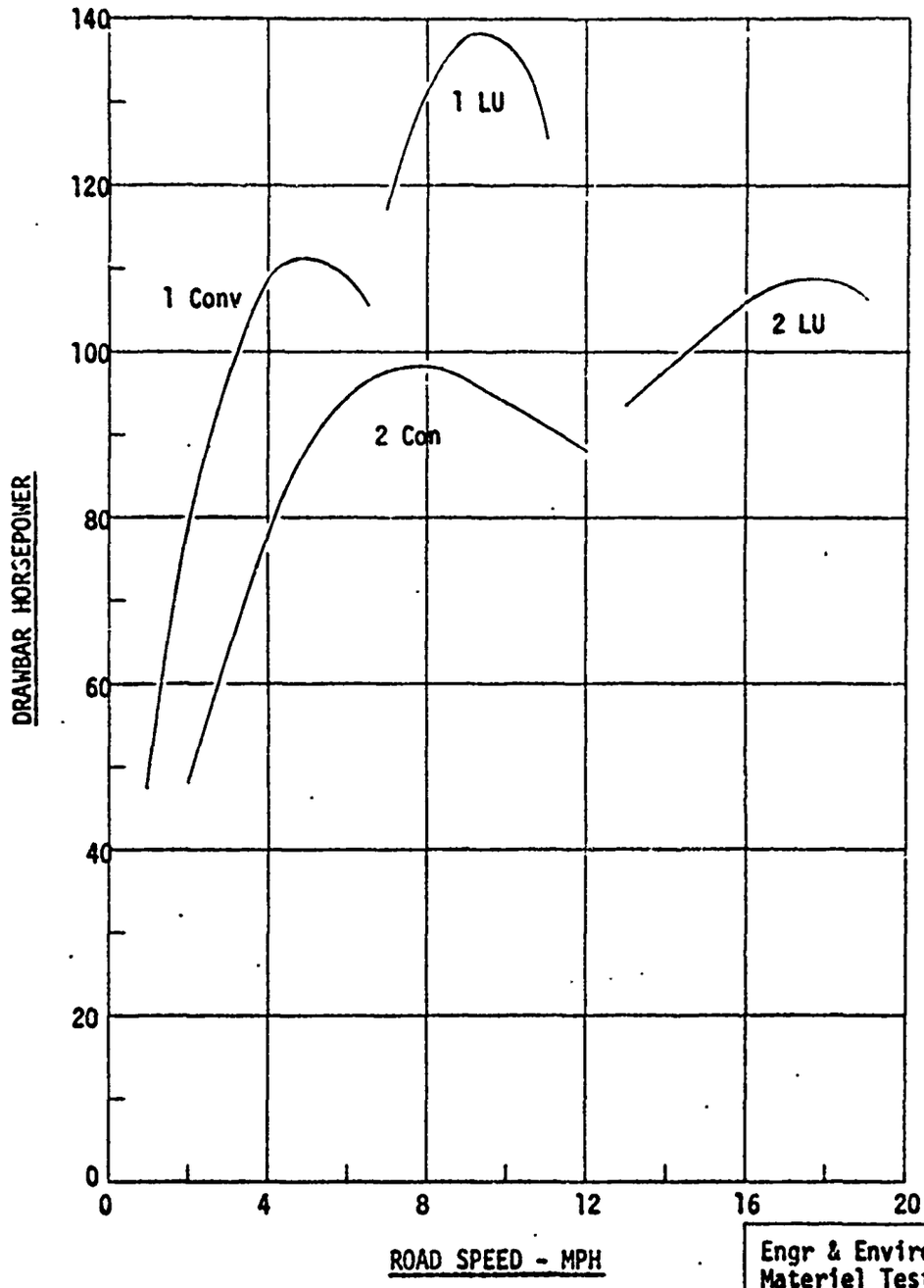
Engine: Model 6V53
Transmission: Model TX-100-1'
Fuel: VV-F-800, Diesel Fuel DF-2
Vehicle Weight: 24,900 Lb
Date of Test: 14 November 1968



Engr & Environmental Test Sec
Materiel Test Directorate
Aberdeen Proving Ground, Md.
PGross/skc/20 November 1968

DRAWBAR HORSEPOWER CHARACTERISTICS

Engine: Model 6V53
Transmission: Model TX-100-1
Fuel: VV-F-800, Diesel Fuel DF-2
Vehicle Weight: 24,900 Lb
Date of Test: 14 November 1968



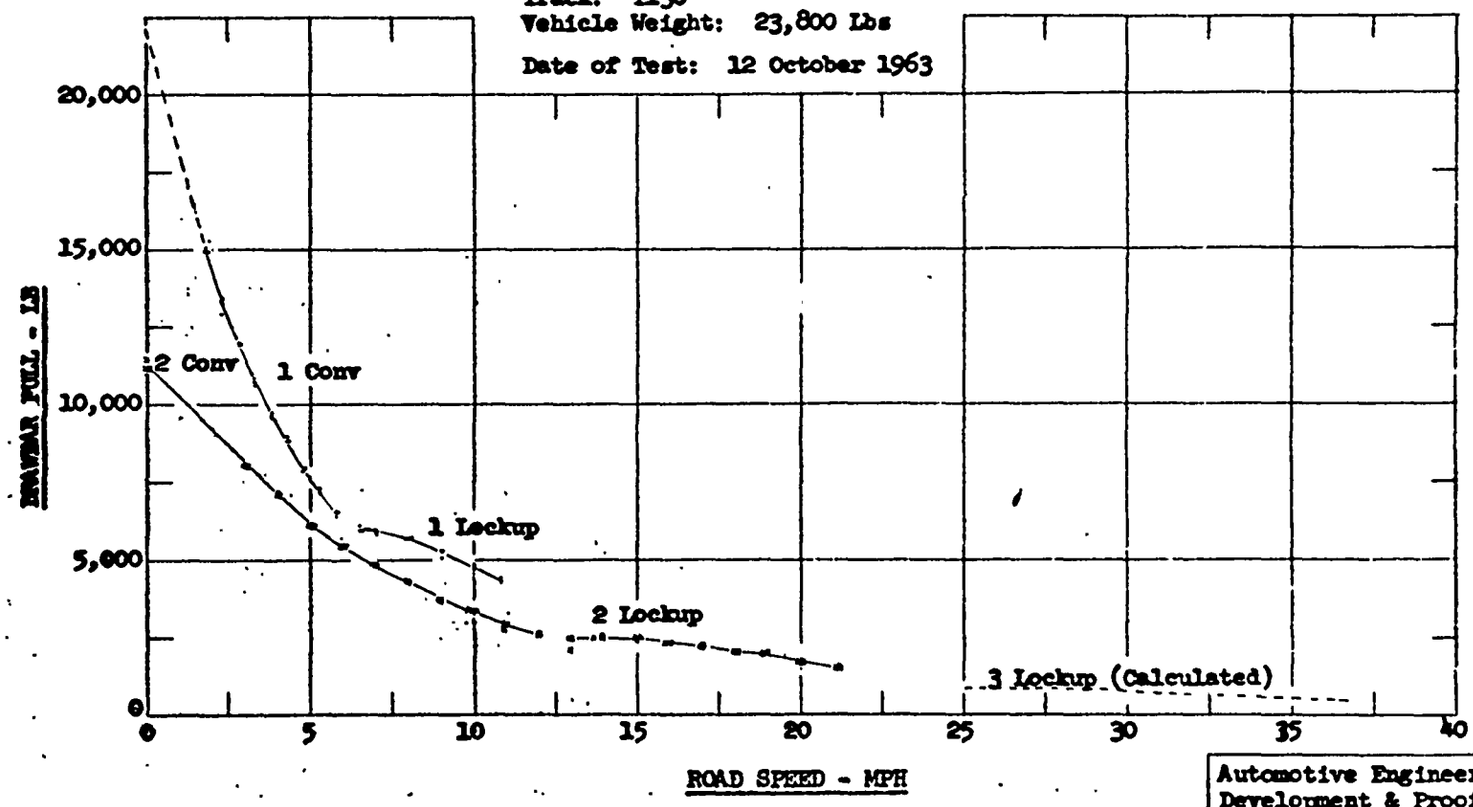
Engr & Environmental Test Sec
Materiel Test Directorate
Aberdeen Proving Ground, Md.
PGross/skc/20 November 1968

CARRIER, PERSONNEL, FULL-TRACKED, ARMORED, M113A1, USA REG. NO. 12CS88

DRAWBAR PULL CHARACTERISTICS WITH VV-F-800, DF-2 FUEL

Engine: Model No. 6V53
Transmission: Model No. TX-100-1
Steer Unit: Model No. DS-200
Track: T130
Vehicle Weight: 23,800 Lbs

Date of Test: 12 October 1963

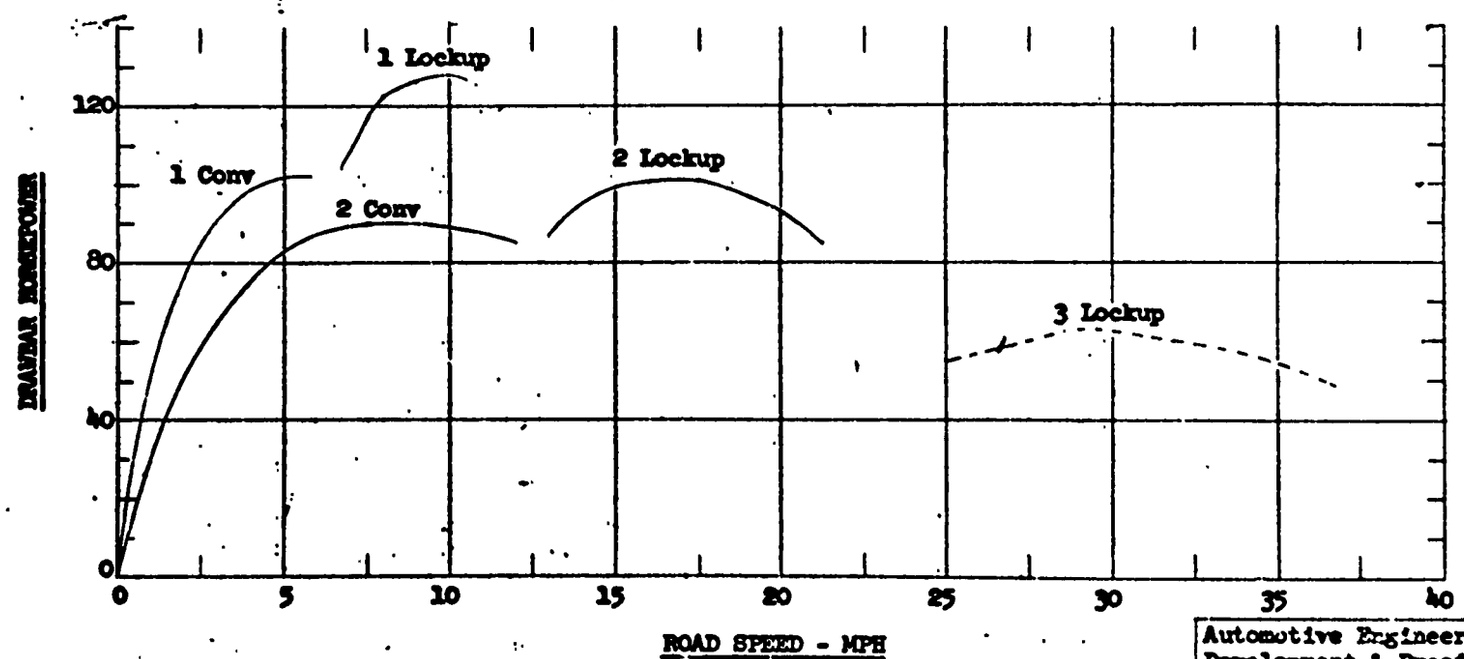


Automotive Engineering Lab.
Development & Proof Services
Aberdeen Proving Ground, Md.
TCooke/skc/21 October 1963

63-188-3

DRAWBAR HORSEPOWER CHARACTERISTICS

Engine: Model No. 6V53
Transmission: Model No. TX-100-1
Steer Unit: Model No. DS-200
Track: T130
Vehicle Weight: 23,800 Lbs



Automotive Engineering Lab.
Development & Proof Services
Aberdeen Proving Ground, Md.
TCooke/skc/22 October 1963

63-188-4

DEVELOPMENT AND PROOF SERVICES
ABERDEEN PROVING GROUND
MARYLAND

MECHANICAL LABORATORY DATA SHEET

DATE: SUMMARY DATA DURING FULL LOAD COOLING TEST

TEST OF: MARGINAL TERRAIN ASSAULT BRIDGE WITH APC LAUNCHER, USA REG NO 12HU76

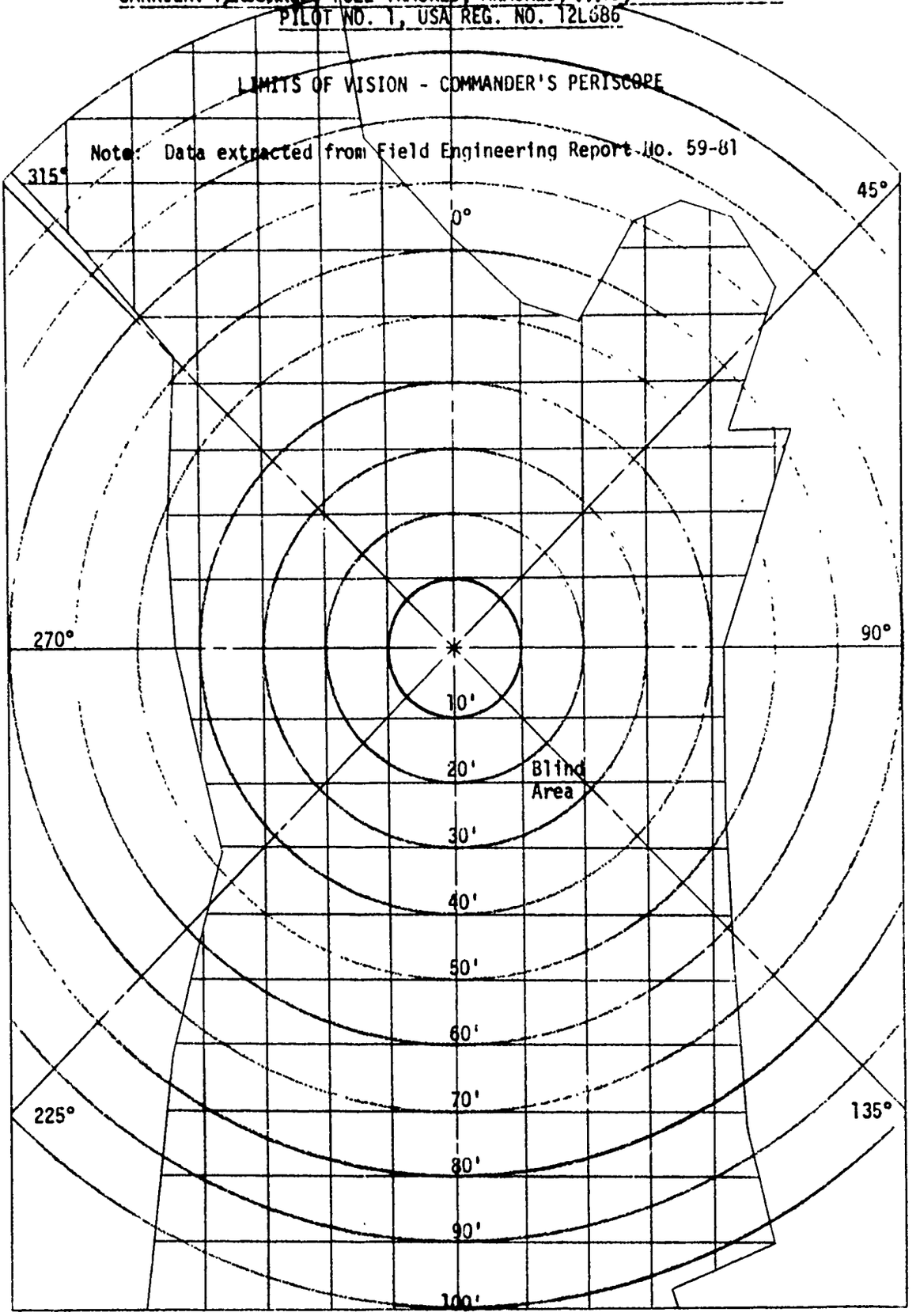
								ROAD	LOAD						
GEAR	2-CON	2-CON	2-CON	2-CON		1-LU		3-LU							
MPH	5.0	6.4	9.0	12.0		10.0		42.0							
RPM	2120	2110	2140	2270		2780		2820							
INV. SPEED RATIO	.31	.40	.56	.70											
WATER OUT RADIATOR	162	156	153	153		145		156							
WATER IN RADIATOR	174	167	163	163		153		166							
ENG OIL - SUMP	212	207	206	207		202		208							
ENG OIL - GALLERY	197	193	190	192		191		198							
TRANS OIL TO COOLER	268	242	220	229		171		188							
TRANS OIL FROM COOLER	202	190	179	182		152		160							
DIFF OIL TO COOLER	164	158	155	155		147		191							
DIFF OIL FROM COOLER	162	157	153	154		146		178							
DRIVERS COMPARTMENT	71	72	71	68		77									
CREW COMPARTMENT															
LEFT SIDE	73	75	73	70		78									
RIGHT SIDE	76	77	75	73		80									
BRIDGE OPERATOR	74	76	73	70		79									
AMBIENT	66	66	68	66		69		67							

STEAP-DS Form 59, 1 Mar 65 (Replaces STEAP Form 605-(R), Rev 17 Oct 47)

CARRIER: PERSONNEL, FULL-TRACKED, ARMORED, M113, PREPRODUCTION
PILOT NO. 1, USA REG. NO. 12L686

LIMITS OF VISION - COMMANDER'S PERISCOPE

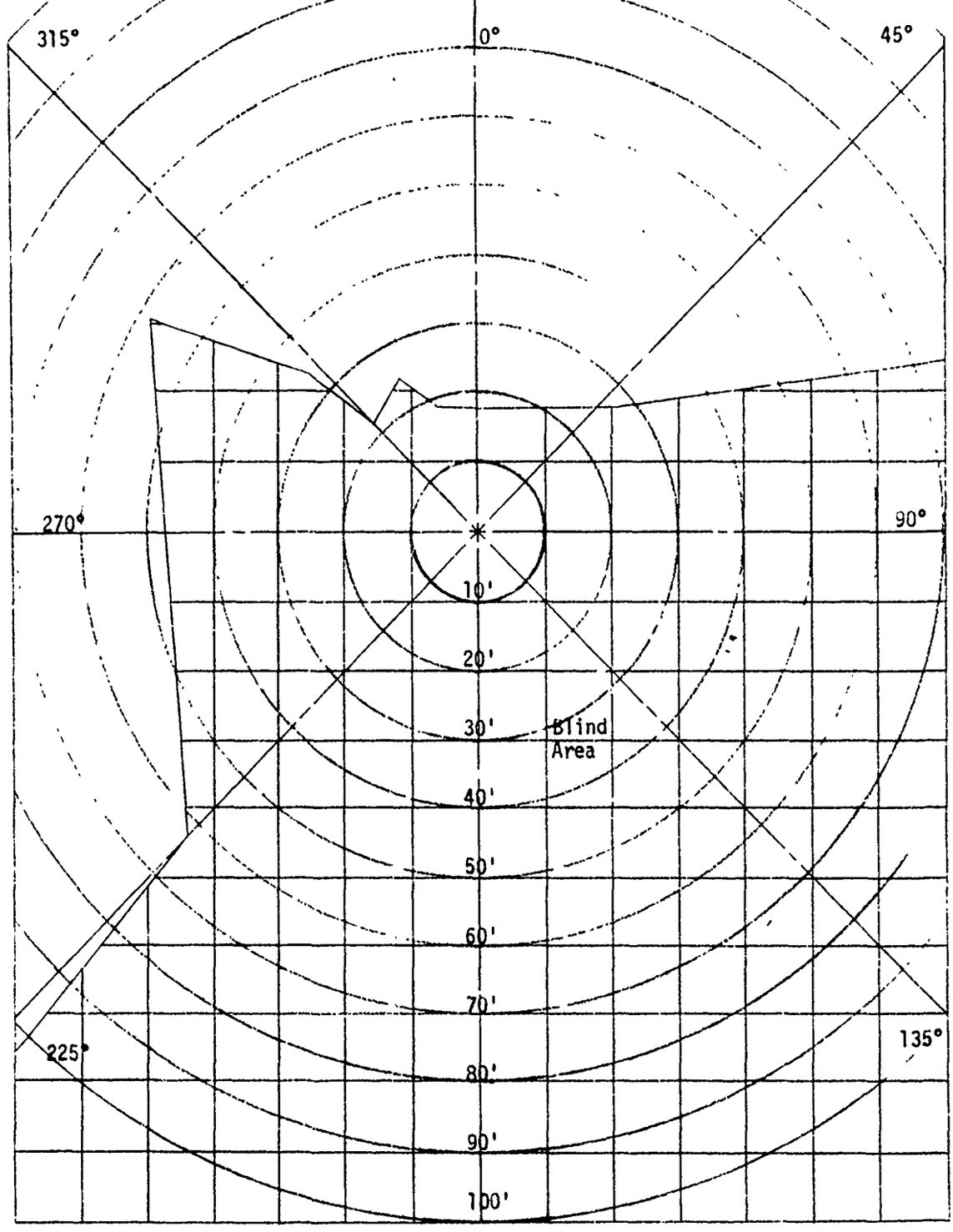
Note: Data extracted from Field Engineering Report No. 59-81



CARRIER, PERSONNEL, FULL-TRACKED, ARMORED, M113, PREPRODUCTION
PILOT NO. 1, USA REG. NO. 1-086

LIMITS OF VISION - DRIVER'S PERISCOPE

Note: Data extracted from Field Engineering Report No. 59-81



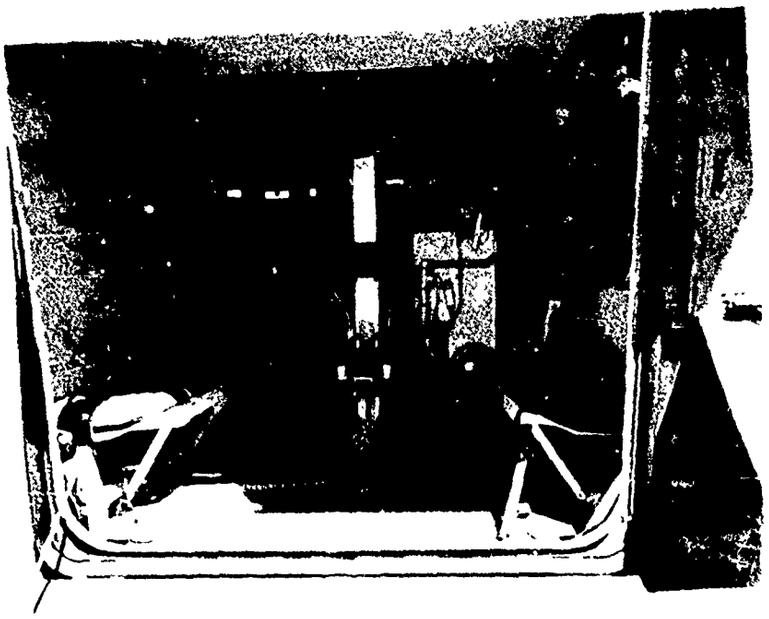


Figure I-1: Interior View.

Figure I-2: Front View with Bridge in Carrying Position.

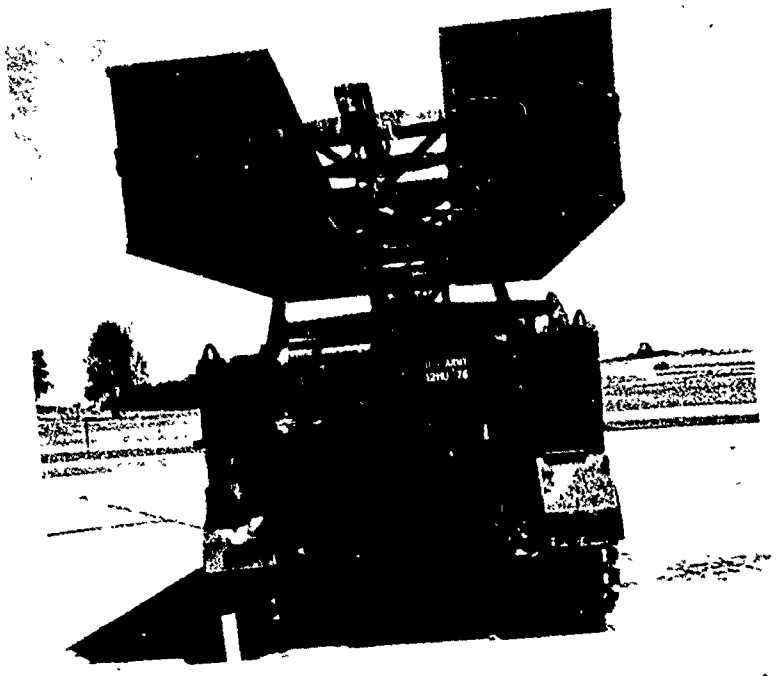


Figure I-3: Rear View with Bridge in Carrying Position.

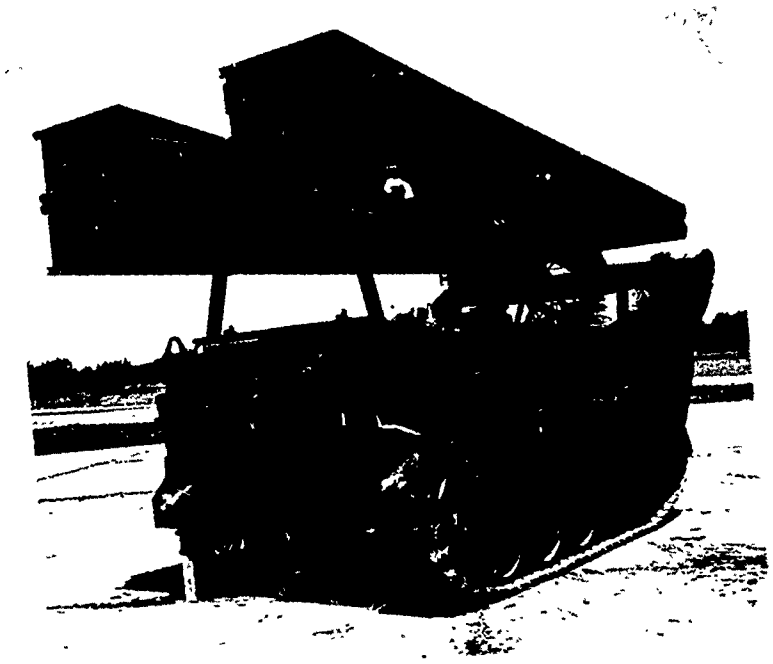


Figure I-4: Three-Quarter Right Rear Position with Bridge in Carrying Position.

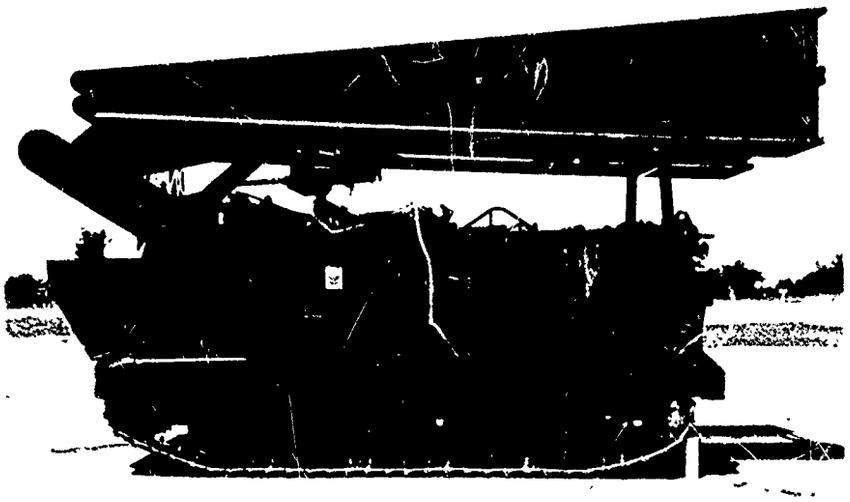


Figure I-5: Left Side View with Bridge in Carrying Position.

Figure I-6: Three-Quarter Right Front View with Launcher Raised and Bridge Lowered. Vehicle on Bridge.

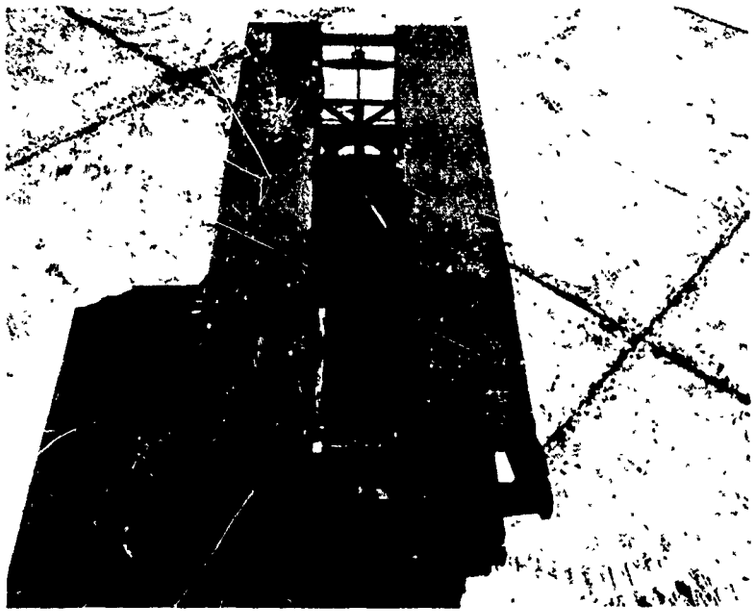


Figure I-7: Top View with Bridge in Carrying Position.

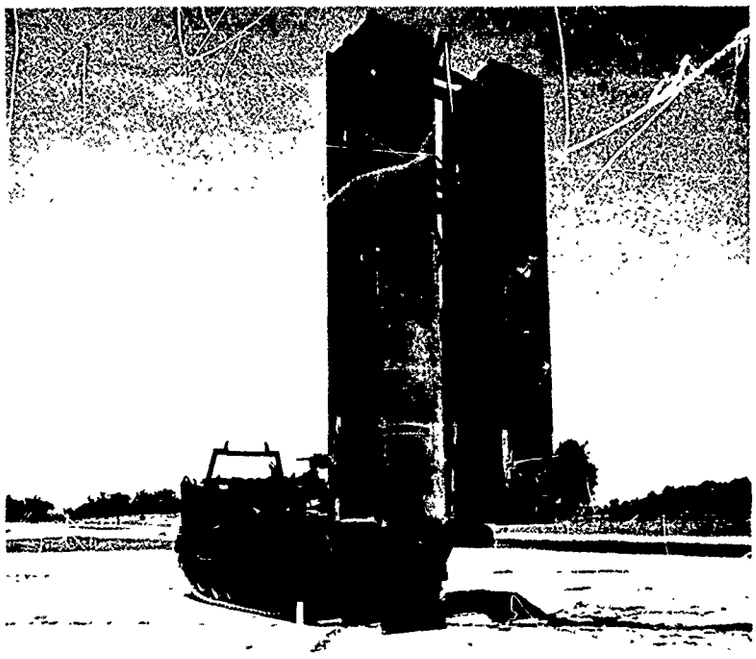


Figure I-8: Three-Quarter Right Front View with Bridge Raised and Partially Extended.

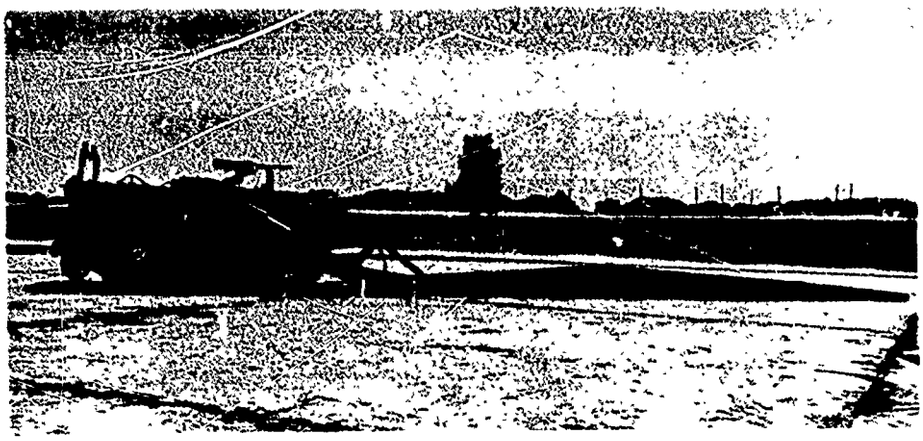


Figure I-9: Right Side View with Bridge Fully Extended and Lowered

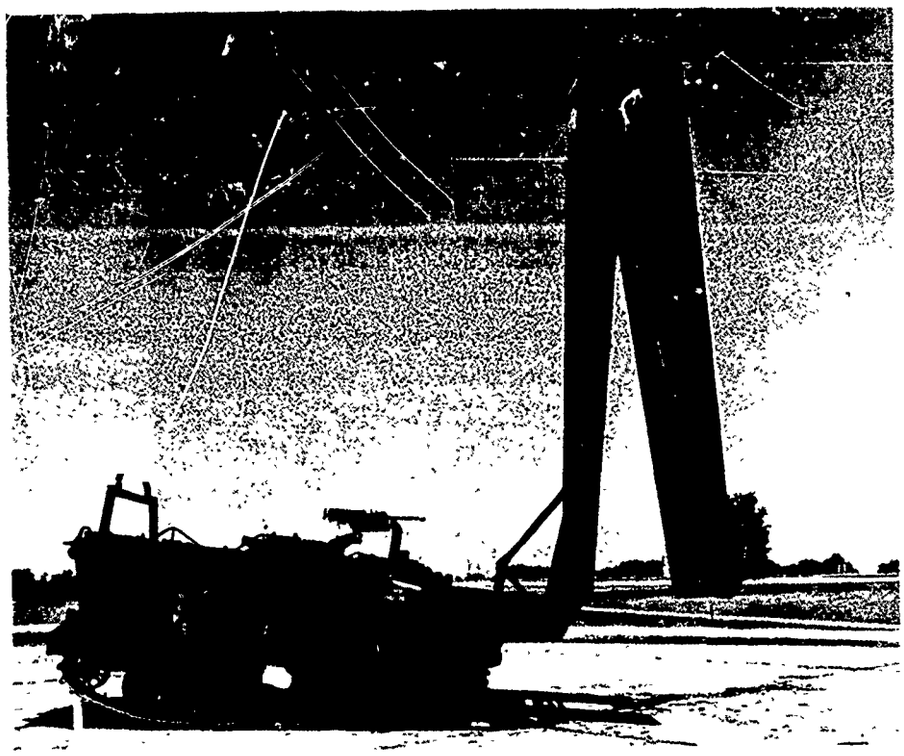


Figure I-10: Right Side View with Bridge Partially Raised and Being Lowered Into Position.

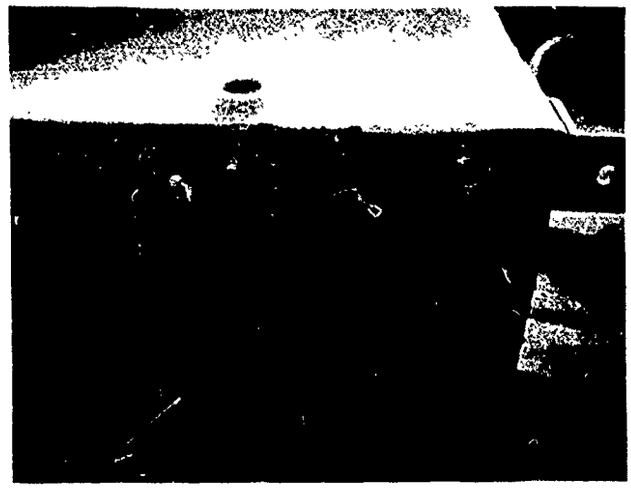


Figure I-11: Drip in Hydraulic Oil Reservoir Odometer 167.

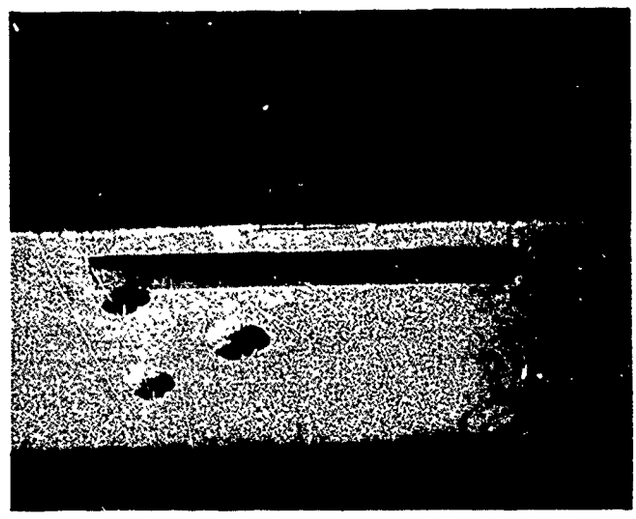


Figure I-12: Crack in Weld on Hydraulic Oil Reservoir Odometer 220.

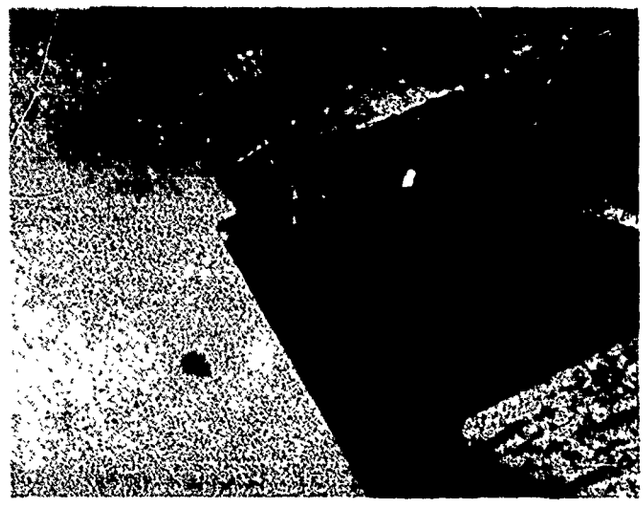


Figure I-13: Cracks in Vertical Brace Odometer 344 Miles.

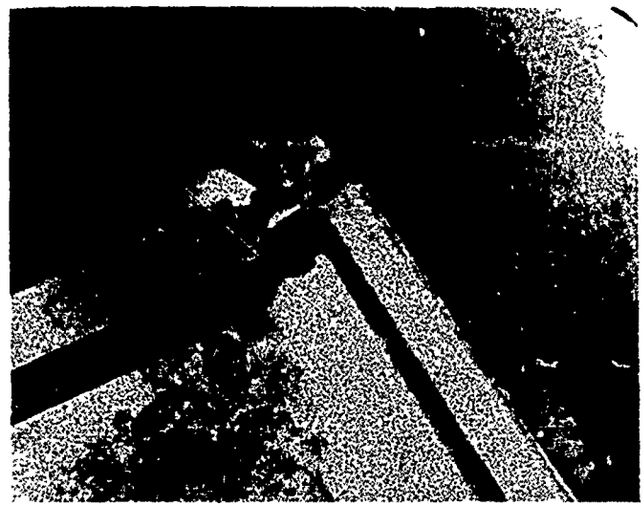


Figure I-14: Crack Where Vertical Brace Attaches to Female Ramp, Odometer 344 Miles.

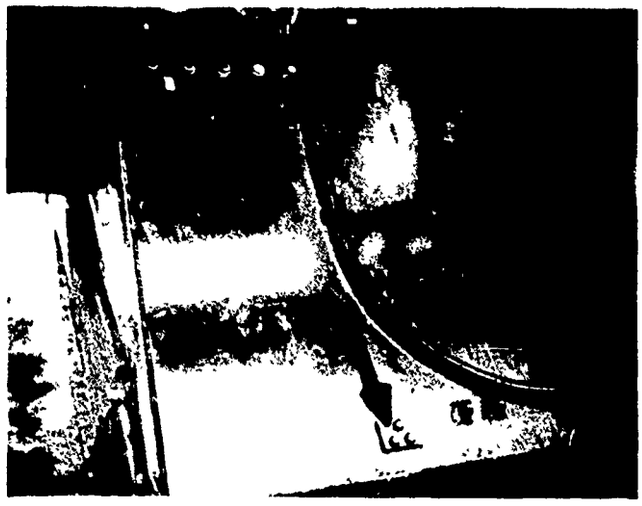


Figure I-15: Failed Mounts. Odometer 500 Miles.

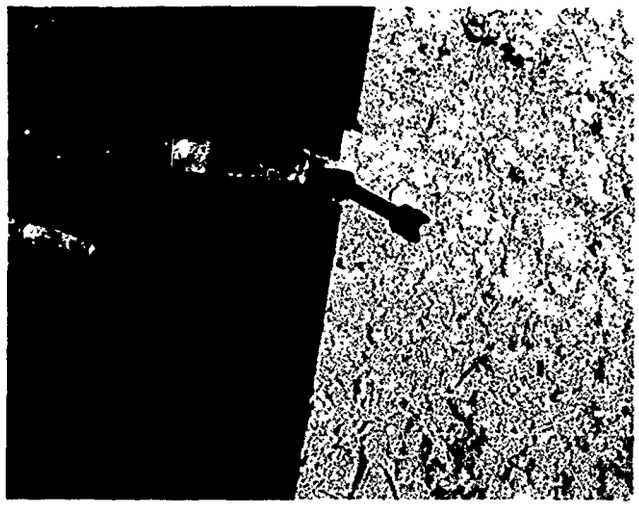


Figure I-16: Failed Weld in Vertical Brace.

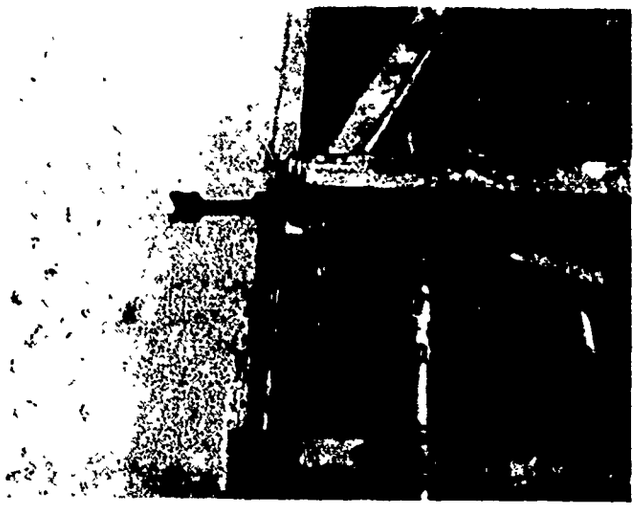


Figure I-17: Failed Welds in Vertical Brace After 15 Launches.

Figure I-18: Failed Weld in Hose Retractor Beam.

Figure I-19: Failed Hose Retractor.

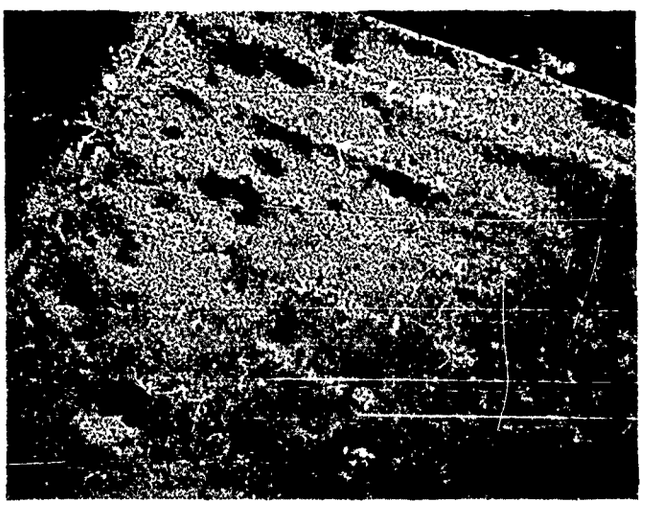


Figure I-20: Gouged Ramp.

Figure I-21: Crack at "X" of Horizontal Brace.

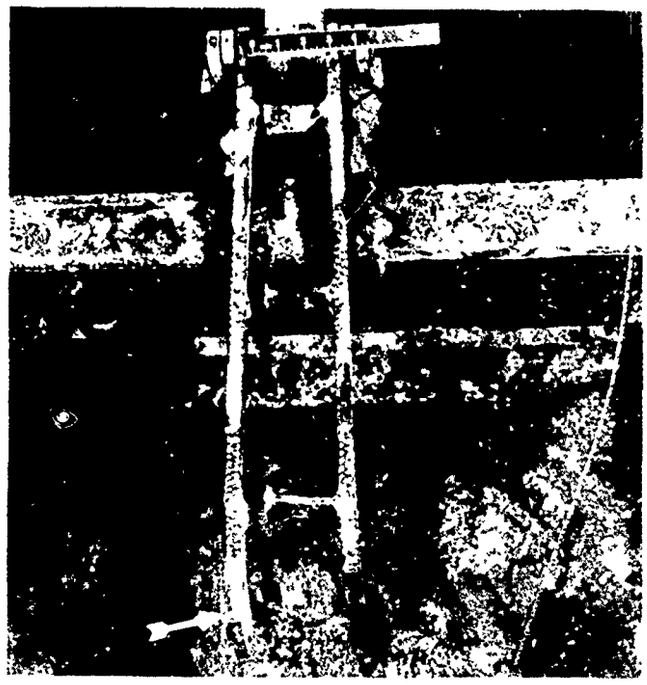


Figure I-22: Failed Connection to Link Beam (White Arrow) and Failed Welds at Crosspieces (Black Arrows). Odom. Odom. 856, 320 Launches.

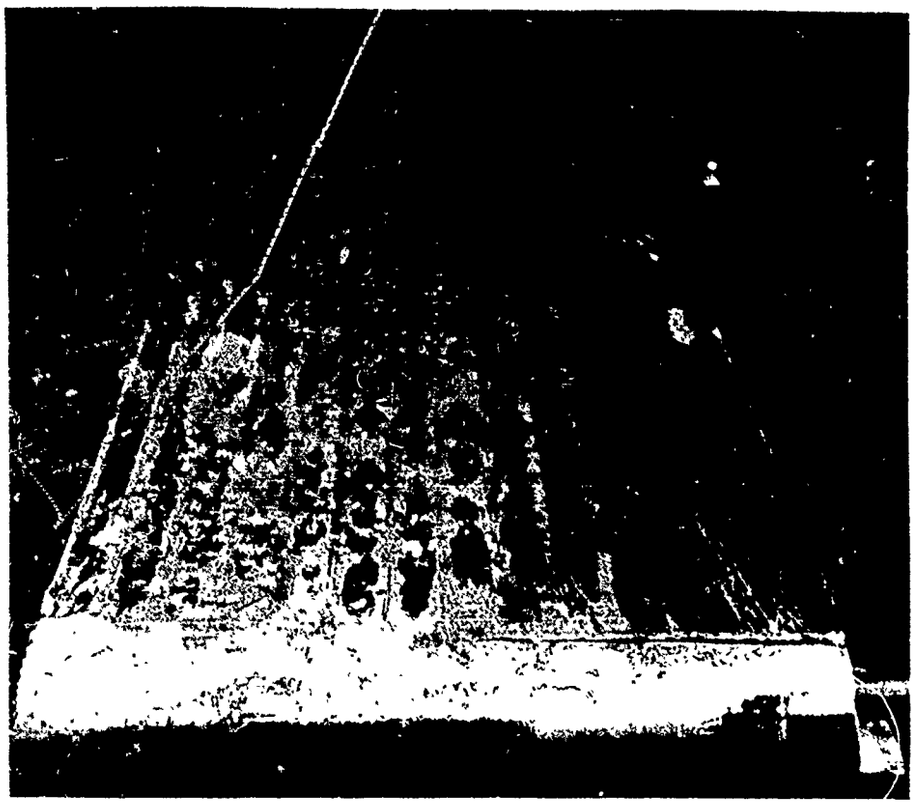


Figure I-23: Surface Condition of the Male Ramp of the Bridge Half with the Hydraulic Cylinder. 827 Miles Odom, 291 Launches.

Figure I-24: Damaged Seal Area on Transmission Front Pump Housing. 441 Launches, 1070 Miles.

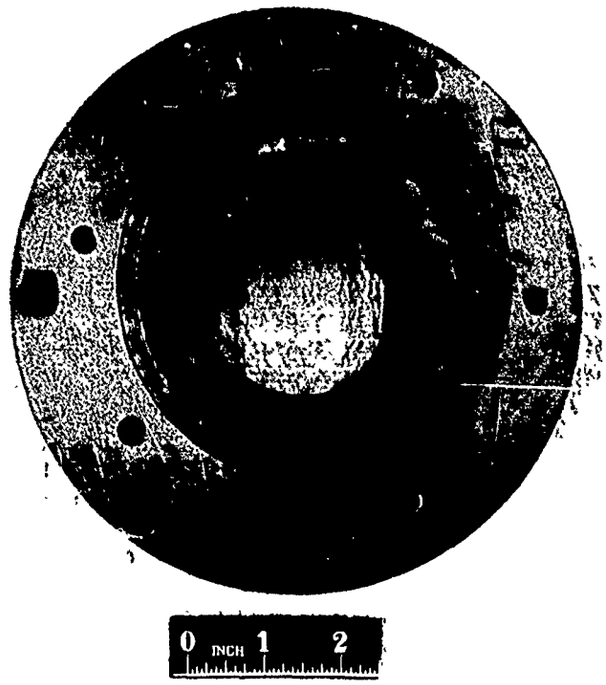


Figure I-25: Damaged Front Pump in Transmission. 441 Launches, 1070 Miles.

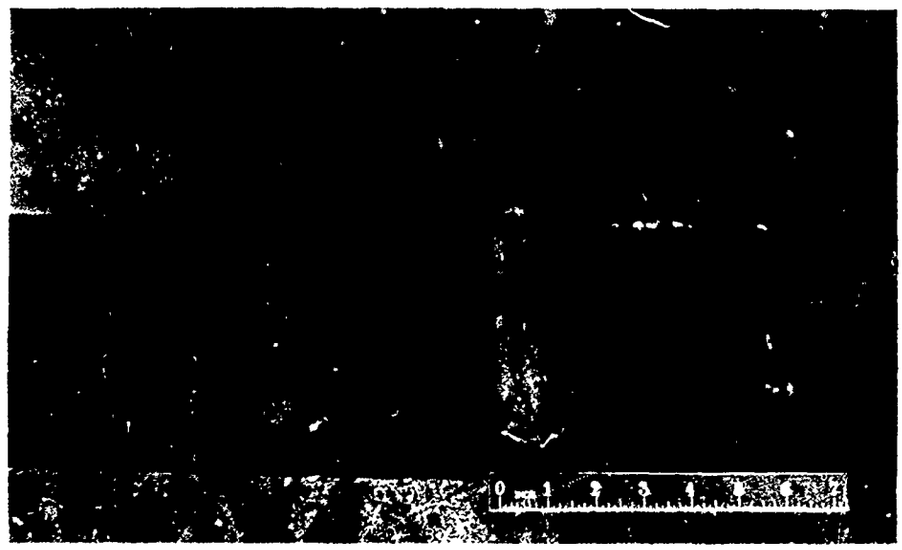
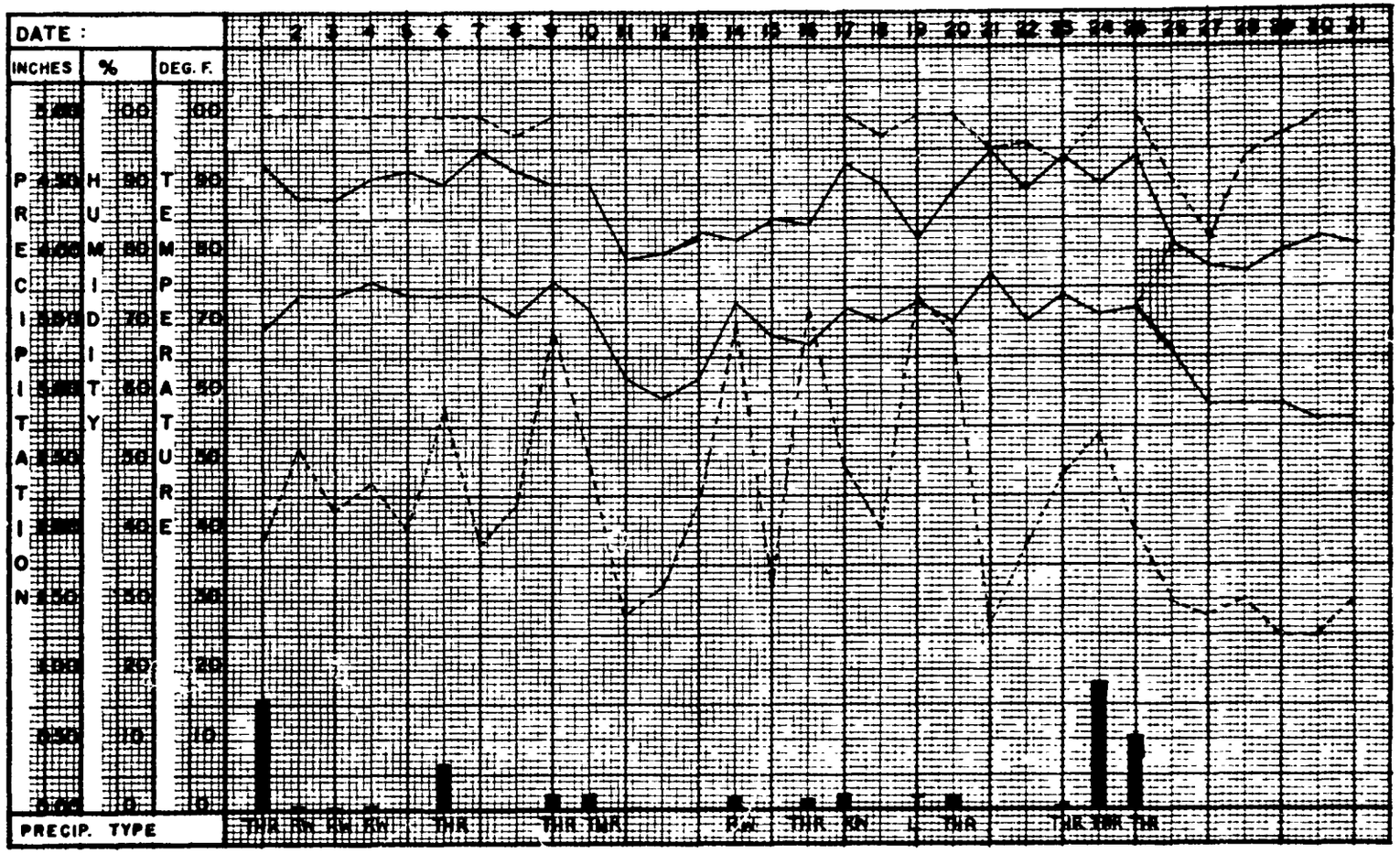


Figure I-26: Cracked Welds in Rotating Beam Struts. Odometer 827, 291 Launches.

MONTHLY TEMPERATURE, HUMIDITY, & PRECIPITATION SUMMARY

MONTH AUG 1968



——— MAX. & MIN. TEMPERATURE
..... MAX. & MIN. HUMIDITY
▯ PRECIPITATION

R - RAIN
L - DRIZZLE
S - SNOW
E - SLEET

RW - RAIN SHOWERS
SW - SNOW SHOWERS
ZR - FREEZING RAIN
ZL - FREEZING DRIZZLE

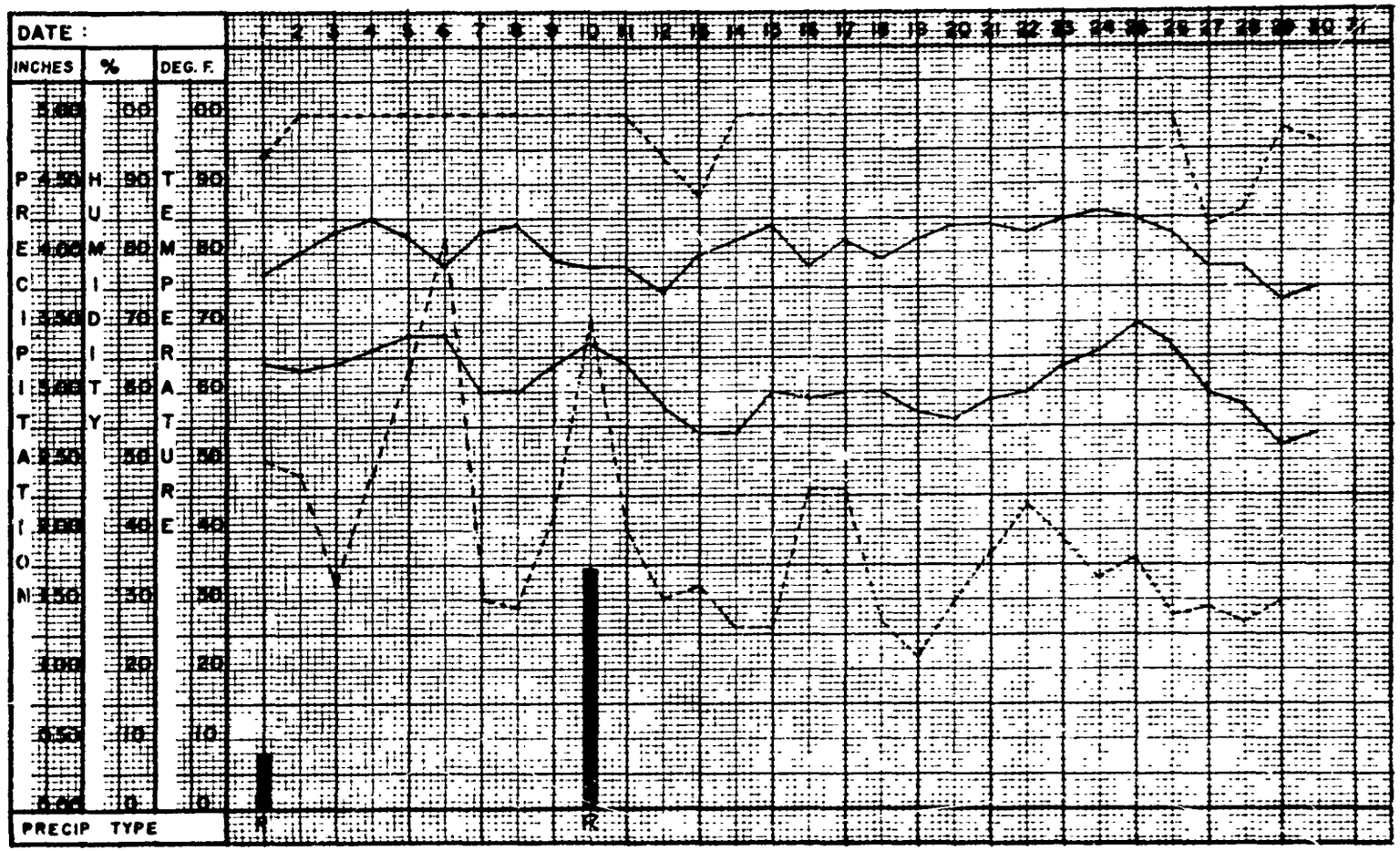
A HAIL
THR - THUNDERSTORM

METEOROLOGICAL SECT.
RANGE SERVICES BR

STAF Form 2698-(it), 2 Apr 63

MONTHLY TEMPERATURE, HUMIDITY, & PRECIPITATION SUMMARY

MONTH SEP 1968



——— MAX. & MIN. TEMPERATURE
····· MAX. & MIN. HUMIDITY
▯ PRECIPITATION

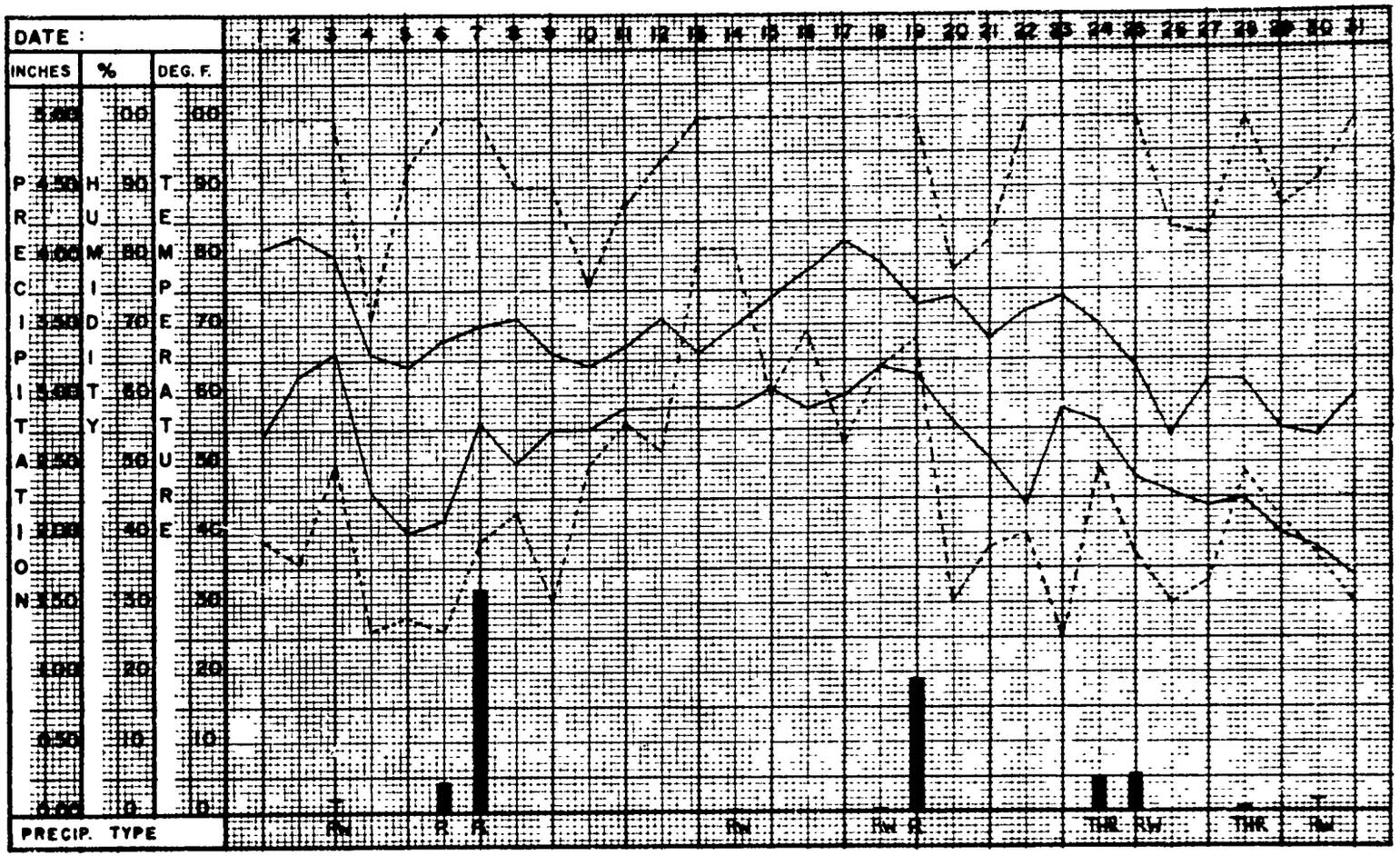
R - RAIN
L - DRIZZLE
S - SNOW
E - SLEET
RW - RAIN SHOWERS
SW - SNOW SHOWERS
ZR - FREEZING RAIN
ZL - FREEZING DRIZZLE
A HAIL
THR - THUNDERSTORM

METEOROLOGICAL SECT.
RANGE SERVICES BR

STLAr Form 2698-(R), 2 Apr 63

MONTHLY TEMPERATURE, HUMIDITY, & PRECIPITATION SUMMARY

MONTH OCT 1968



MAX & MIN. TEMPERATURE
MAX. & MIN. HUMIDITY
PRECIPITATION

R - RAIN
L - DRIZZLE
S - SNOW
E - SLEET

RW - RAIN SHOWERS
SW - SNOW SHOWERS
ZR - FREEZING RAIN
ZL - FREEZING DRIZZLE

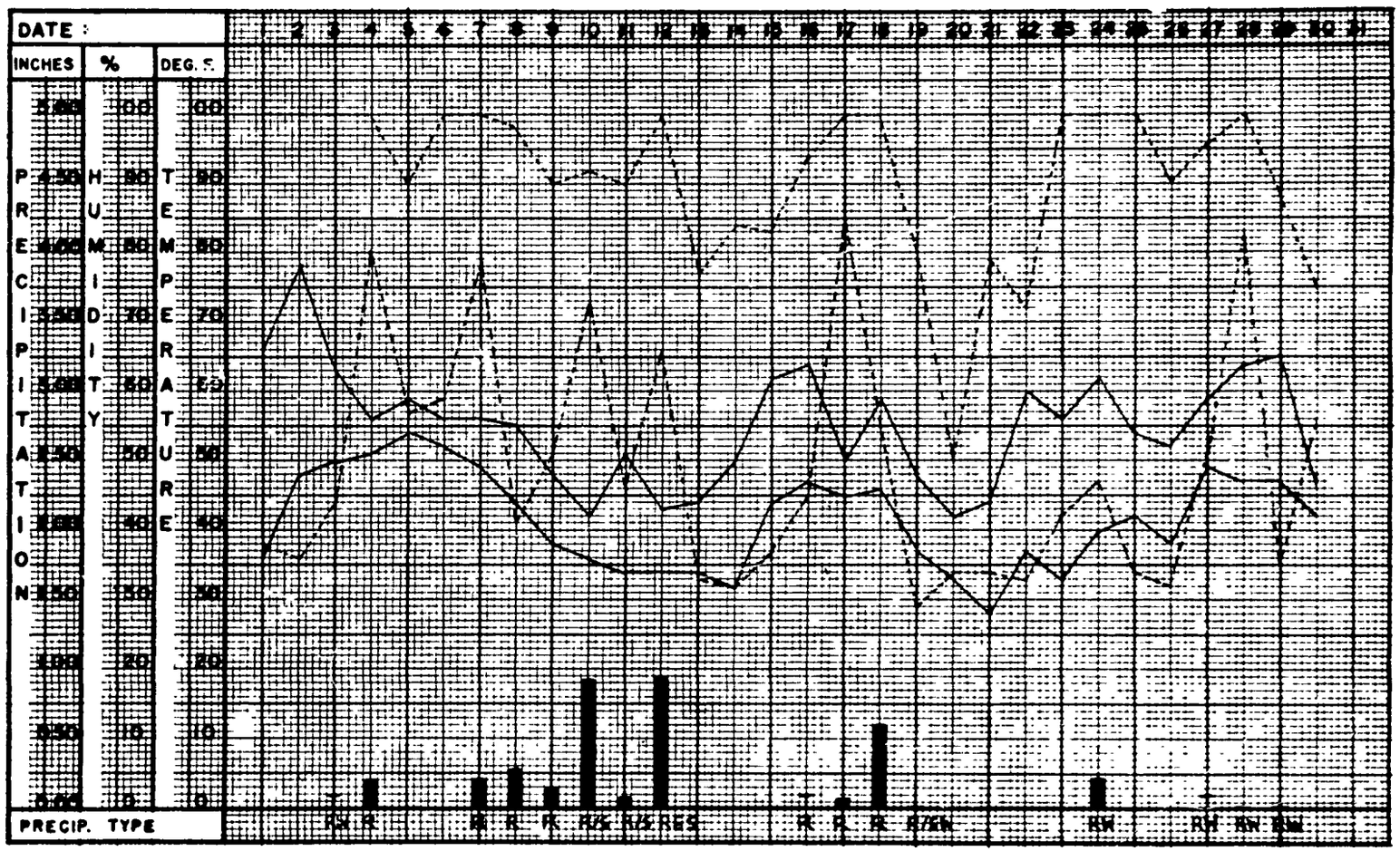
A HAIL
THR.- THUNDERSTORM

METEOROLOGICAL SECT
RANGE SERVICES BR.

STEAP Form 2698-(u), 2 Apr 63

MONTHLY TEMPERATURE, HUMIDITY, & PRECIPITATION SUMMARY

MONTH NOV 1968



——— MAX & MIN. TEMPERATURE
..... MAX. & MIN. HUMIDITY
▯ PRECIPITATION

R - RAIN
L - DRIZZLE
S - SNOW
E - SLEET

RW - RAIN SHOWERS
SW - SNOW SHOWERS
ZR - FREEZING RAIN
ZL - FREEZING DRIZZLE

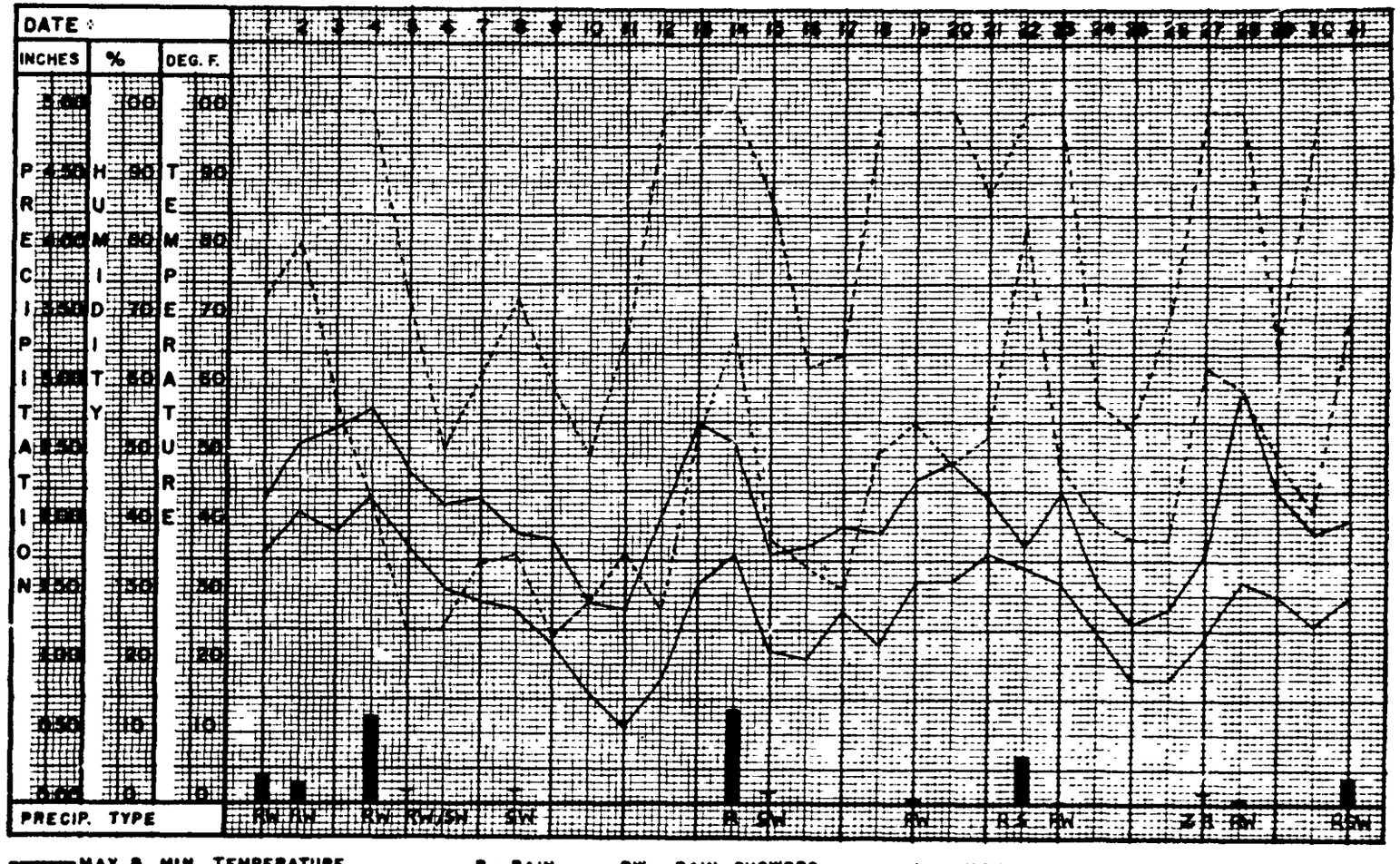
A HAIL
THR - THUNDERSTORM

METEOROLOGICAL SECT
RANGE SERVICES BR.

STEAP Form 2698-(R), 2 Apr 63

MONTHLY TEMPERATURE, HUMIDITY, & PRECIPITATION SUMMARY

MONTH DEC 1968



——— MAX. & MIN. TEMPERATURE
····· MAX. & MIN. HUMIDITY
▯ PRECIPITATION

R - RAIN
L - DRIZZLE
S - SNOW
E - SLEET

RW - RAIN SHOWERS
SW - SNOW SHOWERS
ZR - FREEZING RAIN
ZL - FREEZING DRIZZLE

A HAIL
THR.- THUNDERSTORM

METEOROLOGICAL SECT.
RANGE SERVICES BR

STWAF Form 2698-(R), 2 Apr 63

APPENDIX II - FINDINGS

Requirement	Source, PSDR Par.	Finding	Test Par. No.
1. The assault bridge shall have a roadway width of no more than 106 inches.	3a	Satisfactory	2.3
2. Must negotiate both natural and man-made wet and dry gaps of up to 33 feet in width.	3b	Satisfactory	2.16
3. It is essential that the equipment possess the following characteristics:	3b		
a. Sufficient ruggedness in design to withstand military service without requiring major overhaul or replacement for 750 miles, 75 hours, or 500 launching cycles.		Unsatisfactory, due to replacement of transmission during test period.	2.16
b. Be capable of launching the bridge without exposing the crew while providing armor protection equivalent to the current APC.		Satisfactory.	2.16
c. Be capable of being launched and ready for use within three minutes.		Satisfactory.	2.16

Requirement	Source, PSDR Par.	Finding	Test Par. No.
d. Be capable of being emplaced without site improvement.		Satisfactory.	2.16
e. Be capable of spanning gaps up to and including 33 feet.		Satisfactory.	2.16
f. Be capable of sustaining all standard military vehicles up to and including class 12 loads.		Satisfactory.	2.16
g. Be capable of being recovered from either bank by launching the vehicle with only one man exposed.		Satisfactory.	2.16
h. The launcher (vehicle and mechanism) with bridge in travel position will have as low a profile as possible but not to exceed a height of 12 feet.		Satisfactory.	2.3
i. Swimming characteristics with bridge in travel position will equal that of the current APC except as affected by the changed center of gravity location resulting from the bridge - launching mounting.		Satisfactory.	2.9

Requirement	Source, PSDR Par.	Finding	Test Par. No.
j. Mobility equivalent to the current APC except as affected by the changed center of gravity location resulting from the bridge - launcher mounting.		Satisfactory.	2.6, 2.7, 2.8, 2.9, 2.13, 2.15, 2.16
k. Weight of launcher and bridge in travel position will not exceed the weight of the combat-loaded current APC.		Unsatisfactory, vehicle weighed 24,900 pounds versus 24,080 pounds for a current standard M113A1.	2.10
l. Must operate utilizing standard Army fuel and lubricants.		Satisfactory.	2.3, 2.17
m. Be capable of being delivered by air, rail, and waterway movement equivalent to that of the current APC with the minimum of removal of the bridge from the travel position.		Satisfactory.	2.3
n. Have sufficient fuel capacity for a distance traveled equal to the current APC.		Satisfactory.	2.17
o. Possess an operational availability of at least 93%.		Unsatisfactory, for pre-modification period, insufficient opera-	2.18

Requirement	Source, PSDR Par.	Finding	Test Par. No.
		tion for 121 post-modification launches.	
p. The launcher will possess reliability that the mean time between failures (MTBF) shall be not less than 600 miles or 60 launches whichever occurs first.		Unsatisfactory.	2.18
q. The bridge shall be capable of immediate use after launch.		Satisfactory.	2.16
r. The bridge will possess reliability that the mean time between failures (MTBF) shall be not less than 60 launches or 900 crossings by a class 12 load.		Unsatisfactory.	2.18
s. Be capable of launching and recovery of the bridge in the folded or travel position for ease of transport operations.		Satisfactory.	2.16
t. Be provided with connections to be towed and to tow equivalent to the current APC.		Satisfactory.	2.3

Requirement	Source, PSDR Par.	Finding	Test Par. No.
u. Have simple, easily accessible controls so that the bridge can be launched or recovered by 3-man crew (essential) and 2-man crew (desirable).		Satisfactory.	2.16
v. Be provided with lifting and tiedown instructions for air, rail, and waterway shipment.		Satisfactory.	2.3
w. Be designed to withstand shock and vibration environments and be sufficiently rugged and robust to withstand normal field usage.		Unsatisfactory.	2.17
x. Bridge should be capable of being launched and retrieved when launcher is positioned on a 8% side slope.		Not tested.	2.16
y. Bridge should be capable of being launched and retrieved when the slope between launching plane and the far shore is as large as plus 15% or minus 10%.		Not tested.	2.16

Requirement	Source, PSDR Par.	Finding	Test Par. No.
4. Must be capable of traversing inundated areas now possible with the current APC and impossible with a tank.	3c(1)	Satisfactory for the APC tested.	2.3
5. Turnaround time shall not exceed 30 minutes (essential), 20 minutes (desirable), assuming no repairs are necessary. This is the time required to service and check-out the material for recommitment, beginning from engine shutdown to restarting the engine.	3c(2)	Satisfactory.	2.3 and 2.18
6. Vehicle reaction time shall not exceed two minutes in the intermediate zone. This is the time required for the operator, in position, to start the engine and move the vehicle with the bridge in travel position.	3c(3)(a)	Satisfactory.	2.17
7. The time required for the bridge to be launched, once the launcher is at the gap site is three minutes. This interval includes the time to emplace the bridge and back the launcher away to allow other vehicles to pass.	3c(3)(b)	Satisfactory.	2.17

Requirement	Source, PSDR Par.	Finding	Test Par. No.
8. The time for the launcher to remount the bridge into travel position shall not exceed ten minutes in the intermediate zone. (This includes connection of hydraulic components as required.)	3c(3)(c)	Satisfactory.	2.16
9. The launcher conversion components for the APC vehicle shall demonstrate a mean time between failures (MTBF) of no less than 600 miles or 60 launches. The bridge shall demonstrate a MTBF of no less than 60 launches and 900 crossings by a class 12 load. A failure is defined for the purpose of computing MTBF as a malfunction which causes abortion of the mission, damage to the system by continued use, or a safety hazard which cannot be repaired by the crew using OEM (tools and parts) in 30 minutes.	3c(4)	Unsatisfactory.	2.16
10. Availability due to unscheduled maintenance for the launcher and bridge shall be no less than 97% with a mean time to repair of not more than 12 hours. Availability	3c(5)	Unsatisfactory.	2.16 and 2.18

Requirement	Source, PSDR Par.	Finding	Test Par. No.
due to downtime incurred for preventive and corrective maintenance (30 minutes repair by crew using OEM) shall not be less than 93%.			
11. This equipment will be required to support assault elements over natural and man-made terrain obstacles. Organizational and direct support maintenance units will have maintenance tents in the TO&E. Other maintenance facilities may range from permanent facilities to no cover at all.	3c(6)	Satisfactory.	2.18
12. A typical mission will be for a period of two days (48 hours) and will consist of the following: a. Launches, ten. b. Movement to and from launch sites, 20 miles. c. Vehicle traffic per launch, 15 class-12 loads.	3c(7)	Testing not conducted on mission basis.	2.16
13. The bridge will provide a gap crossing capability for 15 vehicles in not more than 15 minutes.	3c(8)	Satisfactory.	2.6

Requirement	Source, PSDR Par.	Finding	Test Par. No.
14. The launcher shall possess the maintenance characteristics of the current APC. The installation of the launcher equipment will not significantly increase the practicable time, degree of skill, or variety of tools required for maintenance.	6b(1)	Satisfactory.	2.16 and 2.18
15. The bridge will be designed to facilitate maintenance so that maintenance can be performed in the minimum practicable time with the minimum of skills and variety of tools; and provide permanent lubrication to the maximum extent.	6b(2)	Satisfactory.	2.16 and 2.18
16. The bridge and launch mechanism will be designed to minimize malfunctioning and damage to controls and linkages due to freezing, dirt, and mud accumulation.	6b(3)	Satisfactory.	2.16
17. Maintenance limited to cleaning, minor lubrication, adjustments, replacement of modules and minor components. Crew maintenance shall not average more than 2.0 man-hours per 100 miles or 50 launches of operation (exclusive of daily 'A' services).	6b(4)(a)(1)	Unsatisfactory.	2.18

Requirement	Source, PSDR Par.	Finding	Test Par. No.
18. Maintenance limited to minor adjustments of components and replacement of assemblies. Services performed shall not average more than 30 minutes for diagnosis and four man-hours per maintenance action. Scheduled and unscheduled organizational maintenance shall not exceed 25 man-hours per 1000 miles or 500 launches for the launcher and 2 man-hours per 500 crossings of class 12 loads for the bridge.	6b(4)(a)(1)	Unsatisfactory.	2.18
19. Maintenance performed will include technical inspection and support assistance to units by contact teams in the repair or replacement of components, assemblies, and parts. Services performed shall not average more than 30 minutes for diagnoisis and 16 man-hours for maintenance action.	6b(4)(b)	Unsatisfactory.	2.17 and 2.18
20. Maintenance performed will reinforce the direct support maintenance units and	6b(4)(c)	Satisfactory.	2.17 and 2.18

Requirement	Source, PSDR Par.	Finding	Test Par. No.
will accomplish major end item repair and repair of minor components - assemblies for return to stock. Extent of repairs will be determined by economic repair limits and stock status of replacement items.			
21. The mean downtime per 1000 miles or 500 launches shall not exceed 2.0 hours for all unscheduled organization and direct support maintenance.	6b(5)	Unsatisfactory.	2.17 and 2.18
22. To facilitate maintenance and repair by modular replacement of assemblies or subassemblies shall be incorporated in the design wherever consistent with reliability and cost factors.	6c	Satisfactory.	2.17 and 2.18

Requirement	Source, Launcher PD Par.	Finding	Test Par. No.
1. The launcher shall be capable of completely launching and recovering the bridge 500 times without incident as follows:	4.5.2.3.2.1	Not determined, testing was terminated per letter, AMSTE-68, 11 February 1969, (Appendix IV), before 500 launches were accrued.	2.16

Requirement	Source, Launcher PD Par.	Finding	Test Par. No.
a. Two hundred and fifty launchings and recoveries with launcher on level ground. The lock cylinder shall be capable of disconnecting the bridge for 50 of the launchings when the bridge is unfolded. Fifty per cent of these launchings and recoveries shall be with the launcher at each end of the 33-foot span bridge.			
b. One hundred and fifty launchings and recoveries shall be with the launcher on a slope: 75 at an upward slope of 15% and 75 at a downward slope of 15%. Fifty per cent of the launchings and recoveries shall be with the launcher at each end of the 33-foot span bridge.			
c. One hundred launchings and recoveries shall be with the launcher on a transverse side slope of 8%. Fifty per cent of the launchings and recoveries shall be with the launcher at each end of the 33-foot span bridge.			

Requirement	Source, Launcher PD Par.	Finding	Test Par. No.
2. The launcher shall, with the bridge stowed in the transport position, be capable of operating without incident, for a minimum distance of 100 miles equally divided on paved and graded roads, and level and hilly cross-country terrain. Ten per cent of the level road operation shall be at maximum speed. Speed for other test conditions shall be dictated by the type of terrain.	4.5.2.3.2.2	Satisfactory.	2.16
3. The launcher with the bridge stowed in the transport position shall be capable of being driven into and out of the water a total of 4 cycles. The type of bank conditions shall vary as those typical of stream banks on small inland rivers. The launcher and bridge shall be capable of operation in the water for a total of 10 hours without incident.	4.5.2.3.2.3	Not tested.	2.16
4. The launcher shall function as an amphibious vehicle while transporting the 33-foot span, armored personnel carrier launched bridge, as above, shall launch (in two minutes), and	3.12	Satisfactory, minor difficulty was encountered with hydraulic quick-disconnects, locking pins, lower launching beam pins.	2.16 and 2.18

Requirement	Source, Launcher PD Par.	Finding	Test Par. No.
disconnect and recover the bridge without evidence of the following defects: a. Malfunction of components. b. Binding or hanging of parts. c. Permanent distortions. d. Material defects such as cracks or open joints. e. External hydraulic oil leakage (except weepage normally expected at piston rod seals). f. Bridge not mating with launcher or not bearing on the bridge seat of the launcher. g. Binding or sticking of controls or linkages.			

Requirement	Source, Bridge PD Par.	Finding	Test Par. No.
1. The bridge shall be capable of 500 complete launchings and recoveries and 500 vehicle crossings as follows:	4.5.2.3.2.2	Unsatisfactory.	2.17

Requirement	Source, Bridge PD Par.	Finding	Test Par. No.
a. Two hundred and fifty launchings and recoveries with launcher on level ground. The lock cylinder shall be retracted and the bridge shall be disconnected for 50 of the launches when the bridge is unfolded. Fifty per cent of these launchings and recoveries shall be with the launcher at each end of the bridge.			
b. One hundred and fifty launchings and recoveries with launcher on slope: 75 at upward slope of 15 per cent and 50 with downward slope of 15%. Fifty per cent of the launchings and recoveries shall be with the launcher at each end of the bridge.			
c. One hundred launchings and recoveries shall be with the launcher on a transverse side slope of 8%. Fifty per cent of the launchings and recoveries shall be with the launcher at each end of the bridge.			
d. Five hundred vehicle crossings shall be with an M113 series armored			

Requirement	Source, Bridge PD Par.	Finding	Test Par. No.
personnel carrier transporting launcher (total weight 23,520 pounds) over a 33-foot length of bridge span. Fifty per cent of the crossings from each end of the bridge.			
2. The bridge shall be capable of being transported and launched by the M113 series armored personnel carrier transporter without evidence of the following defects as specified: a. Malfunctions of components. b. Binding or hanging of parts. c. Permanent distortions. d. Material defects such as cracks or open joints. e. Hydraulic oil leakage (except weepage normally expected at piston rod seals). f. Bridge not mating with launcher or not bearing on the bridge seat of the launcher. g. Binding or sticking of linkages.	3.14	Unsatisfactory, the bridge was not capable of being launched as required. Test data obtained after application of the modifications were inconclusive due to limited operation.	2.17 and 2.18

APPENDIX III - DEFICIENCIES AND SHORTCOMINGS

1. Deficiencies

Deficiency	Suggested Corrective Action	Remarks
1. Control handle for launch cycle failed where it is attached to the base of the valve bank.	Use higher strength material.	The handle failed while the bridge was being launched, disabling the launch cycle. (EPR's K2-59, -76, -106(76-2)).
2. Cracks appeared in the ramps.	Investigate designs for stress concentrations.	The ramp had cracks in the vicinity of mounting points. (EPR's K2-22, -53, -54, -60, -73, -92(73-2), -96).
3. The spider of the front universal joint on the differential drive shaft failed.	Investigate the additional loading that the launching system places on the basic vehicle drive train to determine if the need exists for stronger components.	The transmission case was cracked due to this failure, and a new transmission was required. (EPR's K2-100, -102, -109(102-2)).

2. Shortcomings

Shortcomings	Suggested Corrective Action	Remarks
1. The launching mechanism has adverse effects on access to the engine and cargo areas.	Redesign components for better access.	Access to the engine through the power-plant door and engine-access door panel is poor due to the location of launching mechanism components. Access to the cargo hatch is compromised by the bridge seat. (EPR's K2-2, -3, -5)).
2. The surfboard pins are difficult to operate, because of design and location.	Redesign and relocate the pins and secure the pins more positively.	(EPR's K2-6, -25).

Shortcomings	Suggested Corrective Action	Remarks
3. The quick-disconnects for the folding mechanism of the bridge were difficult to connect.	Redesign system to remove pressure.	Pressure was preventing connection of the quick-disconnects. (EPR K2-19, -64).
4. The supporting braces for the valve bank failed at the top attachment to the valve bank on the hydraulic controls.	Redesign supporting braces to improve mounting.	The braces failed at the first full thread. (EPR's K2-20, -97(20-2)).
5. The locking pins unscrewed from the cylinder rods on the locking mechanism.	The pins should be secured with a locking screw.	(EPR's K2-23, -41(23-2), -74(23-3)).
6. The retainer plate on the launching boom became loose, and screwed out of its mount.	The plate should be secured more positively.	The left side plate was completely off the vehicle. (EPR's K2-24, -108(24-2)).
7. The surfboards were damaged during amphibious operations, when water became trapped behind the covering on the ends.	Redesign surfboards for better draining.	The end coverings were deformed. (EPR K2-27).
8. Bolts which secure the splash plate loosened and were lost.	Investigate torque requirements for installing bolts.	The bolts were holding the splash plate on the launcher tongue. (EPR's K2-30, -40(30-2)).
9. The ramps were gouged, and the nonskid coating was worn off.	None.	(EPR's K2-35, -65). Nonskid coating paint worn off by vehicular traffic.

Shortcomings	Suggested Corrective Action	Remarks
10. Sealed-beam unit cracked.	None.	The left side head light cracked. (EPR's K2-38, -72(38-2)).
11. The capscrews securing the ramp pickups were loose.	None.	(EPR's K2-45, -52(45-2)).
12. The hose which covers the drive shaft for the hydraulic pump was torn.	None.	The hose was torn circumferentially at the clamps which secures the hose to the engine-access panel. (EPR K2-49).
13. Gear teeth failed on the ramp hinges.	None. Gear teeth probably failed due to closing ramps together hydraulically to knock off mud, etc.	Two teeth failed on one hinge and one tooth failed on another. (EPR K2-50).
14. The right side track-tension adjustor failed.	None. Track adjuster was probably at or near extreme extended position when incident occurred.	Two capscrews securing the adjustor mounting bracket and one shock absorber were also damaged. (EPR K2-57).
15. The cotter pin securing the hydraulic-pump control lever to the shaft was missing.	None.	(EPR's K2-66, -98).
16. The two struts on the rotating beam which form the sliding links with the folding hydraulic cylinders cracked and failed where the struts project from the rotating beam.	Redesign struts, to accommodate additional sliding distance.	At the extreme position, the struts receive a side load which causes them to crack and fail. (EPR's K2-70, -81(70-2), -111(70-3)).

Shortcomings	Suggested Corrective Action	Remarks
17. The cotter pin securing the tensile link to the link beam was missing.	None.	(EPR K2-75).
18. Both right side shock-absorber lower washers were damaged.	Investigate added loading applied by launcher system to basic vehicle.	The plain encased seals were also replaced. (EPR K2-104).
19. The left launching-beam pin was binding.	Redesign pin for easier and better lubrication.	The inside journals were not receiving lubrication. The lube passages were clogged with sand and mud. (EPR K2-105).

3. Corrected Deficiencies - Shortcomings

Corrected Deficiency	Suggested Corrective Action	Remarks
1. The voltage regulator was functioning improperly.	Replaced with unit which functioned properly.	Regulator was putting out 25.5 volts, instead of the normal 28. The relay points were burned. (EPR K2-8).
2. The hydraulic-oil reservoir dipstick fell out of the cap which holds it.	The dipstick was reinstalled in the cap correctly.	The dipstick had been improperly installed. (EPR K2-9).
3. The hydraulic-oil reservoir was leaking from cracks in the welds.	A redesigned reservoir and shock mountings supplied by USAMERDC, were installed.	(EPR's K2-10, -13(10-2) -15(10-4), -16(10-5), -26(10-6)).
4. The transmission would not remain in third gear lockup.	A new valve body was installed.	(EPR's K2-11, -12, -17).

Corrected Deficiency	Suggested Corrective Action	Remarks
5. Cracks propogated in welds in all braces and beams on both ends of the bridge. Some of the braces and beams were subsequently bent.	New items with redesigned welds were installed, supplied by USA USAMERDC.	(EPR's K2-21, -33, -33's -36, -36's, -51, -62(33-2), -63, -71, -83(42-2), -84(33-3), -93(71-2), -95, -96).
6. The surfboard mounts failed during and after amphibious operations.	Redesigned mounts supplied by USAMERDC were installed.	(EPR's K2-28, -29, -31 (28-2), -94(28-3)).
7. The quick-disconnects and hose retractors on the folding-mechanism hydraulic lines were bent and damaged, due to misalignment during retrieving operations.	Redesigned quick-disconnects, were supplied and installed by USAMERDC.	(EPR's K2-32, -34, -43 (34-2), -46(34-3), -85 (34-4)).
8. The retaining bolts (1/4 in. by 3 in.) in the rotating beam sheared due to excess stress.	Modifications were made to the rotating beam and 3/8 in. by 3 in. bolts were supplied by USAMERDC.	(EPR's K2-37, -48(37-2), -58(37-3), -61(37-4), -67(37-5), -81(70-2), -82(37-6), -87).
9. The tensile link failed where it connects to the link beam.	A redesigned tensile link, supplied by USAMERDC, was installed.	(EPR K2-77, -79(77-2)).
10. The low engine-oil pressure warning light was not functioning properly due to a defective pressure switch.	A switch which functioned correctly was installed.	(EPR K2-107).

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EPR SUMMARY SHEET
(TECP 700-700
Interim Pam. 60-20)

PROJECT: IP Test of Marginal Terrain Assault Bridge w/M113 Launcher USA 12HU76

USATECOM PROJECT NO: 7-8-1018-05

TYPES OF INCIDENTS

A - DEFICIENCY D - DESIGN

B - SHORTCOMING M - MANUFACTURING

C - SUGGESTED IMPROVEMENT

SML GRP	VEH NO.	INCIDENT			PART NO.	PART MILEAGE	VEH ODOM	REMARKS
		AFG NO.	TYPE	ITEM				
03		4	B	Coupling assembly, quick disconnect	4730-800-2828	50	50	Paper tape in quick disconnect coupling restricting fuel flow to engine and causing poor engine operation. Tape removed.
06		8	B	Regulator, generator, voltage	10947439	50	50	Voltage adjustment could not be changed from 25.5 volts. Relay points burned and other components damaged. New regulator installed.
06		38	B	Lamp Unit, Headlight, Seal Beam	6240-368-4972	554	554	Left headlight lens cracked. New sealed beam unit installed.
06		72 (38-2)	B	Lamp Unit, Headlight, Sealed Beam	6240-368-4972	273	827	Replacement left headlight sealed beam unit failed. Replaced.
07		11	A	Arm, throttle valve	10875280	219	219	Throttle valve arm cracked. Welded.
07		12	B	Transmission	2520-066-4239	219	219	Transmission would not stay in third lockup. New seals and rings installed in high range clutch.
07		17 (12-2)	B	Transmission	2520-066-4239	220	220	Transmission operation in 3d lockup still unsatisfactory. New main control valve and oil transfer plate installed.
10		100	A	Spider, universal joint	2520-679-9239	935	935	Spider on front universal joint of drive shaft to differential failed. Other vehicular components damaged. Being repaired.
13		47	B	Track		665	665	Right track thrown during operation. One center guide broken. Track worked back on vehicle.

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USATECOM PROJECT NO: 7-8-1018-0[illegible]

TYPES OF INCIDENTS

A - DEFICIENCY D - DESIGN

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SNL GRP	VEH NO.	INCIDENT			PART NO.	PART MILEAGE	VEH ODOM	REMARKS
		APG NO.	TYPE	ITEM				
13		56	Info	Nut, Extended washer, track pin	5310-655-9863	685	685	Nut missing from right track pin. Replaced.
13		57	B	Adjuster, track, tension	2530-773-9390	693	693	Right track tension adjuster broke during operation. Damage to other suspension components. Repaired damage and replaced components as necessary.
15		7	B	Fitting, hydraulic, male ramp section	5420-880-2778	50	50	Loose fitting caused leak in system. Tightened fitting to correct.
15		21	A	Brace, vertical	5420-880-2639	344	344	Vertical brace cracking at upper connection to female ramp. No action.
15		95 (21-2)	Info	Brace, vertical	5420-880-2639	868	868	Top horizontal cross-member on bridge half with hydraulic cylinder bent and cracked. Straightened and welded.
15		22	A	Ramp Section, female	5420-880-2777	344	344	Crack in lower connection at female ramp for vertical brace.
15		35	B	Ramp Section, female	5420-880-2777	558	558	Ramp gouged by sprocket of M113 launcher.
15		73	B	Ramp section, female/male	5420-880-2777/2778	827	827	Several cracks where hinges attach to ramps. No action.
15		92 (73-2)	Info	Ramp, section, female/male	5420-880-2777/2778	868	868	Cracks in inboard hinges of male and female ramp sections welded.
15		96	B	Ramp, section, female	5420-880-2777	894	894	Top mount for the vertical brace on the bridge half w/o hydraulic cylinder failed. Rewelded.

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SNL GRP	VEH NO.	INCIDENT			PART NO.	PART MILEAGE	VEH ODOM	REMARKS
		APG NO.	TYPE	ITEM				
15		23	B	Pin, locking	5420-880-2598	368	368	Right locking pin loose and unscrewing from cylinder. Tightened.
15		41 (23-2)	B	Pin, locking	5420-880-2598	581	581	Both locking pins loose and unscrewing from cylinders. Retightened.
15		74 (23-3)	B	Pin, locking	5420-880-2598	252	833	Locking pins unscrewed. Tightened.
15		86	Info	Pin hinge	11546-18-1	0	868	New inboard and outboard hinge pins installed in place of original pins.
15		24	B	Plate, retainer	5420-880-2615	368	368	Left retainer plate loosened and unscrewed from beam. Reinstalled.
18		25	B	Pin, surfboard	5420-880-2703	368	368	Right surfboard top mounting pin loosened and was lost.
18		27	B	Surfboard	5420-880-2708	500	500	Surfboard panels deformed during swimming operations.
18		6	B	Pin Surfboard	5420-880-2703	50	50	Surfboard pins are difficult to remove because of location and limited accessibility
18		28	A	Mount, surfboard	11545-27-4	500	500	Surfboard lower right mount welds failed during swimming operations. Rewelded.
18		31 (28-2)	A	Mount surfboard	11545-27-4	11	511	Right lower surfboard mount failed during swimming operations. Rewelded.

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SNL GRP	VEH NO.	INCIDENT			PART NO.	PART MILEAGE	VEH ODOM	REMARKS
		APG NO.	TYPE	ITEM				
18		29	A	Mount, surfboard	11545-27-5	500	500	Upper right surfboard mount failed during swimming operations. Rewelded.
18		30 (30-2)	B	Bolt, Plate, splash, mounting	11545-27-1	500	500	Two lower bolts replaced in splashplate.
18		31 (28-2)	A	Mount surfboard	11545-27-4	11	511	Right lower surfboard mount failed during swimming operations. Rewelded.
18		40		Bolt, plate, splash, mounting	11545-27-1	558	558	One splashplate bolt missing and three bolts loose. Replaced and retightened.
18		2	B	Door, power plant	10861155	50	50	Power plant door cannot be opened with launching mechanism and bridge in transport position if engine is inoperable.
18		3	B	Panel, engine access door	10861395	50	50	Panel difficult to remove because of interference with intercom and hydraulic reservoirs.
18		18	Info	Gasket, transmission access cover	2510-714-6138	325	325	Gasket stretched during removal. New gasket installed.
43		9	A	Cap, dipstick	5420-880-2952	50	50	Oil level dipstick for hydraulic reservoir fell out of cap. Rewelded.
43		10	A	Reservoir, hydraulic oil	11545-17-1	161	161	Hydraulic oil reservoir leaking. Welded.
43		13 (10-2)	A	Reservoir, hydraulic oil	11545-17-1	220	220	Hydraulic oil reservoir leaking. New reservoir installed.

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TYPES OF INCIDENTS

A - DEFICIENCY D - DESIGN

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C - SUGGESTED IMPROVEMENT

SML GRP	VEH NO.	INCIDENT			PART NO.	PART MILEAGE	VEH ODOM	REMARKS
		ARC NO.	TYPE	ITEM				
43		14 (10-3)	Info	Gasket, reservoir cover	5420-880-2690	220	220	Gasket stretched during removal. New gasket installed.
43		15 (10-4)	B	Reservoir, hydraulic oil	11545-17-1	220	220	Hole for hydraulic oil pump out of round. Reworked.
43		16 (10-5)	A	Reservoir, hydraulic oil	11545-17-1	220	220	Crack in original reservoir approximately 3 inches long. Other cracks in reservoir.
43		26 (10-6)	B	Reservoir, hydraulic oil	11545-17-1	265	485	Welded joint near drain in hydraulic reservoir leaking slightly.
43		19	B	Plug, quick disconnect	5420-880-2955	325	325	High pressure behind plug must be bled to allow coupling.
43		20	B	Brace	11545-20-4	325	325	Valve bank braces fractured at first full thread.
43		32	B	Nipple, hose retractor	N	524	524	Nipples connecting hose assemblies to bridge half w/hydraulic cylinder bent during retrieving operation. Replaced.
43		33	B	Bridge, half,w/o hydraulic cylinder	NA	538	538	Weld failures in vertical braces and hose retractor beams. New vertical beams installed. Hose retractor beams not replaced.
43		33-S	B	Bridge, half,w/o hydraulic cylinder	NA	538	538	Failed welds rewelded on hose retractor beams.

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TYPES OF INCIDENTS

A - DEFICIENCY D - DESIGN

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SML GRP	VEH NO.	INCIDENT AFG NO.	INCIDENT TYPE	INCIDENT ITEM	PART NO.	PART MILEAGE	VEH ODOM	REMARKS
43		55 (39-2)	B	System, hydraulic launching	NA	681	681	Bridge could not be retrieved when covered with mud.
43		34	B	Retractor, hose	NA	524	524	Screws securing retainer plate failed.
43		43 (34-2)	B	Retractor, hose	NA	595	595	Left hose retractor failed. Repaired.
43		46 (34-3)	B	Retractor, hose	NA	643	643	Two retractors failed. Repaired.
43		85 (34-4)	Info	Retractor, hose	11546-19-2	0	862	New hose retractors with new beam mounts installed.
43		36	B	Bridge half w/hydraulic cylinder	NA	524	524	Weld failures in vertical braces, horizontal brace and hose retractor beam. New vertical braces installed.
43		36S	B	Bridge half w/hydraulic cylinder	NA	524	524	Failed welds in horizontal brace and hose retractor beam rewelded.
43		37	B	Bolt, rotating beam	5305-725-4187	548	548	Bolt lost from rotating beam connection to female ramp. Replaced.
43		48 (37-2)	B	Bolt, rotating beam	5305-725-4187	120	668	Bolt lost from rotating beam. Replaced.
43		48 (37-3)	B	Bolt, rotating beam	5305-725-4187	25	693	Bolt failed in rotating beam. Replaced.
43		61 (37-4)	B	Bolt, rotating beam	5305-725-4187	29	722	Bolts were lost from rotating beam. Replaced.

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USATECOM PROJECT NO: 7-E-1018-05

TYPES OF INCIDENTS

A - DEFICIENCY D - DESIGN

B - SHORTCOMING M - MANUFACTURING

C - SUGGESTED IMPROVEMENT

SML GRP	VEH NO.	INCIDENT: APG NO.	INCIDENT: TYPE	INCIDENT: ITEM	PART NO.	PART MILEAGE	VEH ODOM	REMARKS
43		67 (37-5)	A	Bolt, rotating beam	5305-725-4187		859	Bolts failed on 12 occasions during 137 miles of test. Bolt failures allow hinge pins and rotating beam to move out of proper position.
43		82 (37-6)	Info	Bolt, retaining beam	5305-725-4187	0	868	Increased diameter bolts installed during retrofit program.
43		39	B	System, hydraulic launching	NA	558	558	Bridge cannot be lifted when coated with mud.
43		55 (39-2)	B	System, hydraulic launching	NA	681	681	Bridge could not be retrieved when covered with mud.
43		42	B	Bolt, beam, link	5420-880-2783	593	593	Twelve bolts securing beam to ramps were loose. Retightened.
43		45	B	Bolt, pickup, male and female ramp	11546-10-1 11546-10-2	615	615	Capscrews securing pickups to respective ramps were loose. Retightened.
43		52 (45-2)	B	Bolt, pickup, male and female ramp	11546-10-1 11546-10-2	668	668	Bolts loosened. Retightened.
43		49	B	Cover, Pump Drive Shaft	11549-15-39	668	668	Cover torn at clamp to engine access panel. No action.
43		50	B	Hinge, female, male	11546-7-1 11546-7-2	668	668	Several broken teeth on the various male and female hinges. No action.

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USATECOM PROJECT NO: 7-8-1016-05

TYPES OF INCIDENTS

A - DEFICIENCY D - DESIGN

B - SHORTCOMING M - MANUFACTURING

C - SUGGESTED IMPROVEMENT

SNL GRP	VEH NO.	INCIDENT AFG NO.	INCIDENT TYPE	INCIDENT ITEM	PART NO.	PART MILEAGE	VEH ODOM	REMARKS
43		51	Info	Brace, vertical	11546-9-2	120	668	Horizontal cross member of vertical braces on bridge half within hydraulic cylinder dented and bent. No action.
43		69	Info	System, hydraulic launching	NA	811	811	Pressures checked in syste With approximately 200 lb weight on ramps, bridge could not be retrieved w/pressures 3000-3200 psg.
43		53	B	Ramp, female	5420-880-2777	674	674	Weld at top of cylinder beam mount cracked. Rewelded.
43		54	B	Ramp, male	5420-880-2778	680	680	Weld on lower mounting tab for vertical brace broke. Rewelded.
43		59	B	Handle, bridge extension, control	11545-21-5	712	712	Handle failed at base of control system. Repaired.
43		60	B	Ramp, male	5420-880-2778	720	720	Top mount weld for vertical brace failed on end of bridge without hydraulic cylinder. Rewelded.
43		62 (33-2)	B	Beam, hose retractor	NA	730	730	Weld failures on beam at connection to female ramp on bridge end without hydraulic cylinder. Rewelded.
43		63	B	Brace, vertical	5420-880-2646	730	730	Lower cross member of brace cracked at intersection with diagonal member on male ramp on bridge half without hydraulic cylinder. Rewelded.

STEAP-DS Form 206, 29 Nov 65

EPR SUMMARY SHEET
(TECP 700-700
Interim Pam. 60-20)

PROJECT: _____

USATECOM PROJECT NO: 7-8-1018-05

TYPES OF INCIDENTS

A - DEFICIENCY D - DESIGN

B - SHORTCOMING M - MANUFACTURING

C - SUGGESTED IMPROVEMENT

SML GRP	VEH NO.	INCIDENT ARC NO.	INCIDENT TYPE	INCIDENT ITM	PART NO.	PART MILEAGE	VEH ODOM	REMARKS
43		64	B	Plug, quick disconnect	11546-17-24	730	730	Leak at plug. Metal particles preventing plug from seating. Cleaned.
43		65	Info	Surface, non skid	NA	733	733	Non skid coating on ramp surfaces worn off ramps.
43		66	B	Pin, cotter	5315-234-1650	734	734	Pin missing from launching system control lever. Replaced.
43		68	NA	Cylinder, hydraulic	NA	811	811	Hydraulic cylinders that launch and retrieve bridge are seeping oil at seals. No action.
43		70	B	Beam, rotating	11546-12-1	827	827	Weld failures in struts after failure of rotating beam bolt. Rewelded.
43		81 (70-2)	Info	Beam, rotating	11546-12-1	868	868	Rotating beam modified by chamfering ends and also by providing for 3/8 inch retaining bolts.
43		71	B	Beam, cylinder	11546-12-3	827	827	Beam cracked at male ramp. No action.
43		93 (71-2)	Info	Beam, cylinder	11546-12-3	868	868	Mounting bosses for the hydraulic cylinder rewelded into cylinder beam. Beam also rewelded to eliminate cracking (reference EPR K2-71).
43		75	B	Pin, cotter	5315-298-1481	842	842	Missing cotter pin installed in pin securing tensile link to link beam.
43		76	A	Handle, control, launching	11545-21-4	851	851	Handle failed at base of control system. Repaired.

STEAP-DS Form 206, 29 Nov 65

EPR SUMMARY SHEET
(TECP 700-700
Interim Pam. 60-20)

PROJECT: _____

USATECOM PROJECT NO: 7-8-1018-05

TYPES OF INCIDENTS

A - DEFICIENCY D - DESIGN

B - SHORTCOMING M - MANUFACTURING

C - SUGGESTED IMPROVEMENT

SNL GRP	VEH NO.	INCIDENT			PART NO.	PART MILEAGE	VEH ODOM	REMARKS
		APG NO.	TYPE	ITEM				
43		77	A	Link, tensile	11546-12-2	856	856	Tensile link failed at link beam after rotating beam bolt failure and displacement of rotating beam.
43		79 (77-2)	Info	Link, tensile	5420-880-2719	868	868	New tensile link installed as part of retrofit program.
43		78	Info	Pump, hydraulic	5420-880-2882	868	868	Pump removed and shipped to manufacturer for refurbishment.
43		80 (78-2)	Info	Pump, hydraulic	5420-880-2882	0	868	Modified hydraulic pump installed.
43		87	Info	Pin, rotating beam	11546-18-3	0	868	New rotating beam pivot pins with holes for 3/8 inch bolts installed as part of retrofit program.
43		88	Info	Pin, clevis	11546-18-4	0	868	New clevis pin installed as retrofit item.
43		89	Info	Pin, cylinder beam	11546-18-2	0	868	New pin attaching tensile link to rotating beam installed.
43		90	Info	Pin, link beam	11546-18-5	0	868	Modified link beam pin installed.
43		91	Info	Spacer, tensile and sliding links	11546-13-10	0	868	New spacers installed as part of retrofit program.
43		98	Info	Control, pump	5420-206-15/5-21	915	915	Pump control handle arm requires positive indexing to shaft to obtain satisfactory pump operation.

STEAP-DS Form 206, 29 Nov 65

EPR SUMMARY SHEET
(TECP 700-700
Interim Pam. 60-20)

PROJECT: _____

USATECOM PROJECT NO 7-8-1016-05

TYPES OF INCIDENTS

A - DEFICIENCY D - DESIGN

B - SHORTCOMING M - MANUFACTURING

C - SUGGESTED IMPROVEMENT

SML GRP	VEH NO.	INCIDENT AFG NO.	INCIDENT TYPE	INCIDENT ITEM	PART NO.	PART MILEAGE	VEH ODOM	REMARKS
43		5	B	Seat, bridge	NA	50	50	Cargo hatch cover cannot be opened with bridge in transport position. Bridge seat also prevents cover from latching.
		1		Launcher, M113 series, w/bridge		50	50	Received for test but test funds unavailable.
15		44	Info	Ramp, female	5420-880-2777	617	617	Front differential gouged surface of bridge when truck slid off side of ramp during vehicle crossing.

STEAP-DS Form 206, 29 Nov 65

COPY/dw

APPENDIX V - CORRESPONDENCE

DEPARTMENT OF THE ARMY
ABERDEEN PROVING GROUND
ABERDEEN PROVING GROUND, MARYLAND 21005

6 FEB 1968

AMSTE-GE
7-8-1018-05/06
SUBJECT: Test Directive, Initial Production Test of Marginal Terrain Assault Bridge with M-113 Launcher, USATECOM Project No. 7-8-1018-05/06

TO: Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-DS-TU, Aberdeen Proving Ground, Maryland 21005
President, U. S. Army Armor and Engineer Board, Fort Knox, Kentucky 40121

1. References:

a. Letter, SMEFB-MG, U. S. Army Mobility Equipment Research and Development Center, 13 June 1967, subject: "Marginal Terrain Assault Bridge Mounted on M-113 Armored Personnel Carrier," with two inclosures.

b. Pretest planning conference on Marginal Terrain Assault Bridge with M113 Launcher, held at U. S. Army Mobility Equipment Research and Development Center, Fort Belvoir, 5 December 1967.

c. Purchase description for Bridge, Armored Personnel Carrier Launched: Class 12, Aluminum; 33-Foot Length of Span, 31 July 1967.

d. Purchase description for Launcher, M113 Series, Armored Personnel Carrier Transporting; for Bridge, Armored Personnel Carrier, Launched, Class 12, 31 July 1967.

e. Letter, AMSME-QX, U. S. Army Mobility Equipment Command, 8 January 1968, subject: "IPT of Marginal Terrain Bridge (MTAB) with M-113 Launcher; Code A, DAAK02-68-C-0226; USATECOM Project Nos. 7-8-1018-05 (APG) and 7-8-1018-06 (AEBd)."

f. Letter, AMSTE-GE, this headquarters, 9 January 1968, subject: "Coordinated Test Program - Marginal Terrain Assault Bridge with M113 Launcher."

2. Background:

In late 1965 an urgent request was made for a light assault bridge to be employed with the M-113 Armored Personnel Carrier. An

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expedient deck balk bridge was developed using available standard equipment. The bridge was satisfactorily employed in the field. However, studies of the general problem, operational requirements were continued and as a result of this project, a light assault bridge structure was developed which was launched and retrieved by an M-113.

3. Description of Materiel:

a. The test item consists of two basic components - the bridge, a class 12, aluminum bridge with a 33-foot length of span and the launcher, a modified M113 armored personnel carrier.

b. The bridge is a modified open box with composite deck sections. In addition to the use of weldable aluminum alloy (7039), the bridge features a noneccentric hinge employed at the juncture of the two folding leaves; thus, providing a completely flush bottom flange.

c. The launching operation is similar in principle to that of the standard AVLB, but major changes eliminate the use of a tongue cylinder in the launcher and cables and quadrant in the bridge. In addition to the aforementioned, the major components of the bridge are four tapered box sections, hinge pins, and horizontal and vertical crossing bracing.

d. The hydraulically operated launching mechanism is connected to the M-113 vehicle at six points, which are pin-connections to weldments modifying the vehicle. The external launching system consists of two launching cylinders, a locking cylinder for positive connection to the bridge, and necessary hydraulic lines and control valves. Power take-off components attached to the power plant drive a hydraulic pump which provides a combination of control and relief valves with 3000 psi hydraulic pressure. The hydraulic reservoir and controls are located directly aft of the vehicle engine compartment.

4. Test Objectives: The objectives of this test are:

a. To determine if the performance requirements of the purchase descriptions, references 1c and 1d, have been met.

b. To conduct such additional engineering and service type testing as required to insure that the test item is suitable for issue to troops under provisions of AMCR 700-34.

5. Responsibilities:

a. President, U. S. Army Armor and Engineer Board, is assigned the responsibility of preparing the plan and conducting sufficient tests to insure attainment of service type test objectives in paragraph 4b above. USATECOM Project No. 7-8-1018-06 is assigned for conduct of this test program.

b. Commanding Officer, Aberdeen Proving Ground, is assigned the responsibility of preparing a plan and conducting tests to insure attainment of quality assurance test and engineering type test objectives in paragraph 4 above. USATECOM Project No. 7-8-1018-05 is assigned for conduct of this test program.

6. Coordination:

a. The draft test plans will be coordinated with the following agencies:

(1) U. S. Army Combat Developments Command Engineer Agency
(2) U. S. Army Combat Developments Command Maintenance Agency
(3) U. S. Army Engineer School
(4) U. S. Army Mobility Equipment Command, ATTN: AMSME-QX
(5) U. S. Army Mobility Equipment Research and Development Center

b. Direct coordination between test agencies and U. S. Army Mobility Equipment Command or U. S. Army Mobility Equipment Research and Development Center is encouraged.

7. Special Instructions:

a. This is a Category II test directive.

b. Three test items will be furnished on or about 8 April 1968 for this test and will be shipped as follows:

(1) Aberdeen Proving Ground - 1

(2) U. S. Army Armor and Engineer Board - 2

c. Points of contact are:

(1) USATECOM - Mr. G. Daneker, Autovon 895-3350, extension 4270.

(2) USAMEC - 1LT J. L. Hirsch, Autovon 683-2145

(3) USAMERDC - Mr. J. Kerr, Autovon 851-1450, extension 45326.

d. Test agencies will provide to points of contact listed above the name and telephone number of an individual at each test site who may be contacted for information about this test.

e. Sufficient repair parts to support this test will be provided as to sustain testing. Should any additional parts be required, contact 1LT Hirsch, U. S. Army Mobility Equipment Command.

f. Operator's manuals, maintenance manuals, and repair parts manuals will be provided with each item.

g. Funds will be provided by the U. S. Army Mobility Equipment Command for this test.

h. An ENSURE requirement for this item has been validated, therefore, this program is assigned a code 2 for accomplishment in accordance with USATECOM Regulation 705-7.

i. Since an engineering and service test of this item is currently planned after this program, test results obtained will be used for the engineering and service test results.

j. The Proposed Small Development Requirement for Marginal Terrain Assault Bridge, furnished by reference 1a, and incorporating the changes recommended in reference 1f, will be used as test criteria for determination of suitability for issue.

8. Test Plans and Reports:

a. Test plans will be prepared in accordance with USATECOM Regulation 705-2, coordinated with the agencies listed in paragraph 6,

COPY/dw

6 FEB 1968

AMSTE-GE
7-8-1018-05/06
SUBJECT: Test Directive, Initial Production Test of Marginal Terrain Assault Bridge with M-113 Launcher, USATECOM Project No. 7-8-1018-05/06

above, and submitted to this headquarters for approval not later than 15 March 1968. Copies of the draft test plan should also be furnished this headquarters for early review during the coordination phase of test plan preparation.

b. Equipment performance reports will be prepared in accordance with USATECOM Regulation 705-4.

c. Interim Report.

(1) An interim report will be submitted by Aberdeen Proving Ground upon completion of tests required to meet the objective listed in paragraph 4a.

(2) Test agencies will forward a teletype report to this headquarters upon completion of all testing. These reports will be used by this headquarters in preparing a suitability for issue statement as required by reference 1e.

d. A formal final report will be prepared as prescribed in USATECOM Regulation 705-2 and submitted to this headquarters 30 working days after conclusion of all testing.

e. Distribution for test plans and final reports is as follows:

		Plan	EPR	Final Report
(1)	USATECOM, ATTN: AMSTE-GE	2	2	2
(2)	USAMEC, ATTN: AMSME-QX	8	8	8
(3)	USAMERDC, ATTN: SMEFB-CO	8	8	8
(4)	USAMC, ATTN: AMCRD-GS	1	1	1
(5)	USACDC, ATTN: USACDC LnO (USATECOM)	3		3
(6)	Participating USATECOM test agencies	1	1	1
(7)	DCASO/Oklahoma City		1	

f. STE Form 1028 required to enter this test program into Test Scheduling and Management System is at inclosure 1. Items marked by an asterisk will be scheduled by your test agency. Test progress will be reported as prescribed in USATECOM Regulation 705-5.

COPY/dw

AMSTE-GE 6 FEB 1968
7-8-1018-05/06
SUBJECT: Test Directive, Initial Production Test of Marginal Terrain Assault Bridge with M-113 Launcher, USATECOM Project No. 7-8-1018-05/06

9. Safety: There are no known safety hazards associated with the specific use of this test item. Normal safety precautions utilized for the operation of bridges and launchers will be utilized in the conduct of this test.

10. Security: This project is unclassified.

FOR THE COMMANDER:

/s/ James O. Daulton
/t/ JAMES O. DAULTON
Colonel GS
Director, General Equipment
Testing Directorate

1 Incl
as

Copy furnished:
CG, USAMEC, ATTN: AMSME-QX
CG, USAMC, ATTN: AMCRD-GS
CG, USACDC, ATTN: USACDC
LnO (USATECOM) (3 cy)
CO, USAMERDC, ATTN: SMEFB-CO

DEPARTMENT OF THE ARMY
HEADQUARTERS, U S ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-GE

13 JUN 1968

SUBJECT: Amendment No 1, Test Directive, Initial Production Test of Marginal Terrain Assault Bridge with M-113 Launcher, USATECOM Project No 7-8-1018-05/06

Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-DS-TU, Aberdeen Proving Ground, Maryland 21005
President, U. S. Army Armor and Engineer Board, Fort Knox, Kentucky 40121

1. References:

a. Letter, AMCRD-GS, U. S. Army Materiel Command, 22 May 1968, subject: "Coordinated Test Program for M113A1 Bridge/Launcher," (Inclosure 1).

b. Letter, AMSTE-GE, this headquarters, 6 February 1968, subject: "Test Directive, Initial Production Test of Marginal Terrain Assault Bridge with M-113 Launcher, USATECOM Project No 7-8-1018-05/06."

2. In order to comply with the request, reference 1a, the following changes should be made to indicated paragraphs of the test directive, reference 1b:

a. 1. References - Add the following:

g. Letter, AMCRD-GS, U. S. Army Materiel Command, 22 May 1968, subject: "Coordinated Test Program for M113A1 Bridge/Launcher."

b. 7b. Change to read:

Three test items will be furnished on or about 15 July 1968 for this test and will be shipped as follows:

(1) Aberdeen Proving Ground - 1

(2) U. S. Army Armor and Engineer Board - 2

c. 7j. Change to read:

AMSTE-GE

SUBJECT: Amendment No 1, Test Directive, Initial Production Test of Marginal Terrain Assault Bridge with M-113 Launcher, USATECOM Project No 7-8-1018-05/06

The Proposed Small Development Requirement for Marginal Terrain Assault Bridge, furnished by reference 1a, and incorporating the changes recommended in reference 1f, as revised by reference 1g, will be used as test criteria for determination of suitability for issue.

d. 8a. Change to read:

Test plans will be prepared in accordance with USATECOM Regulation 705-2, coordinated with the agencies listed in paragraph 6, above, and submitted to this headquarters for approval not later than 15 July 1968. Copies of the draft test plan should also be furnished this headquarters for early review during the coordination phase of test plan preparation.

FOR THE COMMANDER:

1 Incl
as

JAMES O. DAULTON
Colonel, GS
Director, General Equipment

Copies furnished (w/incl):
CG, USAMECOM, ATTN: AMSME-QRT
CG, USAMC, ATTN: AMCRD-GS
CG, USACDC, ATTN: USACDC LnO (USATECOM) (3 cy)
CO, USAMERDC, ATTN: SMEFB-CO

DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-GE

11 FEB 1969

SUBJECT: Initial Production Test of Marginal Terrain Assault Bridge with M113 Launcher, USATECOM Project No. 7-8-1018-05/06

Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-MT-TU, Aberdeen Proving Ground, Md. 21005
President, U. S. Army Armor and Engineer Board, Ft. Knox, Kentucky 40121

1. Subject test is terminated.

2. Test agencies will enter test termination in test scheduling and management system along with revised completion and reporting dates.

3. Disposition instructions for test items on hand have been requested from U. S. Army Mobility Equipment Command.

FOR THE COMMANDER:

QUELLEN D. BOLLER
Colonel, GS
Dir, GE Mat Test Dir

COPY/dw

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY MATERIEL COMMAND
WASHINGTON, D. C. 20315

IN REPLY REFER TO:

AMCRD-GS

22 MAY 1968

SUBJECT: Coordinated Test Program for M113A1 Bridge/Launcher

Commanding General
US Army Test and Evaluation Command
ATTN: AMSTE-GE
Aberdeen Proving Ground, Maryland 21005

1. References:

a. Letter, AMSTE, US Army Test and Evaluation Command (TECOM), 9 January 1968, subject: Coordinated Test Program - Marginal Terrain Assault Bridge with M113 Launcher; with one inclosure (DA Form 1598).

b. Letter, SMEFB-RDE-RE, US Army Mobility Equipment Research and Development Center (MERDC), 13 Mary 1968, subject: M113A1 Bridge/Launcher; copy inclosed, with one inclosure (Minutes of USAMERDC and USAMC Conference on Testing Criteria for M113A1 Bridge/Launcher).

2. Request in the subject test program, the testing criteria incorporate the proposed TECOM changes as given in the inclosure to reference 1a which are in consonance with the proposed MERDC changes as given in the inclosure to reference 1b.

3. Further request planning action be taken to change from an integrated Engineering and Service Test (ET/ST) to only an Engineering Test (ET).

FOR THE COMMANDER:

/t/ EDWIN M. RHOADS
Colonel, GS
Chief, Ground Mobility Office

1 Incl
as

COPY/dw

DEPARTMENT OF THE ARMY
U. S. ARMY MOBILITY EQUIPMENT COMMAND
RESEARCH DEVELOPMENT AND ENGINEERING DIRECTORATE
FORT BELVOIR, VIRGINIA 22060

IN REPLY REFER TO:
SMEFB-RDE-RE

SUBJECT: M113A1 Bridge/Launcher 13 May 1968

Commanding General
U. S. Army Materiel Command
ATTN: AMCRD-GS
Washington, D. C. 20315

1. Inclosed are minutes of the 2 May 1968 conference of AMC and MECOM representatives on subject item. The conference was convened for an informal discussion of the known or anticipated discrepancies between the M113A1 Bridge/Launchers scheduled for delivery in July-October 1968, and the Draft Proposed Small Development Requirement (DPSDR) which is to be used as the criteria for TECOM tests of the units.

2. The DPSDR changes, agreed by the conferees to be necessary for compatibility with the design approved by ACSFOR for procurement to satisfy the ENSURE 84 requirement, are delineated in paragraph 6 of the minutes. The AMC representatives agreed that AMC headquarters (AMCRD-GS) would take the necessary action to staff the agreed upon DPSDR changes to TECOM for guidance in developing the test plan. It was agreed that the DPSDR with these changes would then be a realistic criteria for tests by TECOM to determine the suitability of the Bridge/Launchers for issue under the procedures of AMCR 700-34.

3. It is requested that the agreed upon changes to the DPSDR be processed to TECOM for incorporation into the criteria against which the suitability for issue (AMCR 700-34) test plan will be prepared.

FOR THE COMMANDER:

/s/ R. W. Beal
/t/ R. W. BEAL
Director of Engineering

Incl
as

cc: QA, MECOM (Mr. Rich)

COPY/dw

SMEFB-RDE-RE 13 May 1968

MEMORANDUM FOR RECORD

SUBJECT: Minutes of USAMERDC and USAMC Conference on Testing Criteria for M113A1 Bridge/Launcher

1. A conference between representatives of USAMC and USAMERDC was held at Fort Belvoir, Virginia on 2 May 1968 to resolve a potential controversy on the criteria to be used for USATECOM testing of the M113A1 APC Launchers and Bridges (ENSURE 84). A list of attendees is attached as Inclosure 1.

2. Current status of the contract for manufacture of twenty-nine (29) M113A1 Bridges and Launchers (5 for ET/ST and 24 for ENSURE 84) was given by Mr. R. W. Beal, USAMERDC. Mr. Beal said that if the aluminum extrusions are delivered by the subcontractor (Code B) on the 9 May 1968 schedule, the prime contractor (Code A) will deliver five (5) bridge units on 9 July 1968, and the remaining twenty-four bridges and launchers in three deliveries of eight (8) units each on 9 August 68, 9 September 68, and 9 October 68. Three (3) of the first five (5) bridges and launchers will go to USATECOM for test and evaluation in an Initial Production Test (IPT) and an AMCR 700-34 Suitability for Issue determination. A fourth unit is scheduled to be provided later for use with these three bridges in an Engineering Test and Service Test (ET/ST).

3. Planned USATECOM tests to be performed on the M113A1 Bridges and Launchers were described by LTC W. D. Jones, Deputy Chief, Operations Division, Plans and Operations Office, USAMERDC. LTC Jones stated that USATECOM had agreed to test and evaluate the bridges and launchers in three phases, beginning with the IPT conducted by Aberdeen Proving Ground (APG), progressing to the AMCR 700-34 Suitability for Issue Test conducted jointly by APG and U. S. Army Armor and Engineer Board (USAARENBD), and ending with the ET/ST conducted by APG (ET) and USAARENBD (ST). Test data from the IPT would be utilized for the AMCR 700-34 determination which would in turn provide data for evaluation in the ET/ST phase. USATECOM was said to have previously agreed to complete the IPT test within 60 days of delivery of the test items and the AMCR 700-34 determination (Suitability for Issue) within 90 days of test item delivery provided no delays occur due to failure of the bridge units; the 60 and 90 day test times include issuance of

message or letter reports giving results of tests on contractor compliance with purchase description (IPT Test) and results of tests and Suitability for Issue statement for release of equipment to the field (AMCR 700-34 tests).

4. Criteria for the various USATECOM tests was discussed in detail because USAMERDC and USATECOM are in disagreement as to testing criteria to be used in the AMCR 700-34 Suitability for Issue Test. USATECOM has agreed to use the Purchase Description as the test criteria for the IPT to determine contractor compliance with the contract, so no controversy exists on this test. On the AMCR 700-34 Suitability for Issue Test, however, USATECOM has proposed changes to the USAMERDC Draft Proposed Small Development Requirement (DPSDR) which they intend to use with their changes as the test criteria for that test as well as the ET/ST. Mr. Beal of USAMERDC emphasized the fact that the twenty-four (24) bridges and launchers being procured to satisfy SEA ENSURE 84 were being manufactured to specifications of the USAMERDC inhouse prototype bridge and launcher as mentioned by ACSFOR, Department of the Army, in their approval of the Limited Production type classification; furthermore, it was stated that the 24 bridges and launchers to satisfy the ENSURE 84 requirement would not meet the criteria of the USAMERDC DPSDR (neither the original MERDC draft or as amended by TECOM) because that document was intended for development of an APC bridge and launcher for all Army use (Standard A) and not for the SEA bridges and launchers which have capabilities of the USAMERDC prototype bridge. Mr. A. J. Hill of USAMC said the M113A1 bridges and launchers were approved for ENSURE 84 as a special purpose item designed for self-help of M113 APC crossings of gaps in SEA only, with the 24 bridge units being special equipment for LP only; development of an all Army vehicular mounted bridge and launcher may be a new development after completion of the ENSURE 84 task, so the criteria of the DPSDR as modified by USATECOM should not be the criteria for AMCR 700-34 testing of the current M113A1 bridge units. Moreover, the ENSURE 84 bridge units should not undergo ET/ST, and RDT&E supported activities leading to the development of an all Army (Standard A) vehicular mounted bridge and launcher should pass to the Engineering Test Phase.

5. Conference participants agreed that the DPSDR modified by USA TECOM should not be the criteria for the AMCR 700-34 Suitability for Issue Tests of the ENSURE 84 bridges and launchers. Mr. Marshall of USAMC stated that only the USACDC changes to the DPSDR, as listed in Inclosure 2 hereto, would apply for the AMCR 700-34 test at USATECOM.

He said these USACDC changes were forwarded to USATECOM by USAMC letter, AMCRD-GS, 6 December 1967 (copy attached as Inclosure 3), and were incorporated into the DPSDR as part of the USATECOM changes. Participants further agreed that the criteria for the AMCR 700-34 tests of ENSURE 84 bridges and launchers should be the DPSDR as changed by USACDC (Inclosure 2), and modified by the 2 May 1968 meeting between representatives of USAMC and USAMERDC.

6. Modifications of the DPSDR as agreed on by the conference participants were as follows:

a. Change paragraph 3a of the DPSDR to read "...with a roadway width of 106 inches..." Reason: Roadway width of bridge being built under contract is 106 inches.

b. Change paragraph 3b (1) of DPSDR to delete requirements for environmental testing under paragraphs 7a (hot-dry climatic conditions), 7b (warm-wet conditions), and 7c (intermediate climatic conditions) of AR 705-15. Reason: No on-site environmental testing is required for suitability for issue determination under the provisions of AMCR 700-34. Environmental testing requirement under AR 705-15 only apply to ET/ST of all Army Standard A bridge and launcher.

c. Change paragraph 3b (10) of DPSDR to read "swimming characteristics with bridge in travel position will equal that of the Standard M113 except as affected by the changed center of gravity location resulting from the bridge/launcher mounting".

d. Change paragraph 3b (11) of DPSDR to read "Mobility equivalent to the M113 except as affected by the changed center of gravity location resulting from the bridge/launcher mounting". Reason for changes to paragraph 3b(10) and paragraph 3b(11) of SDR: The swimming and mobility characteristics of the M113A1 APC vehicle with launcher and bridge are reduced from those of the standard M113 vehicle because the center of gravity is raised by mounting of the launcher and bridge. The stated requirement in the DPSDR cannot be met even in future design of a launcher and bridge.

e. Change paragraph 3b(8) of DPSDR to read "Be capable of being recovered from either bank by the launching vehicle" (deleting "with no more than one man exposed"). Reason: Recovery of the bridge from other than ideal bank sites would probably necessitate that more than one man be exposed because the bridge/launcher has no inherent lifting devices.

COPY/dw

SMEFB-RDE-RE 13 May 1968

SUBJECT: Minutes of USAMERDC and USAMC Conference on Testing Criteria for M113A1 Bridge/Launcher

f. Delete the added USATECOM requirement to DPSDR that "Hydraulic lines shall be recessed and/or protected from damage by travel through wooded areas and to provide as much protection from small arms fire as may be feasible and practicable." Reason: This was not in the DPSDR for the ENSURE 84 bridge units approved for LP by ACSFOR, so the hydraulic lines are not recessed and components have no armor protection. It is not possible to add much additional weight to the current configuration and still retain a satisfactory swimming capability.

g. Change the added USATECOM requirement to the DPSDR that the unit "Have simple, easily accessible controls so that the bridge can be launched or recovered by the two man crew" to read, "Have simple, easily accessible controls so that the bridge can be launched or recovered by a three man crew (essential) and two man crew (desirable)". Reason: The vehicle automotive controls and the launching mechanism controls are at two different locations. In retrieving the bridge, one man probably will be required to manipulate the vehicle, one to operate the launcher controls, and a third person outside to guide the operators in effecting a connection to the bridge and to connect the hydraulic couplings between launcher and bridge.

h. Delete the added USATECOM requirement to the DPSDR that the unit "Have overall dimensions, when sectionalized into launcher and bridge sections, such that they can be transported and parachute delivered by current aircraft for Phase I airborne operation". Reason: This was not in original DPSDR and is a criteria not required of ENSURE 84 bridges. Studies or tests have not been conducted on prototype to determine whether it will survive parachute delivery.

i. Change added USATECOM requirement to DPSDR that the unit "Be provided with lifting and tie-down devices for air, rail, and water shipment" to read "Be provided with lifting and tie-down instructions for air, rail, and water shipment". Reason: Lifting and tie-down devices are not provided on the ENSURE 84 bridges being manufactured. Lifting and tie-down instructions for shipment (air, rail, water) will be included in DTM for ENSURE 84 bridges. Launcher contains same lifting and tie-down devices as standard M113A1 APC.

j. Change paragraph 3b(2) - under durability of the DPSDR to read "...sufficient ruggedness in design to withstand military service without requiring major overhaul or replacement for 750 miles, 75 hours, or 500 launching cycles. (Deleting "other than organizational

maintenance for 1000 miles, 100 hours or field maintenance for 2,000 miles, 200 hours, or 1,000 launching cylces".) Reason: Tests were not conducted on prototype launcher and bridge to determine maintenance characteristics or component replacement value factors. Prototype launcher and bridge were subjected to approximately 1000 launchings, however, this was not without numerous changes and/or repairs. The prototype launcher was not driven for the specified mileage to determine its durability.

k. Change paragraph 3c(4) "Mission Reliability" to read "The minimum, acceptable, overall mission reliability is 90 percent in intermediate zones for all missions". (deleting "95" percent) Reason: MTBF data for the M113A1 Launcher and Bridge was not considered or recorded during prototype tests. During confirmatory II tests of two (2) M60A1 AVL Bridge Launcher (a similar system) MTBF data obtained was 19.7 and 31.1 hours, respectively, which is considerably less than the time required to traverse the 600 miles envisioned for the M113A1 launcher.

l. Change the added USATECOM requirement under paragraph 3c(4) of the DPSDR to read "The launcher conversion components for the APC vehicle shall demonstrate a MTBF of no less than 600 miles or 60 launches. The bridge shall demonstrate a MTBF of no less than 60 launchings and 900 crossings by a class 12 load..." Reason: It is assumed that the USATECOM reliability requirements are in part lifted from the characteristics of the standard M113 APC. The addition of a launcher and bridge will probably lower the reliability factor of the basic APC vehicle.

m. Change the added USATECOM requirement under paragraph 6b - Maintenance - of the DPSDR to read... "The launcher shall possess the maintenance characteristics of the current APC. The installation of the launcher equipment will not significantly increase (deleting "impair the maintenance accessibility or") the practicable time, degree of skill, or variety of tools required for maintenance. Scheduled and unscheduled organizational maintenance shall not exceed 25 manhours per 1000 miles or 500 launches for the launcher and 2 manhours per 500 crossings of class 12 loads for the bridge." (deleting "unit maintenance manhours shall not exceed 20 manhours per 1000 or 500 launches. Direct support maintenance shall not exceed 80 manhours per 2000 miles or 100 launches"). Reason: Maintainability tests have not been conducted on the prototype bridge. Addition of the launching mechanism, hydraulic components, and power take-off obviously will impair maintenance functions. Different maintenance procedures will probably be required that will be more time consuming.

COPY/dw

SMEFB-RDE-RE 13 May 1968

SUBJECT: Minutes of USAMERDC and USAMC Conference on Testing Criteria for M113A1 Bridge/Launcher

7. On several occasions, Mr. Hill emphasized that AMC desired the Bridge/Launcher to be operated extensively by MERDC and/or TECOM to discover any extended-use deficiencies and necessary modifications before failures were experienced in normal service in Vietnam.

8. In conclusion, Mr. A. J. Hill of USAMC requested that USAMERDC write up the conference approved changes to DPSDR, as delineated in paragraph 6 above, and forward them to USAMC, Attn: AMCRD-GS for transmittal to USATECOM for compliance in the AMCR 700-34 testing of the ENSURE 84 bridges and launchers. Mr. Hill further requested that USAMERDC take necessary action to proceed from AMCR 700-34 tests to ET tests of the bridge/launcher to improve the state-of-the-art as a basis for future development of an all Army vehicular mounted launcher and bridge for eventual type classification/standard A when the qualitative requirements are established by ACSFOR, DA. Mr. Beal requested that the Bridge and Marine Division, Military Technology Laboratory, USAMERDC, take action to cancel ET/ST of the ENSURE 84 design bridges and launchers and continue the RDT&E project in the ET phase until disposition of the current RDT&E project is determined.

/s/ R. W. Beal
/t/ R. W. BEAL
Director of Engineering

3 Incl
as

LIST OF PARTICIPANTS

NAME	RANK/GRADE	ORGANIZATION	ADDRESS	TELEPHONE	OFFICE SYMBOL
J. A. Dennis	Civ	USAMERDC	Ft. Belvoir, Va.	45515	SMEFB-CO
R. W. Beal	Civ	USAMERDC	Ft. Belvoir, Va.	45251	SMEFB-RE
A. S. Warner	Civ	USAMERDC	Ft. Belvoir, Va.	45620	SMEFB-MG
J. F. Bolton	Civ	USAMERDC	Ft. Belvoir, Va.	45426	SMEFB-MG
R. G. Marshall	DAC	Hqs, AMC	Washington, D. C.	54111	AMCRD-GS
N. K. Dickinson	Civ	USAMERDC	Ft. Belvoir, Va.	45433	SMEFB-MD
R. M. Rich	Civ	USAMECOM	St. Louis, Mo.	693-2145	AMSME-QRT
K. K. Harris	Civ	USAMERDC	Ft. Belvoir, Va.	45463	SMEFB-RDE-KC
John V. Kerr	Civ	USAMERDC	Ft. Belvoir, Va.	45463	SMEFB-RDE-KC
W. D. Jones	LTC	USAMERDC	Ft. Belvoir, Va.	45515	SMEFB-CO
S. W. Romano	Civ	USAMERDC	Ft. Belvoir, Va.	45561	SMEFB-RDE-KC
A. J. Hill	Civ	Hqs, AMC	Washington, D. C.	54111	AMCRD-GS

COPY/dw 1 DEC 1967

FOR DS SSS (11 Sep 67) 3rd Ind
SUBJECT: Proposed Small Development Requirement (SDR) for a Marginal Terrain Assault Bridge with M113 APC Launcher

HQ, DA, OACSFOR, Washington, D. C. 20310

TO: Commanding General, United States Army Materiel Command, Washington, D. C. 20315

1. Subject Proposed SDR has been forwarded to CGUSACDC for appropriate action.

2. Criteria contained in the proposed SDR plus that recommended in para 1 of the 2nd Indorsement will be used for testing of the ENSURE item.

3. Copies of the proposed test plan should be furnished to this headquarters and USACDC.

FOR THE ASSISTANT CHIEF OF STAFF FOR FORCE DEVELOPMENT:

1 Incl
nc

/s/ Daniel B. Williams
/t/ DANIEL B. WILLIAMS
Colonel, GS
Acting Director of Doctrine
and Systems, OACSFOR

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DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY MATERIEL COMMAND
WASHINGTON, D. C. 20315

AMCRD-GV 11 SEP 1967

SUBJECT: Initial Draft Proposed Small Development Requirement (SDR) for a Marginal Terrain Assault Bridge with M113 APC Launcher.

TO: Assistant Chief of Staff for Force Development
ATTN: FOR-DS-SSS (LTC R. L. Hunt)
Department of the Army
Washington, D. C. 20310

1. References:

a. Unclassified message 815050, DA, ACSFOR, dated 16 2101Z May 67, subject: Launcher and Lightweight Assault Bridge for the M113 (ENSURE 84).

b. Unclassified message 829465, DA, ACSFOR, dated 24 2116Z August 67, subject: same as reference a.

c. CONFIDENTIAL letter LOG/PE-PCB7674, DCSLOG for AMCMI-PE, dated 31 August 67, subject: FY68 PEMA Procurement Program - Bridge Assault, Lightweight for M113 Carrier (ENSURE #84). (U)

2. Subject requirement has been identified and established for increased Army mobility. Review of the requirement has been made and in response to the requirement, the inclosed SDR is proposed.

3. In view of the materiel under development and scheduled for further tests, the need has arisen to provide documentation whereby the developing and testing activities have properly staffed guidance to measure the RDTE effort.

4. It is recommended that consideration be given the processing of the inclosed initial draft proposed SDR.

FOR THE COMMANDER:

/s/ Edwin M. Rhoads
/t/ EDWIN M. RHOADS
Colonel, GS
Chief, Ground Mobility Office
Development Directorate

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FOR DS SSS (11 Sep 67) 1st Ind
SUBJECT: Proposed Small Development Requirement (SDR) for a Marginal Terrain Assault Bridge with M113 APC Launcher

HQ, DA, OACSFOR, Washington, D. C. 20310 19 OCT 1967

TO: Commanding General, United States Army Combat Developments Command, Fort Belvoir, Virginia 22030

1. Forwarded for appropriate action in accordance with paragraph 7c(1), AR 71-1, dated 27 May 1966.

2. Development of the subject item has been expedited to meet a validated USARV ENSURE requirement.

3. Request your comments and/or concurrence in using the criteria stated in the proposed SDK for test of the ENSURE item pending formal action on the proposed SDR.

4. Comments are requested by 15 November 1967.

FOR THE ASSISTANT CHIEF OF STAFF FOR FORCE DEVELOPMENT:

1 Incl
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/t/ JOHN R. DEANE, JR.
Brigadier General, GS
Director of Doctrine
and Systems, OACSFOR

Copy furnished:
CGUCAMC
ATTN: AMCRD-CV

/t/ DANIEL B. WILLIAMS
Colonel, GS
Deputy Director of
Doctrine & Systems, OACSFOR

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CDCMR-O(11 Sep 67) 2d Ind
SUBJECT: Proposed Small Development Requirement (SDR) for a Marginal Terrain Assault Bridge with M113 APC Launcher

Headquarters, United States Army Combat Developments Command,
Fort Belvoir, Virginia 22060 9 NOV 1967

TO: Assistant Chief of Staff for Force Development, Department of the Army, ATTN: FOR DS SSS, Washington, D. C. 20310

1. The US Army Combat Developments Command has reviewed subject DPSDR and concurs in using the criteria established for testing the ENSURE item. The following additional test objectives are offered to supplement the criteria of the DPSDR.

a. Bridge should be capable of being launched and retrieved when launcher is positioned on a 8% side slope.

b. Bridge should be capable of being launched and retrieved when the slope between launching plane and the far shore is as large as plus 15% or minus 10%.

c. Launcher should be tested to determine driver 1 operator visual limitations to the side, front, rear and overhead.

d. The launcher should be tested, with and without the bridge mounted, in cross-country mobility and swimming tests to insure performance is equivalent to the M113A1.

e. Special tools and tow bars used and stowed on the Bridge/Launcher should be evaluated.

f. Bridge should be tested on gaps where the banks include, but are not limited to, the following soil conditions:

(1) Sandy bank with dry gap.

(2) Clay bank with dry gap.

(3) Clay bank with wet gap.

(4) Gap which has far shore inundated, similar to a rice paddy.

2. Request that this headquarters be provided copies of test plans and reports of tests.

FOR THE COMMANDER:

1 Incl
nc

V-22 /t/ HUNT
Major, AGG
Asst Adj Gen

COPY/dw

AMCRD-GS

SUBJECT: Assault Bridge and Launcher for M113APC (Ensure #84)

Mr. Marshall/n/m/T 6 Dec 67

TO: Commanding General
US Army Test and Evaluation Command
ATTN: AMSTE-GE
Aberdeen Proving Ground, Maryland 21005

1. References:

a. Telecon of 1 Sept. 67 between Mr. George W. Daneker, TECOM and Mr. Robert G. Marshall, AMC, Re: Test Criteria on subject items.

b. USAMERDC Proposed Small Development Requirement (SDR) for a Marginal Terrain Assault Bridge with M-113 APC Launcher, dated 17 Feb. 67.

2. Reference 1a related the need for test guidance to evaluate the ENSURE item. Reference 1b is a proposed SDR originating from USA Army Mobility Equipment Research & Development Center.

3. The referenced proposed SDR has been coordinated with US Army Combat Developments Command with the objective of using the criteria stated therein for test of the ENSURE item pending formal action on the proposed SDR. Concurrence has been received with the following additional operations characteristics:

a. Bridge should be capable of being launched and retrieved when launcher is positioned on a 8% side slope.

b. Bridge should be capable of being launched and retrieved when the slope between launching plane and the far-shore is as large as plus 15% or minus 10%.

c. Launcher should be tested to determine driver 1 operator visual limitation to the side, front, rear, and overhead.

COPY/dw

AMCRD-GS
SUBJECT: Assault Bridge and Launcher for M113APC (Ensure #84)

d. Launcher should be tested, with and without the bridge mounted, in cross-country mobility and swimming tests to insure performance is equivalent to the M113A1.

e. Special tools and tow bars used and stowed on the Bridge/launcher should be evaluated.

f. Bridge should be tested on gaps where the banks include, but are not limited to, the following soil conditions:

(1) Sandy bank with dry gap.

(2) Clay banks with dry gap.

(3) Clay bank with wet gap.

(4) Gap which has far-shore inundated, similar to a rice paddy.

4. Request necessary action be accomplished to conduct required test program.

/t/ EDWIN M. RHOADS
Colonel, GS
Chief, Ground Mobility Office
Development Directorate

APPENDIX VI - REFERENCES

1. Letter, AMSTE-GE, Marginal Terrain Assault Bridge with M113 Launcher, 3 October 1967, with 1st Ind, same subject, STEAP-DS-TU, 1 November 1967.

2. Letter, AMSME-QR, IPT of Marginal Terrain Assault Bridge (MTAB) with M113 Launcher, Code A Co, DAAK 02-68-C-0226, USATECOM Project Nos. 7-8-1018-05 (APG) and 7-8-1018-06 (ARBD), 8 January 1968.

3. Letter, AMSTE-GE; Coordinated Test Program, Marginal Terrain Assault Bridge with M113 Launcher, 9 January 1968.

4. Letter, SMEFB-RDE-KC, Initial Production Test of M113 APC Launcher and Bridge, USATECOM Project No. 7-8-1018-05, 23 July 1968.

5. Letter, AMSTE-GE, Initial Production Test of M113 APC Launcher and Bridge, USATECOM Project No. 7-8-1018-05, 29 July 1968.

6. Letter, STEAP-DS-TU, Proposed Plan for Initial Production Test of Marginal Terrain Assault Bridge with APC Launcher, RDT&E Project No. Not available, USATECOM Project No. 7-8-1018-05, August 1968.

7. Letter, STEAP, MT-TU, Proposed Plan for Initial Production Test of Marginal Terrain Assault Bridge with APC Launcher, RDT&E No. Not available, USATECOM Project No. 7-8-1018-05, 13 September 1968.

8. Letter, CSGEN-MH, 1st Ind Proposed Plan for Initial Production Test of Marginal Terrain Assault Bridge with APC Launcher, RDT&E No. Not available, USATECOM Project No. 7-8-1018-05, September 1968.

9. Letter, AMSTE-GE, Proposed Plan for Initial Production Test of Marginal Terrain Assault Bridge with APC Launcher, RDT&E Project No. Not available, USATECOM Project No. 7-8-1018-05, 4 October 1968.

10. Letter, STEAP-MT-TU, Initial Production Test of Marginal Terrain Assault Bridge with M113 Launcher, USATECOM Project No. 7-8-1018-05/06, 26 November 1968.

11. Letter, STEAP-MT-TU, Cost Estimate for IPT of Marginal Terrain Assault Bridge with M113 Launcher, 13 December 1968.

12. Teletype 54, SMEFB-RDE-O, Correction of Deficiencies on Marginal Terrain Assault Bridge with M113 Launcher, USATECOM Project No. 7-8-1018-05/06, 18 December 1968.

13. Letter, AMSTE-GE, Marginal Terrain Assault Bridge, with M113 Launcher, USATECOM Project No. 7-8-1018-05/06, 23 January 1969.

14. Eddington, V. A., Production Engineering Test of Carriers, Personnel, Full-Tracked, Armored, M113, M113E1, and M113E2 (Comparison). Aberdeen Proving Ground. Report No. DPS-772, January 1963. (Distribution Controlled by US Army Mobility Command, AD 293 138L).

15. Hylbert, S.L, Preproduction Test of Carrier, Personnel, Full-Tracked, Armored, M113A1, Pilot No. 1, Aberdeen Proving Ground. Report No. DPS 1238 March 1964 (Distribution Controlled by US Army Mobility Command.

16. Eddington, V. A., Final Report of Product Improvement Test of Carrier, Personnel, Full Tracked, Armored, M113A1, Aberdeen Proving Ground. Report No. DPS 1368. July 1964 (Distribution Controlled by US Army Mobility Command).

17. Purchase Description, FSC 5420, Bridge, Armored Personnel Carrier Launched: Class 12, Aluminum, 33-Foot Length of Span, US Army Mobility Equipment Command, Fort Belvoir, Virginia, 31 July 1967.

18. Purchase Description, Launcher, M113 Series, Armored Personnel Carrier Transporting: For Bridge, Armored Personnel Carrier Launched, Class 12, US Army Equipment Mobility Command.

19. SDR, Proposed Small Development Requirement for Marginal Terrain Assault Bridge with M113 Launcher, US Army Engineer Research and Development Laboratories, 10 February 1967.

20. Materiel Test Procedure, US Army Test and Evaluation Command, Common Engineering Test Procedures.

21. Military Specification, MIL-C-46782A(MO), Amendment 2, Carrier, Personnel, Full-Tracked, Armored, M113A1, 12 May 1967.

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5. AUTHOR(S) (First name, middle initial, last name)

H. Wade Byers, Jr.
E. C. Kotras

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13. ABSTRACT

The marginal terrain assault bridge with APC launcher was subjected to various engineering tests as well as endurance operations. Under most conditions, the test vehicle was able to meet the performance requirements of specification MIL-C-46782A(MO) for the standard M113A1 vehicle. However, while swimming, the vehicle has excessive list and trim forward and to the right which adversely affect vehicle turning ability. The vehicle was operated for 1051 miles on various test terrain and for 441 launches with 15 vehicle crossings per launch. Various weld failures occurred in the braces and beams for the bridge because of insufficient strength. In addition failures of the rotating beam to hinge pin bolts resulted in other failures. Redesigned components were installed after 320 launchers; however, the limited operation thereafter provided insufficient testing as to the suitability of these components. It was concluded that certain operating conditions, such as swimming and bridge launching present operational hazards that can be detrimental to the vehicle and its operating personnel. Also, that the assault bridge failed to meet the PSDR requirements for maintainability and reliability.

DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

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14 KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Assault bridge						
Launcher, APC						
Engineering performance						
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USATECOM PROJECT NO. 7-8-1018-05

FINAL REPORT ON INITIAL PRODUCTION TEST

OF MARGINAL TERRAIN ASSAULT BRIDGE

WITH APC LAUNCHER

Report No. APG-MT-3186

CODE SHEET

Code A - Unit Rig and Equipment Co.
Code B - Kaiser Aluminum Inc.

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