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MASTER TEST PLAN FOR THE FEASIBILITY TESTING OF AN LVA ALUMINUM--ETC(U)
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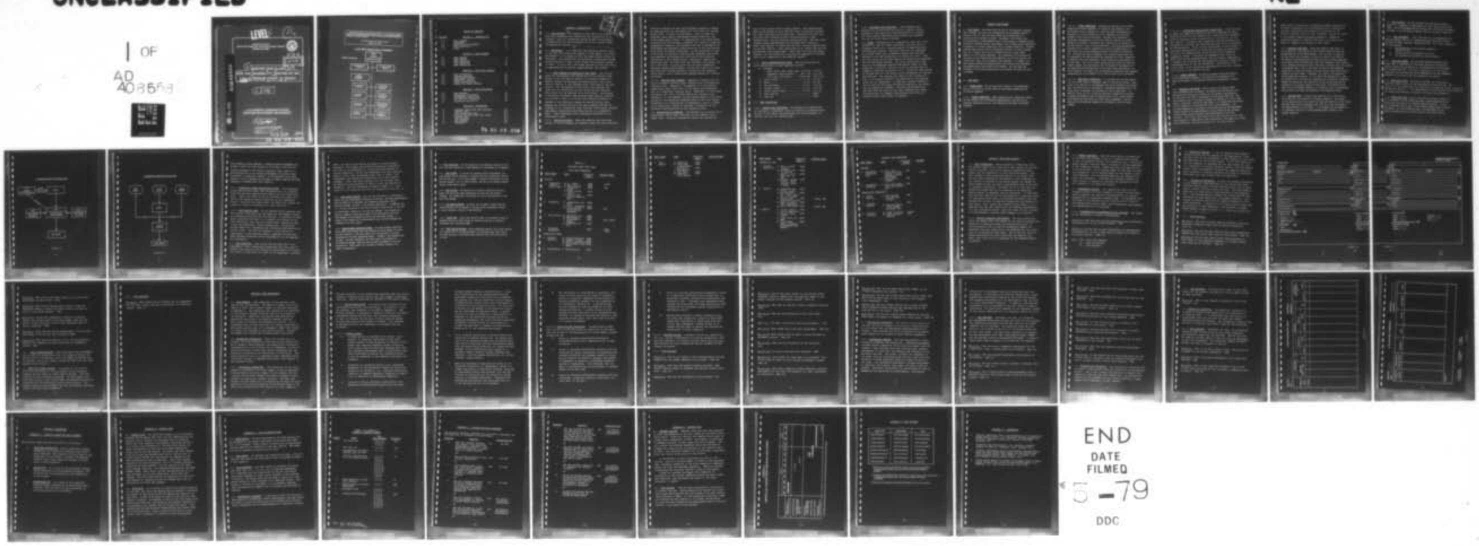

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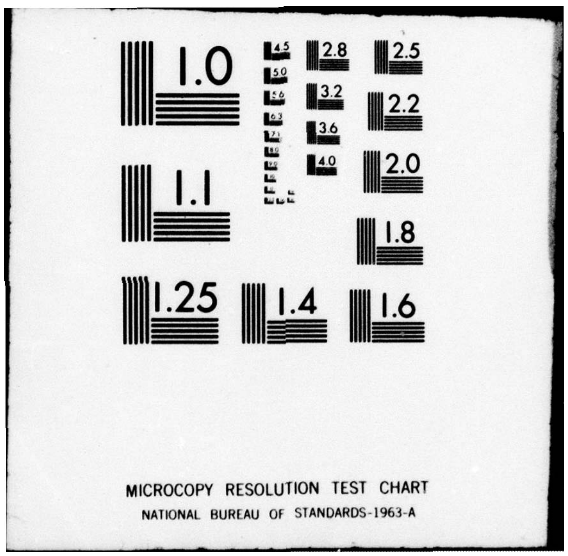
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LEVEL II

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(6)

MASTER TEST PLAN FOR THE FEASIBILITY TESTING OF AN LVA ALUMINUM TRACK (A-TRACK)

(12) 50p.

LVA TECHNICAL MANAGER'S OFFICE
SYSTEMS DEVELOPMENT DEPARTMENT

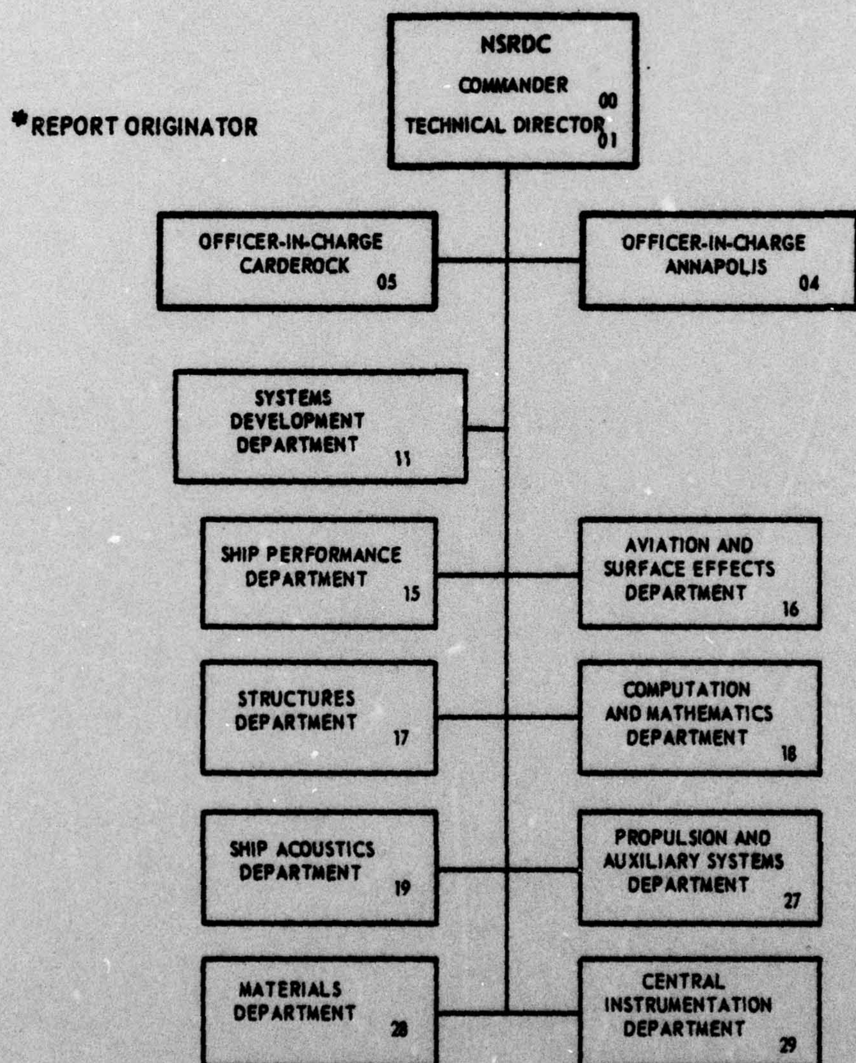
(11) JUL [redacted] 78

The Naval Ship Research and Development Center is a U. S. Navy center for laboratory effort directed at achieving improved sea and air vehicles. It was formed in March 1967 by merging the David Taylor Model Basin at Carderock, Maryland with the Marine Engineering Laboratory at Annapolis, Maryland.

Naval Ship Research and Development Center

Bethesda, Md. 20034

MAJOR NSRDC ORGANIZATIONAL COMPONENTS



NDW-NSRDC 3960/43b (Rev. 3-72)
GPO 928-108

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SECTION 1 INTRODUCTION

1.1 TEST PURPOSE: The purpose of this test is to provide data and information for determining the feasibility of including a track of lightweight design as part of the design considerations for the development of the U.S. Marine Corps' LVA amphibious vehicle.

1.2 BACKGROUND. In an improved land mobility vehicle, such as the LVA, which must also operate at high speed in the water environment, it is essential that the gross vehicle weight be minimized. One possibility for achieving a significant weight savings would be to use a track forged from aluminum instead of steel. In this case, the weight savings of the track could be approximately 20 percent (approximately 1200 pounds).

1.2.1 BASIC DESIGN OF FEASIBILITY TEST TRACK. For the purposes of investigating the feasibility of an aluminum track design for an LVA type of vehicle, the Aluminum Company of America (ALCOA) has designed and manufactured a test track which is similar to the standard steel track used on the LVT7 vehicle. For the purpose of this test, the aluminum test track will be referred to as the A-Track and the standard steel track will be referred to as the S-Track. The A-Track is distinctly different from previous heavy-vehicle aluminum test tracks in that it is of the LVT7 single-pin design as opposed to the double-pin design for the M60 series tank. Because the A-Track was built for test purposes and was not intended to be a production item, the test track design includes some design compromises which would not be in a production model. These compromises were considered acceptable for an experimental model.

1.2.2. PREVIOUS TESTING. Among the efforts that have been devoted to the development of aluminum tracks for heavy vehicles, the most strenuous one was the development program to design an aluminum block for the double-pin T-142 track for the M60 series tank. A track of T-142 design, which is made with aluminum, would permit considerable weight reduction, and would reduce power losses. An experimental T-142 hard-coated aluminum track was designed, produced, and tested by ALCOA and subsequently tested at the Aberdeen test was to determine the performance and endurance characteristics of the track during 5,000 miles of typical operations. At the completion of the 5,000 miles, 82 percent of the original aluminum track shoes had completed the mileage with only one failure directly attributed to the aluminum block. Because of insufficient durability data, the test first was extended 2,000 miles, and ten 1,545 miles, at which point the two track assemblies generally became unserviceable. During the total 8,545 miles, two shoes were changed because of failure of the aluminum block itself, and 47 others were changed because of a variety of causes.

1.2.2.1 PREVIOUS TEST REPORTS. Appendix H contains the results of several previous tests conducted with the double-pin aluminum track. Reference 1 of Appendix H is the Chrysler Corporation report (Feb 1970) of the design and laboratory test of a double-pin aluminum track. Reference 2 is the ALCOA evaluation (Oct 1972) of their double-pin aluminum track. Reference 3 is the Aberdeen Proving Ground report on the intial testing of the double-pin aluminum track of the T-142 design. Reference 4 is a continuation of Reference 3, and is a report of the additional testing to gain more information on the endurance characteristics of the aluminum tracks.

1.3 DESCRIPTION OF MATERIEL. The materiel to be tested is an experimental ALCOA track consisting of 200 complete track shoes (new), including accessories, which will provide one pair of test tracks and 20 percent spares. The aluminum shoe body is die forged of alloy 2014-T6 which is used for aircraft and other heavy-duty structural uses. The alloy has high tensile and yield strength as well as good ductility, good machinability, and fair forging characteristics. The test track assembly design approximates the standard LVT7 single-pin steel track design, in order that the LVT7 vehicle could be used as the test vehicle. Each track block is 21 inches wide and has replaceable road surface pads. Each track will have 84 blocks. However, the new tracks will initially be composed of 85 blocks each, until completion of the break-in period.

1.3.1 <u>TRACK CHARACTERISITICS DATA</u>. The following data for track characteristics were supplied by ALCOA.

- Weights:
  - Basic block (with steel cap)..16.8 lbs (7.6 kg)
  - Assembled block section.......25.5 lbs (11.6 kg)
  - Full track (84-block).......2142.0 lbs (972.5 kg)
- Pitch length.......................6 in. (15 cm)
- Width..............................21 in. (53 cm)
- Pad thickness.....................1.5 in. (3.8 cm)
- Grouser height....................1.1 in. (2.8 cm)
- Center guide height...............3.8 in. (9.7 cm)
- Type bushing: LVTP7
- Type pin: LVTP7

1.4 TEST OBJECTIVES.

1.4.1 <u>PRIMARY TEST OBJECTIVE</u>: To determine the feasibility of including a lightweight track of single-pin aluminum design as part of the design considerations for the development of the LVA, for the U.S. Marine Corps.

1.4.2 SECONDARY TEST OBJECTIVE: The secondary test objective is to gain data upon which to base an initial estimate of the durability characteristics of a single-pin track design fabricated from aluminum and intended for use on an LVA type of vehicle.

1.5 SCOPE. Because this is a feasibility test and is constrained by time and fiscal resources, only one pair of aluminum tracks and a limited quantity of spare parts are available for testing. The test track will be installed on an LVTP7 which has a suspension system that has been modified by the FMC Corporation to accept the track. Both the test track and the test vehicle are serving as surrogates for the LVA design program. The track testing will take place at the Amphibian Vehicle Test Branch (AVTB) at Camp Pendleton, California, and will utilize a vehicle that is loaded as specified in Section 2.5.5. During the test period, an optimum goal of 2,000 miles (3,218 kilometers) of testing has been set. The testing will focus on the suitability and, to the extent possible, the endurance of the aluminum track and its components. In addition, careful attention will be paid to the cross-influencing effects of the tracks and the suspension assembly. The data and observations obtained from the test will be used, together with other available data, to compare the aluminum track with the standard steel LVTP7 track, if possible.

SECTION 2 TEST PROGRAM

2.1 TEST CONCEPT. The planning for the test of the single-pin aluminum track (A-Track) has taken into consideration the considerable amount of testing by the U.S. Army that has already been accomplished on an aluminum track of double-pin design. Accordingly, this A-Track test will concentrate on those aspects which, either because of different design features or different mission involvements, have not been tested sufficiently to establish (1) mission feasibility, and (2) mission durability. Previous aluminum track testing (both by contractors and the U.S. Army) indicated that, as a concept, the use of an aluminum track on a heavy combat vehicle is a valid design approach. Also considered in the planning for this test are the limited test-item resources, the one test vehicle, the limited test funds, and the burden on test personnel. In summary, the test concept provides for maximum benefit from previous test experience and maximum benefit from scarce test resources. The test goals are contained in the following description of the phases into which the test is divided.

2.2 TEST PHASES

2.2.1 PRETEST PHASE. The two significant efforts to be accomplished prior to the start of the main tests are the Pretest Inspections and the Pretest Shakedown.

2.2.1.1 PRETEST INSPECTIONS. These inspections will include the A-Track, the host vehicle, and the suspension modifications, and they will be conducted immediately prior to, and immediately following, the Pretest Shakedown.

2.2.1.1.1 A-TRACK INSPECTIONS. Following the delivery of the A-Track assemblies and spare components to the AVTB at Camp Pendleton, the deliverables will be inspected by a qualified ALCOA representative to determine the initial suitability of all components and the proper assembly of the tracks as delivered. Following this inspection, a designated representative of the Chief, AVTB will examine the A-Track system and the spares to determine their readiness for installation on the host vehicle. Prior to the installation, a qualified representative from FMC will be given an opportunity to verify the compatibility of the A-Track set with the suspension system of the LVTP7 as modified by FMC. Following the Pretest Shakedown, the installed tracks again will be inspected by the same personnel who conducted the initial inspection to determine the final suitability of the A-Tracks for participation in the Main Test. Upon initial track installation and before and after the break-in period, the track tension will be adjusted in accordance with the specifications provided prior to the inital track installation. On other occasions, the tension will be adjusted as required by daily operator inspections and in accordance with instructions to be provided.

2.2.1.1.2 HOST VEHICLE INSPECTIONS. It is planned that the host vehicle will be an LVTP7 which is completely ready for testing the A-Track. Both prior to the beginning of the Shakedown Test and the beginning of the Main Test, the vehicle will be inspected by a designated representative of the Chief, AVTB, to determine its readiness for use in those tests. In addition, there will be a visual and functional inspection by the AVTB following the Shakedown Test to determine what, if any, unusal effects the A-Tracks may have had on the other vehicle components. Any such effects will be described completely and included in the final field reports.

2.2.1.1.3 SUSPENSION MODIFICATION INSPECTIONS. After delivery to AVTB, the suspension modification parts designed and manufactured by FMC will be inspected by a qualified FMC representative to determine their suitability for installation on the host vehicle. Following that inspection and the acceptance of the parts by the AVTB, the modification parts will be installed by AVTB personnel. Prior to the installation of the A-Track, a qualified representative of ALCOA will be given an opportunity to verify the compatibility of the track with the modified suspension system. Following the Shakedown Test, both the ALCOA and the FMC representatives will be given an opportunity to examine the A-Tracks and the suspension system to assess the interoperability of the two assemblies. Concurrently, the Chief, AVTB, or his designated representative also will examine the results of the break-in period.

2.2.1.2 PRETEST SHAKEDOWN. To ensure the proper seating and break-in of the running gear components, the A-Track will be subjected to 50 miles (80 kilometers) of preliminary operation as prescribed in Section 3.2.

2.2.2 FEASIBILITY TEST PHASE. The main part of the testing effort will be separated into two phases: the Feasibility Test Phase and the Durability Test Phase, both of which will be tested at Camp Pendleton by the Chief of the AVTB in accordance with this Master Test Plan. The most important part of the effort concerns the feasibility of the A-Track design. During the Feasibility Test Phase, it is planned that the A-Track will be subjected to 100 hours/1,000 miles (1,609 kilometers). The principal emphasis will be placed on the vehicle mobility and performance and/or reliability and maintainability of the A-Track and the influence of the A-Track on the reliability and maintainability of the host vehicle. Sufficient test details for this portion of the test with respect to feasibility are contained in the Table 2-1, Test Task Breakdown, and also section 3.3. If this initial phase fails to provide all information deemed essential by the Test Coordinator for the determination of feasibility, the Test Coordinator will report the situation to the Technical Manager (Vehicle) and recommend a course of action to be followed to complete the phase successfully. Pending the Technical Manager's (Vehicle) decision, no action will be taken to commence the Durability Test Phase.

2.2.3 DURABILITY TEST PHASE. During the Durability Test Phase, it is unlikely that a full testing of the A-Track's durability could be accomplished for the following reasons: only one pair of tracks and one test vehicle are available; the test facilities at the AVTB are not geared to high-rate durability testing; previous testing experience with aluminum tracks indicates that some track components could require a full expected-track-life of 400 to 600 hours of testing (this test program is estimating only a total of 200 hours of testing); and unexpected casualties to either the A-Track or the test vehicle could significantly interrupt the test program. Therefore, the intent of the durability testing described in Section 3.4 is to obtain the maximum data on what are expected to be the high-risk components from a durability standpoint. Whereas the Feasibility Test Phase will be very closely monitored for information on the design aspects of the A-Track, the Durability Test Phase will shift emphasis primarily to a repetitive type of standardized testing which will stress the operation of the suspension system.

2.2.4 POSTTEST PHASE. Following the completion of the AVTB testing, the vehicle will be subjected to a Posttest inspection. The purpose of the inspection will be to verify the final test condition of the A-Track and those other vehicle components that could be or were influenced by the characteristics of the A-Track. It is intended that the members of the inspection team will be those representatives involved in the Pretest inspection.

2.3 TEST STRUCTURE. The test structure and functions are shown in Figure 2-1. Submission of AVTB reports will be to Chief, M&L Division, MCDEC. The LVA Development Project Officer (DPO) will submit the reports for MCDEC to the LVA Technical Manager (Vehicle) as shown in Figure 2-2.

2.3.1 TEST COORDINATOR. A test coordinator will be designated by the Technical Manager (Vehicle) to coordinate the activities which involve the AVTB and support agencies, (ALCOA and/or FMC). He is also responsible for the following:

- The coordination of the resources required to support the test.
- The monitoring of the progress of the test.
- The reporting and evaluation of the test results.

2.3.2 FIELD TEST MANAGER. The Field Test Manager designated by the Chief, AVTB, is responsible for the overall execution of the testing and will ensure that the testing is in accordance with the requirements of the Master Test Plan. He is also responsible for the final reporting of all test data and for the submission of his own independent evaluation of the testing that was performed at his activity.

2.3.3 FIELD TEST OFFICER. The Chief of the AVTB will designate a Field Test Officer to carry out the field portion of this test plan. The officer will be responsible for obtaining the data and other information required by Section 3. His responsibility and authority with regard to test changes and deviations is covered in the Control Plan (Appendix B).

2.3.4 A-TRACK TEST AGENT. Prior to the start of the actual testing, it will be essential for the A-Track Test Agent (ALCOA representative) to certify that the track is in a ready-for-testing condition. It also will be important for the Agent to have regular opportunities to observe and examine, on a not-to-interfere basis, the performance and the physical characteristics of the host vehicle, the A-Track, and the

ALUMINUM TRACK TEST STRUCTURE

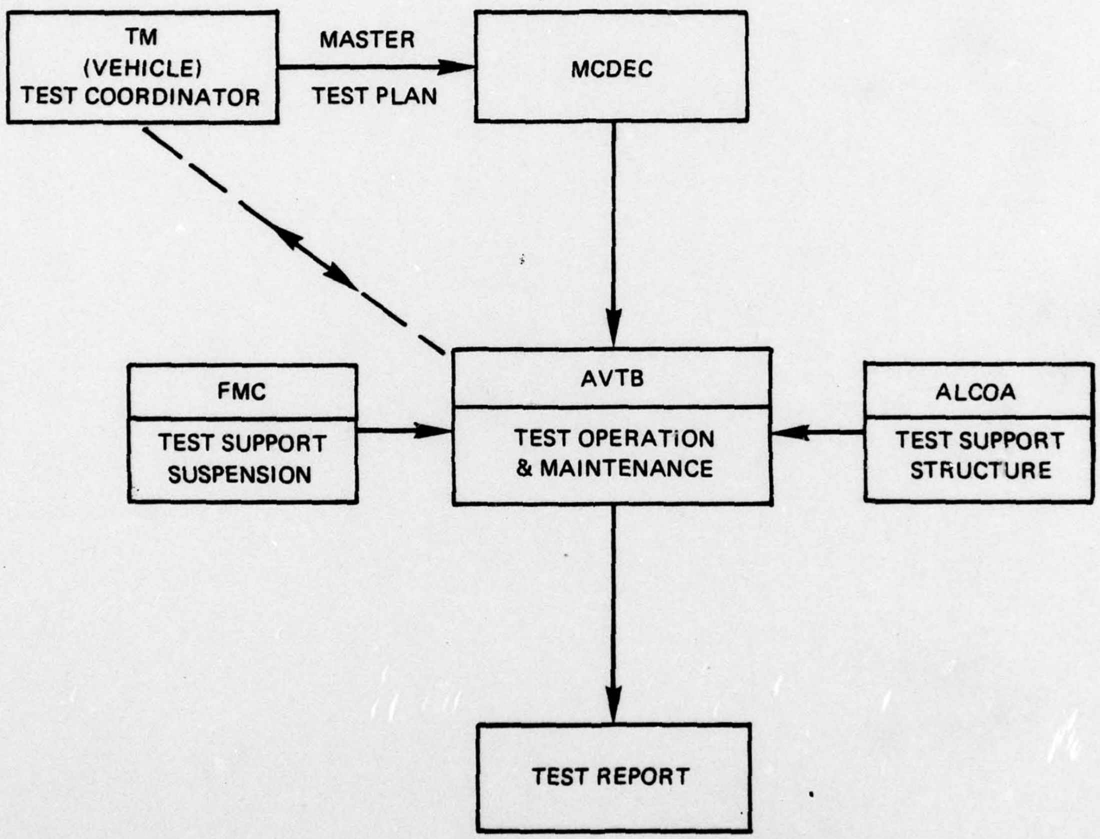


Figure 2-1

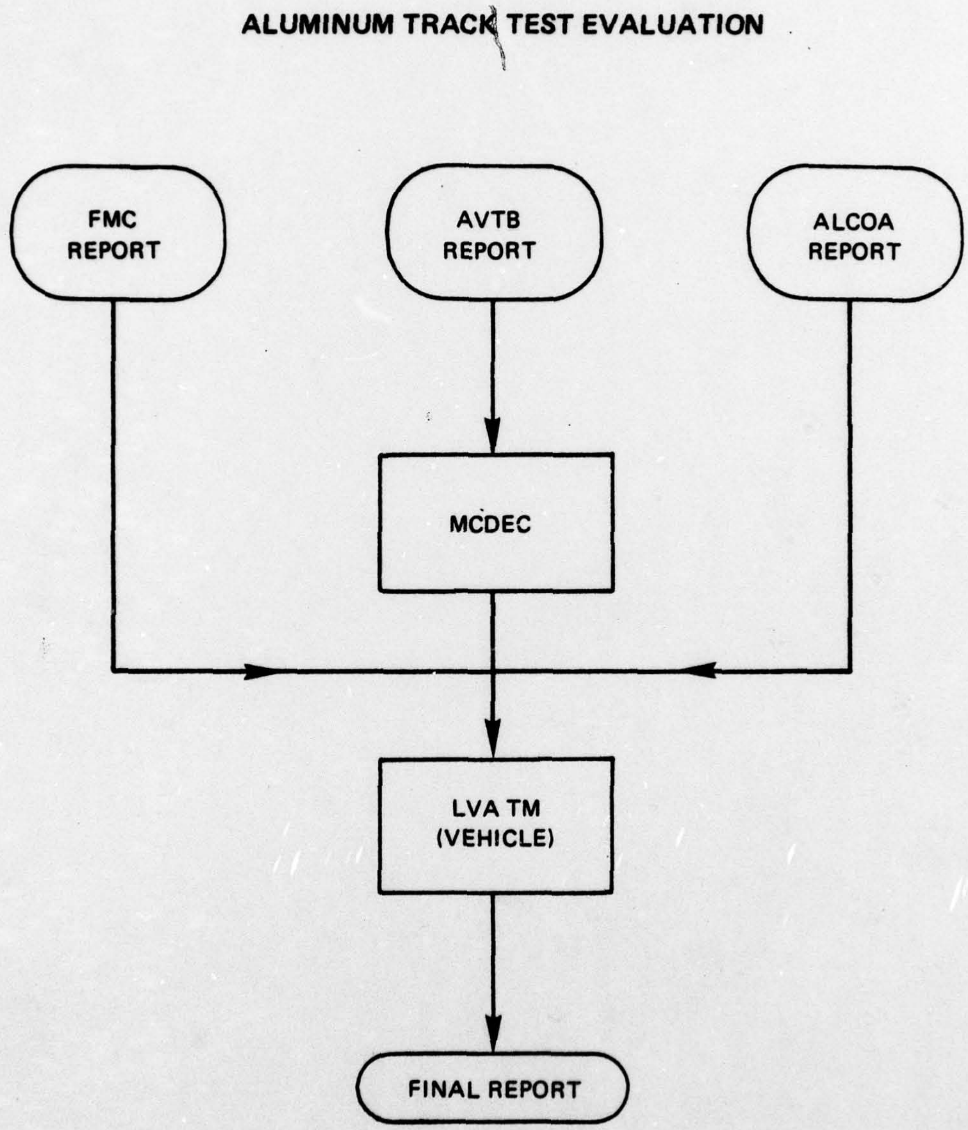

ALUMINUM TRACK TEST EVALUATION
FMC REPORT
AVTB REPORT
ALCOA REPORT
MCDEC
LVA TM (VEHICLE)
FINAL REPORT

Figure 2-2

other suspension system components. Suitable contract arrangements will be made to permit the ready availability of the Agent in the event his technical knowledge of the A-Track is required on short notice or it would be beneficial to the conceptual development of the track to have him present in a particular situation. At the conclusion of the field testing, it will be important for the Agent to examine carefully the track components to determine their final condition.

2.3.5 <u>SUSPENSION SYSTEM MODIFICATION AGENT</u>. The Suspension System Modification Agent (FMC Representative) will perform functions and have opportunities similar to the A-Track Test Agent. Before the start of any of the tests, the Agent will certify the ready-for-testing condition of the suspension system. Following the field tests, the Agent will inspect the suspension system to determine its final condition.

2.3.6 <u>HOST VEHICLE CREW</u>. To the maximum extent possible, the host vehicle crew chief and the remaining crew members should be available exclusively for the testing. In addition to their major responsibility which is to subject the A-Track to the test conditions, they also will gather data, observe the day-to-day test experience, record observations, and possibly provide beneficial recommendations concerning modifications or failure fixes. The crew can perform a vital function by identifying, at the earliest moment, component failures and other adverse situations and by recording all of the appropriate information.

2.4 <u>TEST EXECUTION</u>. Even though the aluminum track is an experimental item, considerable experience with that type of assembly has significantly lowered the development risk levels that would be associated with some of the components. Furthermore, the basic track design is based on a proven design. Therefore, the primary test objective-feasibility-should be one that can be addressed in a relatively short period of vehicle operation. As the test progresses into the endurance phase, it will take considerably more time to obtain, with confidence, the durability characteristics of the A-Track assembly. Thus, the field testing will, for the most part, be repetitive and stressful in order to gain the desired information. The task breakdown is shown in Table 2-1. The details of the required test data are addressed in Section 3.0.

2.4.1 TEST CHANGE AUTHORITY. Only the Test Coordinator is authorized to modify the test requirements contained in this plan. Any major modifications that are made will be reported, with supporting rationale, to the Technical Manager (Vehicle) at the earliest opportunity. In addition, the key personnel designated by the test and support organizations in the Test Structure Chart, Figure 2-1, will also be informed. Test changes of a minor or temporary nature may be made at the discretion of the Field Test Manager and as delegated by him to the Field Test Officer. A record of the changes will be maintained by the Field Test Manager and included in his final report.

2.4.2 UNANTICIPATED SIGNIFICANT EVENTS. Any unanticipated significant event which occurs during this test program and which impacts on either the test execution or the test results will be reported to the Test Coordinator by the most appropriate means. (Normally, the telephone will be used.) The Test Coordinator will then report the situation to the Technical Manager (Vehicle) and the other key members of the test organization. Every effort will be made to document carefully the events as appropriate.

2.5 TEST CONDITIONS. For the feasibility and endurance purposes of this test, the test conditions at Camp Pendleton are considered to be adequate.

2.5.1 TEST COURSES. To satisfy the mission profile requirements, the test vehicle will be operated in a manner which will provide 80% land use and 20% water use. Of the land mileage, 5% should be obtained on a level concrete surface, 15% on a beach surface, and 80% on the standard tracked vehicle cross-country course.

2.5.2 TEST CYCLING. The testing will be done in repetitive cycles to permit the relatively equal accumulation of data over the various surfaces. The scheduling of the cycles will be at the discretion of the Field Test Manager.

2.5.3 SALT WATER EXPOSURE. An effort will be made to ensure that the A-Track vehicle will be exposed to the salt water environment as would a typical amphibian vehicle at Camp Pendleton.

2.5.4 IDLING TIME. Idling time should be kept to a minimum in order to maximize the use of engine hours for traveling time and it should be considered when calculating MTBF.

2.5.5 TEST VEHICLE PAYLOADS. While undergoing testing, the A-Track vehicle will operate 25% of the time carrying a 10,000 pound cargo load, 50% of the time carrying a 5,600 pound cargo load and 25% of the time carrying no load.

TABLE 2-1

ALUMINUM TRACK TEST PLAN

TEST TASK BREAKDOWN

TEST PHASE	TASK	PRINCIPAL AGENT	SUPPORT AGENT
Pretest			
1. Inspection (before & after test)	a) Al Track	AVTB	ALCOA
	b) Host vehicle	AVTB	
	c) suspension & Modif.	AVTB	FMC
	d) track installation	AVTB	
	e) track & suspension measurement	AVTB	
2. Shakedown	a) preparation for test	AVTB	
	b) 50 mi. shakedown	AVTB	
	c) track tension and other adjustments	AVTB	FMC
3. Test Record	a) operation log	AVTB	
	b) maintenance	AVTB	
	c) adjustment & repair	AVTB	FMC, ALCOA
	d) shakedown report	AVTB	
4. Shakedown assessment		AVTB	ALCOA FMC
FEASIBILITY TEST			
1. General Mobility	a) 100hrs/1000miles	AVTB	
	b) speed 0 to Max.	AVTB	
	c) turning capability	AVTB	
	d) land, water, and beach	AVTB	
2. Performance	a) acceleration	AVTB	

TEST PHASE	TASK	PRINCIPAL AGENT	SUPPORT AGENT
3. Test Record	a) operation	AVTB	
	b) track wear & measurement	AVTB	
	c) failure & maintenance	AVTB	
	d) test data	AVTB	
	e) progress & test reports	AVTB	

TEST PHASE	TASK	PRINCIPAL AGENT	SUPPORT AGENT
DURABILITY TEST			
1. Mission Operation	a) Max. & rated loading	AVTB	
	b) distance 1000 to 2000 mi.	AVTB	
	c) speed 0 to 25 mph, Max. 40 mph.	AVTB	
	d) course: paved, gravel, cross country, beach & water.	AVTB	
2. Record	a) operation log, miles & hours	AVTB	
	b) maintenance - mi. & hrs. daily Sch. & non-Sch.	AVTB	
	c) failure and corrective action	AVTB	ALCOA, FMC
	d) wear of track & Ass. components	AVTB	
	e) parts and repair	AVTB	ALCOA, FMC
3. Report	a) 25 hrs. opera-ation inspection	AVTB	
	b) monthly filed report	AVTB	
	c) final field re-port	AVTB	
	d) file folder (data, progress, maintenance and repair)	AVTB	

SUPPORT TASK BREAKDOWN

TEST PHASE	TASK	PRINCIPAL AGENT	SUPPORT
PRETEST			
1. Inspection and shake-down	a) Tech. Prep. & guidance, track tension, system adjustment	FMC	Alcoa
	b) contingent support	FMC	
2. Inspection fixtures	a) tools and gages for test measurement	FMC	
FEASIBILITY DURABILITY			
1. Field Service	a) work beyond routine maintenance	FMC	
2. Failure support	a) vehicle damage, track damage, accident, etc.	FMC	
3. Failure Analysis	a) track structure	Alcoa	
	b) track system & vehicle	FMC	

SECTION 3 MAIN TEST DETAILS

3.1 TEST CONSTRAINTS. Being primarily a feasibility test, and because there is only one set of test tracks and one test vehicle available, the initial testing (Feasibility Test Phase) must be conducted in a very controlled manner. The main purpose of such controlled testing is to ensure that the very basic feasibility information on each component of the A-Track is obtained in the purest manner, as opposed to being masked by more inclusive circumstances which could hide an important occurrence. The above is not to mean that the feasibility phase will not be conducted in an aggressive manner typical of amphibian vehicle operations. It does mean that the test vehicle will not be subjected to severely stressful operations until there is reasonable confidence that the A-Track will be able to complete successfully the Feasibility Test Phase. Then, during the Durability Test Phase, it is expected that the test vehicle will be operated progressively in a very aggressive manner, using the normal driver cautions to avoid personnel injuries and/or damage to the vehicle.

3.1.1 VEHICLE OPERATING CONSTRAINTS. The only constraints which this Master Test Plan places on the testing concerns the execution of emergency stops and vehicle pivot turns. To avoid premature risk of track and suspension damage, the emergency stop test events are to be scheduled for the latter part of the Durability Test Phase. Due to the high risk of damage associated with pivot turns that are made at full power, such turns are to be executed in the standard operating manner.

3.2 PRETEST SHAKEDOWN. When the test vehicle is determined by the Field Test Manager to be in a ready-for-test status, it will be operated 50 miles (80 kilometers) over a relatively smooth surface (land and water) to break-in the new components of the suspension system. Speed rates for the operation are to be as follows: 30% of maximum speed for the first 15 miles (24 kilometers); 50% of maximum speed for the second 15 miles (24 kilometers); and 75% maximum speed for the remaining 20 miles (32 kilometers). Following the shakedown period, the track tension is adjusted as required and appropriate bolts are tightened to the specified torques.

3.3 PERFORMANCE TESTING. As a feasibility test, the performance portion of it will endeavor to obtain certain information regarding the mobility characteristics of a vehicle equipped with a single-pin aluminum track. In consonance with the scope of the feasibility test objective and in view of the limited facilities at AVTB, only acceleration and deceleration performance will be examined.

3.3.1 ACCELERATION AND DECELERATION DATA REQUIRED. The source of the information is shown in parentheses.

DR 3.3.1.1 What were the on-land acceleration and deceleration characteristics of the A-Track vehicle? (FTM)

DR 3.3.1.2 How did the on-land acceleration and deceleration characteristics of the A-Track vehicle compare with those of an S-Track vehicle? (FTM; TC)

Note: FTM - Field Test Manager
TC - Test Coordinator
DR - Data Required

3.4 DURABILITY TESTING. It is not expected that complete durability data will be gathered on the experimental track. The best that can be anticipated is some evidence of the strong and weak parts of the A-Track system. If the full period of the test schedule is completed and the test tracks are still in a condition to continue endurance testing, then the desired course, from the standpoint of gathering complete durability data, would be to continue operating the tracks in connection with some other test program that was compatible.

3.4.1 DURABILITY MONITORING. To gain the maximum information on the durability characteristics of the A-Track and other effected vehicle parts, the main wearing points will be measured at 25-hour intervals during the test. The first measurements will be taken prior to the beginning of the Shakedown Test. The interoperability between the A-Track and the drive sprockets and idler wheels will be watched carefully. Also, torques on mounting bolts will be checked frequently to preclude elongation. A report will be filed on each incident and each period of 25-hour operation. For reference, a report format sample is shown in Figure 3-1. Other test record formats are shown in Sect. 4.5.

3.4.2 DATA REQUIRED.

DR 3.4.2.1 What were the wear rates of the major track and suspension components after each 25 hours of operation? (FTM; TC)

DR 3.4.2.2 How did the wear rates of the A-Track components compare with the normal wear rates of the S-Track? (FTM; TC)

DR 3.4.2.3 Did the wear rates of the A-Track degrade any other parts of the suspension assembly to a degree greater than normal by the S-Track? (FTM; TC)

A-TRACK TEST

Submitted by: ______________________________

Reviewed by: ______________________________

[1] EMRR
Date
Report

Report Type ☐ Incident ☐ 25-Hour [2]

Equipment Type

Part Name ______________________________ [4]

Part No. ______________________________

Part S/N ______________________________

Mfg. ______________________________

Quantity ______________________________

Site ______

Test Course ______

Temp ______

Odometer Reading ______

Operating Hours ______

Counter Reading ______

HOW Malfunction Code [5]

Discovered During ______________________________

Action Taken ______________________________

Part Life - ______________________________

Troubleshooting Time ______

Active Repair Time ______

Number of Men ______

Total Man-hours ______

Replacement Part S/N ______________________________ [6]

Replacement Part Life ______________________________

MEASUREMENTS

Center Guide ______

Track Pad ______

Sprocket ______

Idler ______

Track Stretch ______

Malfunction Human Induced [7]

Gross Vehicle Weight ______________________________

Descriptive Comments [11]

INCIDENT CLASS [11A]

Deficiency ______

Shortcoming ______

Suggested Improvement ______

Other ______

ENVIRONMENT [11B]

Weather

Operating conditions

INCIDENT DESCRIPTION/COMMENTS [11C]

ACTION TAKEN [12]

Replaced ______

Repaired ______

Adjusted ______

DISPOSITION OF DEFE

VEHICLE CONDITION

Operable ______

Nonoperable ______

Figure 3-1

ENGINEERING MAINTAINABILITY
RELIABILITY REPORT

EMRR	
1 Date Report	
2 Equipment Type	3 S/N
4 Site ______ 8 Test Course ______ Temp ______ Odometer Reading ______ Operating Hours ______ Counter Reading ______	
5 Troubleshooting Time ______ 9 Active Repair Time ______ Number of Men ______ Total Man-hours ______	
6 MEASUREMENTS 10 Center Guide ______ Track Pad ______ 7 Sprocket ______ Idler ______ Track Stretch ______	

ACTION TAKEN 12

Replaced ______ Disconnected ______
Repaired ______ Removed ______
Adjusted ______ None ______

DISPOSITION OF DEFECTIVE MATERIAL 13

VEHICLE CONDITION 14

Operable ______
Nonoperable ______

Figure 3-1

2

DR 3.4.2.4 What was the corrosive effect of the salt water environment on the A-Track? (FTM)

DR 3.4.2.5 What was the metallurgical result of the two dissimilar metals, aluminum and steel, being in contact as parts of the A-Track system? (FTM)

DR 3.4.2.6 During high temperature conditions caused by either high vehicle speed or the environment, what was the effect of heat build-up in the A-Track components such as the pin bushings? (FTM)

DR 3.4.2.7 What were the stretch measurements of the A-Track when taken at the 25-hour test intervals? (FTM)

DR 3.4.2.8 What were the effects, if any, of the emergency stops on the components of the A-Track and the suspension system? (FTM)

3.5 PARTS IDENTIFICATION. Each track shoe should be marked with a code in a location that will not damage or affect the service life of the material, will not become obliterated during testing, and can be readily located and read with the track mounted on the vehicle.

3.6 IMPACTS ON OTHER SYSTEMS. The design of the A-Track obviously contributes to the environment of the suspension assembly and may impact on other vehicle systems. Therefore, evidence of such influence is desired. In this regard, the Field Test Officer, test vehicle crew, and assigned maintenance personnel must be continuously seeking such evidence. The primary sources of such evidence are the road wheels, sprockets, idlers, and final drive assemblies.

3.6.1 DATA REQUIRED.

DR 3.6.1.1 What effects do the A-Track and its components have on other vehicle systems, particularly the suspension system? (FTM; TC)

SECTION 4 TEST EVALUATION

4.1 TEST REPORTS. Upon completion of the testing, final reports will be submitted. The AVTB will submit their final report to Chief, M&L Division, MCDEC, by the date indicated in Appendix G. The contractor test reports will be submitted to the Technical Manager (Vehicle) and will be covered in the contracts. Based upon the reports from AVTB and the supporting contractors, the Technical Manager (Vehicle) will conduct an analysis and document the results. It is recognized that the test cycle will not exactly duplicate an LVA mission profile and, as a consequence, RAM-D test results will have to be adjusted to the mission profile. Analysis by DTNSRDC will include the following RAM-D evaluations:

4.2 RELIABILITY EVALUATION. Within the limited test resources, the first reliability objective of the testing will be to estimate, where possible, the quantitative reliability characteristics of the A-Track and its components, as well as the reliabilities of other test vehicle components that are unusually influenced by the functioning of the A-Track. The second objective will be to determine those components which contribute the most to degraded reliability, with respect to the standard S-Track.

4.2.1 RELIABILITY DEFINITION. The reliability of the track assembly is defined as the total number of vehicle operating hours divided by the total number of track mission failures (a track failure which renders the vehicle incapable of performing its mission is a mission failure). The mean time between failures (MTBF) will be computed by dividing the total operating time from the beginning of the Pretest Phase to the last failure recorded for the track by the total number of failures recorded, or by dividing the operating time from the beginning to the end of the test by the total number of failures plus one. Each of these must be adjusted to the mission profile.

4.2.2 FAILURE DEFINITIONS. The definitions of system failure and mission failure are contained below. In addition, a failure decision tree flowchart is included in Appendix D. The failure flowchart is designed to logically filter all incidents encountered during the test into the following categories: no test; no failure; and failures (of which some are system failures and some are also mission failures). All incidents or malfunctions will be classified in accordance with the flowchart.

4.2.2.1 SYSTEM FAILURE.

- A system failure is defined as any actual, intermittent, or incipient malfunction of the track system (subject to the exclusions in Section 4.2.2.2 below) that required diagnostic and/or corrective action which could not have been deferred until the next scheduled maintenance that is prescribed at the level authorized to perform the corrective action, or for the remainder of the expected life before replacement.

- Diagnostic or corrective action is not considered deferrable if the malfunction caused (or would have caused if not corrected, i.e., incipient malfunction) inability to commence operation, cessation of operation, or reduction in performance capability.

- Corrective actions deferred or deferrable to the appropriate scheduled maintenance are to be accomplished without charging a system failure. Incipient malfunctions of the system detected during prescribed inspections connected with a scheduled maintenance will also be corrected without charging a system failure unless higher level maintenance is prescribed for the corrective action. In this event, a failure will be charged if the corrective action was not deferrable as described above. A system failure will also be charged if a malfunction of a component of the system was detected during the scheduled maintenance that would have been previously considered a system failure of the system if an attempt had been made to operate the affected component prior to the scheduled maintenance.

- If an incipient malfunction is detected during the correction of another malfunction, two system failures will be charged provided that the malfunctions were totally unrelated, and both malfunctions comply with the above stated definition of "system failure." However, if the malfunctions were related (e.g., secondary damage caused by primary component malfunction), only the primary malfunction will be considered a system failure.

- When the occurrence of more than one actual or intermittent malfunction is subsequently traced to a common cause which is positively isolated, corrected by maintenance action, and verified, only one malfunction in the series will be scored as a system failure (if otherwise qualified). Diagnostic and unscheduled maintenance time associated with all of the malfunctions will be chargeable.

- Any malfunction or interruption of operation, the cause of which could not be traced by diagnostic action to a specific component failure before acceptable operation resumed, will be classified as an intermittent malfunction. A system failure will be charged for each occurrence of an intermittent malfunction. A system failure will be charged for each occurrence of an intermittent malfunction (if otherwise qualified and subject to the exclusion stated above) until such time as corrective action is effected.

4.2.2.2 SYSTEM FAILURE EXCLUSIONS. Incidents which comply with the above stated definition of system failure but which will not be used in the determination of system MTBF or system reliability are:

- Actual or incipient malfunctions detected or corrected during initial inspection prior to test initiation.

- Actual or incipient malfunctions resulting from not following the normal operational or maintenance procedures dictated by the equipment manuals or which can be directly attributed to improper replacement of components or omission of prescribed scheduled service or inspections. This exclusion does not apply if the malfunction is attributable to improper design of the test item.

- Actual or incipient malfunctions resulting from test item abuse, unrealistic operating conditions, non-valid test, or accident.

- Actual or incipient malfunctions subsequently traced to a common and predictable failure mode which is positively isolated, corrected by modification, and verified by test. Diagnostic and unscheduled maintenance time associated with these malfunctions will likewise not be chargeable against availability or maintenance ratios.

- Malfunctions deferred to and/or corrected during the final test inspection, except for those which caused test termination or which would have previously been considered a system failure if an attempt had been made to operate the affected subsystem prior to final inspection.

4.2.2.3 MISSION FAILURE. A mission failure is a system failure (i.e., actual, intermittent or incipient malfunction) that required diagnostic or corrective action which could not have been deferred and which renders the vehicle incapable of performing its mission

4.2.3 DATA REQUIRED

DR 4.2.3.1 How did the number of the A-Track mission failures compare with the number expected of an S-Track? (FTM; TC)

DR 4.2.3.2 What were the specific mission failures? What actions could be taken to eliminate the specific mission failures? (FTM; TC)

DR 4.2.3.3 What was the reliability of the A-Track? (TC)

DR 4.2.3.4 How did the total number of the A-Track system component failures compare with the expected number of component failures of the standard system? (FTM; TC)

DR 4.2.3.5 What were the specific A-Track component failures? (FTM)

DR 4.2.3.6 What was the reliability of the track shoe? (TC)

DR 4.2.3.7 How many track shoes required replacement? (FTM)

DR 4.2.3.8 What caused each track shoe replacement? (FTM; TC)

DR 4.2.3.9 What action could be taken to solve the shoe replacement problem? (FTM; TC)

DR 4.2.3.10 What was the reliability of the track pad? (TC)

DR 4.2.3.11 How many track pads were replaced? (FTM)

DR 4.2.3.12 What caused the track pads to be replaced? What action could be taken to solve the pad replacement problem? (FTM; TC)

DR 4.2.3.13 What other suspension system components required replacement and how could the necessity for their replacement be eliminated? (FTM; TC)

DR 4.2.3.14 What was the mean-time-to-fail (MTTF) of the A-Track components that failed? (TC)

DR 4.2.3.15 How did the A-Track mean-time-to-fail (MTTF) compare with the mean-times of the failures of the standard track components? (TC)

DR 4.2.3.16 Was the A-Track vehicle more or less reliable than a standard S-Track vehicle when operated 80% on the land and 20% in the water? (FTM; TC)

DR 4.2.3.17 How was the A-Track system affected by the salt water beach environment as compared to a steel track? (FTM; TC)

4.3 MAINTENANCE EVALUATION. The purpose of this portion of the test will be to compare the maintenance characteristics of the A-Track with the maintenance characteristics of an S-Track. Also included will be an evaluation of any maintenance impacts of the A-Track on other vehicle components.

4.3.1 MAINTENANCE METHODS. The track maintenance is categorized as scheduled and unscheduled. Scheduled maintenance includes regular inspection of the track for proper track adjustment, loose hardware and track irregularities, general replacement of track pads, and changing and reversing of the sprockets and hubs. The latter, although not components of the track, must be considered along with the track since the condition of these components directly affects the wear on the track. The unscheduled maintenance includes replacement of individual track shoes, track pads, and other track components. Suspension maintenance will be performed as soon as components are identified as unserviceable. Maintenance actions will be performed using only authorized tools and procedures, in accordance with existing instructions, unless specifically authorized otherwise by the Field Test Manager. The necessary maintenance will be performed to keep the track in a fully serviceable condition. In addition, the required maintenance will be performed on the test vehicle to keep it operational, with particular emphasis on the suspension system so that faulty conditions will not adversely affect the track.

4.3.2 DATA REQUIRED. Throughout the test, all scheduled and unscheduled maintenance actions and times will be recorded. The accumulated operating time and test miles of the failed component will be recorded. The operating times and test miles will be recorded separately for the Pretest Phase and the Main Test Phase. The maintenance indices to be computed are the maintenance ratio (MR), mean-time-to-repair (MTTR), and the maximum corrective maintenance downtimes. A record of repair parts used in support of the test will be required.

DR 4.3.2.1 Was the rate of suspension maintenance for the A-Track more, less, or about equal to an S-Track? (FTM, TC)

DR 4.3.2.2 What maintenance requirements were peculiar to the A-Track? (FTM; TC)

DR 4.3.2.3 Was the A-Track easier or harder to maintain than the S-Track? (FTM; TC)

DR 4.3.2.4 Did it require more or less maintenance time to maintain tension on the A-Track than it does on the S-Track system? (FTM; TC)

DR 4 .3.2.5 How many man-hours were required to repair each failure? (FTM)

DR 4.3.2.6 What were the MTTRs for the A-Track and its components? (TC)

DR 4 .3.2.7 How did the MTTR times for the A-Track compare with those of the S-Track? (FTM; TC)

DR 4.3.2.8 Were the crew scheduled preventative maintenance services prescribed for the A-Track adequate? (FTM)

DR 4.3.2.9 How many miles and hours of operation were accumulated on the A-Track? (FTM)

DR 4.3.2.10 How many man-hours were required to perform scheduled and unscheduled maintenance? (FTM)

DR 4 .3.2.11 What were the maintenance ratios for the major components of the A-Track? (TC)

DR 4.3.2.12 What were the maximum corrective maintenance downtimes? (FTM)

DR 4.3.2.13 To what degree and for which major parts did the A-Track vehicle indicate a need for greater maintenance time than a standard S-Track vehicle would require? (FTM)

4.4 AVAILABILITY EVALUATION. The availability evaluation will be based on computations using the reliability and maintenance factors. Due to the limited time available to conduct this feasibility test and the small sample size, the availability evaluation will probably be only a gross estimation in some respects and incomplete in other respects.

4.4.1 DATA REQUIRED. The data being sought is that which deals with the inherent availability, which is MTBF divided by MTBF plus MTTR.

DR 4.4.1.1 What is the inherent availability rate of the A-Track? (TC)

4.5 DURABILITY EVALUATION. The durability evaluation is intended to determine the operational life expectancy of an aluminum track. It is recognized that this can not be accomplished with only one pair of tracks and limited operational hours and mileage. The information collected from the tests at AVTB can only serve a base for the evaluation.

4.5.1 DATA REQUIRED. Throughout the test, the accumulated operating time and test miles of the A-Track components and suspension system will be recorded. Special care must be taken on the test record of wear, failure and replacement of the track components. For reference, samples of report formats are shown in Figures 4-1 and 4-2.

DR 4.5.1.1 What is the test record of wear, failure and replacement of the A-Track components? (FTM)

DR 4.5.1.2 What is the wear measurement of the track shoe and pad? (FTM)

DR 4.5.1.3 What is the track shoe mileage of the A-Track at test termination and how was it tested in comparison with a S-Track? (FTM; TC)

Report No.: ____________ **A-TRACK TEST RECORD - WEAR** Submitted by: ____________

Date: ____________ Reviewed by: ____________

CONDITION AT MILES	TRACK SHOE			TRACK PAD							PAD HEIGHT ABOVE GROUSER IN.		
	GROUSER			THICKNESS, IN.			WEAR, IN.						
	HEIGHT IN.	WEAR IN.	WT. LB.	CENTER	EDGES L.	EDGES R.	CENTER	EDGES L.	EDGES R.	WT. LB.	CENTER	EDGES L.	EDGES R.
0 (NEW)													

Figure 4-1

Report No.: ________ **A-TRACK RECORD - COMPONENTS** Submitted by: ____________

Date: ____________ Reviewed by: ____________

CONDITION AT MILEAGE	TRACK SHOE ID		COMPONENT	WEAR	FAILURE	REPLACEMENT	CAUSE
	LEFT	RIGHT					
REMARKS							

*1. TRACK SHQE
2. CENTER GUIDE
3. PIN BUSHING
4. SPOCKET
5. IDLER
6. OTHERS

Figure 4-2

SECTION 5 APPENDICES

APPENDIX A. CRITICAL ISSUES AND TEST CRITERIA

The critical issues and test criteria are as follows:

- TECHNICAL FEASIBILITY: From an exploratory design standpoint, is a single-pin aluminum track technically feasible? The criterion for this issue is the capability of the A-Track to perform its designed function over a test operating distance of 1,000 miles (1,609 kilometers).

- RELIABILITY: Is a track of the single-pin aluminum design estimated to be sufficiently reliable? The criterion for this estimation is the reliability of the S-Track.

- MAINTAINABILITY: Is a track of the single-pin aluminum design estimated to be sufficiently maintainable? The criterion for this estimation is the maintainability of the S-Track.

APPENDIX B. CONTROL PLAN

B.1 CONTROL PLAN. The Field Test Manager, as the principal executor of the Master Test Plan, has the responsibility for ensuring that a thorough and strenuous test is conducted within the time, material, and manpower resources available. It is within the prerogative of the Field Test Manager to order the execution of the test as he deems appropriate within each of the test phases. Any major test plan changes which the Field Test Manager would like to make or any incidents which disrupt the testing must be reported to the Test Coordinator as soon as possible. Major test changes desired by the Test Coordinator, and all incidents seriously affecting the test schedule, will be reported to the Technical Manager (Vehicle). As considered appropriate, the HQMC, NAVSEA, MCDEC, AVTB, ALCOA, and FMC representatives will be kept informed, by the Test Coordinator, about test plan changes. The Field Test Officer is responsible to the Field Test Manager for compliance with this Master Test Plan as directed by the Field Test Manager.

B.2 TEST HOURS. In an effort to satisfy the primary objective of the test, the Field Test Manager should endeavor to maximize the number of test hours during the Feasibility Phase of the Main Test. A goal of 50 hours for each of the first two test months is desired. To complete a total of 200 test hours would require that the next four months of the testing (durability) be conducted at an average rate of 25 hours per month. This assumes that mileage would be accumulated at the overall rate of 10 miles per hour. Thus, a total of 200 hours or 2,000 miles (3,218 kilometers) of testing could be accomplished.

APPENDIX C. DATA COLLECTION PLAN

C.1 ORGANIZATION. The data generated by the AVTB testing will be collected in the manner prescribed by the Field Test Manager. As a minimum, a daily report of events will be maintained covering each day of operation of the test vehicle. The report will be as complete as resources will allow.

C.2 TEST EVENTS. To generate the required test data, a list of required test events has been drawn up and is included as Table 1 to this appendix.

C.3 DATA RECORDING. The data forms for recording the basic test data (Fig. 3-1, 4-1, 4-2) will be provided separately. It is expected that the forms would be used for each major test track component at each 25-hour interval in the testing. In addition, the forms would also be used to report on a suspected failure or other incident of an important nature. With regard to failures or incidents, it is extremely important that the descriptive comments are as thorough and detailed as possible.

C.4 PHOTOGRAPHIC COVERAGE. In addition to data and narrative descriptions of significant events, photographic coverage should be sought in those instances when such evidence would provide useful information for an understanding of a particular problem.

TABLE 1 TO APPENDIX C
ROSTER OF REQUIRED EVENTS

Number	Event	Data Requirements	Frequency
1	20% water use	4.2.3.16 4.2.3.17 3.4.2.4	N/A
2	80% land use	4.2.3.16	N/A
3	Acceleration and deceleration runs on land	3.3.1.1	5
4	50-mile cross-country run, and regular tests	4.2.3.2 4.2.3.3 4.2.3.5 4.2.3.6 4.2.3.7 4.2.3.10 4.2.3.11 4.2.3.13 4.2.3.14 3.6.1.1 3.4.2.1 3.4.2.7	30
5	High speed run on hard level surface	3.4.2.6	10
6	Heat buildup in A-Track components	3.4.2.6	TBD
7	Emergency stop	3.6.1.1 3.4.2.8	
8	Scheduled maintenance	4.3.2.2 4.3.2.5 4.3.2.6 4.3.2.8 4.3.2.10 4.3.2.11 4.3.2.12 3.4.2.5	TBD

Note: N/A - Not Available
TBD - To be Designated

APPENDIX D. FAILURE DECISION FLOWCHART

The following decision flowchart will be used to determine the chargeability of incidents or malfunctions.

Sequence	Question		Classification
1	Does the incident concern: the breach of any specified performance tolerance; a component malfunction; or creation of a safety hazard?	No	No test
	Yes		
2	Was incident detected during pretest inspection?	Yes	No test
	No		
3	Did incident result from test item abuse, unrealistic operating conditions, accident or improper maintenance or operating procedures?	Yes	No test
	No		
4	Was the incident detected during an inspection and no action or only authorized scheduled crew maintenance was required for correction?	Yes	No test
	No		
5	Was the incident a scheduled replacement or service of parts before failure?	Yes	No failure (Scheduled Maintenance)
	No		
6	Was the incident an incipient malfunction detected during scheduled maintenance and corrected at that level?	Yes	No failure (Unscheduled Maintenance)
	No		

Sequence	Question		Classification
7	Was the incident an incipient malfunction detected during operation for which corrective action could have been deferred to the next scheduled maintenance and be corrected at that level?	Yes	No failure (Unscheduled Maintenance)
	No		
8	Was the incident an actual malfunction for which maintenance can be deferred to the next scheduled maintenance and corrected at that level or deferred to the end of test?	Yes	No failure (Unscheduled Maintenance)
	No		
9	Was the incident caused by, or secondary to, another incident?	Yes	No failure (Unscheduled Maintenance
	No		
10	Could the vehicle mission be completed without degradation to mission essential functions or critical or catastrophic hazard to personnel or equipment?	Yes	System Failure and Unscheduled Maintenance
	No		
11	Classify as Mission Failure, System Failure, and Unscheduled Maintenance.		

APPENDIX E. SUPPORT PLAN

E.1 CONTRACT SUPPORT. Separate contracts have been executed to cover the supplying of the test tracks and the LVTP7 modification parts. ALCOA will deliver 200 complete track shoes including their accessories to AVTB. This supply is sufficient to assemble one pair of test tracks plus 20% of spares. FMC will provide the modified suspension parts and engineering liaison for a week during the mounting of the aluminum track at AVTB. This technical support will be officially terminated after the initial installation of the A-Track.

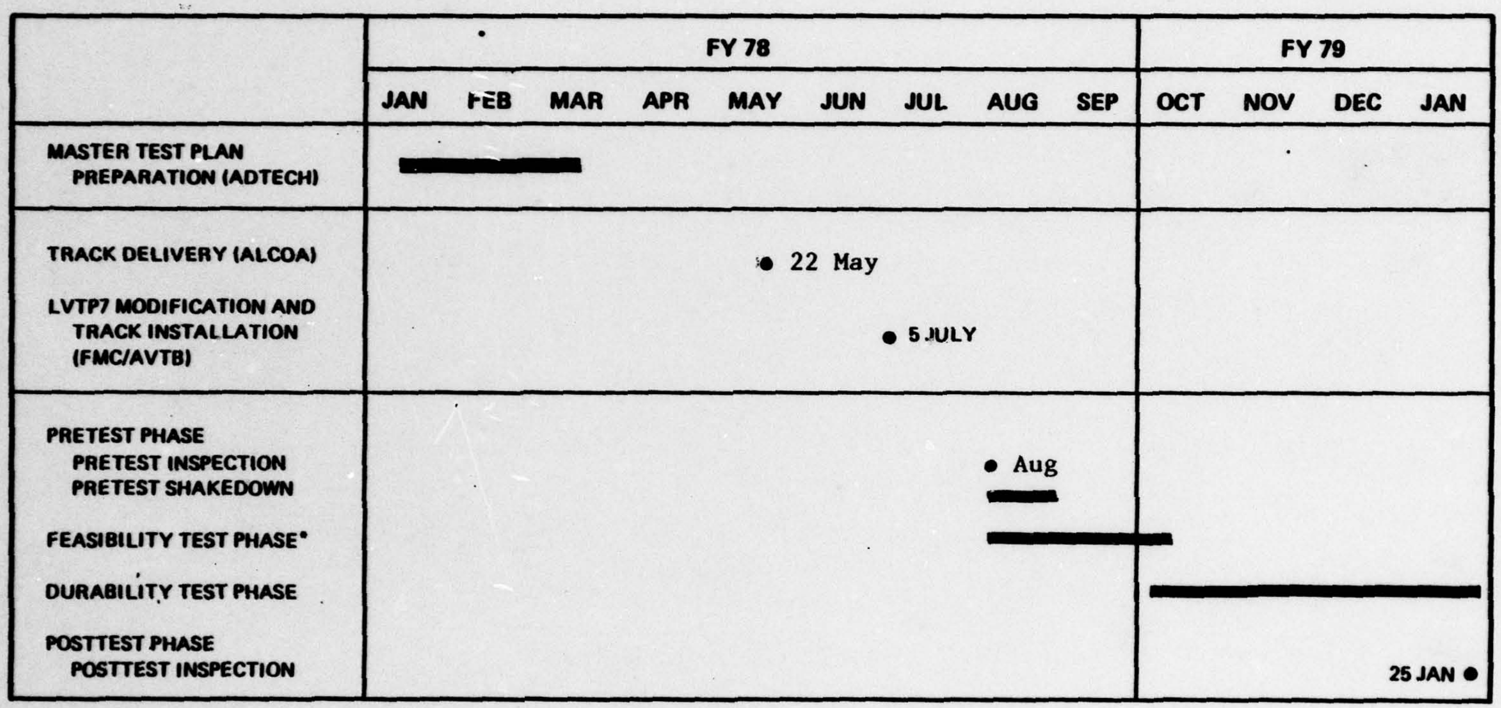
A new contract is being negotiated with FMC at this writing. They will provide support to AVTB for the shakedown test, including inspection of the track suspension components before and after the shakedown operation. They will provide consultation and technical service in case of contingency.

ALCOA will provide the support for inspection of suitability of the A-Track components before and after shakedown operation, and adjustment and repair of the track structure, if needed.

E.2 AVTB SUPPORT. AVTB has been designated as the activity to conduct the test. AVTB personnel will install the suspension system modifications and the A-Track on the host vehicle (which belongs to AVTB). At the conclusion of the test, AVTB will restore the host vehicle to its normal configuration. To cover the extra operating and maintenance costs of the host vehicle, a job order will be executed.

APPENDIX F

TENTATIVE LVA ALUMINUM TRACK FEASIBILITY TEST SCHEDULE



*If the Feasibility Test Phase demonstrates that the aluminum track is technically non-feasible, the Durability Test Phase will be cancelled.

APPENDIX G. TEST REPORTS

Report Title	Submitted By	Due
Pretest Inspection	Field Test Manager	Part of Final Report
Pretest Shakedown	Field Test Manager	Part of Final Report
25-Hour Inspection	Field Test Officer	When Completed
Posttest Inspection	Field Test Manager	Part of Final Report
Monthly Field Report*	Field Test Manager	15th of month
Monthly Test Report**	Test Coordinator	20th of month
Final Field Report***	Field Test Manager	1 February 1979
Final Test Report	Test Coordinator	1 April 1979

*Format to be as desired by Field Test Manager; report will cover significant accomplishments, problem areas, and any recommended test changes or initiatives.

**Format to be as desired by Test Coordinator; report will cover significant accomplishments, problem areas, and any recommended test changes or initiatives.

***Format to be as desired by the Field Test Manager and Test Coordinator.

APPENDIX H. REFERENCES

1. "Design, Laboratory Test, and Manufacture of a Double-Pin, Rubber-Bushed Track", D.S. Replogle, Defense Operations Division, Chrysler Corporation, Detroit, Michigan, February 1970.

2. "Aluminum Track Evaluation", R.L. Garrett, Aluminum Company of America, Cleveland, Ohio, October 1973.

3. "Product Improvement Test of Hard-Coated Aluminum Track Shoes and Hard-Coated Road Wheels for M60 Series Tank (T142 Aluminum Track) Final Report", R. Wilkie, U.S. Army Aberdeen Proving Ground, April 1974.

4. "Final Letter Report on Product Improvement Test of Hard-Coated Aluminum T142 Track for M60 Series Tanks", A.L. Cummings, U.S. Army Proving Ground, July 1975.