PO chefs, file, me
FYI only

GENERAL DYNAMICS
Land Systems Division
P.O. Box 1901, Warren, Michigan 48090

[redacted] [redacted]

WFB
FB
LVC
RJF
GMH

Inter-Office Memo

PLE/mna 86-183
22 August 1986

TO: R. G. Hill

XC: J. Brummans, T. Offer, J. Ruma

SUBJECT: Water Ingestion - Mississippi National Guard

REFERENCE: RGH/86-356 Correspondence Dated 01 July 1986

ENCLOSURES: (1) Trip Report
(2) Engineering Work Directive

Engineering has spent a considerable amount of time investigating the water ingestion problem discussed in your memo referenced above. Our concern over this issue led to a Camp Shelby trip by PMO and GD representatives as described in the attached trip report.

Your observations regarding the Pall Land precleaner are probably correct, but we do not have the technical basis for taking the engineering actions you have recommended. We must offer the government solid evidence that the Pall Land configuration is worse than the Donaldson regarding water ingestion.

Note the attached work directive which we have submitted to obtain the necessary test evidence.

P. L. Erickson

P. L. Erickson

RECEIVED
AUG 25 1986
J. J. McCUEN

AUG 25 1986

HILL
DIRECTOR ILS

GENERAL DYNAMICS
LAND SYSTEMS DIVISION
TRIP REPORT

TRIP DATES:	10, 11 June 1986
SITE VISITED:	Camp Shelby, MS. National Guard
PURPOSE OF TRIP:	Investigate Air Induction Water Ingestion
TRAVELER:	P. R. Bauer
PERSONNEL CONTACTED:	General Dynamics: J. Roach - Site Manager Government: W. Appleyard - TACOM PMO Lt. Col. W. Steele - U.S. Army Cpt. B. Koedding - U.S. Army

DISCUSSION

The trip was initiated in response to reports of water ingestion through the air induction system. The Mississippi National Guard (Camp Shelby) has experienced M1 engine aborts during rain storms. Examination by site personnel (prior to this trip) revealed water contaminated vee packs (P/N 12287727). Some M1 vehicles at Camp Shelby, that have been parked, have had 2 inches of water in the air box (approximately 2-3 gallons). Parked vehicles are now covered with tarps to prevent this. Water ingestion has been cited as the cause for a forward engine module failure (ref. ITR 05312-0001-00).

During the trip few M1 vehicles were active, and those that were active, had little or no exposure to rain. The Mississippi National Guard was not conducting training exercises the week of 8 June 1986 and, although some rain fell during the trip, the intensity and range of the rains were mild and limited. No engine aborts were observed or reported during the trip.

Col. Steele, Cpt. Koedding, and J. Roach all reported multiple M1 engine aborts during the beginning of heavy rains, which they attribute to air induction water ingestion. Vee packs pulled from these vehicles have been water contaminated, supporting this conclusion. Old style Donaldson vee packs may lose a fire retardent material they contain when they become water saturated. The water contaminated vee packs exceed the operational weight limit of 43 lbs. Vee packs that become water saturated may take several days to dry. Due to the limited availability of replacement vee packs, vehicles scheduled for operation use vee packs from vehicles not scheduled for operation until suitable replacements are obtained. An exercise later this summer is scheduled that is intended to field all the Camp Shelby vehicles.

J. Roach on several occasions expressed the need for more explicit manual instructions on the following:

a. Methods of detecting water ingestion.

b. Actions for continued vehicle operation after detection of water ingestion.

c. Maintenance pertaining to water contaminated vee packs.

It is Col. Steele's, Cpt. Koedding's, and J. Roach's belief that vehicles with PLM precleaners are more susceptible to water ingestion than vehicles with Donaldson precleaners. The vehicles at Camp Shelby all have precleaners (P/N 12287821) manufactured by Pall Land and Marine Inc. (PLM). Donaldson precleaners have screens and are thicker than PLM precleaners. Three possible reasons were expressed in support of this belief:

a. The Donaldson precleaner (Fig. 1) may not have as much water falling on to it as the PLM precleaners do (Fig. 2), due to its higher top surface relative to the air scoop outlet.

b. The Donaldson precleaner may be able to extract greater amounts of water due to different vortex tube design.

c. The Donaldson precleaner assembly has a screen, that PLM precleaner does not. This may cause the water to splatter, allowing increased water extraction.

Differences in vendor precleaner design and their effects on vehicle performance could not be evaluated at this time due to the unavailability of Donaldson precleaners at Camp Shelby.

ECP GDLL 3626 has released a change to incorporate drip rails to alleviate air induction water ingestion. Reported incidents of water ingestion from Fort Hood, Fort Poke, APG and Europe were the reason for the drip rail ECP. A vehicle at GDLS engineering facility was modded with drip rails and successfully tested in the prototype shop with both Donaldson and PLM precleaners. A modded vehicle underwent a salt fog and field test at Eglin Air Force Base in Florida with a Donaldson precleaner. None of the Camp Shelby vehicles has been modded with the drip rails. When site personnel were shown photographs of the drip rails installed on a vehicle, all indicated that the rails would reduce water ingestion, but some were uncertain that the mod would be sufficient to eliminate it.

W. Appleyard proposed testing of the precleaner to determine if one vendor's product is able to extract water better than the others. Mr. Appleyard also proposed a five-vehicle test to be conducted at Camp Shelby as outlined below:

	NO DRIP RAILS	DRIP RAILS
Donalson Precleaner	1 M1	1 M1
PLM Standard Precleaner	1 M1	1 M1
PLM Modified Precleaner	1 M1	

The modified PLM precleaner would have a strip of material added to match the Donaldson precleaner height at the air scoop outlet.

Paul Bauer

6-30-86

M1 WITHOUT DRIP RAILS

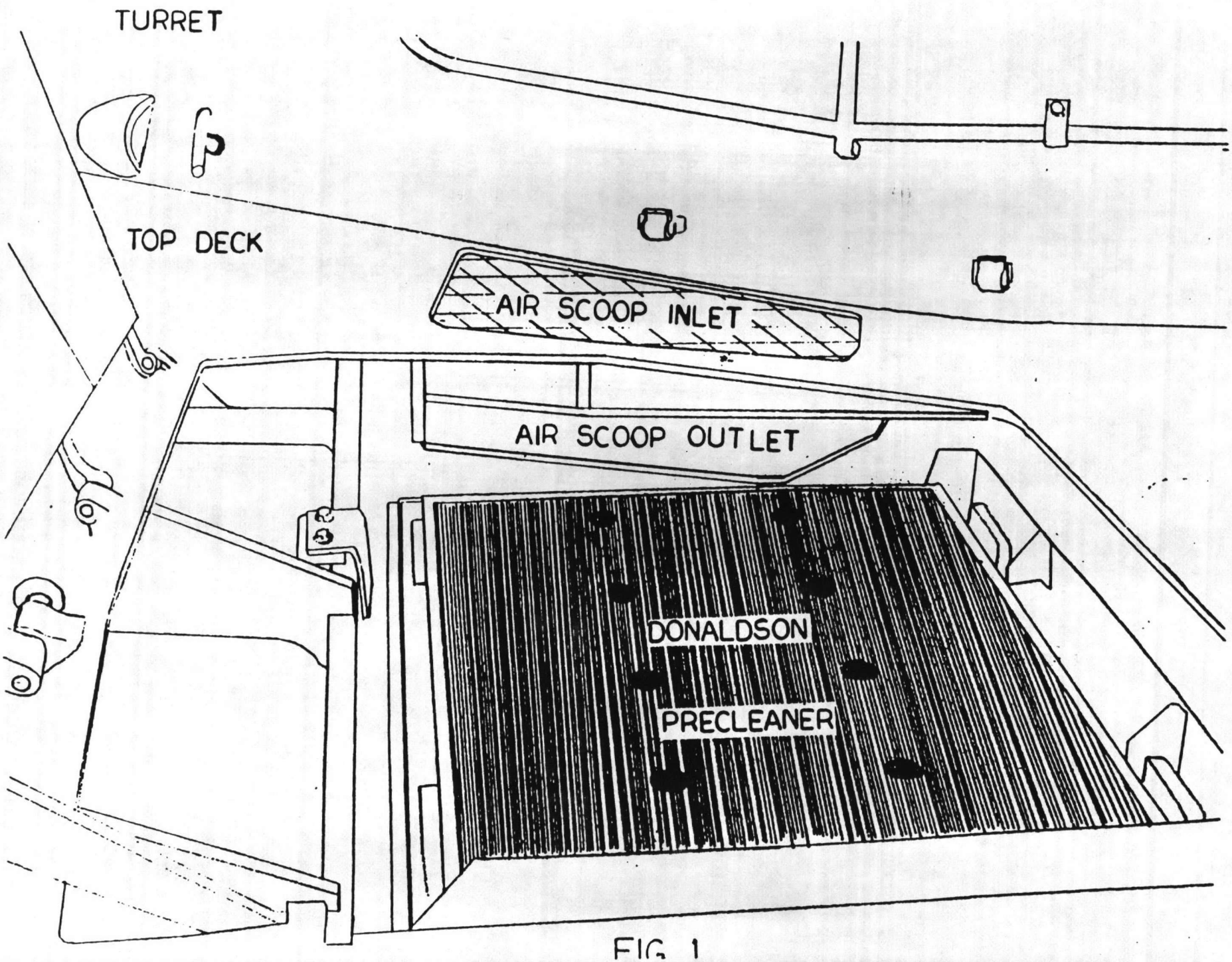

FIG 1

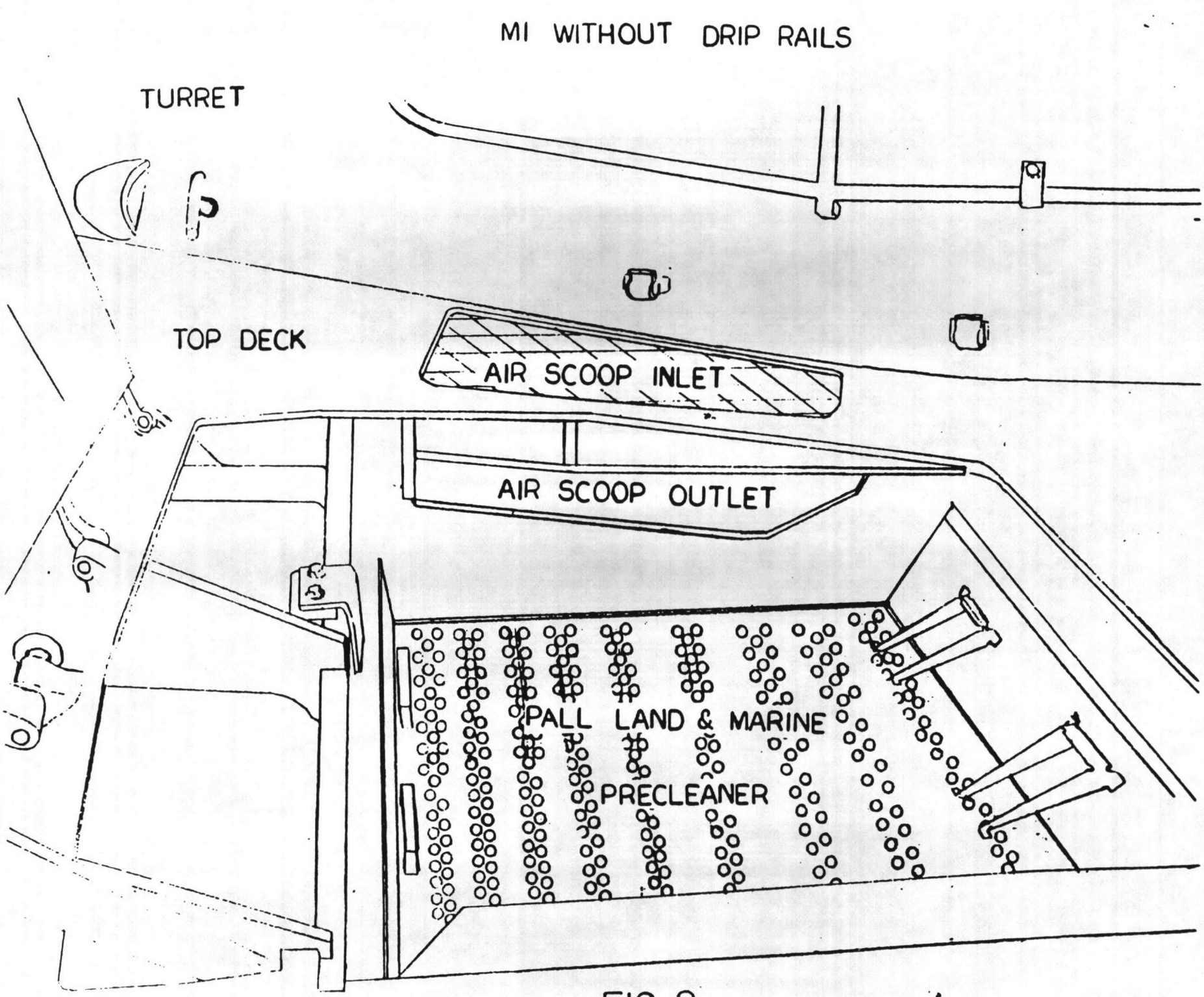
MI WITHOUT DRIP RAILS
TURRET
TOP DECK
AIR SCOOP INLET
AIR SCOOP OUTLET
PALL LAND & MARINE
PRECLEANER

FIG. 2

MI WITH DRIP RAILS

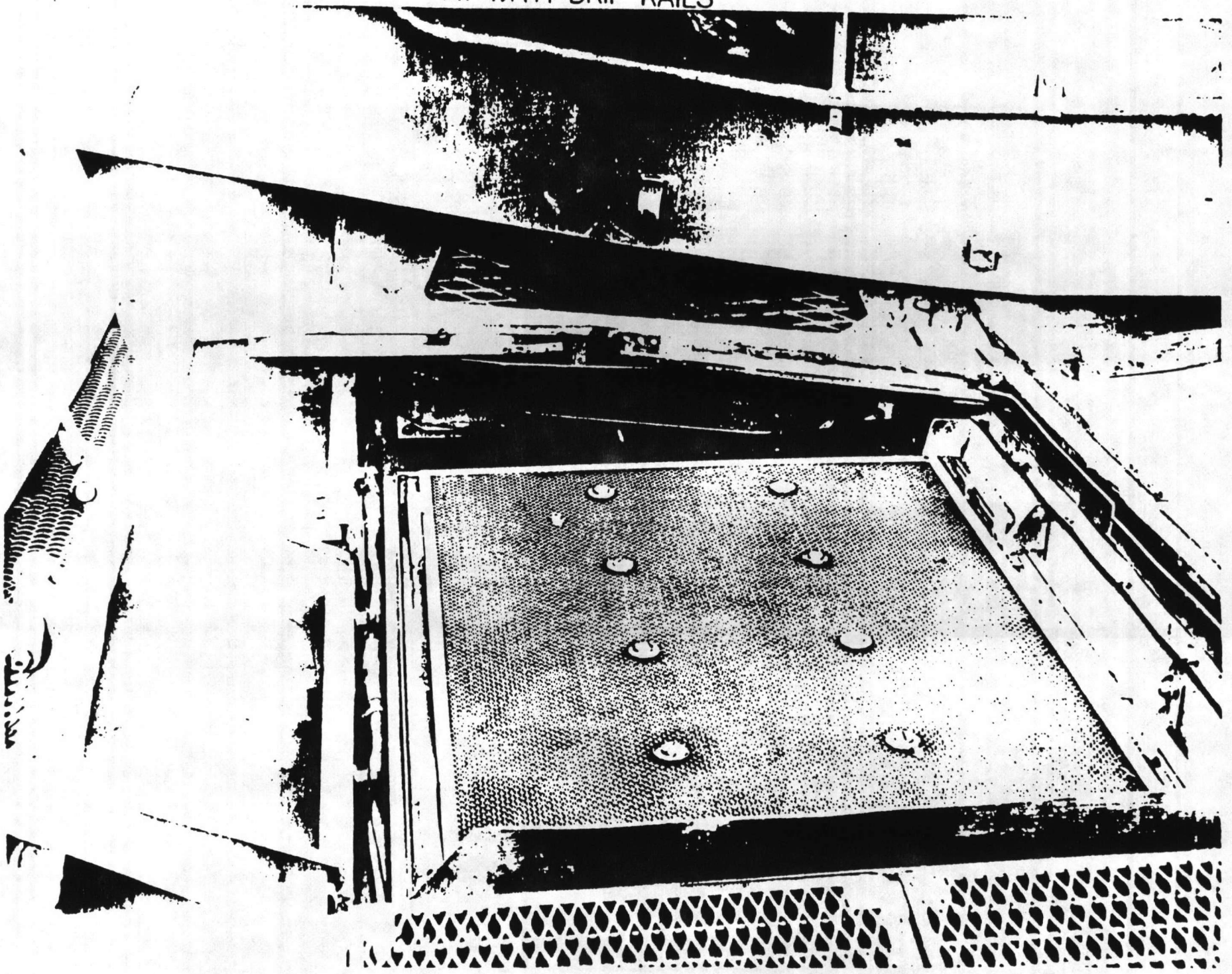

FIG 3

GENERAL DYNAMICS
Land Systems Division

WD-86-217-1

ENGINEERING WORK DIRECTIVE

CATEGORY Engineering

ENGINEERING CONTRACTOR:
GENERAL DYNAMICS LAND SYSTEMS DIVISION

W. D. NUMBER _____

DATE _____

END ITEM(S) AFFECTED: M1/IPM1/M1A1

CONTRACT NO. _____

SUBJECT: Air Induction Water Ingestion

PRIORITY: _____

SOW | CDRL NO.: | DID:

TASK SUMMARY:

Investigate M1/M1A1 water ingestion through the air induction system.

SOURCE:

Work directive requested by W. Appleyard and A. Jocubaitis, TACOM M1-PMO and have approved the scope of work.

SCOPE OF WORK:

1. Prepare test plan.
2. Procure eight precleaner assemblies (P/N 12287821) manufactured by Donaldson Co.
3. Procure one set of drip rail hardware.
4. Monitor drip rail modification (L3626) of 24 vehicles at Camp Shelby. (Installation of the mod to be performed by the Government).
5. Monitor the installation of precleaner assemblies on 32 vehicles, per Table 1 attachment A.
6. Provide test support.
7. Prepare and submit an informal test report.
8. Prepare and submit a change request to Pre-CCB.
9. Submit closeout letter to PMO.

ENGINEERING Program Manager		

84-101-0007 (3-82)

BACKGROUND:

M1 engine aborts, attributed to water ingestion of the air induction system, have occurred at Camp Shelby National Guard in Mississippi. Vehicles at Camp Shelby have not been modded with drip rails (Mod L 3626) which has been released to alleviate water ingestion. Vehicles at Camp Shelby are all presently equipped with Pall Land and Marine Inc. precleaners, which has prevented precleaner performance comparisons under water ingestion conditions.

GENERAL DYNAMICS
Land Systems Division

W. O. Number	
Date	8-14-86

ENGINEERING WORK DIRECTIVE ESTIMATE

Dept. No.	Description	MONTHLY Estimated Man - Hours Only	MONTHLY Est. Mtl. Costs
4011	Program Mgmt. Operations - M60		
4021	Program Mgmt. Operations - M1		
4341	Publications Opers.		
4352	Data Management Opers.		
4361	Management Info./Project Ctl. M1		
4362	Mgmt. Info./Project Ctl. M60		
4363	Mgmt. Info./Project Ctl. Engr.		
4381	Mgmt. Info. Systems Opers.		
4391	Material Planning	20	
5011	ILS Mgmt. Operations		
5111	Logistics Engineering		
5121	Technical Training		
5131	Technical Documentation		
5151	Advanced Logistics		
5201	Support Equip. Operations		
5301	Warranty & Administration		
5401	Field Activities Center		
5411	Conus Field Opers.		
5421	Internat'l Field Opers.		
5431	TAC Val/Ver		
5441	Fielding Support		
5451	Mod. Implementations		
5481	Quality Inspection		
5501	Spares & Support Services Operations		
5511	LSAR/Provisioning		
5521	Repair Parts and Special Tools List		
5531	Packaging/Handling/Transportability		
5541	Support Services		
5551	Spares Control		
8011	Engrg. Program Management		
8101	Engrg. Program Office		
8111	Systems Engineering Opers.		
8112	Analytical Engineering		
8113	Radiation Engineering		
8122	Battlefield Management Systems		
8131	Product Design & Drafting Veh. Systems		
8132	Product Design & Drafting Support Systems		
8133	Engineering Release		
8134	Engineering Controls		
8135	Administrative Controls & Programs		
8141	Mockup Development		
8142	Prototype Shop		
8144	Adjunct Plant - Groesbeck		
8151	Systems Design Integration		

Dept. No.	Description	MONTHLY Estimated Man - Hours Only	MONTHLY Est. Mtl. Costs
8161	Structures & Armor		
8162	Vehicle Support		
8163	Electrical		
8164	Static and Dynamic Analysis		
8171	Turret Systems		
8172	Armament		
8173	Control Systems		
8174	Mechanical/Hydraulic Systems		
8181	Chassis Systems		
8182	Power Train		
8183	Suspension		
8184	Air Handling and Cooling Systems	390	10000.00
8191	Liaison Engineering		
8211	Training Devices Opers.		
8221	Vehicle Systems Opers.		
8241	Environmental Test		
8251	Wheeled Vehicle Prog. Opers.		
8261	Fire Control Opers.		
8271	Vetronics Opers.		
8291	Test Equipment		
8292	Materials & Process		
8301	Prod. Assur. Prog. Mgmt.		
8311	Reliability Engineering		
8312	Reliability Control		
8313	Maintainability		
8314	HFE and Safety		
8321	Field Test	435	
8322	Test Engineering		
8331	Producibility and Value Engrg.	4	
8332	Inspection Equip. Design		
8333	Quality Engineering	10	
8334	Quality Control	120	
8335	Quality Assurance Planning & Control		
8421	Operations Research Analysis		
8431	Adv. Prog. Mgt. Opers.		
	TOTAL	979	10000.00

SUBCONTRACTORS

Name	Est. Mtl. Costs

Approvals

Originator: Paul Bauer 8-15-86
P. R. Bauer

Phone No.: x-7781

Dept. No.: 8184

Dept. Manager: Thomas L. Brumaghim 8-15-86

Project Manager:

Miscellaneous Costs

CAD/CAM	
Computer Time	
Travel	$18000.00
Other	

Accepted/Date

04 101-1023 (6-83)

GENERAL DYNAMICS
Land Systems Division

GENERAL DYNAMICS LAND SYSTEMS DIVISION
WORK DIRECTIVE SCHEDULE

Work Directive Title	Air Induction Water Ingestion		W.D. No.
Date Prepared	8-14-86	Start Date	Prepared by: Paul Bauer

Approved by: _____

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Mo-Yr																
Milestone No. / Dept No.																
	PREPARE TEST PLAN.															
1.																
8184	20															20
	PROCURE (8) DONALDSON PRECLEANER ASSEMBLIES															
2.																
8184	20	20	20													60
4391	10															10
	PROCURE (1) SET OF DRIP RAIL HARDWARE.															
3.																
8184	20	20	20													60
4391	10															10
	MONITOR DRIP RAIL MODIFICATION															
4.																
8184				80												80
8321				160												160
8334				90												90
Total Hours	80	40	40	330												490
Material	$10000.00															$10000.00

GENERAL DYNAMICS
Land Systems Division

GENERAL DYNAMICS LAND SYSTEMS DIVISION
WORK DIRECTIVE SCHEDULE

Work Directive Title	Air Induction Water Ingestion		W.D. No.
Date Prepared	8-14-86	Start Date	Prepared by: Paul Bauer
			Approved by: _____

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Mo-Yr																
	80	40	40	330												490
Milestone No. / Dept No.																$10000.00
	MONITOR PRECLEANER INSTALLATION															
5.																
8184				20												20
8321				40												40
8334				20												20
	PROVIDE TEST SUPPPORT															
6.																
8184					80											80
8321					225											225
8334					10											10
	PREPARE AND SUBMIT INFORMAL TEST REPORT															
7.																
8184						20										20
8321						10										10
	SUBMIT CHANGE REQUEST TO PRE-CCB															
8.																
8184						40										40
8331						4										4
8333						10										10
Total Hours	80	40	40	410	315	84										969
Material																$10000.00

GENERAL DYNAMICS
Land Systems Division

GENERAL DYNAMICS LAND SYSTEMS DIVISION
WORK DIRECTIVE SCHEDULE

Work Directive Title	Air Induction Water Ingestion		W.D. No.
Date Prepared	8-14-86	Start Date	Prepared by: Paul Bauer

Approved by: _____

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Mo-Yr																
	80	40	40	410	315	84										969
Milestone No. / Dept No.																$10000.00
	SUBMIT CLOSEOUT LETTER TO PMO															
9.																
8184						10										10
Total Hours	80	40	40	410	315	94										979
Material																$10000.00

ATTACHMENT A

TABLE 1

PRECLEANER TYPE	VEHICLES WITH DRIP RAILS	VEHICLES WITHOUT DRIP RAILS	TOTAL
DONALDSON	8	0	8
PLM Standard	8	8	16
PLM Modified	8	0	8
TOTAL	24	8	32

The modified PLM precleaner would have a strip of material added to match the Donaldson precleaner height at the air scoop outlet.

The eight vehicles without drip rails, that will have PLM precleaners, will be the test baseline vehicles.

All test vehicles are to have their veepacks weighed and their airboxes inspected for water before and after each National Guard exercise. Any airboxes containing water shall have the quantity noted and the water removed prior to vehicle operation.