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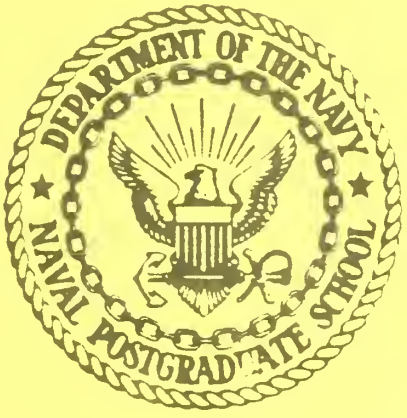

COMBAT DAMAGE ASSESSMENT TEAM

A-10/GAU-8 LOW ANGLE FIRINGS
VERSUS
SIMULATED SOVIET TANK COMPANY (ARRAY 21)
AEROJET LOT NUMBER AJD 79A181-001
(30 OCTOBER 1979)

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MAY 1980

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red for: A-10 System Program Office
Wright Patterson Air Force Base
Ohio 45433

NAVAL POSTGRADUATE SCHOOL
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The work reported herein was supported by the A-10 System Program Office, Wright Patterson Air Force Base, Ohio.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NPS-56-80-007	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): A-10/GAU-8 Low Angle Firing versus Simulated Soviet Tank Company (Array 21) (Aerojet Lot No. AJD 79A181-001) (30 October 1979)	5. TYPE OF REPORT & PERIOD COVERED: Special report for Array Firings of 30 October 1979
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): R.H.S. Stolfi, R.R. McEachin	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Naval Postgraduate School, Monterey, California 93940	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: MIPR# ACFR 79-177
11. CONTROLLING OFFICE NAME AND ADDRESS: A-10 System Program Office, Wright-Patterson Air Force Base, Ohio 45433	12. REPORT DATE: May 1980
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report)
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

1. automatic cannon ammunition
2. GAU-8 cannon
3. A-10 aircraft
4. main battle tank (MBT)
5. empirical firing tests
6. combat stowed targets
7. gun ammunition lethality
8. MBT vulnerability & survivability

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes firings of the A-10/GAU-8 weapon system on 30 October 1979 against a Soviet tank company simulated by 10 combat loaded M-47 tanks. The pilots making the firing passes attacked at low altitude and used correspondingly low dive angles in order to simulate movement through a hostile air defense system. Ammunition used in the attacks comprised 30mm armor piercing incendiary (API) rounds, which proved Aerojet Lot Number AJD 79A181-001 to be effective damage agents against substantial

areas of the U.S. MK 47 tanks used as targets. The pilots in nine successful firing passes (one pilot missed his intended target) fired a total of 289 rounds of which 98 impacted the targets. Of the projectiles impacting on targets, 22 achieved perforations of the armored envelope. Significant results include 3 tanks immobilized, of which 2 tanks were also silenced and six others damaged.

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COMBAT DAMAGE ASSESSMENT COMMITTEE (CDAC) EXECUTIVE SUMMARY

Under the technical direction of the Combat Damage Assessment Committee (CDAC), the Combat Damage Assessment Team (CDAT) conducted firings of the A-10/GAU-8 weapon system against an array of 10 tanks simulating a Soviet tank company deployed for an attack. The CDAT used M-47 tanks stowed with main gun ammunition, diesel fuel, lubricating oil, and crew mannikins to simulate the Soviet tanks. The pilots of the A-10 aircraft used in the firings conducted firings at low altitudes and low dive angles which simulated attack below the altitude of effective engagement for opposing air defense networks employing acquisition and fire control radar. The purpose of the test was to evaluate the effects of the 30mm API anti-tank ammunition (Aerojet lot number AJD 79A181-001) of the GAU-8 gun under challenging conditions of engagement for the A-10/GAU-8 system against realistically simulated Soviet main battle tanks.

The CDAC assessed the results of the low angle cannon firings of the A-10 aircraft against the simulated Soviet tank company as follows:

1. Attack Parameters: The pilots of the A-10 aircraft attacked the simulated Soviet tank company for 7 minutes 11 seconds at low altitude and dive angles. The pilots made a total of 13 passes, each at a primary tank target. The GAU-8 cannon has a cockpit selectable nominal fire rate of either 4200 rounds per minute or 2100 rounds per minute. The system was set to fire at the 2100 round per minute rate during this test. The passes resulted in projectile impacts on 9 primary target tanks. The attack open-fire dive angles averaged 1.3 degrees for the ten passes against the targets. Open-fire slant range averaged 2731 feet. The pilots fired 289 rounds in thirteen bursts averaging 22 rounds and 0.69 seconds each.

2. Weapons Effects: The A-10/GAU-8 weapon system achieved 98 impacts on the 10 tank targets. The ratio of direct impacts to total rounds fired was a substantial 0.30. Ricochet impacts are also capable of causing damage. If the ricochet impacts are added to the direct impacts, the overall ratio of impacts to rounds fired becomes 0.34. The weapon system achieved 22 perforations of the armored envelopes of the tanks with a ratio of perforations to total impacts of 0.22. The ratio of perforations to direct impacts is 0.26. Many projectiles, which did not perforate armor, severely damaged exterior track and suspension components of the tanks as well as gun tubes.

3. Damage Assessment: The attacking A-10/GAU-8 weapon system inflicted no catastrophic kills on tanks in the company

array. Three tanks were immobilized, of which two were deprived of the use of main armament and the other seriously degraded in firepower. Of the remaining tanks three were seriously degraded in mobility and firepower, three suffered minor or insignificant damage, and one was not hit. The effective loss of six tanks precluded continued or sustained offensive combat by the simulated Soviet tank company.

4. Test Conditions: The target tanks were sited in open, flat desert terrain with no cover and little concealment. Aerial weather conditions were ones of unlimited ceiling and visibility. Shortly after the initial firing, clouds of white dust from projectile impacts were evident. Such conditions effectively simulated the actual obscuration which would have been presented to the pilots in combat.

5. Results: The overall results of the test are summarized in Table I.

TABLE I. A-10 Aircraft in Low Angle Gun Attack versus Simulated Soviet Tank Company
(30 October 1979)

Tank No.	A-10 Primary Pass	APPROACH		ATTACK		GUN EFFECTS			DAMAGE			Tank Immobilized ?	Tank Aspect (Degrees)
		Speed (FPS)	Alt (Feet)	Open Fire Range (Feet)	Dive Angle (Degrees)	Rounds (Each)	Impacts (Each)	Perfs (Each)	M %	F %	K %		
33	1/1	589	463	2344	-3.0	11	-MISSED-		-	-	-		UNK
33	1/6	557	413	2120	-2.0	18	-MISSED-		-	-	-		UNK
33	2/6	589	383	3528	.0	31	17	5	100	100	-	Yes	090
38	2/1	584	363	3118	.0	25	12	2	65	95	-		093
34	1/2	564	383	2334	-1.0	11	-MISSED-		-	-	-		UNK
34	1/7	552	433	*	-3.0	18	14	7	100	100	-	Yes	089
39	2/2	574	363	3105	.0	22	16	3	-	-	-		090
28	1/3	573	433	2272	-3.0	20	-MISSED-		-	-	-		UNK
7	2/3	579	363	3255	.0	24	7	0	<5	-	-		090
41	1/4	576	463	2272	-3.0	25	21	3	100**	95	-	Yes	085
48	2/4	574	363	3392	.0	31	3	1	90	95	-		085
30	1/5	581	413	2487	-2.0	24	5	0	-	-	-		085
47	2/5	573	363	3460	.0	29	3	1	55	65	-		080
Total:***						289	98	22					
Average:***		574.	400	2731	-1.3	22.2	7.5	1.7	2 M- and F-Kills 1 M-Kill, High % F degradation 3 High % M and F degradation		3		Right Side

*Position uncertain
**Interdiction type M-Kill after 3 to 5 kilometers of movement.
***Based on HUD film
Note: 1/1 means pilot 1, pass 1; 1/2 means pilot 1, pass 2, etc.

BACKGROUND

Since February, 1978, the Armament Directorate, A-10 System Program Office, Wright Patterson Air Force Base, Ohio, has conducted firing tests using the A-10/GAU-8 system in low-level, air-to-ground engagements of armored targets. The tests have been conducted within the framework of the GAU-8 30mm ammunition Lot Acceptance Verification Program (LAVP) - Airborne. The LAVP has the following objectives which apply to the present tests:

A. To evaluate the performance of existing production lots of GAU-8 ammunition when fired from the air under operational conditions.

B. To evaluate the lethality of GAU-8 ammunition against armored targets when fired at low level from A-10 aircraft using operational tactics.

To conduct the LAVP program, the Armament Directorate has cooperated with Headquarters, Tactical Air Command, Langley AFB, Virginia and, in turn, with the Tactical Fighter Weapons Center, Nellis AFB, Nevada. Within the framework of that cooperation, the Armament Directorate has set up a Combat Damage Assessment Team (CDAT) to plan and execute the firing tests and evaluate the results. The CDAT functions under the direction of a Combat Damage Assessment Committee (CDAC) which has prepared this report of the firing test of 30 October, 1979.

TEST PHILOSOPHY

To generate realistic data, the CDAC determined to use a highly empirical technique of destructive testing of actual tank targets. Tests have involved firings at individual tanks in November, 1977 and February - March, 1978, and, more recently, arrays of vehicles in tactical formations. The experimental setup for the firings of 30 October, 1979 involved the use of a multitarget, tactically arrayed tank formation for attack by the A-10/GAU-8 system. The CDAT elected to simulate a Soviet tank company, as organized within a tank division, as the target array for two attacking A-10 aircraft. As few constraints as possible were placed on the attacking pilots in an attempt to develop as much realism as possible. Table II shows the test factors which would have been ideal in the test of 30 October, 1979 and the practical setup which was achieved.

TABLE II. Comparison of Ideal & Practical Test Situations

Ideal Test Parameters	Practical Test Parameters
1. Air Attack Realism	1. Air Attack Realism
a. Actual A-10/GAU-8	a. Actual A-10/GAU-8
b. 30mm API	b. 30mm API
c. European Weather & Terrain	c. Nevada Weather & Desert Terrain
d. Optimum open-fire ranges (2000 ft)	d. Average open-fire range - 2731 feet
e. Low Altitude attack angle (< 6 degrees)	e. Low Altitude attack angle (< 6 degrees)
2. Air Defense Realism	2. Air Defense Realism
a. Automatic cannon firing at aircraft	a. Low-altitude, low-angle, minimum-exposure attacks versus assumed AD system
b. Missile systems firing at aircraft	b. Low-altitude, low-angle, minimum-exposure attacks versus assumed AD system
c. Small arms firing at aircraft	c. Low-altitude, low-angle, minimum-exposure attacks versus assumed AD system
d. AD suppression by aircraft	d. No suppression simulation in test
3. Threat Targets and Doctrine	3. Threat Targets and Doctrine
a. T62/T64/T72 high fidelity targets	a. Simulated Soviet Tanks
b. Stowed combat loads (in T62/T64/T72)	b. Stowed combat loads (in US M-47)
c. Realistic crew station postures	c. Wooden crew manikins
d. Dynamic combat formation	d. Static combat formation
e. Maneuvering evasive targets	e. Stationary targets

SIMULATED GROUND COMBAT SITUATION

The firing test of 30 October, 1979 simulated the attack by two A-10 aircraft on a Soviet tank company. The CDAC hypothesized the Soviet tank company to be the lead march security detachment for its battalion, which in turn, is the advance guard of a larger mobile formation. The lead detachment operates approximately five kilometers in front of the Soviet battalion column. The mission of the advance company is to ensure the uninterrupted advance of the battalion and provide security against attack. Upon meeting heavy resistance, the company deploys into an appropriate combat formation to reduce the resistance, or form a base of fire for offensive action by the remainder of the battalion.

A Soviet tank company, would probably have other units attached to it for its support. Attached units might include any one or all of the following elements: (1) motorized rifle platoon; (2) engineer detachment; (3) chemical defense specialists; (4) 122mm howitzer battery; (5) air defense element. The lead detachment simulated in the firing test consisted of tanks alone. The pure tank formation was arranged in column formation, simulating high speed travel along an axis of advance. The tanks used in the firing test were US M-47 tanks, largely intact, containing crew manikins, and stowed with ammunition, fuel, and oil. The tanks were not maneuvered during the firing test and the formation remained essentially a snapshot of the company at a single point in time.

TARGET TANKS

The most effective targets available in sufficient numbers to simulate Soviet T-55 and T-62 (Figure 1) tanks were the US M-47 tanks. Both of the Soviet tank models are similar in armor protection to the M-47. With the appropriate purging of the gasoline fuel system of the US tanks, the CDAT managed to field a target similar in survivability to the T-55 and T-62 tanks from the viewpoint of ignitable internal material. Few data are available on the Soviet T-64 and later model tanks from the viewpoints of armor protection and the arrangement of internal components. The decision was made, accordingly, to simulate the earlier model Soviet tanks with the readily available US tanks.

The M-47 tanks used for targets were in excellent condition from the viewpoint of damage assessment. The exterior components were complete and the tanks have proven to be effective targets for the collection of exterior mobility damage. Interior components were less complete in the target tanks. All of the most essential items were present, e.g., main gun, engine, transmission, fuel tanks, ammunition racks, etc., but other items such as oil coolers, range finders, vision devices, and radios, have not been present in all tanks.

The most sensitive internal items from the viewpoint of catastrophic kills and high percentage M and F kills are the following, which were placed in the test tanks as noted:

Generic Sensitive Item	Test Item
1. Ammunition	US Cartridge, 90-mm TP-T
2. Fuel	Number 2 Diesel
3. Oil	Oil in Engine, Transmission and Drive Components.
4. Personnel	Articulated Plywood Manikins

The tanks were static during the test and their engines were not running, with the result that the fuel and oil were much cooler and more inert than would have been the case with a moving tank or a static vehicle with its engine running. The kill ratio achieved in the firing test of 30 October, 1979, therefore, is probably conservative from the viewpoint of fires resulting from ignited fuel and oil.

TEST PERFORMANCE AND RESULTS

Conduct of the test consisted of bringing together the ammunition, gun, aircraft, pilots, and combat arrayed and loaded tanks into a several minutes simulation of combat. In essence, the

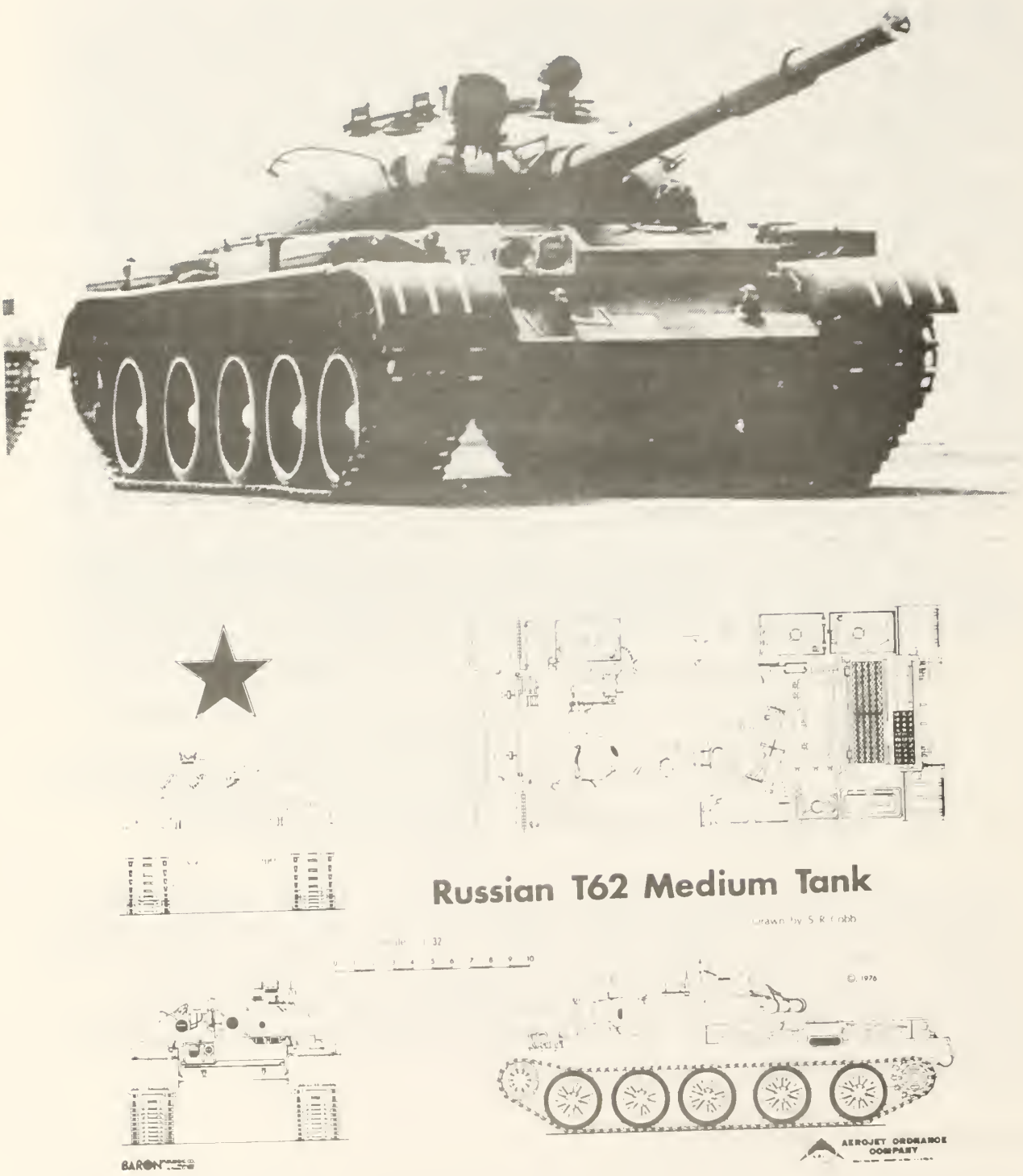


FIGURE 1. Russian T62 Medium Tank

decisive elements which were fed into the test immediately prior to the firing were the following:

1. Aerojet 30mm API ammunition
   Lot AJD 79A181-001.
2. General Electric GAU-8 Gatling gun.
3. Fairchild Republic A-10 attack aircraft.
4. Fighter Pilots, 66th FWS, Nellis AFB.
5. US Designed M-47 main battle tanks, combat loaded.

The combat simulation itself comprised the aerial fire and maneuver of the attacking A-10 aircraft. A realistic way of presenting the combat simulation is to outline the sequence of pertinent events in each firing pass. These events and the pertinent data which the CDAT attempted to collect, in order to reconstruct the simulated combat firing of 30 October, 1979, were as follows:

Sequence	Event	Data
1.	Aircraft Approach	Speed, Altitude
2.	Aircraft Attack	Open-Fire Range, Dive Angle
3.	Aircraft Attack	Burst Time, Rounds Fired
4.	Aircraft Attack	Cease-Fire Range, Dive Angle
5.	Gun Effects, (Accuracy)	Impacts on Tanks
6.	Gun Effects, (Lethality)	Perforations through armor
7.	Tank Damage	Catastrophic (K-Kill), Mobility (M-Kill), and Firepower (F-Kill) Kills

The data noted immediately above were collected through the combined efforts of the CDAT and range personnel at Nellis AFB. Aerojet Ordnance Manufacturing Company personnel provided the industrial efforts required to repair, refurbish, and field the tank targets. The CDAT applied various systematic research techniques used to describe weapon effects and combat damage. The most basic materiel used in the test, i.e., the aircraft, gun, and projectile are illustrated in Figures 2, 3, 4, and 5. The targets were arrayed in the tactical formation of a Soviet tank company as shown in Figure 6.

The pilots making the attack flew from the base area in a two-ship, mutually supporting element and employed operational tactics immediately before and during the firing passes. The pilots approached the target area at low altitude and simulated target acquisition with the help of a forward air controller. The pilots then proceeded to attack the entire tank company and acquired targets at low altitudes and dive angles, simulating operation below the altitudes for effective acquisition and engagement by opposing air defense missile and gun systems.

FIGURE 2. U.S.A.F./Fairchild Republic A-10 Aircraft.

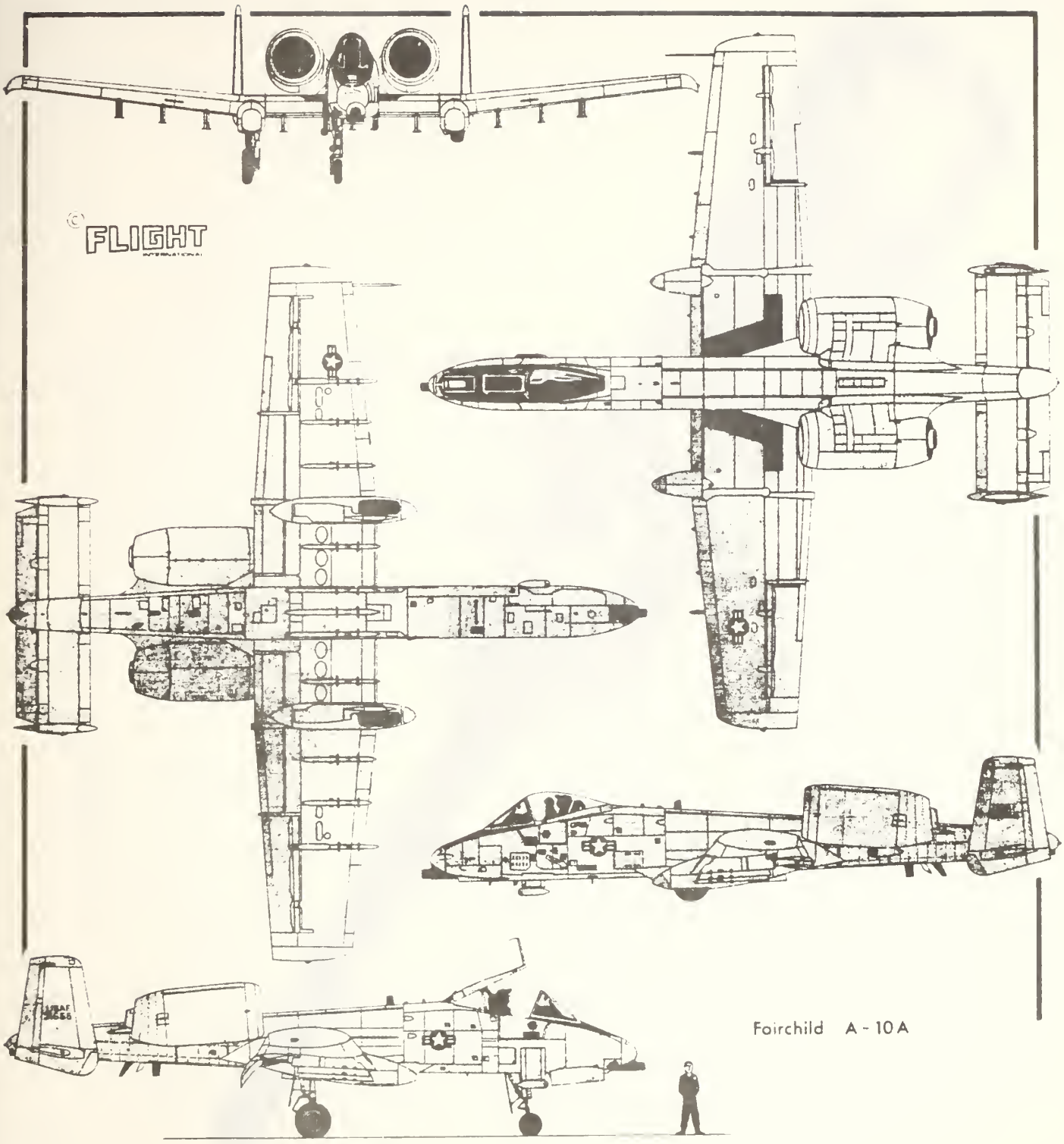


FIGURE 3. Fairchild A-10 Series Aircraft.

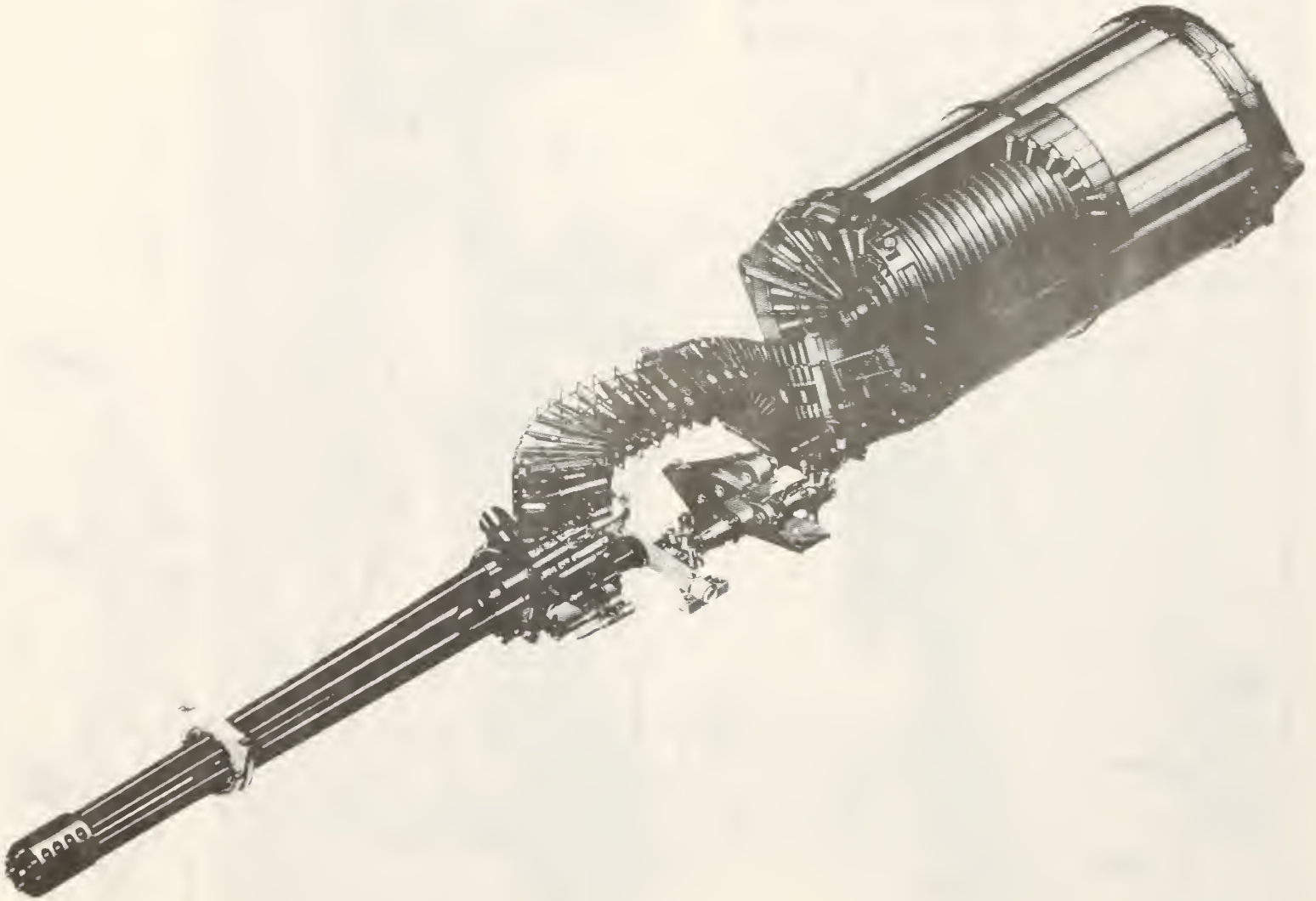


FIGURE 4. GAU-8/A 30mm Gun System

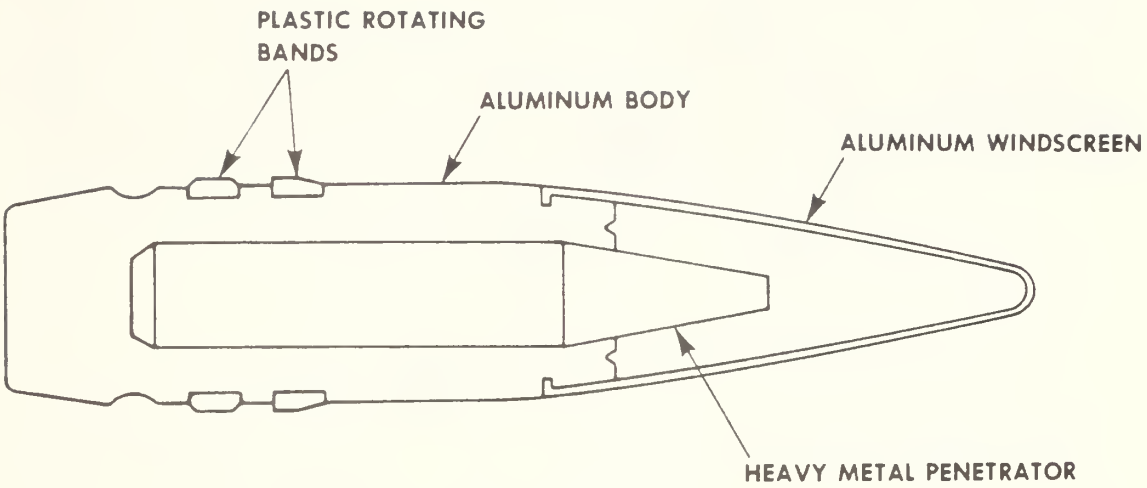


FIGURE 5. 30mm Armor Piercing Incendiary (API) Projectile.

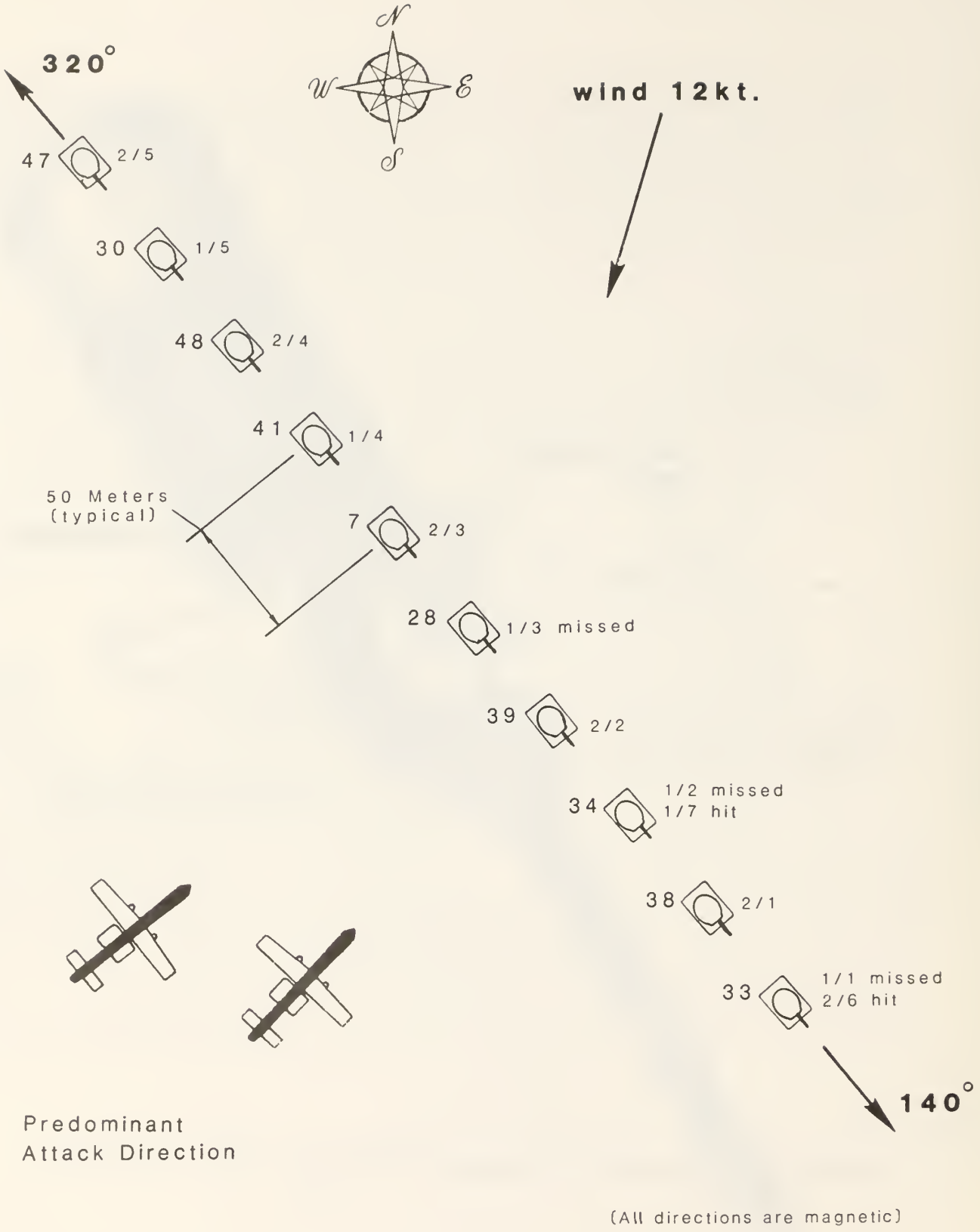


FIGURE 6. Approximate Target Layout.

DAMAGE ASSESSMENT

The damage assessment conducted by the CDAT is presented on the following pages. Appendix A contains graphical and tabular information relative to the mission in general plus summaries of the damage assessment for easy reference.

Terms used in the damage assessment summaries are defined in Appendix B.

Impacts on the targets were arbitrarily numbered for identification purposes. The impacts were numbered sequentially, first at the turret level, then at the hull level. If additional impacts were discovered during the combat damage assessment (as was sometimes the case) they were given the next sequential number, i.e.,no attempt was made to "correct" the sequence. THE READER IS CAUTIONED THAT THIS NUMBERING SYSTEM HAS NO RELATIONSHIP WHATSOEVER TO THE ARRIVAL SEQUENCE OF PROJECTILES ON THE TARGET OR TO THE PORTION OF THE BURST IMPACTING THE TARGET.

TARGET TANK DAMAGE SUMMARY

M-47 Tank Number 33

1. Description:

The attacking A-10 aircraft achieved impacts on the tank from an attack aspect of 090 degrees (right side) during three firing passes at low altitude and low dive angle. The A-10 expended 60 rounds during three firing passes. The first two passes were observed to have resulted in misses.

2. Kill Assessment:

100% M-Kill and 100% F-Kill resulting from the following observed effects (Figure 7):

a.	Perforations	: 5
b.	Significant Impacts	: 3
c.	Insignificant Impacts	: 9
	TOTAL IMPACTS	: 17

3. Rationale for Kill Assessment:

a. M-Kill: A 100% M-Kill was attritributed to impact 13 which perforated the hull armor into the engine compartment penetrating one valve cover (destroying the oil cooler, had it been installed), and to impact 3 which perforated the hull armor into the drivers compartment causing casualties to the driver and assistant driver. Perforation 12 into the engine compartment caused indeterminate damage. Impacts 15 and 16 destroyed two track shoes, making a minor contribution to the kill.

b. F-Kill: A 100% F-Kill was attributed to impact 5 which hit in the turret ring with a high probability of jamming the turret (which had been jammed during a previous test) and to impact 6 which perforated the turret causing a loader casualty. One other perforation of the hull into the ammunition stowage area caused indeterminate damage, since the turret could not be traversed for access.

NOTE: Impacts 14, 15, and 16 not depicted.

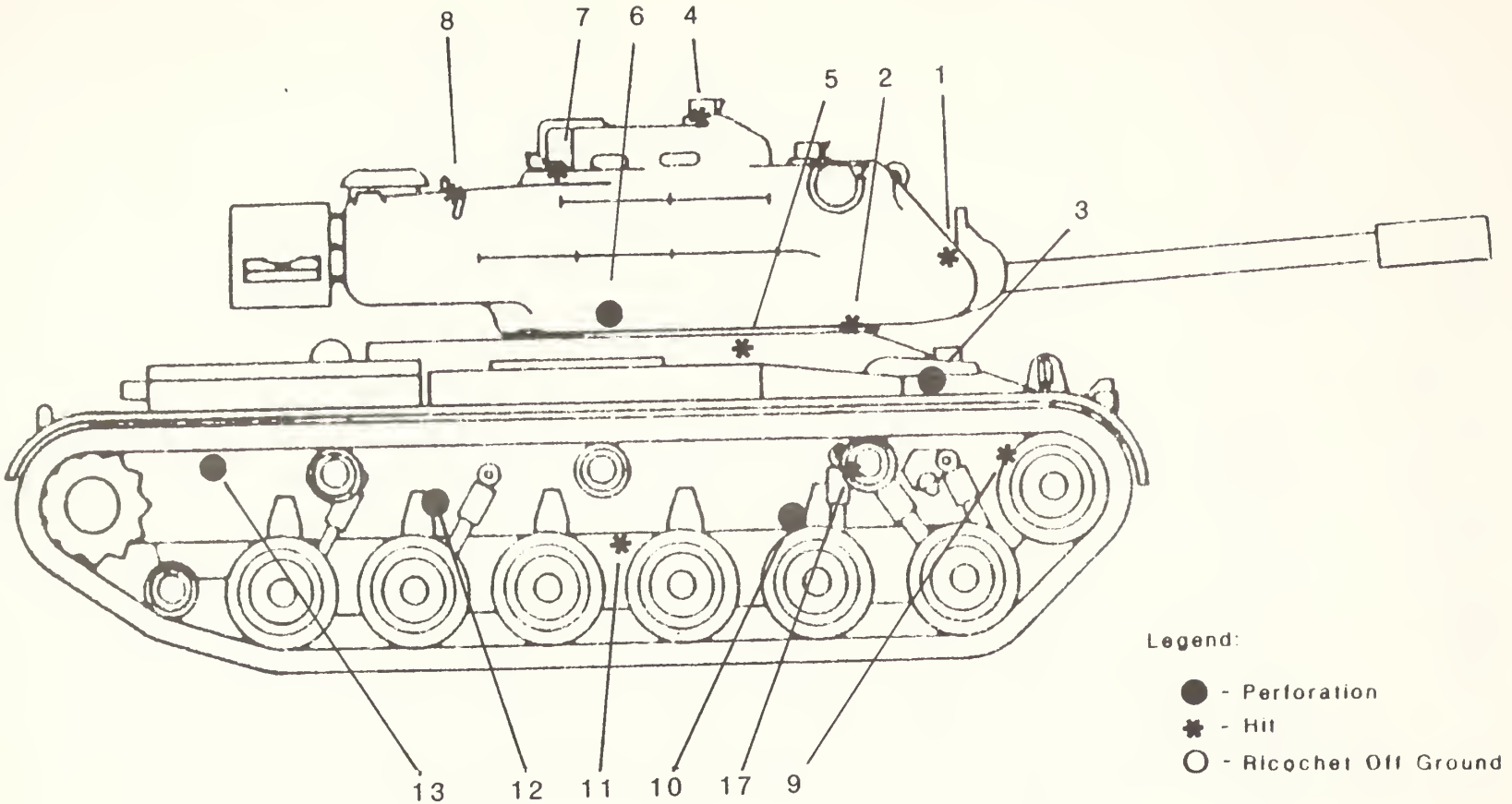


FIGURE 7. Locations of Impacts, Tank 33.

TARGET TANK DAMAGE SUMMARY

M-47 Tank Number 38

1. Description

The attacking A-10 aircraft achieved impacts on the tank from an attack aspect of 093 degrees (right side) during one firing pass at low altitude and low dive angle. The A-10 expended 25 rounds in the firing pass.

2. Kill Assessment:

65% M-Kill and 95% F-Kill resulting from the following observed effects (Figure 8):

a. Perforations	:	2
b. Significant Impacts	:	1
c. Insignificant Impacts	:	9
TOTAL IMPACTS	:	12

3. Rationale for Kill Assessment:

a. M-Kill: A 65% M-Kill was assessed based solely on crew casualties. Mobility was not impaired by mechanical damage and the tank could continue its mission after replacement of three crewmen.

b. F-Kill: A 95% F-Kill was assessed based solely on crew casualties from impacts 6 and 7 which perforated the turret and caused casualties to the commander, gunner and loader. The damage to the loader manikin was judged not severe enough to warrant his evacuation. Impact 8 which did not completely penetrate the turret armor may have contributed to the casualties through back-spalling.

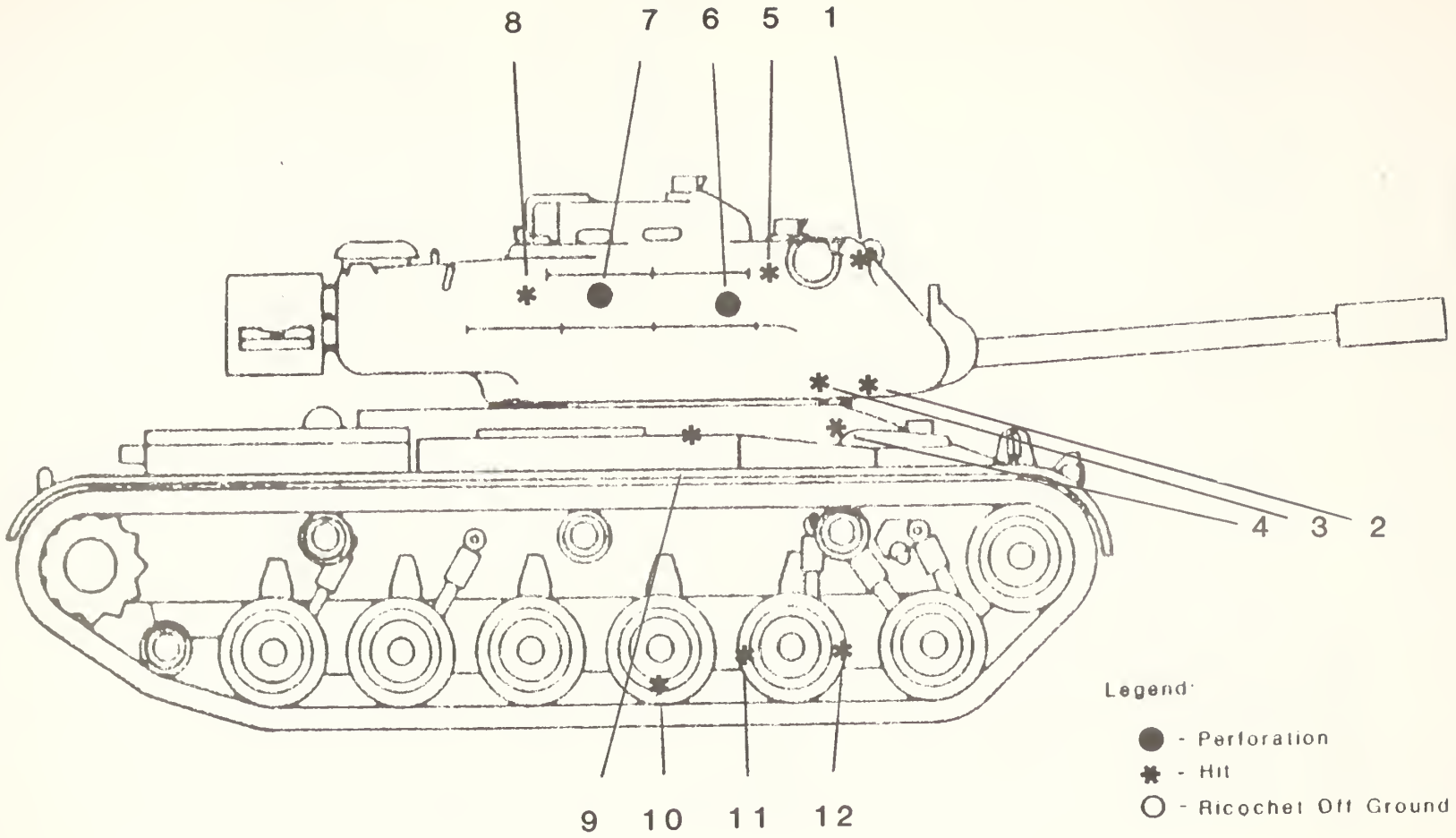


FIGURE 8. Location of Impacts, Tank 38.

TARGET TANK DAMAGE SUMMARY

M-47 Tank Number 34

1. Description:

The attacking A-10 aircraft achieved impacts on the tank from an attack aspect of 089 degrees (right side) during two firing passes at low altitude and low dive angle. The A-10 expended 29 rounds during the two firing passes. The first pass was observed to have resulted in a miss.

2. Kill Assessment:

100% M-Kill and 100% F-Kill resulting from the following observed effects (Figure 9):

a.	Perforations	: 7
b.	Significant Impacts	: 2
c.	Insignificant Impacts	: 5
	TOTAL IMPACTS	: 14

3. Rationale for Kill Assessment:

a. M-Kill: A 100% M-Kill was attributed to impacts 13 and 14 which perforated the right hull and penetrated the fuel tank. Contributing to the kill were impacts 8 and 10 which perforated the right hull and caused casualties to the driver and assistant driver, and impacts 11 and 12 which damaged the bearings and seal of the right #2 roadwheel hub.

b. F-Kill: A 100% F-Kill was assessed based on impacts 2 and 3 which perforated the right turret armor and caused casualties to the commander, gunner, and loader. The driver and assistant driver casualties, caused by impacts 8 and 10, contributed to the kill. One other perforation (impact 4) damaged an inverter and the ventilation blower, but did not contribute to the kill.

NOTE: Impacts 1, 5, and 6 not depicted (insignificant damage).

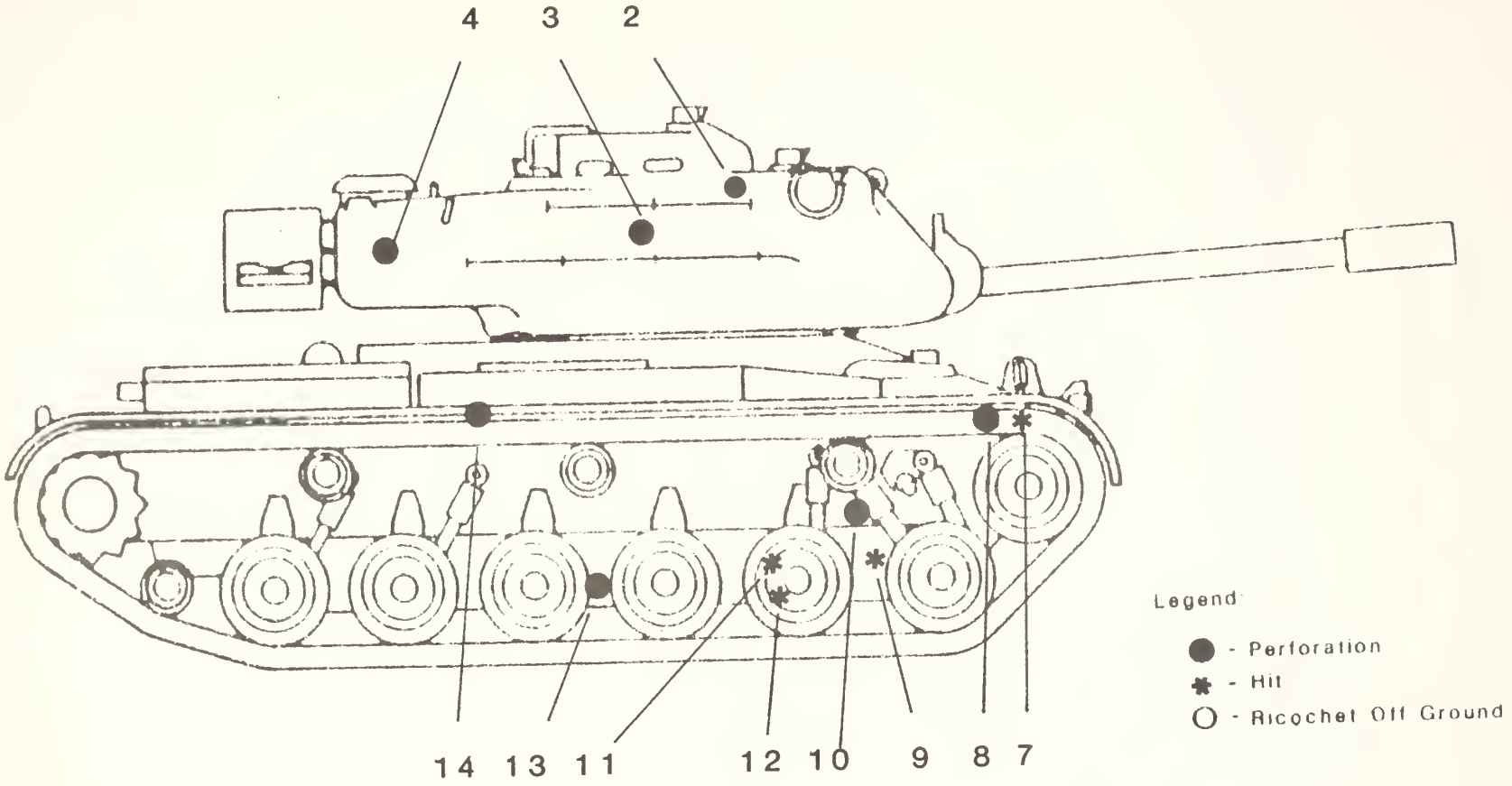


FIGURE 9. Locations of Impacts, Tank 34.

TARGET TANK DAMAGE SUMMARY

M-47 Tank Number 39

1. Description:

The attacking A-10 aircraft achieved impacts on the tank from an attack aspect of 090 degrees (right side) during one firing pass at low altitude and low dive angle. The A-10 expended 22 rounds during the firing pass.

2. Kill Assessment:

No degradation in mobility or firepower (Figure 10):

a.	Perforations	: 3
b.	Significant Impacts	: 0
c.	Insignificant Impacts	: 13
	TOTAL IMPACTS	: 16

3. Rationale for Kill Assessment:

Three perforations into the engine compartment (impacts 11, 12, and 16) failed to penetrate the fuel tank or damage any mobility or firepower related components.

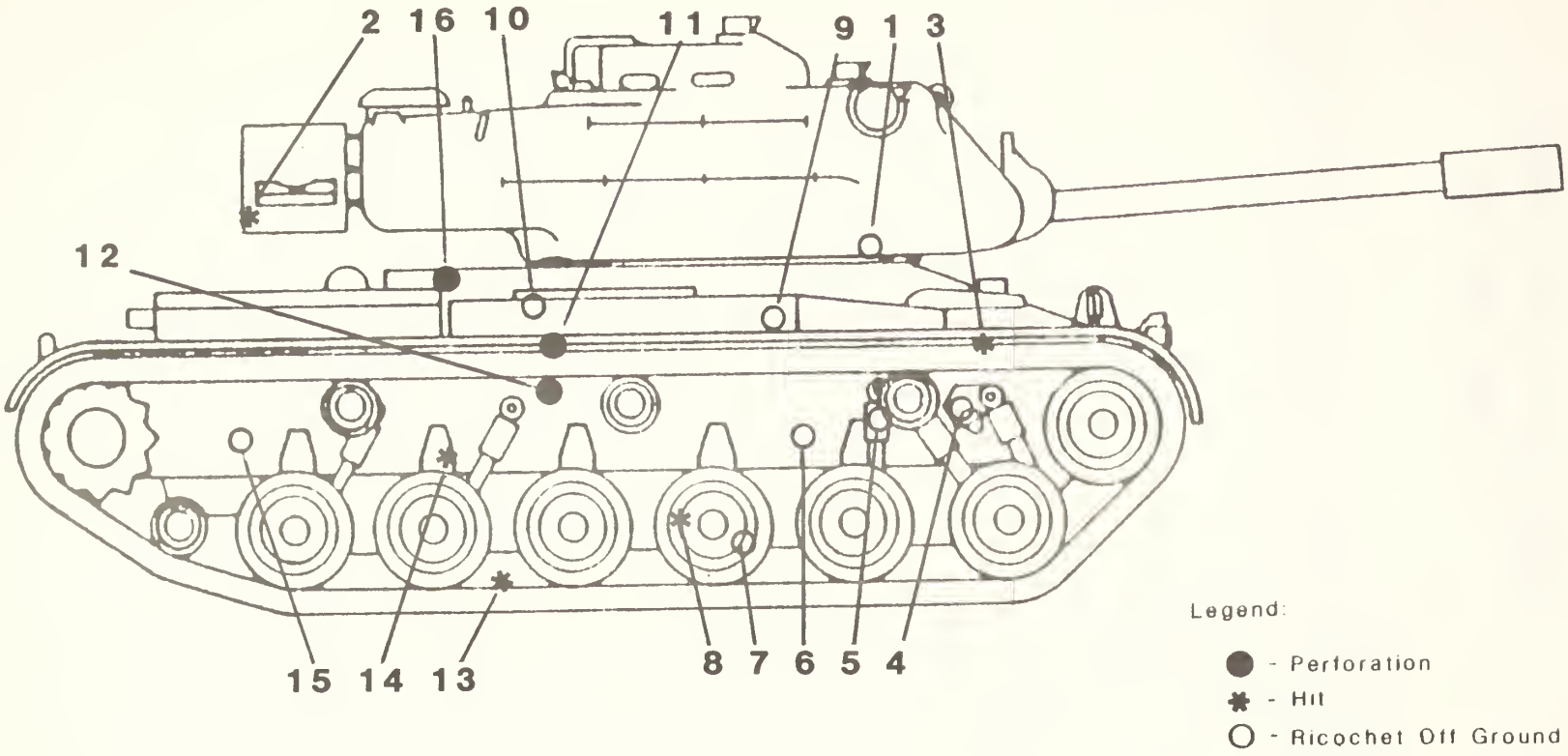


FIGURE 10. Locations of Impacts, Tank 39.

TARGET TANK DAMAGE SUMMARY

M-47 TANK NUMBER 28

1. Description:

The attacking A-10 aircraft failed to achieve any impacts on the tank in the burst of 20 projectiles which were fired toward the right side of the tank.

2. Kill Assessment:

Not Applicable.

TOTAL IMPACTS: 0

3. Rationale for Kill Assessment:

Not Applicable.

TARGET TANK DAMAGE SUMMARY

M-47 Tank Number 7

1. Description:

The attacking A-10 aircraft achieved impacts on the tank during one firing pass on the right side at low altitude and low dive angle. The A-10 expended 24 rounds during the firing pass.

2. Kill Assessment:

Less than 5% M-Kill resulting from the following observed effects (Figure 11):

a. Perforations	:	0
b. Significant Impacts	:	2
c. Insignificant Impacts:		5
TOTAL IMPACTS	:	7

3. Rationale for Kill Assessment:

Impact 4 destroyed one right track center guide; impact 7 destroyed the right track inside end connector.

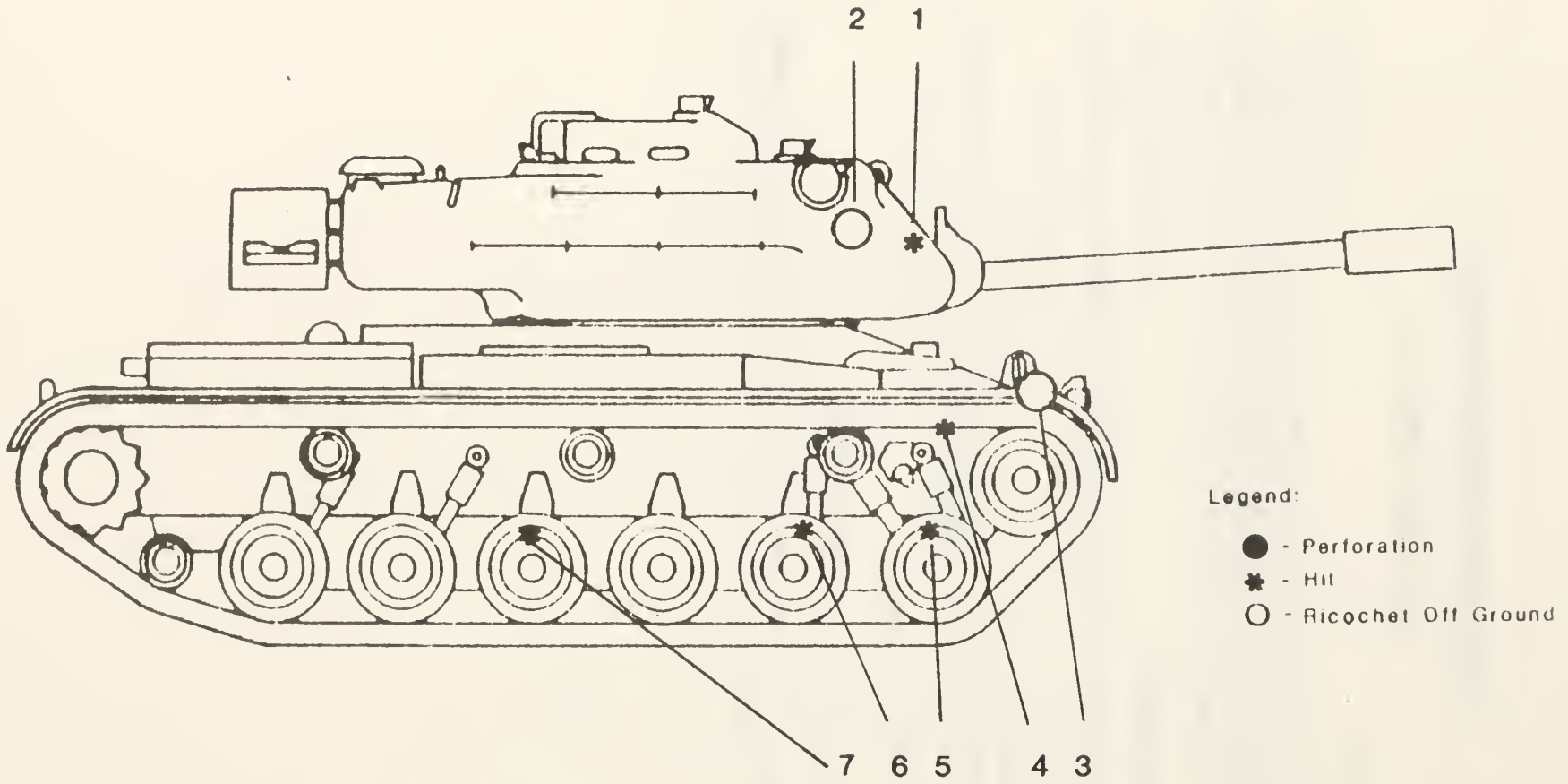


FIGURE 11. Locations of Impacts, Tank 7.

TARGET TANK DAMAGE SUMMARY

M-47 Tank Number 41

1. Description:

The attacking A-10 aircraft achieved impacts on the tank during one firing pass from an attack aspect angle of 085 degrees at low altitude and low dive angle. The A-10 expended 25 rounds during the firing pass.

2. Kill Assessment:

100% interdiction type M-Kill and 95% F-Kill resulting from the following observed effects (Figure 12):

a. Perforations	:	3
b. Significant Impacts	:	5
c. Insignificant Impacts	:	13
TOTAL IMPACTS	:	21

3. Rationale for Kill Assessment:

a. M-Kills: A 100% interdiction type M-Kill after 3-5 km movement was assessed attributed to cumulative damage from impact 17 which perforated the right hull armor, severed one spark plug wire (immediate loss of power) and penetrated one valve cover (loss of engine oil), and from impact 14 which damaged the right #4 roadwheel causing an oil leak. Minor damage to the track and suspension system from 4 other impacts contributed to the kill.

b. F-Kill: A 95% F-Kill was attributed to the results of impacts 7 and 8 which perforated the right turret armor causing casualties to the commander, gunner, and loader.

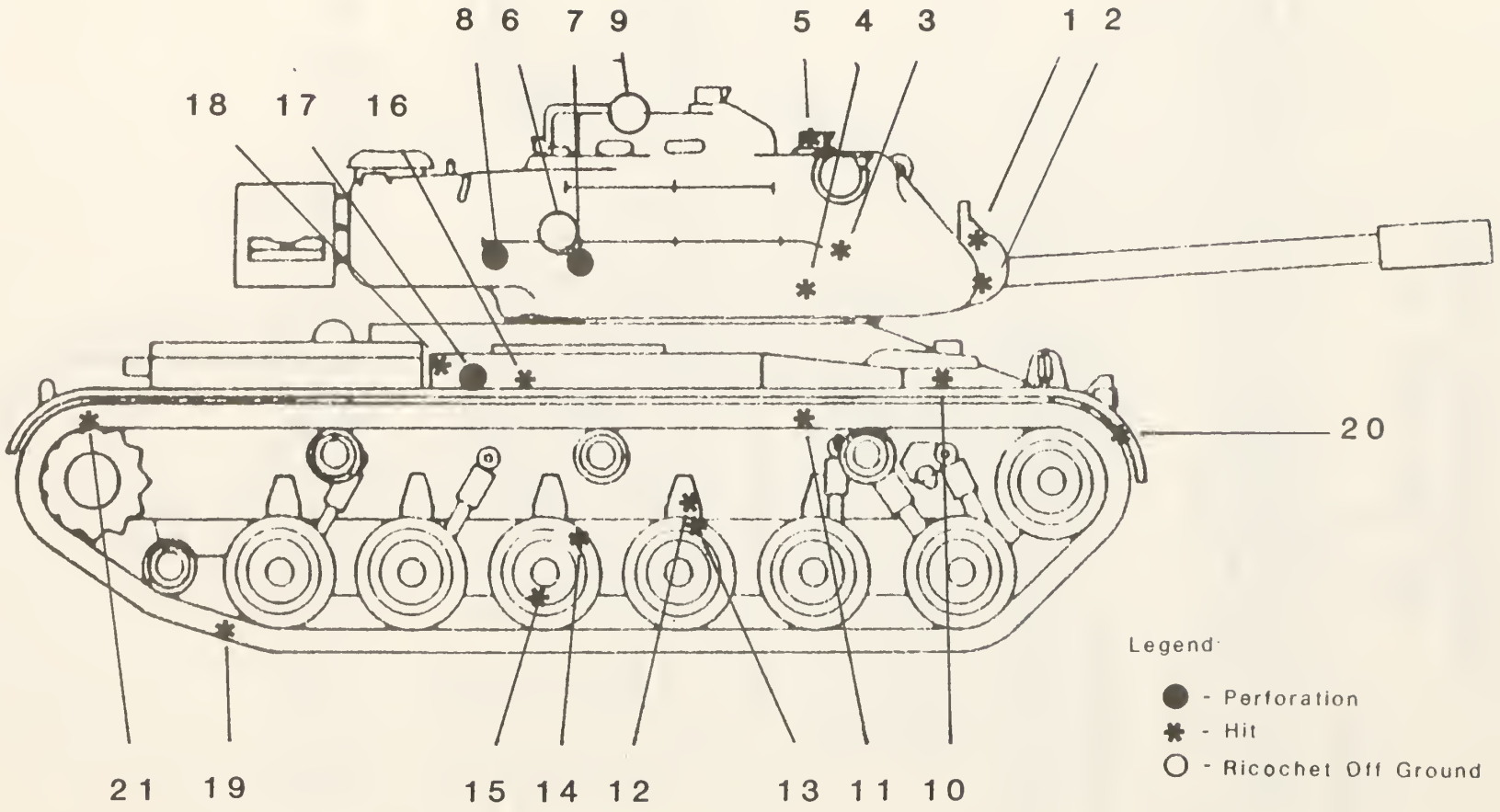


FIGURE 12. Locations of Impacts, Tank 41.

TARGET TANK DAMAGE SUMMARY

M-47 Tank Number 48

1. Description:

The attacking A-10 aircraft achieved impacts on the tank from an attack aspect of 085 degrees (right side) during one firing pass at low altitude and low dive angle. The A-10 expended 31 rounds during the firing pass.

2. Kill Assessment:

90% M-Kill and 95% F-Kill based on the following observed effects (Figure 13):

a.	Perforations	: 1
b.	Significant Impacts	: 1
c.	Insignificant Impacts	: 1
	TOTAL IMPACTS	: 3

3. Rationale for Kill Assessment:

a. M-Kill: A 90% immediate M-Kill was assessed attributable solely to crew casualties. Damage to the right #1 track support roller hub from impact 2 was judged as probably sufficient to cause an interdiction type mobility kill during continued movement.

b. F-Kill: A 95% F-Kill was assessed based solely on crew casualties from impact 1 which perforated the right turret armor and caused casualties to the commander, gunner, and loader.

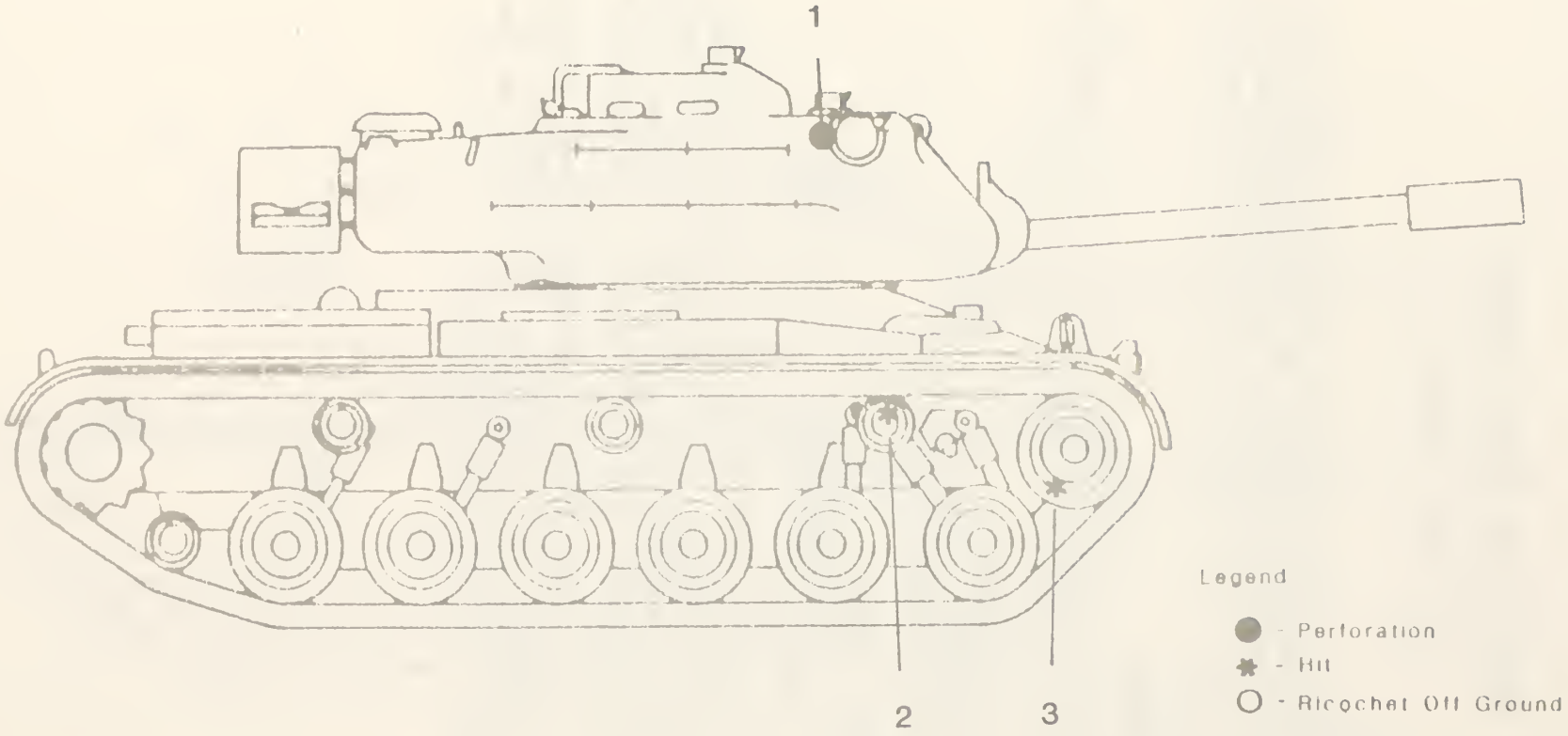


FIGURE 13. Locations of Impacts, Tank 48.

TARGET TANK DAMAGE SUMMARY

M-47 Tank Number 30

1. Description:

The attacking A-10 aircraft achieved impacts on the tank from an attack aspect angle of 085 degrees (right side) during one firing pass at low altitude and low dive angle. The A-10 expended 24 rounds during the firing pass.

2. Kill Assessment:

No degradation in mobility or firepower (Figure 14):

a.	Perforations	: 0
b.	Significant Impacts	: 0
c.	Insignificant Impacts	: 5
	TOTAL IMPACTS	: 5

3. Rationale for Kill Assessment:

No damage was observed which was substantial enough to cause a degradation of either firepower or mobility.

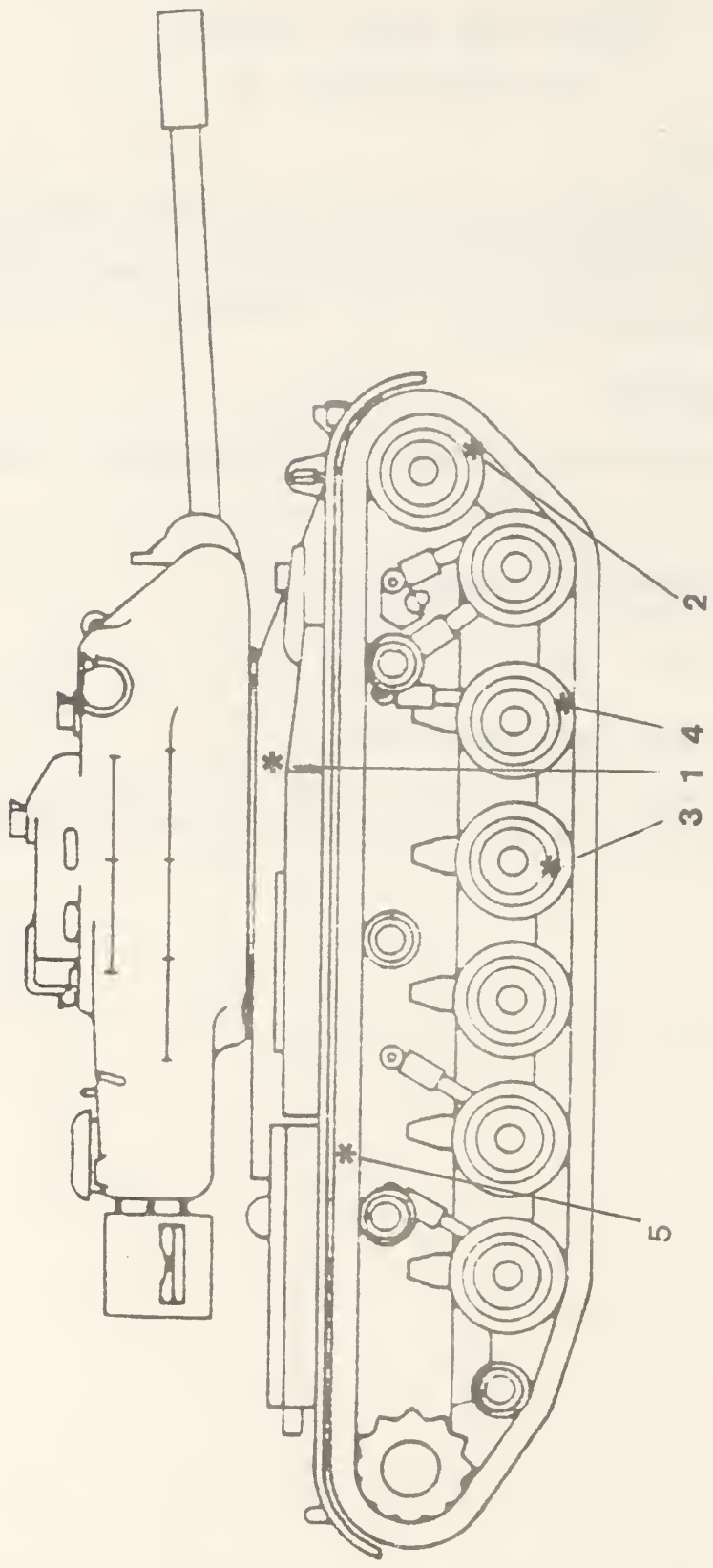


FIGURE 14. Locations of Impacts, Tank 30.

TARGET TANK DAMAGE SUMMARY

M-47 TANK NUMBER 47

1. Description:

The attacking A-10 aircraft achieved impacts on the tank from an attack aspect of 080 degrees during one pass initiated at low altitude and low dive angle. The A-10 expended 29 rounds during the firing pass.

2. Kill Assessment:

55% M-Kill and 65% F-Kill due to the following observed effects (Figure 15):

a.	Perforations	: 1
b.	Significant Impacts	: 0
c.	Insignificant Impacts	: 2
	TOTAL IMPACTS	: 3

3. Rationale for Kill Assessment:

a. M-Kill: A 55% M-Kill was assessed based solely on crew casualtes. Mobility was not impaired by mechanical damage and the tank could continue its mission after replacement of two crewmen.

b. F-Kill: A 65% F-Kill was assessed based solely on crew casualties from impact 2 which perforated the right turret and caused casualties to the commander, gunner, and loader. The damage to the commander manikin was judged not severe enough to warrant his evacuation.

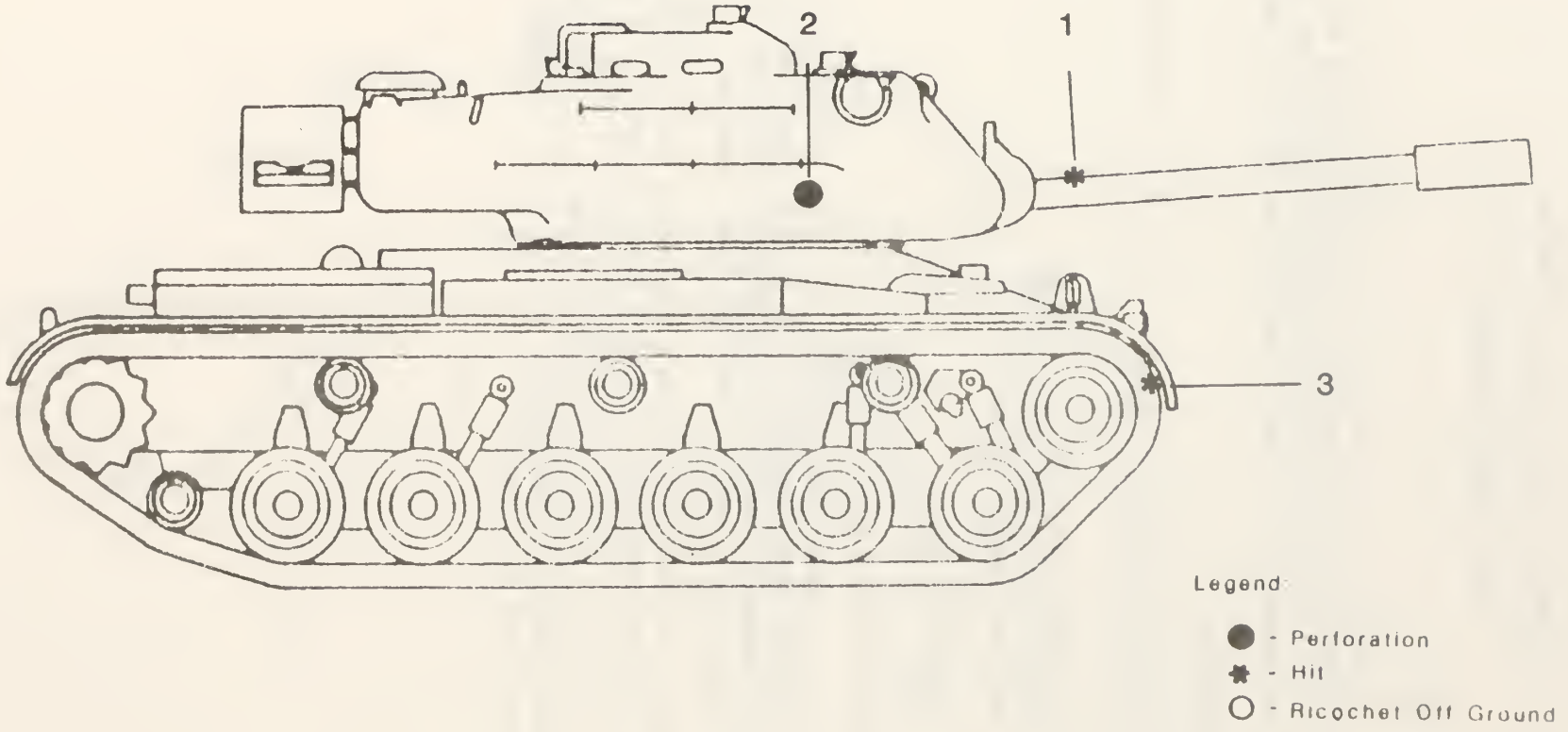


FIGURE 15. Locations of Impacts, Tank 47.

SUMMARY AND CONCLUSIONS

On 30 October, 1979, at Nellis AFB, Nevada, the Combat Damage Assessment Team (CDAT) conducted firings of the A-10/GAU-8 weapon system against an array of 10 tanks simulating a Soviet tank company deployed for an attack. The purpose of the firing test was to evaluate the effects of Aerojet lot number AJD 79A181-001 30mm API antitank ammunition for the GAU-8 gun under challenging conditions of engagement for the A-10/GAU-8 system against realistically simulated Soviet tank formations. The CDAT used M-47 tanks stowed with main gun ammunition, diesel fuel, lubricating oil, and crew manikins to simulate the Soviet tanks. The pilots of the two A-10 aircraft used in the firings conducted their attacks at low altitudes and low dive angles which simulated attack below the altitude of the effective engagement for opposing air defense systems using acquisition and fire control radar.

The firing test can be summarized in terms of the following data which were collected and/or extracted from the firings:

Aircraft Parameters

1. Open-fire Speed (average)-------- 574 feet/sec
2. Dive Angle (average)------------- 1.3 degrees
3. Open Fire Slant Range (average)-- 2731 feet
4. Burst Length/Rounds (averages)--- .69 sec/22 rds.
5. Number Passes (primary)---------- 13
6. Target Aspects (predominantly)--- Right Side

Weapon Effects		Target Damage	
1. Rounds Fired----------	289	1. K-Kills-------	0
2. Impacts---------------	98	2. M+F-Kills-----	2
3. Ricochets (off grnd)--	12	3. M-Kill--------	1
4. Direct Impacts--------	86	4. F-Kill--------	0
5. Perforation-----------	22	5. Hi% M+F-Kills-	3
		6. Negligible----	3

These data and the more detailed base from which they were extracted can be arranged into measures of effectiveness for the A-10/GAU-8 system under conditions similar to those in the firing test, i.e., empirical combat simulation. The following values of effectiveness are based on the firing test on 30 October, 1979:

Measures of Effectiveness

Accuracy Related Ratio:		Lethality Related Ratio:	
$\frac{\text{Total Impacts}}{\text{Rounds Fired}}$	=0.34	$\frac{\text{Perforations}}{\text{Total Impacts}}$	=0.22
$\frac{\text{Direct Impacts}}{\text{Rounds Fired}}$	= 0.30	$\frac{\text{Perforations}}{\text{Direct Impacts}}$	= 0.26

Weapon System Effectiveness Ratio:

$\frac{\text{Tank Immobilized}}{\text{Passes}}$	= 0.23	$\frac{\text{Tanks K-Killed}}{\text{Passes}}$	= 0.00

The ten target tanks were attacked predominately from the right side and suffered the severe damage shown in Table I and Table A-I.

The data and measures summarized above, and the other data contained in this report, support several conclusions:

1. The A-10/GAU-8 system in realistic simulation of combat is capable of inflicting M- and F-Kills on M-47 and similarly protected main battle tanks, e.g., Soviet T-55 and T-62 tanks.

2. The weapon system in low level attacks can perforate specifically the side surfaces of the hulls and turrets of M-47 and similarly protected main battle tanks.

3. The weapon system is an effective killing agent against the side surfaces of M-47 and similar tanks when firing moderate length bursts of 0.38-0.94 seconds, containing 11-31 rounds.

4. From the viewpoint of GAU-8 30mm API ammunition effects and resulting damage to combat stowed main battle tanks, the tactic of low level attack in this firing test was shown to be a succesful one.

APPENDIX A

Graphical and Summary Information

Table A-I contains a summary of the results achieved against array 21 on 30 October, 1979. Table A-II relates the assessment of damages in Table A-I to locations of perforations. Table A-III summarizes the Aircraft Attack Parameters Altitude, Attitude, Airspeed, Firing Slant Range and Burst length for each pass on each target. Figure A-1 relates aircraft attack aspect by tank number to burst length in feet.

TABLE A-I. Array 21 Results Summary
(30 October 1979)

Target Tank No.	Damage Assessment* (M%)	(F%)	(K%)	All Target Impacts	Direct Impacts	Rounds Fired	Total Perforations
33	100	100	-	17	17	60	5
38	65	95	-	12	12	25	2
34	100	100	-	14	14	29	7
39	-	-	-	16	8	22	3
28	MISSED			0	0	20	0
7	<5	-	-	7	5	24	0
41	100	95	-	21	19	25	3
48	90	95	-	3	3	31	1
30	-	-	-	5	5	24	0
47	55	65	-	3	3	29	1
TOTALS:				98	86	289	22

*K = Catastrophic Kill; M = Mobility Kill; F = Firepower Kill

TABLE A-II. Array 21 Perforation Location Summary
(30 October 1979)

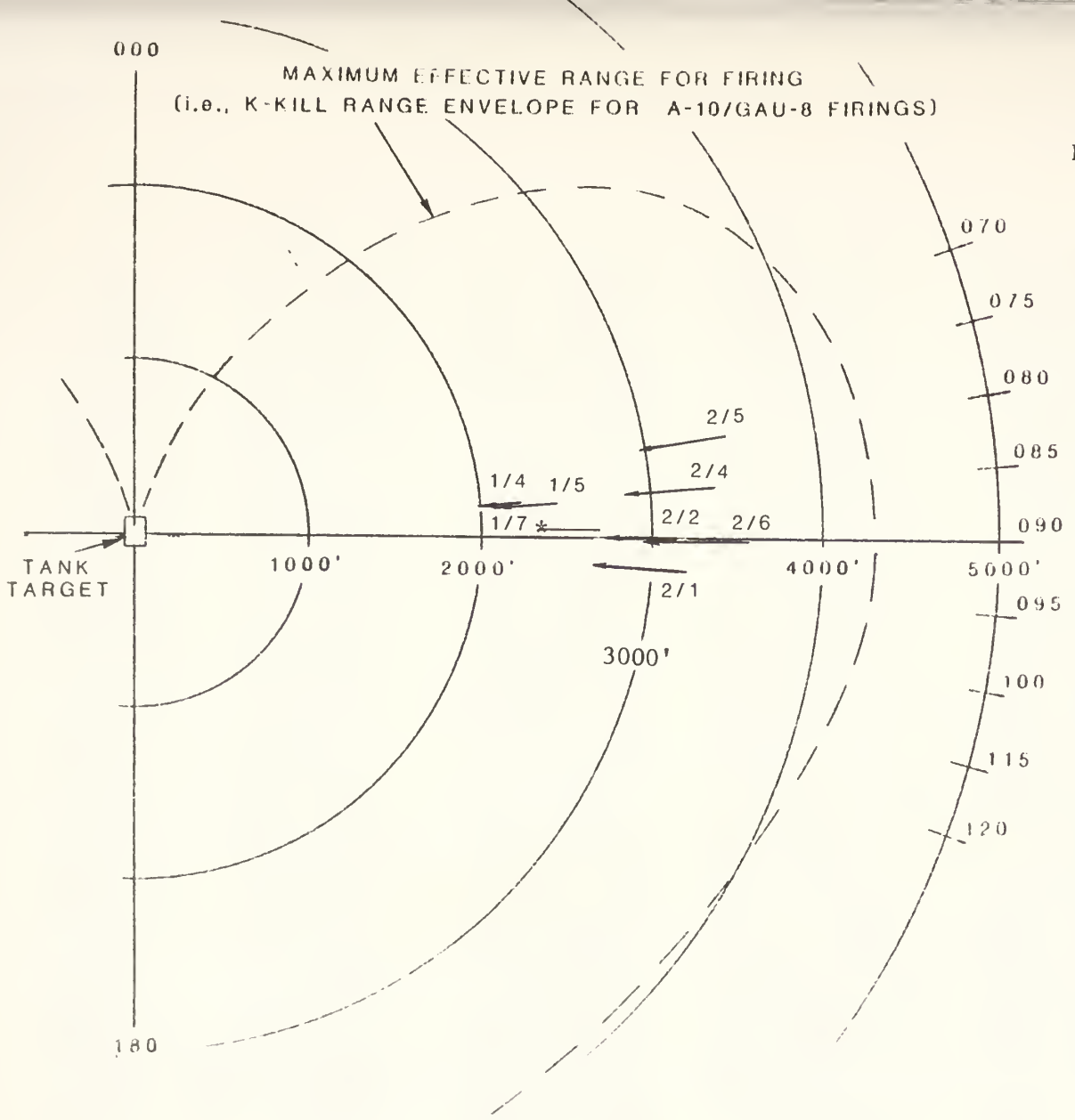
Target Tank	Damage Assessment* (M%)	(F%)	(K%)	Turret Perforations (Fighting Compt)	Hull Perforations: Fighting Compt	Drivers Compt	Engine Compt	Total Perforations
33	100	100	-	1	1	1	2	5
38	65	95	-	2	0	0	0	2
34	100	100	-	3	0	2	2	7
39	-	-	-	0	0	0	3	3
28	MISSED			0	0	0	0	0
7	<5	-	-	0	0	0	0	0
41	100	95	-	2	0	0	1	3
48	90	95	-	1	0	0	0	1
30	-	-	-	0	0	0	0	0
47	55	65	-	1	0	0	0	1
TOTALS:				10	1	3	8	22

*K = Catastrophic Kill; M = Mobility Kill; F = Firepower Kill

TABLE A-III. Array 21 Aircraft Attack Parameters
(30 October 1979)

Acft Pass *	Tank No.	Open Fire Slant Rng (feet)	Dive Angle Open/Cease (degrees)	Altitude (feet)	Velocity Open/Cease (ft/sec)	Burst Length (seconds)	Source
1/1	33	2344	-3/-2	463	584/593	.38	HUD
2/1	38	3118	0/0	363	584/579	.77	HUD
1/2	34	2334	-1/-1	383	564/564	.38	HUD
2/2	39	3105	0/0	363	574/571	.69	HUD
1/3	28	2272	-3/-3	433	573/576	.63	HUD
2/3	7	3255	0/0	363	579/576	.75	HUD
1/4	41	2272	-3/-3	463	576/576	.77	HUD
2/4	48	3392	0/0	363	574/576	.94	HUD
1/5	30	2487	-2/-2	413	581/576	.73	HUD
2/5	47	3460	0/0	363	573/576	.88	HUD
1/6	33	2120	-2/-3	413	557/562	.56	HUD
2/6	33	3528	0/0	383	589/584	.94	HUD
1/7	34	**	-3/-3	433	552/556	.56	HUD

*1/1 means pilot 1, pass 1, etc.
**Slant range uncertain
NOMINAL HUD FILM TOLERANCES:
SLANT RANGES: PLUS ZERO MINUS 150 FEET
DIVE ANGLES : PLUS OR MINUS 0.5 DEGREES
VELOCITIES : PLUS OR MINUS 5 KNOTS
BURST TIMES : PLUS ZERO MINUS 0.021 SECONDS



MISSION 21 ATTACK ASPECT SUMMARY
(30 OCTOBER 1979)

Pilot/Pass	Outer Range	Angle
2/1	3118	093
2/2	3105	090
1/4	2272	085
2/4	3392	085
1/5	2487	085
2/5	3460	080
2/6	3528	090
1/7	*	089

* Position Uncertain

NOTE: Passes 1/1, 1/2, 1/3 and 1/6 resulted in no hits, and are not depicted. Pass 2/3 attack aspect was not recorded and is not depicted.

FIGURE A-1. Mission 21 Attack Aspect Summary.

APPENDIX B

DEFINITIONS

The terms used in this report are defined below:

IMPACT -- Any evidence of a projectile strike against any portion of the target. Ground ricochets striking the target were classified as "impacts".

PERFORATION -- Any rupture of the armored envelope caused by an impacting projectile which results in a complete rupture of an armored surface by the projectile or spall fragments. A perforation can occur only when the armor is impacted. The word "Perforation" was deliberately selected to avoid the ambiquities which may occur through use of the word "penetration". Behind-the-plate effects may or may not result from a perforation.

HIT -- Any impact not classified as a perforation.

MOBILITY KILL (M-KILL) -- Loss of tactical mobility resulting from damage which cannot be repaired by the crew on the battlefield. A tank is considered to have sustained a 100% M-Kill when it is no longer capable of executing controlled movement on the battlefield. Mobility is DEGRADED when a tank can no longer maintain position in its formation.

FIREPOWER KILL (F-KILL) -- Loss of tactical firepower resulting from damage which cannot be repaired by the crew on the battlefield. A tank is considered to have sustained a 100% F-Kill when it is incapable of delivering controlled fire from its main armament. Firepower is DEGRADED when a tank can no longer maintain its "normal" rate-of-fire, velocity, accuracy, time to shift targets, etc.

CATASTROPHIC KILL (K-KILL) -- A tank is considered to have sustained a K-Kill when both an M-Kill and a F-Kill have occurred as the result of killing fires and explosions from ignited fuel and/or ammunition. A tank which has suffered a K-Kill is considered not to be economically repairable, and, by U.S. standards, would be abandoned on the battlefield.

ATTACK ASPECT -- The angle of approach of the aircraft with respect to the orientation of the tank with zero degrees representing the front of the tank (gun forward) and 180 degrees representing the rear of the tank.

SIGNIFICANT IMPACTS -- Impacts which damage systems, components or sub-systems resulting in their destruction or partial loss of function. This type damage contributes to the assessed kill.

INSIGNIFICANT IMPACTS -- Impacts which damage non-critical structural, convenience, or accessory components and which may result in their destruction or partial loss of function, but with no impact on mobility or firepower considerations. Good maintenance practices necessitate repair or replacement of such items at the earliest opportunity consistent with accomplishment of the mission.

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