1.4.2

To compare the performance of the S-Tank with existing tank systems.

1.4.3

To evaluate the effects of mobility, agility, and silhouette on tank survivability.

1.5 (U) SCOPE AND TACTICAL CONTEXT

1.5.1

The evaluation of the Swedish S-Tank was conducted by the US Army Armor and Engineer Board at Fort Knox, Kentucky, under prevailing intermediate climatic conditions during the period 16 July 1975 to 28 February 1976 utilizing the approved test plan (ref 2, app C). The minimum and maximum temperatures during the period were 5° and 93° Fahrenheit, respectively. Two M60A1 (with add-on stabilizer (AOS)) tanks were operated and fired concurrently with the test vehicles for direct comparison of capabilities during selected mobility, survivability, and functional field testing exercises. Two M60A1E3 tanks were evaluated during selected portions of the test. Test personnel were instructed in and followed all safety precautions in the equipment publications, or other pertinent documents during the conduct of the test.

1.5.2

Testing performed included: Vehicle characteristics; Fort Knox Armored Reconnaisance Scout Vehicle (ARSV) Force Development Testing and Experiment (FDTE) Mobility Course; various other mobility testing (acceleration and speed runs, tractive effort, vertical obstacle, crew ride, etc.); live fire exercises; gun camera target engagement and tracking exercises; human factors evaluation; and survivability and silhouette experiments.

1.5.3

Training of the S-Tank crews was conducted at Fort Knox by two Swedish Army officers. A total of 7 weeks' training with seven three-man crews was performed. Driving, crew maintenance, battle drill, and live firing were stressed in the course. Each crewmember was tested at the end of training to evaluate his performance as an S-Tank crewmember. Training of the US crews for the M60A1 (AOS) and M60A1E3 tanks was conducted concurrently by qualified Armor School personnel. Training for drivers of other test vehicles was conducted by representatives of the organization which provided the vehicles.

Army Tank Systems and were used to provide inputs to the Army Mobility Model, the Tank Exchange Model (TXM), and the Dynamic Tactical Simulation Model (DYNTACS). These models will be utilized to provide a systematic overall evaluation of the S-Tank. The results from these models will be available in the second partial and final report.

1.5.8.1 The Army Mobility Model will be used to rank the S-Tank's maximum cross-country speed along given paths against the performance of other tanks and scout vehicles. This model only examines vehicle mobility. Results from the ARSV FDTE courses will be used to help validate the model. Model inputs will include vehicle dimensions and characteristics, and selected terrain characterization. Model output will be maximum cross-country speed achievable along a given terrain segment.

1.5.8.2 The TXM will be used to compare the S-Tank's performance against other tanks and antitank weapons in a force-on-force environment. Inputs to the model include vehicle characteristics, vulnerability, weapons firing systems, etc. Tactics and terrain are of minor importance in this model. Outputs will be expressed in terms of kill/loss ratios, kills per rounds fired, etc.

1.5.8.3 DYNTACS is a high resolution force-on-force simulation. It is similar in input/output to TXM, except that it is much more detailed in certain areas (especially tactics, terrain, and dynamic route selection).

1.5.9

Test reports are being submitted in two phases. This report is the first partial report and includes the results from the following subtests: Abbreviated test of vehicle characteristics; speed of lay; hitting performance; limited human factors evaluation; limited reliability/maintainability; safety; FDTE mobility course; and limited data available from the survivability and silhouette experiments. The second report (second partial/final) is to be submitted later in 1977 and will complete the reporting of the results of all testing and analysis, to include: US Army Ballistic Research Laboratories (USABRL) report on vulnerability; survivability analysis; silhouette analysis; intervisibility analysis; results from the Army Mobility Model; the TXM and DYNTACS simulations; the results of the gunner's aim performance against silhouette; and US Army Human Engineering Laboratory (USAHEL) report on human factors evaluation.

1.5.10

The scope of the test and the S-Tank areas of interest required that the USAARENBD obtain support from a number of additional agencies. Support roles included:

1.6.4.2 The smaller silhouette of the S-Tank leads to a lower probability of hit, using either accurate ranging or battlesight techniques when compared to a larger silhouette vehicle, such as the M60A1. Using accurate ranging techniques, the difference in the hit probabilities against the two silhouettes is much larger for the closer ranges with the vehicles masked. Against a full silhouette and using accurate ranging, the differences are smaller but fairly constant over a large range band. With battlesight, the difference increases as the accuracy of the firing system increases. Against targets as small or smaller than the front silhouette of the S-Tank, HEAT battlesight gives a higher P_H than APDS battlesight up to approximately 1,000 meters, but over 1,250 meters, HEAT battlesight is almost totally ineffective. (See para 2.10.4, chapter 2.)

1.7 (C) CONCLUSIONS (U)

1.7.1 (U) Characteristics of the S-Tank

1.7.1.1 A modern turretless tank does not necessarily mean a gun fixed in elevation. Today it is technically feasible to build a fire-on-the-move capability, as evidenced by the German VT 1-1 test bed.

1.7.1.2 The training required to obtain the skill level to effectively operate the "simple" (i.e., the current S-Tank) fire control system (that which contains relatively few crew tasks) is much greater than the training required on a "complicated" fire control system (that which requires more, but easier crew tasks).

1.7.1.3 No decrease in firing accuracy accrues inherently from the turretless tank, although there is an inherent slowness in time-to-fire with the turretless S-Tank when operating from the stationary mode.

1.7.1.4 The S-Tank exhibits relatively high main gun throwoff values as compared to the M60 series tanks.

1.7.1.5 Crew space requirements are reduced dramatically in the turretless tank, and targets can be engaged without a fire command or target handoff.

1.7.1.6 The crewmen better perceive the total essence of their fighting system.

1.7.1.7 A turretless tank or a tank equipped with an automatic loader has the potential to be crewed by less than four men. Nevertheless, four men per tank are required in the organization for sustained operations.

1.7.1.8 A major problem of the S-Tank is the lack of an engine-off capability during defensive operations.

(9) Smoke Ejector System. The S-Tank is equipped with a cupola mounted smoke ejector system. The system has eight tubes, but fire(s) only four white phosphorous smoke grenades on a single shot. During the test a total of 12 grenades (three shots) were fired and one of the 12 grenades did not explode. The average range from the tank to the center of smoke source was approximately 25 meters; time from launch to initial smoke emission was 2.0 seconds; time from launch to minimum cover smoke buildup was 2.4 seconds; and grenade burst height was ground level. (See photo, pages A-11 through A-14, part 1, app A.)

2.1.3.4 Analysis

a. The rates of traverse response for the S-Tank when operating from a nonforward moving aspect are slower than those of the M60A1, both from a standing nonrotating start and from a standing maximum traversing rate start. It should be noted, however, that when the S-Tank traverses while moving forward, a 180° spin can be accomplished in 2-3 seconds by use of the clutch-brake system.

b. The fixed gun on the S-Tank provides several desirable features:

(1) Lower silhouette due to the elimination of the turret.

(2) Allows the attachment of an automatic loader which in turn eliminates the need of a loader and also increases the rate of fire capability. This also contributes to silhouette reduction by decreasing interior space needed for a fourth crewman, and for gun elevation or depression movement.

(3) Eliminates difficulty in sealing turret ring for NBC protection.

(4) The compartmentalization of the crew and main gun magazines in the S-Tank does not decrease crew vulnerability to secondary explosions. However, the potential exists in this or other turretless tanks to increase the size of the separating bulkhead to protect the crew from ammunition explosions.

(5) Integrated driving and main gun controls which combine and simplify crewman tasks.

c. The significant drawback of the fixed guns is the inability to fire on the move.

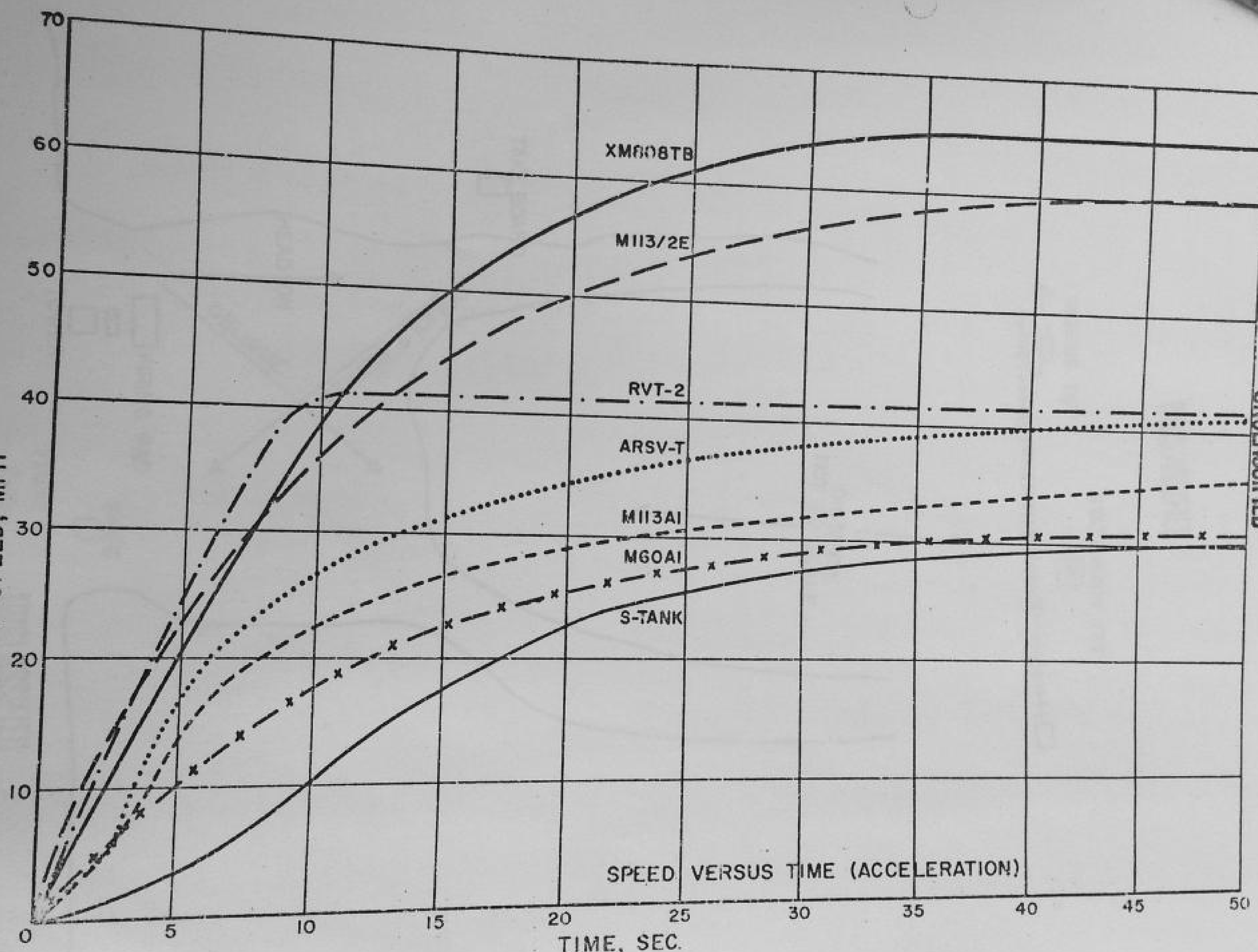

Figure 4

U-BILAGA 11

U-BILAGA 12.

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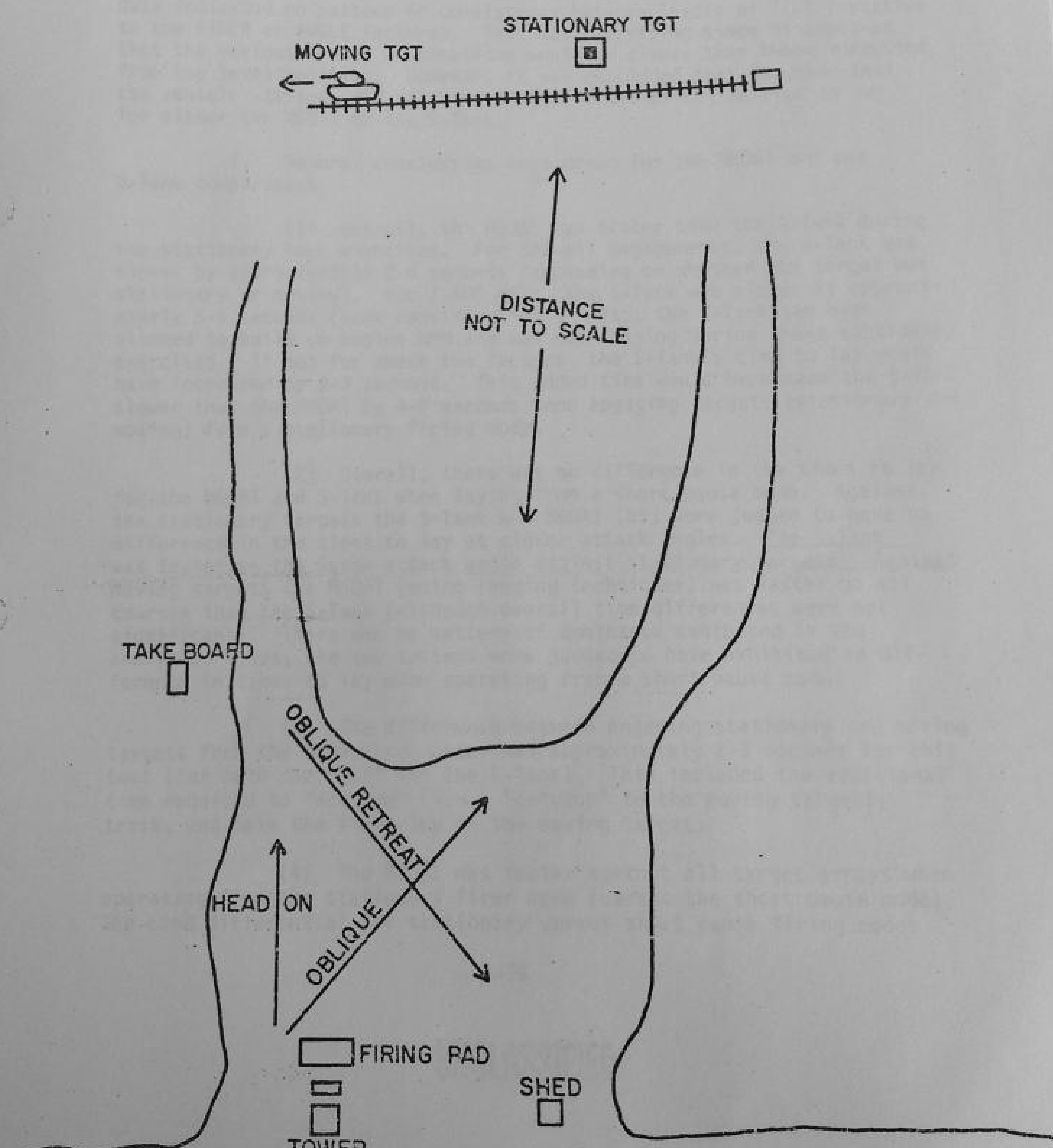

FIGURE 5

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The positive slopes indicate the time increase necessary to lay on a target when beginning the lay from greater attack angles. The difference between the two lines indicates the time difference experienced when engaging a stationary versus a moving target.

e. For the stationary tank exercises, the firers were required to lay on the target from various tilted positions (factor TILT). The data indicated no pattern or consistency between levels of TILT (relative to the FIRER or ANGLE factors). This was surprising since it appeared that the various canted combinations would be slower than those conducted from the level position. However, it was concluded that for this test the vehicle attitude did not have a significant effect on time to lay for either the M60A1 or the S-Tank.

f. Several conclusions were drawn for the M60A1 and the S-Tank comparisons.

(1) Overall, the M60A1 was faster than the S-Tank during the stationary tank exercises. For 540-mil engagements, the S-Tank was slower by approximately 2-4 seconds (depending on whether the target was stationary or moving). For 1,600 mils, the S-Tank was slower by approximately 5-6 seconds (same consideration). Also, the S-Tank had been allowed to build up engine RPM and was not ranging during these stationary exercises. If not for these two factors, the S-Tank's time to lay would have increased by 2-3 seconds. This added time would have made the S-Tank slower than the M60A1 by 4-9 seconds when engaging targets (stationary and moving) from a stationary firing mode.

(2) Overall, there was no difference in the times to lay for the M60A1 and S-Tank when laying from a short pause mode. Against the stationary targets the S-Tank and M60A1 (bs) were judged to have no difference in the times to lay at closer attack angles. The S-Tank was faster on the large attack angle against stationary targets. Against moving targets the M60A1 (using ranging techniques) was faster on all courses than the S-Tank (although overall time differences were not significant). There was no pattern of dominance exhibited in the analysis. Thus, the two systems were judged to have exhibited no difference in times to lay when operating from a short pause mode.

(3) The difference between engaging stationary and moving targets from the same firer modes was approximately 2-3 seconds for this test (for both the M60A1 and the S-Tank). This included the additional time required to "acquire" (i.e., "catchup" to the moving target), track, and make the final lay on the moving target.

(4) The M60A1 was faster against all target arrays when operating from the stationary firer mode (versus the short pause mode). The time differential for stationary versus short pause firing modes

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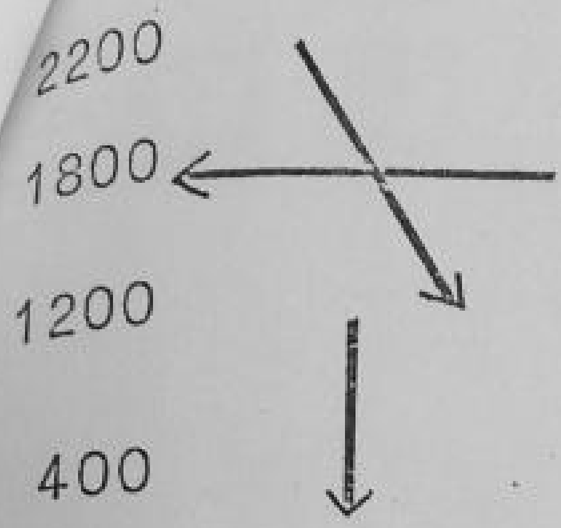
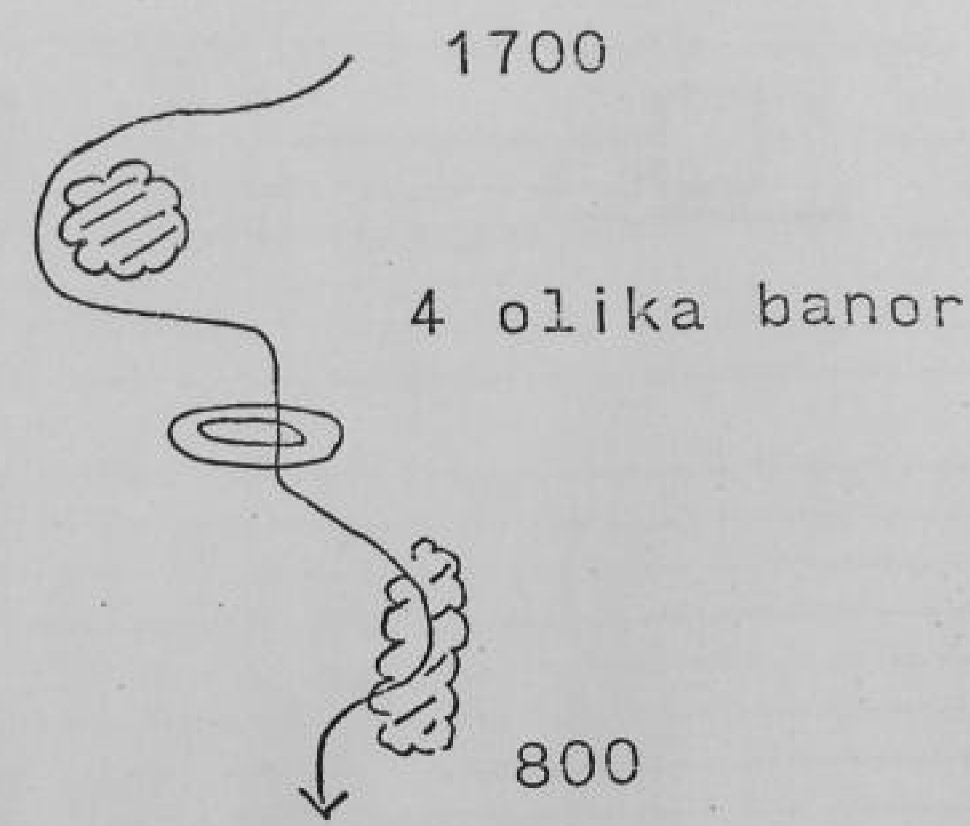
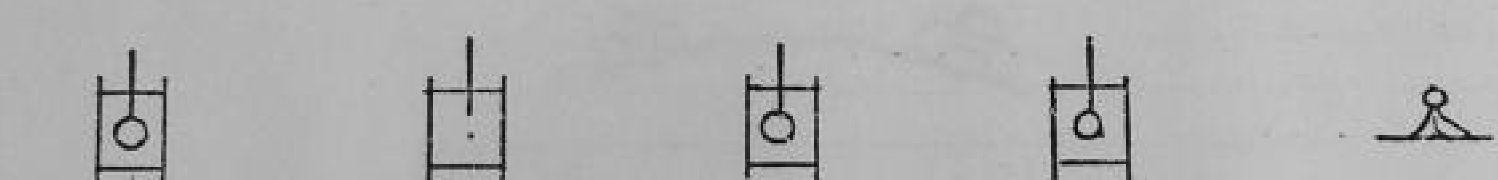




Konstant hast
Max hast
Rakt fram
Sinuskurs
Tvärkast
Fri väg

Målfordon

Strv 103
Strv M 60
Pbv M 113
RVT 2
ARSV
Twister



Ai	Stridss	Laser	Stridss	Avstånd
Bedömt	Bedömt	Ffber	Bedömt	Hast/Ff

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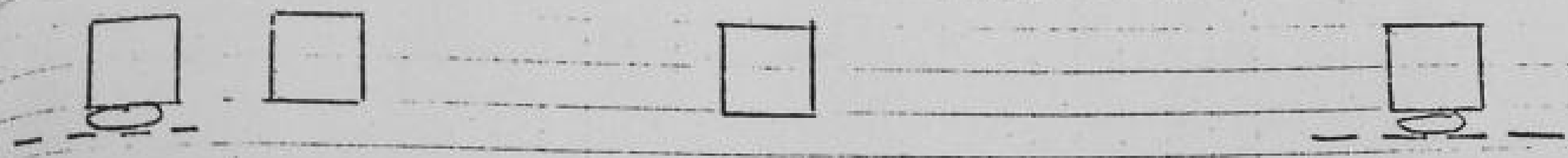
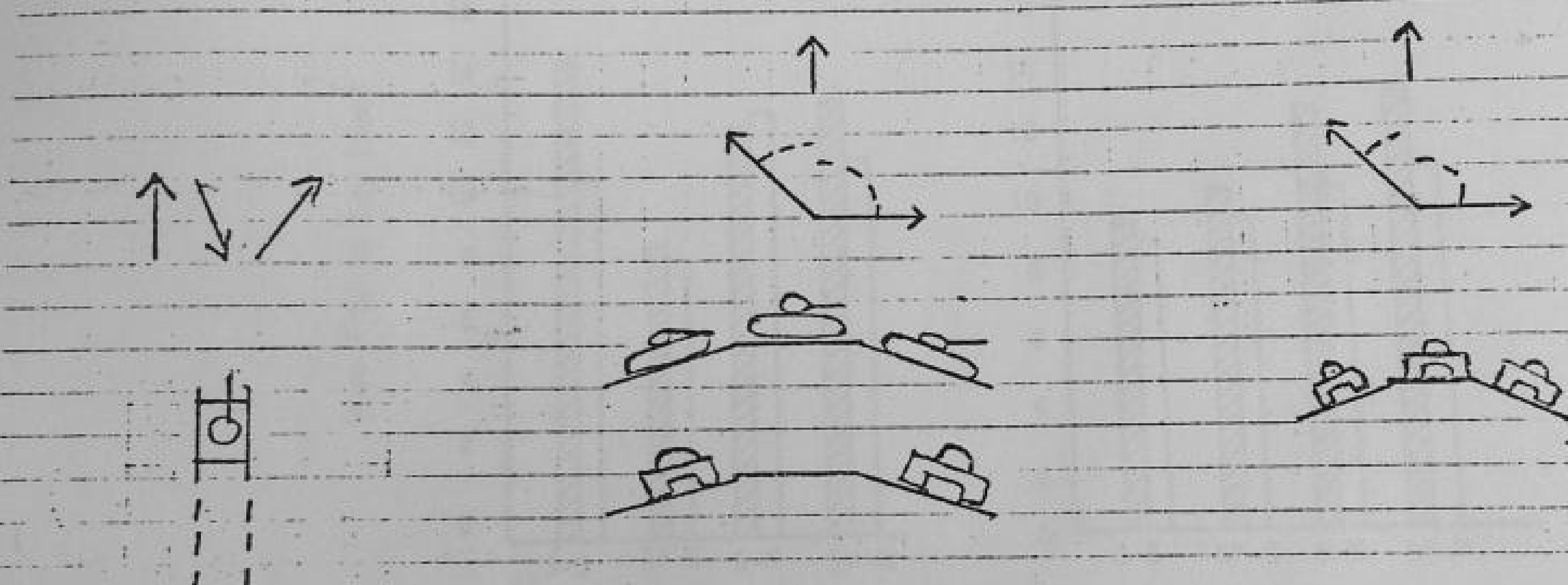
(Kameraskjutning)





Resultat: Tider i sek

Vagn	Mål	Strv 103	Strv M 60
Stilla	Stilla	14,4	11,4
Stilla	Rörlig	16,1	10,9
Rörlig	Rörlig	13,4	11,6
Rörlig	Stilla	10,2	10,6

U-BILAGA 16.

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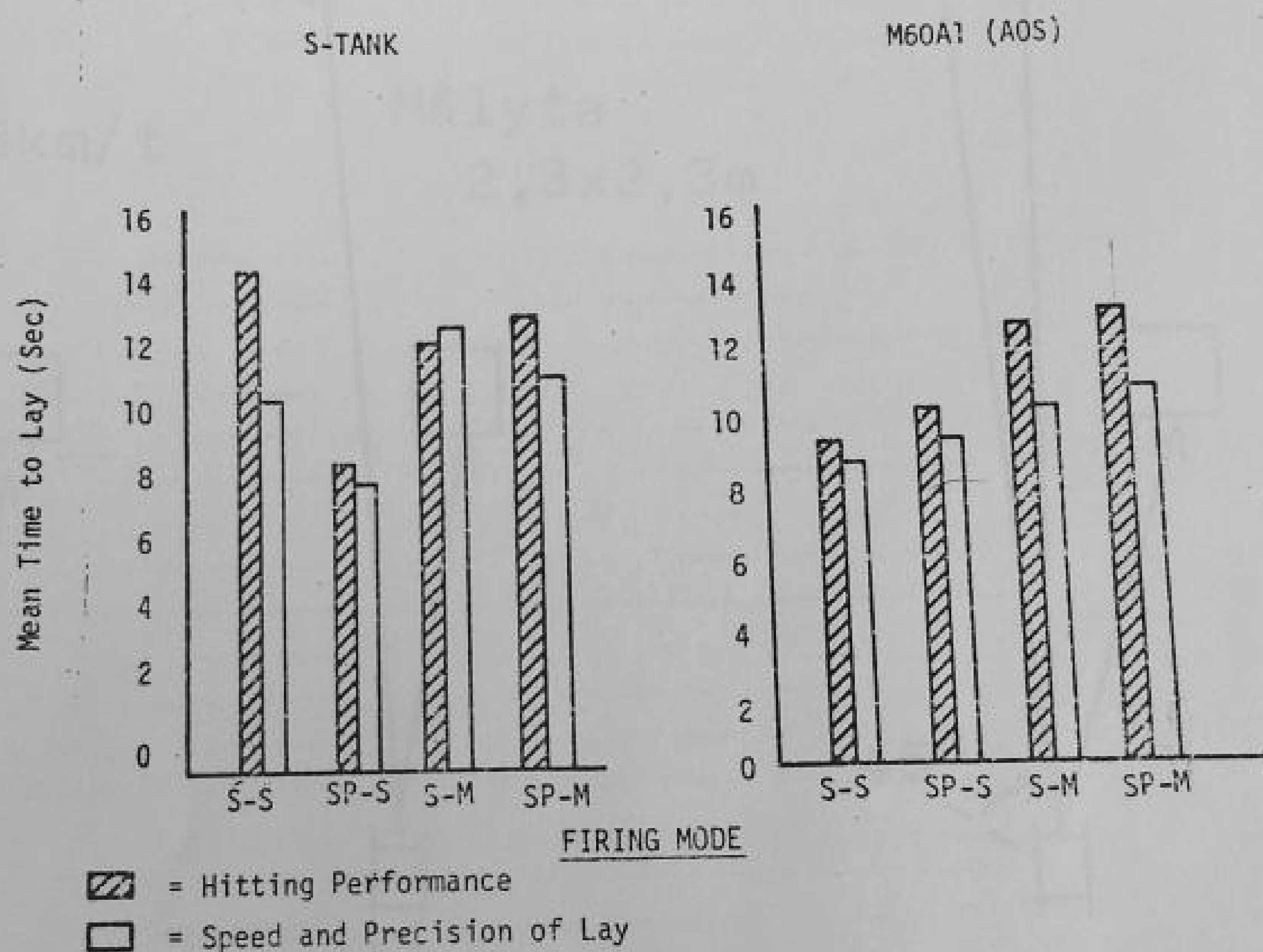

Key:

S-S is stationary firer - stationary target

SP-S is short pause firer - stationary target

S-M is stationary firer - moving target

SP-M is short pause firer - moving target

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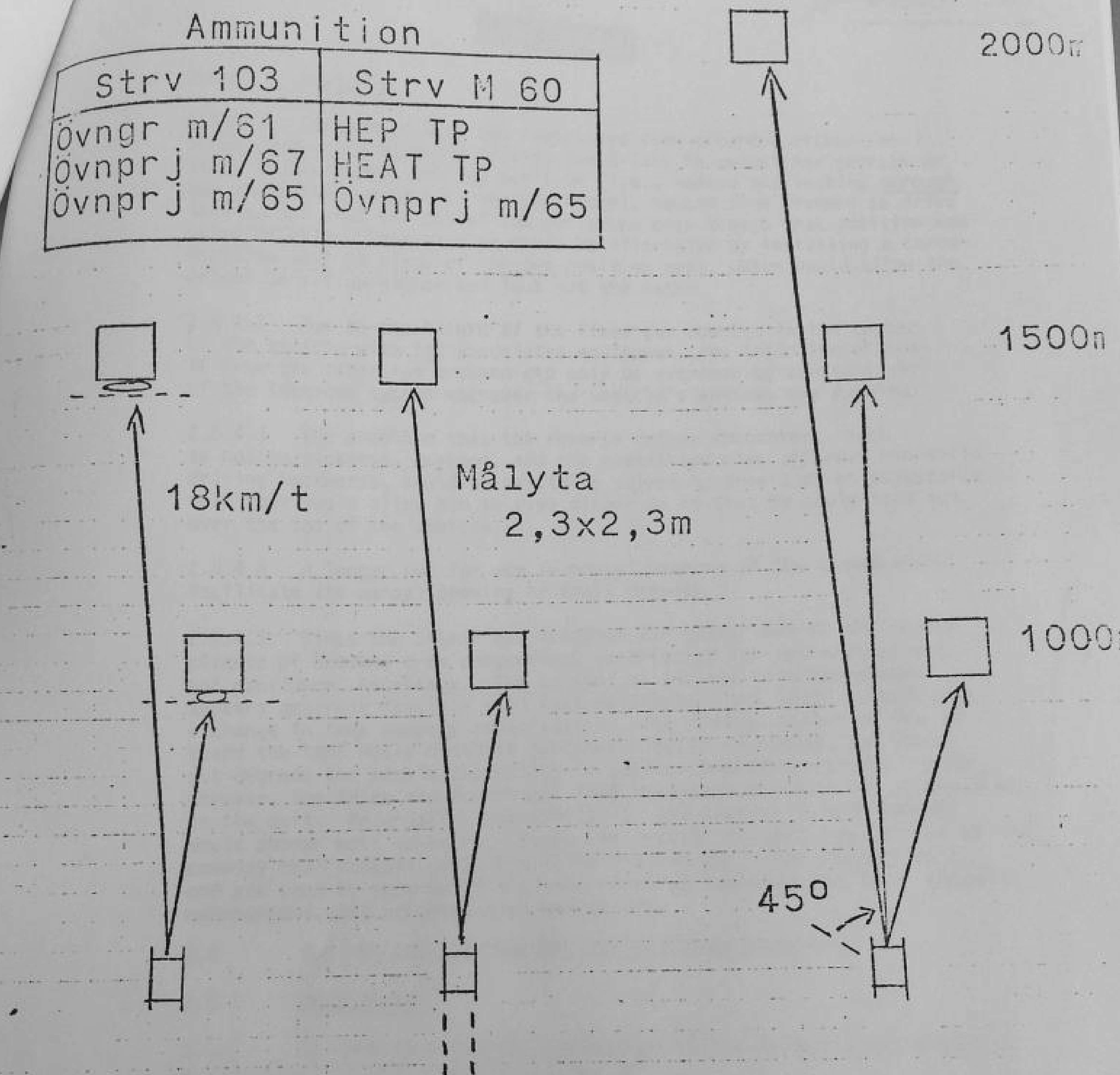
Ammunition

Strv 103	Strv M 60
Övngr m/61	HEP TP
Övnprj m/67	HEAT TP
Övnprj m/65	Övnprj m/65



Genomsnitt: 9 prov x 9 skott x 5 skyttar

Resultat sammanlagt

Vagn	Antal skott	T %	Tid till skott(s)
Strv 103	395	77	13,1
Strv M 60	399	72	12,7

2.5.4 Analysis

2.5.4.1 It appears that the restricted view afforded either the gunner/driver or TC while driving the S-Tank in unfamiliar terrain or areas in the normal driving position (i.e., seated and looking through the unity power window of the periscope), caused some crewmen to drive looking out over the top of the periscope even though that position was uncomfortable. This problem could be alleviated by installing a three-position seat in place of the two-position seat, which would allow the driver to sit up higher and look out the hatch.

2.5.4.2 Due to the nature of the fixed gun mounted in the center of the vehicle with its associated equipment, the isolation of the TC from the other two crewmen can only be overcome by constant use of the intercom system whenever the vehicle's engines are running.

2.5.4.3 The problems that the reverse driver encounters, such as motion sickness, boredom, and the restricted view afforded him while driving backwards, could be partially solved by providing an adjustable seat that would allow him to ride higher up so that he could look out over the top of the vehicle.

2.5.4.4 A longer rod for use in manual opening of the breech would facilitate its manual opening by small crewmen.

2.5.4.5 Since the S-Tank was designed for operations in the cooler climate of Sweden, crew compartment ventilation for hot weather was not considered necessary. The concept of two-man crew operations appears entirely feasible - in fact desirable - but would necessitate a change in tank company organization. The reduced number of men on board the tank would minimize personnel losses in combat, and would not degrade the tank's capability to perform immediate tactical tasks. However, the third and fourth man from each tank would still be required in the unit. An organization similar to the Swedish S-Tank Company would appear most workable. There the "extra" crewmen are carried at the company rear command post, are fully trained as filler replacements, and are used to supplement the tank crews as required for local security, maintenance, and extended time operations.

2.6 (U) RELIABILITY/MAINTAINABILITY EVALUATION

2.6.1 Objectives

2.6.1.1 To perform a limited evaluation of the S-Tank's reliability/maintainability (RM) characteristics by:

a. Comparing the limited operational data collected during this test with that furnished by the Swedish and United Kingdom Governments in order to establish comparability of the data. (Swedish and United Kingdom data were not available as previously planned.)

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b. Because mileage accumulation was minimized on the two S-Tanks throughout Fort Knox testing, and because of the small sample size of two vehicles, no attempt is made in this report to classify the 18 failures as either random or repetitive/characteristic.

c. The number of failures recorded (para 2.6.3.1b) during the accumulation of 1,405 km is not indicative of the actual durability, reliability of the tank. Both vehicle powerplants were in operation 5-8 hours a day throughout the test period with the tank being utilized in a static position elevating, depressing, tracking, etc. During the conduct of cross-country mobility testing, no suspension failures were noted nor tracks thrown on either vehicle. Collective opinion of test personnel was that the S-Tank is reliable. Two exceptions to this assessment were noted: A pattern emerged of engine and transmission oil servo valve failures; and of hydraulic O ring failures beneath the powerpack.

2.6.4.2 Maintainability

a. The following formulas and computations are used to present the maintainability characteristics of the test vehicles:

(1) Mean-time-to-repair-failures = MTTRf

$$MTTRf = \frac{\text{Corrective (unscheduled) maintenance time}}{\text{Total number of failures}}$$

(2) Mean-time-to-repair-malfunctions = MTTRm

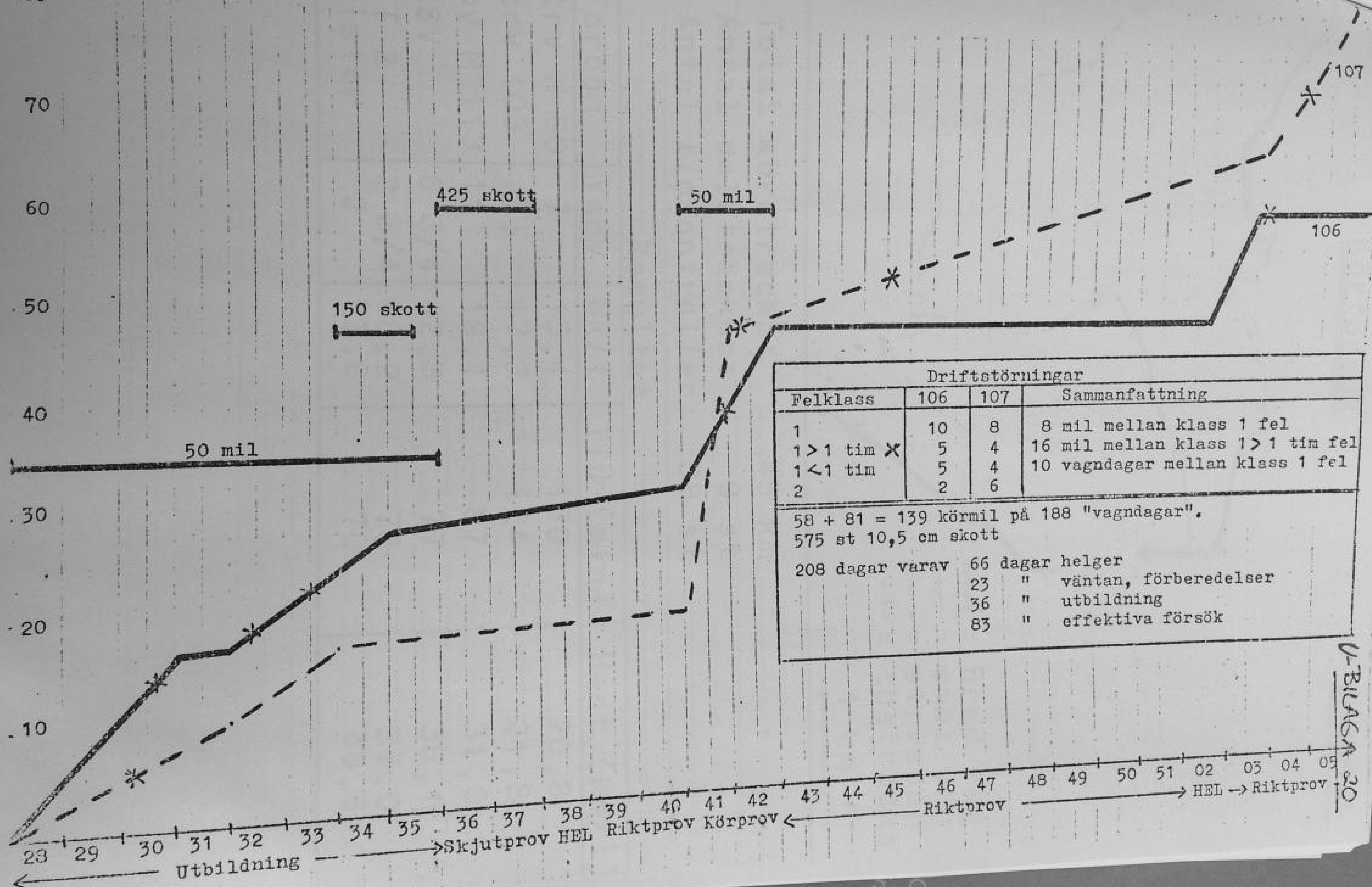
$$MTTRm = \frac{\text{Corrective (unscheduled) maintenance time}}{\text{Total number of malfunctions which required corrective actions}}$$

(3) Mean-active-maintenance-down-time = $\overline{M}$

$$\overline{M} = \frac{\text{Total active maintenance time (CH)}}{\text{Total maintenance actions}}$$

	BD 106	BD 107	Total
MTTRf	$\frac{31.8}{8}$ = 3.98 CH	$\frac{37.10}{10}$ = 3.71 CH	$\frac{68.90}{18}$ = 3.83 CH
MTTRm	$\frac{50.30}{12}$ = 4.19 CH	$\frac{37.30}{11}$ = 3.39 CH	$\frac{87.60}{23}$ = 3.81 CH
$\overline{M}$	$\frac{50.30}{12}$ = 4.19 CH	$\frac{37.30}{11}$ = 3.39 CH	$\frac{87.60}{23}$ = 3.81 CH

STISTIK FRÅN STRV 103 FÖRSÖKEN I US 75 – 76



Driftstörningar			
Felklass	106	107	Sammanfattning
1	10	8	8 mil mellan klass 1 fel
1>1 tim ✕	5	4	16 mil mellan klass 1>1 tim fel
1<1 tim	5	4	10 vagndagar mellan klass 1 fel
2	2	6	

58 + 81 = 139 körmil på 188 "vagndagar".
575 st 10,5 cm skott

208 dagar varav 66 dagar helger
23 " väntan, förberedelser
36 " utbildning
83 " effektiva försök

Körförsök

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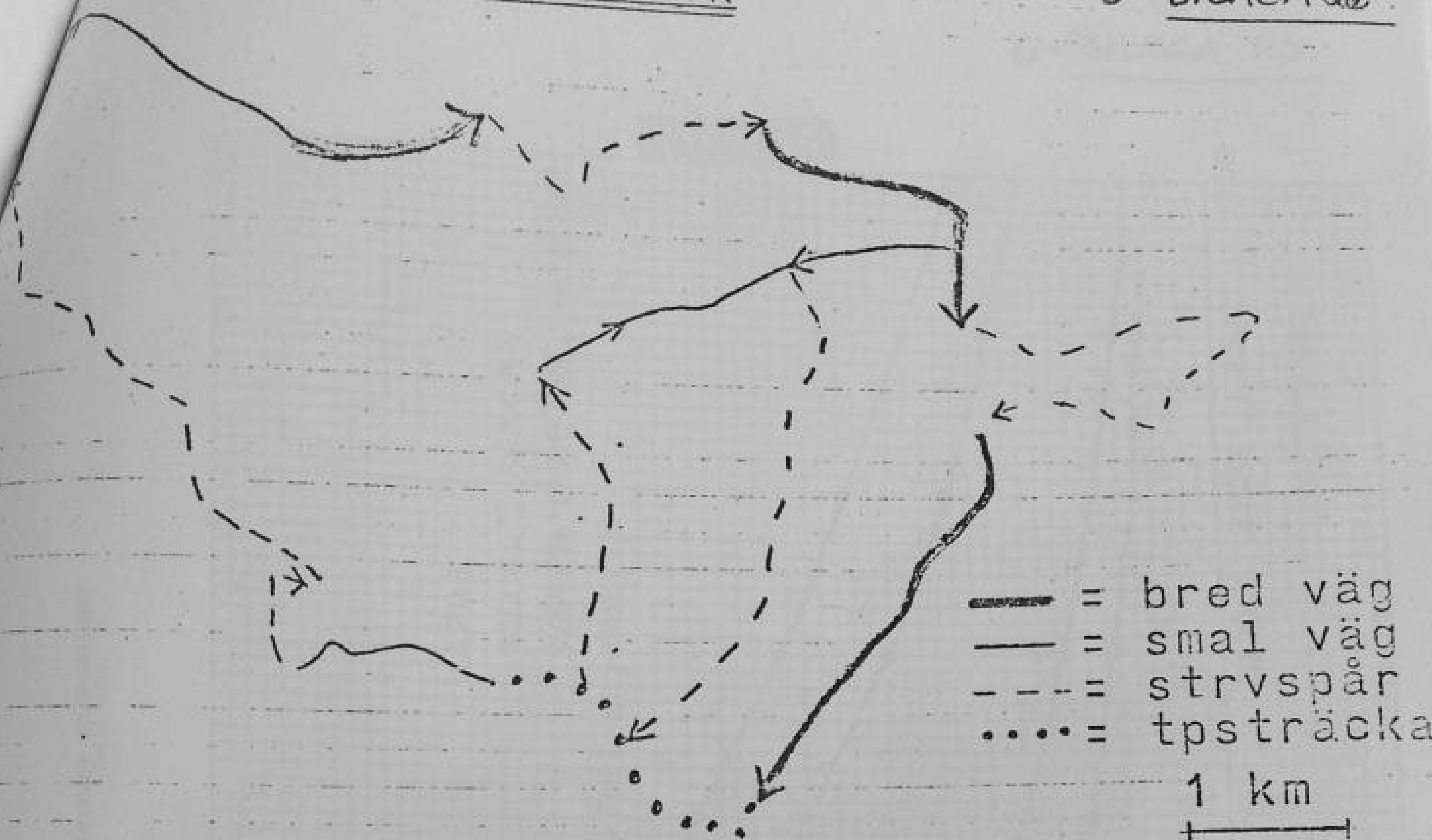

Total körsträcka: 45 km
Antal delsträckor: 9 st
Antal tidkontroller: 38 st

Resultat

Fordon	Varv	Hk/t	Tid (min)	Hast (km/t)
Strv M 60	7	15,4	130	20,8
Strv 103	8½	17,3	124	21,8
Pbv M 113	11	19,4	87	31,0
ARSV	6 3/4	42,3	77	35,1
RVT 2	2 3/4	68,2	73	37,0
Twister	2	73,6	70	38,6

2-123

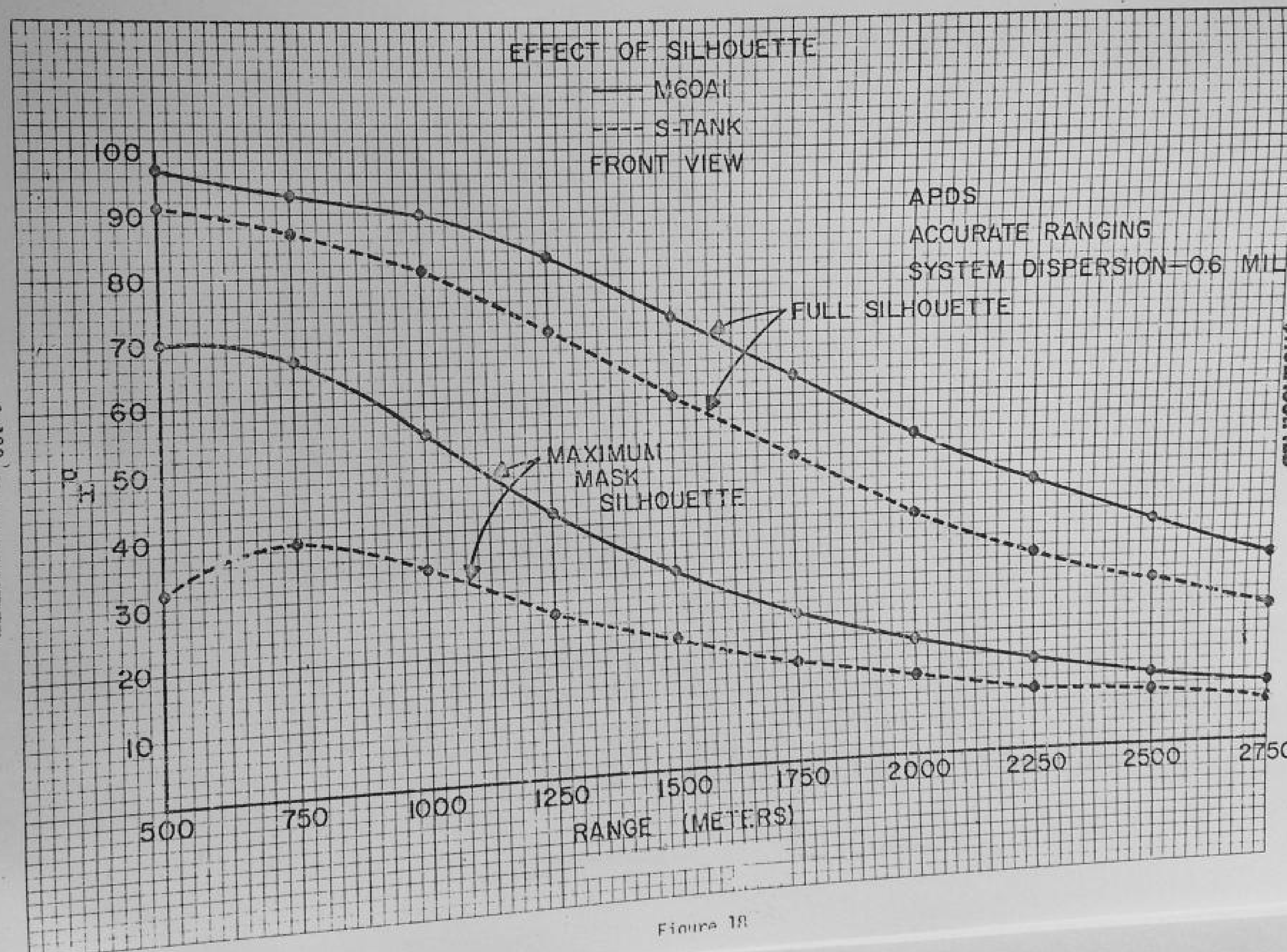

Figure 18

U-BILAGA 23.

b. For a computer printout listing of the results, see part 10, app A.

2.10.3.7 A comparison of APDS vs HEAT against the S-Tank and M60A1 silhouettes, using accurate ranging, reveals no difference in the P_H for similar system dispersion ratios. For other than system dispersion, the only major difference between the two ammunitions is the APDS drift, which is approximately 0.11 mil. For similar system dispersions, this drift is not enough to significantly affect the P_H at ranges less than 3,000 meters. See part 10, app A, for the computer printout listing of the results.

2.10.4 Analysis

2.10.4.1 The first comparison between the S-Tank and M60A1 was against the fully exposed and maximum masked silhouettes utilizing accurate ranging techniques. The S-Tank's silhouette degraded the hit probabilities against it at all ranges.

a. The full front silhouette of the S-Tank is approximately 25 percent lower in height and 28 percent smaller in overall area than the M60A1. This results in a maximum of 14 percent reduction in hit probability at 1,500 meters, with decreasing differences at closer and farther ranges. (See full silhouette APDS-Accurate Ranging, para 2.10.3.3a.) Hit probabilities on either tank are relatively high, with probabilities on the order of 40-50 percent at 2,000 meters. It should be noted that the results are based on 0.6 mil overall system dispersion. A higher, or lower system dispersion factor will change only the magnitude of the hit probabilities against each silhouette, but will not significantly alter the ratio of the differences.

b. When the front silhouettes are masked to the maximum allowable (yet still able to fire), the differences between the S-Tank and M60A1 significantly increase from the P_H of the full front silhouette. At 750 meters the S-Tank has a 28 percent less chance of being hit. (See maximum Masked Silhouette APDS-Accurate Ranging, para 2.10.3.3a.) At the full masked positions, the S-Tank presents a 24 percent lower (height) target, but a 35 percent smaller (area) target. As the range increases, the difference between the S-Tank and M60A1 falls off to 3 percent for 2,500 meters. The magnitude of the hit probabilities must be kept in view, in that the P_H of M60A1 starts at 70 percent (at 500m) and falls below 50 percent at about 1,100 meters, whereas the P_H for the S-Tank never rises above 39 percent (at 750 meters).

c. Against the full silhouette, the largest differences (8-14 percent) in the two silhouettes' hit probabilities occur at