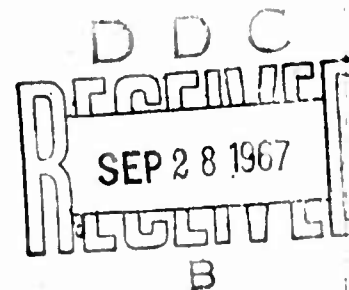


ARMORED MEDICAL RESEARCH LABORATORY  
Fort Knox, Kentucky



Project No. 45  
SPMEA 724-41

28 February 1945

AD 658593

1. PROJECT: No. 45 - Physiological and Operational Characteristics of T26E3 Tank. First Partial Report.

a. Authority: 2nd Ind. by Office of The Surgeon General to letter, Office of Chief of Ordnance, Washington, D. C. File 00470.8/1442 SPCTT dated 14 June 1944. Subject: Service Test of Medium Tank T25E1 and T26E3 by Armored Medical Research Laboratory

b. Purpose: To appraise the T26E3 tank as to its physiological characteristics, with special reference to crew efficiency and comfort, effectiveness of fire control, provision for general vision and ventilation.

2. DISCUSSION:

a. This report considers the characteristics of the T26E3 tank only from the standpoint of recommendations for change in the following stages:

- (1) Changes immediately necessary in current production vehicles.
- (2) Changes of sufficient importance to be introduced at the earliest practicable date, including minor changes which can readily be incorporated without retarding production.

b. This preliminary report will not enter upon considerations which are regarded as fundamental to the major design characteristics of the vehicle, such as stowage and flow of ammunition and service of the piece, which will be taken up later in a final report.

c. The recommendations of the present report are considered in detail in the Appendix.

3. RECOMMENDATIONS:

a. That the following essential changes and improvements be initiated immediately:

- (1) Improve and replace as much of the elevating mechanism as is necessary to secure easy and positive control.
- (2) Improve performance of traverse mechanism to reduce lost motion, over-run and slip in the manual traverse control and to eliminate excessive lost motion in the power traverse control.

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- (3) Change hull casting to permit field installation of 1000 cfm fan and provide adapter to support present fan for interim use.

b. That the following changes be made as quickly as possible in accordance with production schedules;

#### I. FIRE CONTROL

- a. (1) Finger firing for the main weapon on the elevating handwheel.
  - (2) Finger firing for the coaxial machine gun on the power traverse control handle.
  - (3) A foot rest hung from the turret ring and incorporating toe firing for both, the right foot for the coaxial machine gun and the left foot for the main weapon.
  - (4) The heel kick firing deleted.
- b. Telescope and Periscope.
- (1) Provide for ready adjustment of headrest and boresight movements on telescope mount without use of wrenches.
  - (2) Redesign periscope headrest in accordance with previous recommendations. (See Project No. 48, Report on Periscope Sight T8 and Mount T105, 22 September 1944.)
  - (3) Relocate stowage of M4 periscope near gunner to eliminate present interference; provide for stowage of adapter on M4 periscope.
- c. Relocate elevation quadrant to give better view by gunner.
- d. Periscopic binoculars.
- (1) Provide improved rotor mounting for T9E1 periscope binoculars, as soon as possible.
  - (2) In interim, shorten sliding bolts about 1/32 inch to receive T9E1.
  - (3) Provide M6 adapter with quick-in channel for protruding bolts.
  - (4) Provide stowage for periscopic binoculars convenient to commander.

e. Bow Machine Gun.

- (1) Modify bow machine gun mount to secure wider range of movement.
- (2) Eliminate interferences with loading of gun.

## II GENERAL VISION

a. Improve driver's vision, as proposed in Appendix.

b. Eliminate auxiliary periscope.

c. Relocate loader's periscope rotor and in addition mount periscope T18 for improved flanking downward vision.

## III SEATS

a. Bow Seats.

- (1) Change height adjustment to give four positions 29, 30, 31 and 32 inches below center of periscope window for buttoned-up operation.
- (2) Tilt seat-back rearward one (1) inch and provide wider seat-back with more curvature.

b. Turret Seats.

- (1) Provide height adjustment for gunner's seat at 29, 30, 31 and 32, 34 and 36 inches below center of periscope window.
- (2) Provide additional height adjustment stops on commander's seat at 29 inches below center of periscope window and in corresponding up position.

## IV HATCHWAYS

a. Escape Hatches.

- (1) Provide factory adjustment of locking mechanism to insure that no more than 40 lbs pull is required to operate.
- (2) Provide softer and thicker gasket on escape hatch to insure seal with this specified maximum opening pull requirement.

**b. Bow Hatches.**

- (1) Reduce force required to close hatches and provide for uniform closing force for both hatches so that hatches may be closed from seated position.
- (2) Reshape padding and metal backing around hatchways to eliminate shoulder interference when driving open.
- (3) Provide drain in splash deflector around bow hatches.

**c. Turret Hatches.**

- (1) Redesign hatch locks on loader's hatch to insure positive locking in closed position.
- (2) Remove pin from commander's open hatch lock to insure positive locking at all times.

**d. Pistol Port.**

- (1) Relocate support arm flange to eliminate interference with passage of empty shell casings.

**e. Engine Compartment Doors.**

- (1) Relocate engine door handles near edge to reduce possible accident hazard when opening.
- (2) Provide torsion bar equilibration of forward final drive doors.

## V INTERNAL ARRANGEMENT, STOWAGE

**a. Relocate the following items to eliminate interference.**

- (1) Relocate stowage of headlight on forward wall between steering levers to eliminate interference with driver's foot position.
- (2) Relocate Commander's traverse control 4" back and 4" to right to eliminate interference with gunner's head movement when making quick change from periscope to telescope.
- (3) Relocate shock mounting for control box to eliminate interference with headrest on periscope.
- (4) Relocate cable crossing roof behind gunner's head.

- (5) Relocate storage box for binoculars to eliminate interference with gunner's shoulders.
  - (6) Move manual firing lever ahead 4" and slant handle inward 15° to eliminate interference with gunner's leg when leaving seat.
  - (7) Relocate gunner's control box as described in Appendix to eliminate interference with commander's knee.
- b. Relocate turret fire extinguisher between left turret wall and ready rack or at another convenient location.
  - c. Bend steering levers' handles toward driver 20° for more convenient operation in forward position (See Appendix).
  - d. Provide gear shift markings for assistant driver.
  - e. Redesign lock on first aid kit on rear of tank for more convenient operation.

#### VI LIGHTING

- a. Provide commander light for map reading, mounted on ceiling directly above breech block.
- b. Provide adjustable mask on warning light on gunner's control box to lessen interference with night vision.

Recommendations concurred in by the Armored Board and Headquarters Armored Center, F. W. Makinney, Colonel, GSC, Chief of Staff.

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#1 - Appendix  
#2 - Table I  
#3 - Table II

## APPENDIX

### I FIRE CONTROL

#### a. Elevating Mechanism:

- (1) The most serious defect noted in the T26E3 tank is the malfunction of the gun laying and control mechanisms, both in azimuth and elevation. The difficulty in the elevation mechanism appears as excessive resistance to elevation of the gun. This occurs irregularly, both as to orientation of hand-wheel and position of gun, the required force varying from 3 to 24 pounds applied tangentially to the hand-wheel. It was found that this was not due to excessive unbalance or mislocation of the roof support. Additional loading produced changes in the force required by as much as 10 times that predicted from the mechanical advantage. This suggests cocking or pinching, probably due to inadequate size of contact surfaces.

#### b. Traverse Mechanism:

- (1) Difficulties with the manual traverse control in the nature of lost motion, over-run, and slip, though not quite so serious as the elevation difficulty, definitely hamper the proper laying of the gun. While part of this difficulty is probably attributable to the inadequate contact surface and type of major ring gear, as well as other parts of the gear train, such changes as are feasible should be made at the earliest possible date. Much more adequate azimuth control mechanism should be provided in any re-design.
- (2) Difficulties with the power traverse, while in part due to the same basic cause considered above, have been shown to arise, at least partly, from lost motion in the control linkage train. This part of the difficulty should be readily correctable. The spring tension is also undesirably heavy.

#### c. Firing Mechanism:

The method provided for firing the gun is unsatisfactory in a number of ways.

- (1) Because of the difficulties of controlling the gun by power traverse, the finger firing button is of little use. Since the gun will probably be laid finally by hand traverse, the advantages of the quicker finger firing are lost. If possible, finger firing should be provided on the hand traverse.

- (2) Foot firing, now accomplished by kicking with the heel, is the slowest conceivable method and tends to disturb the gunner. It is considered far inferior to the types of foot fire previously used. Heel pressure would be preferable but not as good as toe actuated treadle. Serious consideration should be given to improving this situation, as time lapse from the decision of the gunner to fire to the accomplishment contributes fundamentally to inaccuracy.

d. Fire Control Instruments:

- (1) Placement difficulties of inaccessibility by left-eyed gunner to the coaxial telescope are similar to those previously noted, but could only be corrected in re-design.
- (2) Disadvantage of short lever linkage to the periscope is similar to that noted in earlier vehicles, but, again, this situation can be corrected only by redesign.
- (3) The coaxial telescope mount should provide more ready adjustment without using wrenches. The headrest adjustment should be readily accomplished. In order to employ boresight scales in elevation and azimuth for correction of jump, etc., the means of adjustment should be readily available.
- (4) Headrests should be modified to conform to recommended design (See Project 48, 22 September 1944) and agreement with new crash helmet.
- (5) The following minor difficulties are to be noted:
  - (a) Location of commander's azimuth control interferes with the gunner's free head movement owing to its location. This can be obviated by moving it back and nearer the side-wall.
  - (b) The cable connection carried across the roof behind the gunner's head presents a hazard due to the mounting clips and should be relocated.
  - (c) Control box shock mount is too close to the headrest.
  - (d) Elevation quadrant should be moved farther back as the scales are obscure and the index mark is concealed by the illuminating device.

e. Periscopic Binoculars:

Certain defects were noted in the provision for mounting and use of the periscopic binoculars T9E1.

- (1) The sliding bolts are too long for the T9E1 by about 1/32 inch on both sides.
- (2) The periscope adaptor for M6 has not been modified to accommodate the extending bolts and hence cannot be introduced at all.
- (3) Because of the limitation in elevation of the T9E1 in this rotor, the modified rotor should be introduced at the earliest possible time.
- (4) Provision should be made for the stowage of the T9E1 near the commander's position.

f. Bow Machine Gun:

- (1) Bow machine gun is badly balanced and very limited in angular coverage. Armor leading from the machine gun bulge to the hatch could readily be carried up in a straight sloping line instead of dipping in to the normal contour. This, together with details of mounting, should increase the depression available.
- (2) The elevation is unnecessarily limited by interference of certain parts of the equilibrating mechanism.
- (3) In the tank examined, the machine gun could not be properly placed in its mount to permit insertion of the holding pin.
- (4) Arrangement of ammunition bins makes loading of gun difficult.

## II GENERAL VISION

Inadequacies in vision are more pronounced than in previous vehicles examined and are essentially the same as those reported on the T25, (See Project 41, Final Report, 8 November 1944), as follows:

a. Driver's Vision:

Most serious is the lack of driver vision. Such vision as is provided is obtained primarily from the single periscope M6 which is inadequate both in vertical and horizontal vision. The auxiliary periscope, found helpful on former models, is almost useless in this vehicle. When employed from the normal head position, 3/4 of the field of view is obscured by the ventilation bulge. Head position behind the auxiliary periscope is not adequate because of interference to head movement by the pad supports around the hatch and is interfered with further by the cable supports behind the driver's head. Furthermore, located as it is under the gun mantlet, the periscope presents a serious ballistic weakness. In view of these considerations, it would seem preferable to leave it out. We are thus faced with the necessity of providing more driver vision by some other method. An immediate improvement would be the introduction

of a larger periscope, set well forward in a larger rotor of 13" diameter with suitable crowning behind the periscope to permit the use of a relatively short unit. This change can be effected within the present hatch opening. A second and better solution would be to install four (4) special rhombic vision units in the hatch, forming a portion of an octagon in plan. This, however, will require more development.

b. Loader Vision:

The other chief weakness in general vision arises from the lack of loader ground vision on the left flank. The loader's periscope as now provided is of relatively little value due to its location, and lack of vantage point in the relatively flat roof. Relocation of the rotor and provision of an additional fixed periscope of the T18 type would provide a possible interim improvement.

### III SEATS

a. Bow Seats:

Bow seats can be adjusted in only two positions for buttoned-up driving - 29" and 30½" from bottom of seat to center line of periscope. Four positions at 29, 30, 31 and 32 inches below center of periscope window were recommended in AMRL report on "Seat Design for M4 Tanks", dated 5 March 1943. A nine (9) inch excursion is required between lower positions and unbuttoned positions. The seat-back should be tilted back one inch, as it is uncomfortable and causes undue fatigue in its present position. A wider seat-back with more curvature would give better back support. The seat cushions require more padding and a shallower pan similar to that used in M4 Medium Tanks would be desirable. If more positive snap fasteners cannot be provided it is suggested that buckle and strap fasteners be provided on the cushions.

b. Turret Seats:

- (1) The present commander's seat has five stops at 30, 31, 32, 33 and 34 inches from center line of periscope and five corresponding stops at a nine inch excursion for unbuttoned operation. It is recommended that additional stops be added at 29 inches from center line of periscope and in the corresponding up position (to accommodate short personnel).
- (2) The gunner's seat should be modified to give six vertical adjustments at 29, 30, 31, 32, 34 and 36 inches from center line of periscope window. There was no gunner's seat-back in tank inspected.

### IV HATCHWAYS

a. Escape Hatches:

The escape hatches require a pull of more than 90 lbs to release.

If an escape is to serve its purpose it must be easily and quickly opened. The release lever should be adjusted to a maximum of 40 lbs. The design of the release is good and it is mainly a problem of factory inspection to insure proper adjustment. It is suggested that if the angle of pull is toward the operator it would make opening by wounded personnel easier.

b. Bow Hatches:

- (1) Care should be exercised in factory inspection to insure uniformity in equilibration of bow hatches. On the tank examined the assistant driver's hatch required a pull of 28 lbs to close and could be operated while sitting in the seat. A pull of 56 lbs was required, however, to close the driver's hatch and it would not be closed without rising from the seat, thus exposing the driver.
- (2) The trough around the bow hatches requires a drain hole at its lowest point to prevent accumulation of water, ice and sand which might interfere with operation of the hatch.
- (3) The padding around the bow hatches should be formed closer around the armor to provide maximum head and shoulder clearance.

c. Turret Hatches:

- (1) Lock on commander's hatch is not always positive when hatch is open. This lock can be made positive by removal of the small pin in locking pin; this would eliminate the possibility of hatch falling on the commander.
- (2) Vibration and firing cause the loader's hatch lock to loosen when hatch is closed, thus breaking positive pressure seal.
- (3) The arm which holds the pistol port open partially blocks the exit. This can be improved by moving the lock flange  $3\frac{1}{2}$  inches to the rear so the arm is held near the edge of the opening.

d. Outside Hatches:

- (1) Engine compartment door handles are offset from edge, thus requiring change of purchase after opening the door approximately  $75^{\circ}$ . It is recommended that the handles be moved to the edge, allowing complete opening without change of purchase.
- (2) The forward final drive compartment doors require counterbalancing to make opening less hazardous.

## V INTERFERENCES, STOWAGE

### a. Interferences:

Miscellaneous items of stowage and location of equipment were found to cause unnecessary interference, as follows:

- (1) The headlight stowed on the driver's side interferes with the natural foot position of long-legged personnel and should be mounted on the forward wall between the steering levers.
- (2) Considerable time is required to unfasten belt holders on machine pistols. A quick release holder should be provided.
- (3) The commander's power traverse handle interferes with gunner's head movement in its present location. Moving it back four inches and right four inches would eliminate this interference without decreasing the commander's operating efficiency.
- (4) Stowage of gunner's quadrant on the right turret wall interferes with commander's arm movement when operating power traverse. Relocation on ceiling above radio would remove this interference.
- (5) Gunner's control box interferes with commander's knee room. It is recommended that this be improved by relocating step three inches up and three inches back and mounting control box below step flush with turret wall. The flashlight should be mounted vertically, adjacent to step and azimuth indicator battery stowed on turret wall near azimuth indicator.
- (6) Binocular case interferes with gunner's shoulder movement when using manual traverse. Convenient out-of-the-way stowage should be provided, possibly in turret bulge.
- (7) Manual firing lever catches gunner's leg when getting out of seat with gun elevated. It should be angled in toward gun fifteen degrees and moved forward four inches with suitable linkage provided.
- (8) The turret fire extinguisher is inaccessible for quick use and should be mounted on a quick-release bracket. It is recommended that it be stowed between ready rack and left turret wall.
- (9) Spare periscope on right turret wall should be provided with adapter and should be stowed on seat bracket between gunner's seat and turret ring as it interferes with gunner's arm movement in present location.

b. Steering Levers:

It is difficult for personnel with short arms to reach the steering levers when they are fully released, especially in the unbuttoned position. If the grips on the steering levers were angled twenty degrees toward the operator it would bring them  $1\frac{1}{2}$  inches nearer and would allow a more natural driving position.

## VI VENTILATION

Ventilation was provided in the tank under inspection by a Rotoclone, as in the T25 model reported earlier (See First Partial Report, Project 41, 19 July 1944). The limitations of this system with respect to control of gun fumes were demonstrated in that report and recommendations made for a fan of 1000 cfm capacity which, it is understood will be installed in T26E3 vehicles as soon as production permits.

Gun fume tests on the current T26E3, summarized in Table 1 below, are in agreement with the earlier tests in showing the inadequacies of the present ventilation. Carbon monoxide concentrations in buttoned-up firing were below those found previously, owing to the more complete sealing of the present test vehicle. As in the earlier test, however, the inadequate ventilation rate for removal of fumes when the turret hatches are open, is clearly demonstrated, showing again that a certain minimum rate of ventilation as well as positive pressure is required for control of gun fumes under all operating conditions. With regard to the machine gun, the present test agrees with the earlier study in that these weapons were found to contribute no hazard (See Table II).

TABLE I

AVERAGE CARBON MONOXIDE CONCENTRATIONS AT THE LOADER'S POSITION  
DURING FIRING OF THE 90 MM GUN IN THE T-26E3 TANK

Test No.	Test Conditions					Carbon Monoxide Concentrations %	Crew Reaction
	Ammunition	Engine rpm	Hatches	Fan	Static Pressure Inches H <sub>2</sub> O		
1	A.P.	600	closed	on	0.1	0.040	Moderate irritation. Not bad.
4	H.E.	600	closed	on	0.1	0.035	No trouble.
2	A.P.	600	comm. open	on	0	0.086	All turret men severe irritation.
3	H.E.	600	open	on	0	0.091	All turret men severe irritation.
5	H.E.	600	open	on	0	0.113*	All turret men severe irritation. Very bad at gunner

\* At Gunner's Position

TABLE II

AVERAGE CARBON MONOXIDE CONCENTRATIONS DURING THE FIRING  
OF THE MACHINE GUNS IN THE T26E3 TANK

TEST NO.	TEST CONDITIONS				CARBON MONOXIDE CONCENTRATIONS %	CREW REACTION
	ENGINE rpm	HATCHES	FAN	STATIC PRESSURE INCHES H <sub>2</sub> O		
	TURRET	MACHINE	GUN	LOADER		
8	600	closed	on	0.1	< 0.002	no trouble
9	600	comm. open	on	0	< 0.02	no trouble
	BCW	MACHINE	GUN	BCW GUNNER		
10	600	closed	off	0	0.02	no trouble
11	600	closed	on	0.1	< 0.02	no trouble