LEVEL

US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-102
*Test Operations Procedure 3-2-700 — 8 March 1978
AD No.

BALLISTIC CORRECTION SYSTEMS

TOP-3-2-700

1. SCOPE. This TOP describes static nonfiring tests for determining the accuracy of ballistic correction devices in supplying proper superelevation and lead angle data to a fire control system when the weapon is laid to fire at a given range. Tests are applicable to ballistic correction systems contained in tank weapons and late model self-propelled artillery.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

ITEM	REQUIREMENTS
Gridboard	A panel with grid intervals marked to permit location of gun aiming points to the nearest 0.10 mil (±0.05 mil) for the distance employed from the weapon
Target	A point type target for use as an aiming reference downrange
Test site	A level hardstand

*This TOP supersedes MTP 3-2-700, 23 February 1966 and TOP 3-2-700, 9 September 1976

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ITEM (Cont)	REQUIREMENTS (Cont)
Controlled temperature unit	To condition test items to temperatures ranging from +63° to −46° C (+145° to −50° F)
Chamber adapters or V-block mount	To facilitate the mounting of a reference telescope

2.2 Instrumentation.

ITEM	MAXIMUM ERROR OF MEASUREMENT*
Gunner's quadrant	Gun elevation to ±0.4 mil
Collimator (M1 or equivalent)	Infinity aiming reference
Reference telescope (32-power)	Used for grid reference only
Meteorological equipment:	
Windspeed	0 to 150 knots ±1.5 knots
Wind direction	360° ±3°

*Values may be assumed to represent ±2 standard deviations; thus the stated tolerances should not be exceeded in more than 1 measurement out of 20.

3. PREPARATION FOR TEST.

a. Place the test item on a level hardstand.

b. For ballistic computer tests, prepare and install chamber adapters or set up a V-mount as applicable to facilitate the use of a telescope as a bore alignment reference.

4. TEST CONTROLS.

a. Use the same direction of weapon lay for each measurement as used in the initial alignment.

5. PERFORMANCE TESTS.

5.1 Ballistic Reticles.

5.1.1 Method.

a. Determine the zero reference gun elevation angle as follows:

(1) Aim the weapon at a fixed downrange point target (500 to 1000 meters) using the boresight cross (fig. 1) of the sight ballistic reticle.

(2) Measure and record the gun elevation angle using a gunner's quadrant.

(3) Repeat the above measurement 8 to 10 times to record variations in the measurements.

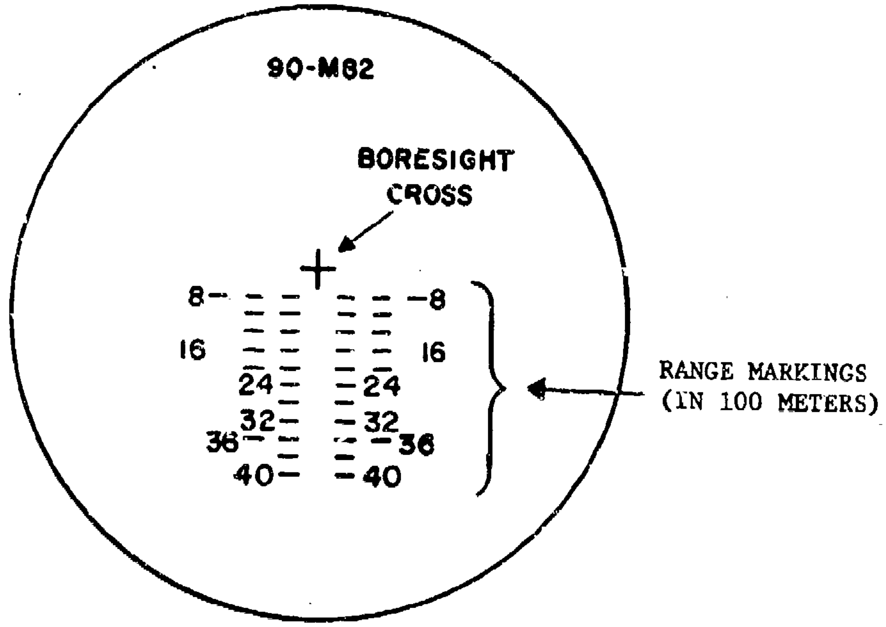

Figure 1. Ballistic Reticle.

b. Aim the weapon at the fixed downrange point target using the various reticle range spacings (200- or 400-meter intervals). Use the same method and direction of gun lay as used in establishing the zero reference.

c. Record the gunner's quadrant reading for each range marking as aimed at the fixed downrange point target.

d. Repeat the measurements four to five times to obtain the variation and mean values for representative range markings.

e. Repeat the above procedure for each ballistic reticle peculiar to the type of ammunition to be fired.

5.1.2 <u>Data Required</u>.

a. Ballistic reticle identification by ammunition type.

b. Zero reference gun angle.

c. Quadrant readings for each reticle range marking.

5.2 Ballistics Computers.

5.2.1 Initial Alignment.

a. Mount a 32-power telescope coincidental with the weapon at the coaxial machine gun port or in the weapon chamber to serve as a bore reference. For the coaxial machine gun position, weld a machined V-block to the mount to provide rigidity for the telescope.

b. Place a calibrated gridboard in a vertical position perpendicular to the line of fire at a distance from the weapon that corresponds to the gridboard calibration.

c. Set all ballistic inputs to the computer at a standard or zero condition.

d. Emplace an infinity aiming reference collimator in the line of sight and align the collimator reticle with the weapon gun sight reticle.

e. Realign the gun sight with the aiming reference collimator 8 to 10 times and record the gun position on the gridboard using the bore reference telescope to obtain variations in measurements.

5.2.2 Basic Test Procedure. Test the ability of the computer to provide correct solutions for applied or sensed ballistic inputs using the following basic procedure:

a. Apply the ballistic input(s) to the fire control system as described in paragraphs 5.2.3 and 5.2.4 while maintaining all other inputs at a standard or zero condition as applicable.

b. Align the sight with the reference collimator using the same direction of lay as used in the initial alignment.

c. Record the gun elevation and deflection from the initial alignment on the gridboard.

d. Make at least two measurements for each test condition from the gunner's station and one measurement from the commander's station.

5.2.3 Solution Tests for Manual Inputs.

5.2.3.1 Ranging Solutions. Manually apply each range specified by the requirements document and measure the computer response (para 5.2.2) for each type of ammunition at each range. If ranges are not specified, select at least four ranges that span the weapon capability.

5.2.3.2 Equivalent Full Charge (EFC) Solutions. Apply EFC counter settings corresponding to 0, 25, 50, 75, and 100 percent of the established EFC round life for the weapon and measure computer response (para 5.2.2) for each type of ammunition at each specified test range (5.2.3.1 above) for each EFC setting.

5.2.3.3 Air Temperature Solutions. Apply ambient air temperature inputs of +21°, -18°, -51°, and +49° C (+70°, 0°, -60°, and +120° F), unless otherwise specified, and measure computer response (para 5.2.2) for each type of ammunition at each specified test range (5.2.3.1 above) for each temperature input.

5.2.3.4 Altitude Solutions. Apply altitude inputs of -200, +1000, +2000, and +3000 meters and measure computer response (para 5.2.2) for each type of ammunition at each specified test range (5.2.3.1 above) for each altitude input.

5.2.3.5 Crosswind Solutions. Apply crosswind inputs of 17 and 35 knots (20 and 40 mph) from left and right and measure computer response (para 5.2.2) for each type of ammunition at each specified test range for each crosswind input.

5.2.4 Solution Tests for Sensor Inputs.

5.2.4.1 Ranging Solutions. Apply range inputs to the computer using the rangefinder for the particular fire control system. For optical rangefinders, set the range scale to each specified test range (para 5.2.3.1); for laser rangefinders, operate the laser in the test mode and use the range inputs provided. Measure computer response (para 5.2.2) for each type of ammunition at each range.

5.2.4.2 EFC Sensor Solutions.

a. Set the EFC counter to the established EFC round life for the weapon.

b. Actuate the EFC sensing switch 10 times for each type of ammunition, resetting the counter as in step a before each count. Record the EFC count for each type of ammunition.

5.2.4.3 Crosswind Sensor Solutions.

a. Position a calibrated recording anemometer adjacent to the vehicle to monitor and record the direction and speed of the wind.

b. Connect an oscillographic recorder to monitor and record the crosswind sensor input to the computer and the resulting output from the computer. Use a time code generator to provide a common time base for all recordings.

c. Expose the vehicle to various wind conditions (i.e., gusty, steady, high-to-calm).

5.2.4.4 Cant Sensor Solutions.

a. Connect an oscillographic recorder to monitor and record the cant sensor input to the ballistic computer and the resulting output from the computer.

b. Switch the sensor on and off and record computer response (para 5.2.2) for the 0° cant position.

c. Install a calibrated wedge corresponding to 5° of left or right cant between the cant sensor and its mounting surface.

d. Manually apply each specified test range (para 5.2.3.1) and measure computer response (para 5.2.2) for each type of ammunition at each range.

e. Repeat steps c and d to obtain measurements for both right and left cant.

f. Repeat steps c through e using calibrated wedges of 10° and 15°.

5.2.4.5 Propellant Temperature Sensor Solutions.

a. Remove the propellant temperature sensor from its mounting and place it in a controlled temperature unit.

b. Condition the sensor to temperatures of 21°, 60°, -18°, and -40° C (70°, 140°, 0°, and -40° F) unless otherwise specified. Manually apply each specified test range (para 5.2.3.1) and measure computer response (para 5.2.2) for each type of ammunition at each range for each temperature condition.

5.2.4.6 Lead Angle Solutions. Introduce lead angle inputs by slewing the turret at the desired tracking rates (using a calibrated rate slewing device) in both the clockwise and counterclockwise directions while depressing and holding in the lead button to lock in the lead angle deflection. Measure the lead angle solution (para 5.2.2) for each specified range and for each type of ammunition at each range.

Some computers have a dynamic lead input that is only present during target tracking. With this situation, a different technique must be applied to measure the lead angle solution. While tracking the target, monitor the electrical signal to the sight reticle or gun which causes the shift for target lead. This electrical signal is, of course, calibrated beforehand so that the signals that are monitored can be equated to lead angle solution measurements.

Measuring a dynamic lead solution may also be accomplished by using a boresighted television camera and television tracker. This technique, coupled with a computer-controlled target movement, permits lead solutions to be recorded for a wide range of target speeds and maneuvers. Additional information on this instrumentation is contained in TOPs 3-2-602 and 3-2-603.

5.2.5 Combination Solutions. Apply combinations of pairs and other multiples of manual inputs (para 5.2.3) and sensor inputs (para 5.2.4) and measure computer response (para 5.2.2) for each type of ammunition at each specified test range. The specific combinations of inputs are determined during test planning and will depend in part on the theoretical solution data available.

5.2.6 Data Required.

a. Gun elevation and deflection data for initial alignment and each ballistic input condition measured in the solution tests.

b. When applicable, records of sensor and computer electrical outputs.

6. DATA REDUCTION AND PRESENTATION.

6.1 Ballistic Reticles. The difference between the gun elevation corresponding to a selected range mark as aimed at the target and the zero reference gun elevation angle represents superelevation for that range and should conform to the firing table superelevation data. Record average variations from the firing table data.

NOTE: Failure of the observed data to conform with firing table computations usually indicates that the reticle spacings are improperly etched, an error has been made in data recording, or the design of the reticle was based on different firing table values from those being employed in the test. All three possibilities should be carefully considered.

6.2 Ballistic Computers. Record the elevation and deflection data of the reticle together with the pertinent controlled-parameter data, usually in tabular form. Compare the results with the design data for the parameters using the elevation and deflection tolerances given in the vehicle specifications or other applicable documents.

When the ballistic corrections do not meet those tolerances, make a further investigation to determine the magnitude of the error and its effect on hit probability.

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