U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY SERVICE TEST PROCEUDRE

PROJECTILE, ILLUMINATING

1. OBJECTIVE

The objective of this document is to describe the tests conducted to determine the suitability of an illuminating projectile and the degree to which it meets the specifications of the Qualitative Materiel Requirements (QMR's), or Small Development Requirement (SDR's).

2. BACKGROUND

Generally, battlefield illumination is used to provide friendly forces with light to assist in night operations, both offensive and defensive.

Specifically, illuminating projectiles are used for:

a. Lighting areas of suspected enemy activity.
b. Providing light for night adjustment or surveillance of artillery fire.
c. Assisting friendly troops for attacks or patrol activities.
d. Guiding low level tactical bombers on important targets within artillery range.

When properly used, battlefield illumination increases morale of friendly forces, facilitates operations and harasses and blinds the enemy.

3. REQUIRED EQUIPMENT

a. Howitzer of appropriate caliber and model.
b. Standard Ammunition Components (fuses and propellants) compatible with the test projectiles.
c. Firing Range(s).
d. Appropriate Standard Ammunition, for comparative firings.
e. Organizational and Direct Support Maintenance Facilities.
f. Appropriate Firing Tables or Aiming Data.
g. Boresighting Devices.
h. Wire or Radio Communications Equipment, Linking Flash Observation Post, Flash Control and Weapon Position.
i. Transport Vehicles, for Ammunition, Equipment, and Personnel.
j. Meteorological Equipment.
k. Medical Aid Personnel and Equipment.
l. Muzzle Velocity Measuring Devices with Operating Personnel.
m. Surveyed Flash Observation Posts with Operating Personnel.
n. Survey, Personnel and Equipment.
o. Powder Thermometer.

4. REFERENCES

A. AR 385-63, Safety Regulation for Firing Ammunition for Training, Target Practice and Combat.
B. Post (or Test Site) Range Regulations.
C. USAMC Regulation 385-12, Verification of Safety of Materiel from Development Through Testing, Production, and Supply to Disposition.
D. USAMC Regulation 385-24, Range Safety.
E. USAMC Regulation 385-224, AMC Safety Manual.
F. USATECOM Regulation 385-6, Verification of Safety of Materiel During Testing.
G. FM 6-40, Field Artillery Cannon Gunnery.
H. FM 9-1300-203, Artillery Ammunition.
I. MTP 3-3-506, Accuracy and Precision.
J. MTP 4-3-500, Preoperational Inspection and Physical Characteristics.
K. MTP 4-3-501, Personnel Training.
L. MTP 4-3-502, Ammunition Functioning and Reliability.
M. MTP 4-3-504, User Reaction.
N. MTP 4-3-511, Transportability (Ammunition).
O. MTP 4-3-513, Maintenance.
P. MTP 4-3-514, Safety Hazards.
Q. MTP 4-3-515, Human Factors Engineering.
R. MTP 4-3-520, Field Storage.
S. MTP 4-3-521, Training Manuals and Technical Publications.

5. SCOPE

5.1 SUMMARY

This document outlines procedures for service testing of illuminating projectiles in order to evaluate their suitability for use by the Army. The evaluation includes:

a. Preparation for Test - A determination of the condition of the test item upon arrival, its physical characteristics, the availability of facilities, personnel training procedures and safety aspects of the test.

b. Component Compatibility - A study to determine the compatability of the test item with "standard" ammunition components of the appropriate size.

c. Accuracy and Precision and Ballistic Match - A study to compare the ability of the test projectile to match a standard projectile in accuracy and precision.

d. Optimum Height of Burst - A determination of the burst height which will allow the flare to burn out just as it strikes the ground.

e. Debris Pattern - A study of the fall of the metal parts of the projectile to determine if pattern aim can constitute a safety hazard to friendly troops.

f. Effectiveness of Illumination - An evaluation of the effectiveness of the test item in the identification of targets and as an aid in the adjustment of fire.

g. Suitability of Fire Direction Procedures - An evaluation of the recommended firing procedures for obtaining continuous illumination.

h. Field Storage - A study to determine the effect of long-term storage, under various conditions, on the accuracy and reliability of the test item.

i. Transportability - An evaluation of the transportability of the test item and its effect on the accuracy and reliability of the test item.

j. User Reaction - A determination of the reaction of personnel to the use of the test item.

k. Ammunition Functioning Reliability - A study to evaluate the reliability of rounds using the test item.

l. Maintenance Evaluation - A study to determine the maintainability of the test item and an evaluation of the test item maintenance package.

m. Human Factors Evaluation - A study to determine the effectiveness of the test item-weapon-crew relationship.

n. Safety Hazards - A study to determine test item-related safety hazards.

5.2 LIMITATIONS

None

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Preoperational Inspection and Physical Characteristics

Upon arrival, determine and record the physical characteristics and operational condition of the test items by subjecting them to the applicable sections of MTP 4-3-500.

6.1.2 Personnel

a. Ensure the availability of service personnel who have been trained using the criteria of MTP 4-3-501 in conjunction with the appropriate technical publications and training manuals of MTP 4-3-521 and are cognizant of the handling, assembling, maintaining, loading and firing, and safety hazard aspects of ammunition and ammunition components, the object of the procedure and the identification and observation requirements of forward observers.

b. Record the adequacy of the supplied training literature.

c. Record the following for all service personnel:

1) Rank
2) MOS
3) Experience in MOS
4) Training Time in MOS

6.1.3 Weapons

a. Ensure the availability of howitzers/guns of the appropriate caliber and tube model(s) which have had average use and which preferably have two-thirds of their tube life remaining.

b. Record the type, caliber and model number of each weapon used.

c. Determine and record the physical condition of each weapon used as indicated by visual inspection, borescoping, and tube wear measurements as

indicated by a pull-over gauge.

6.1.4 Ammunition and Ammunition Components

a. Ensure the availability of sufficient standard ammunition components and standard ammunition to allow for comparative firings, as required.

b. Prior to testing, subject a minimum of 15% of the received test items which have successfully passed the initial inspection procedures of paragraph 6.1.1 to the field storage conditions of MTP 4-3-520 for 90 days.

c. Prior to testing, subject a minimum 15% of the received test items which have successfully passed the initial inspection procedures of paragraph 6.1.1 to the transport conditions of MTP 4-3-511.

6.1.5 Firing Position and Range

a. Select a firing site which shall meet the conditions described in MTP 3-3-506 as concerns range and flash observation posts for accuracy and precision firings (paragraphs 6.2.2, 6.2.7 and 6.2.8).

b. Select a firing site, fairly free of known duds and other debris, that can be entered by personnel without adversely interfering with other units firing on nearby ranges (paragraphs 6.2.3 and 6.2.4).

c. Select a firing site that has a variety of target types (i.e., car bodies, tank bodies, man-size silhouettes - single and in groups to squad size, etc.) set in a variety of terrain (i.e. hills, flat areas, woods, etc.).

6.1.6 Safety

Ensure that a Safety Release, issued as required by USATECOM Regulation 385-6 has been received prior to testing.

6.2 TEST CONDUCT

Note: Normally, when testing ammunition components, only limited quantities of the test item is available, as such all test personnel shall be acquainted with the necessity of accurately gathering maximum data for each round fired. As such, sub-tests shall be conducted concurrently with, or in conjunction with, other subtests, whenever possible.

a. Record the current meteorological data just prior to the start of firing, and at least every two hours thereafter, during testing.

b. Record the following for each round fired, if applicable, to be used for the determination of test item functioning reliability (see paragraph 6.1.10):

1) Height of burst
2) Burning time
3) Time from air burst until flare hits ground
4) Weapon setting
5) Fuze setting

6) Line of sight (azimuth)
7) Malfunction

6.2.1 Component Compatibility

a. Prior to firing, assemble complete rounds, using the test item, and record evidence of incompatibility of the test item with the following:

1) Propellant charge shell-casing
2) Fuze assembled to the test item

b. Disassemble the items of step a and return them to their packaging.
c. During the firing procedures record any difficulty encountered in setting the fuze on the test round.

6.2.2 Accuracy and Precision and Ballistic Match

6.2.1.1 Preparation for Test

a. Assemble a sufficient number of test rounds, consisting of the test projectiles and standard components, to meet the minimum requirements of the applicable section of MTP 3-3-506.

NOTE: In the event that sufficient ammunition is not available to meet the requirements of MTP 3-3-506, the following schedule, as a minimum, shall be fired:

Charge	Range	No. Rds.
1	50% and 80% Max. Range	40
3	50% and 80% Max. Range	40
5	50% and 80% Max. Range	40
6	50% and 80% Max. Range	40
7	50% and 80% Max. Range	40
Higher Charges	50% and 80% Max. Range	40

b. Assemble "standard rounds", using all standard components, equal in number to the test rounds of step a.

6.2.1.2 Test Conduct

Determine the accuracy and precision of the test rounds and their ballistic match with the standard rounds, using the procedures of the applicable section of MTP 3-3-506 and firing test rounds and standard rounds alternately, and from the same weapon and record the following for each round:

1) Horizontal and vertical location as determined by flash observations.
2) Charge used.
3) Powder temperature
4) For the weapon used:

a) Type, model and caliber
b) Weapon settings

NOTE: 1. This accuracy and precision test will vary slightly from the procedures described in MTP 3-3-506. The ten-round groups will be fired at a point in the air with fuzes set for air burst. Horizontal and vertical location will be made by the flash observation posts. This will save ammunition and permit calculating of range deflection and vertical probable errors from each ten-round group.
2. Ballistic match will have been achieved if the center of comparative groups are within the allowable range, deflection and height of burst probable errors of each other as set forth in the test directive, and they have comparable dispersion patterns. Under these conditions the test projectiles, assembled with standard components, are considered to "shoot" the same as the standard projectiles and is, therefore, suitably accurate.

6.2.3 Optimum Height of Burst

NOTE: 1. Unless otherwise specified in the test item's QMR or training literature, the gunnery techniques of FM 6-40 for determining initial quadrant elevation and fuze setting, shall be used.
2. This portion of the test may be performed in daylight.

a. Using normal gunnery procedures have an observer adjust the height of burst and when the height is approximately correct, perform the following:

1) Fire one six-round group at 50% or maximum range and record the following for each round fired:

a) Location of air burst as determined by flash observation.
b) Time to ejection of flare.
c) Time from ejection until flare reaches ground.

NOTE: This data shall be used in determining flare rate of descent.

d) Burning time for flares that burn out prior to reaching the ground.

NOTE: This data will be used in determining the average flare time of burning. (Flares that reach the ground burning do not burn at the same rate as when suspended by the chute.)

2) Fire a six-round group at 80% of maximum range and record the data of steps a.1.a through a.1.d.

b. Repeat the procedures of step a for all charges.

NOTE: If test ammunition is limited, perform step b for alternating charges (i.e., 1, 3, 5, 7, etc.).

6.2.4 Debris Pattern

Determine the debris pattern of the test item as follows:

NOTE: Since illuminating projectiles are of the base ejection type, their debris pattern can constitute a safety hazard to friendly troops.

a. When sufficient ammunition is available:

1) Fire a minimum of 50 rounds, when weather conditions are relatively stable, at the same quadrant elevation and time setting and record the following:

a) Quadrant elevation
b) Time setting
c) Current meteorological data

2) At the completion of firing have troops search the impact area, recover metal parts from the functioning projectiles and record the location of parts by type with respect to distance from landmarks of known location.

b. When ammunition is not available in sufficient quantity, record the required gun and debris data of step a.1 and a.2 while conducting the optimum height of burst firings of paragraph 6.2.3.

6.2.5 Effectiveness of Illumination

Record the degree of darkness during firing

6.2.5.1 Identification of Targets

a. Fire the test projectiles in accordance with the procedures outlined in FM 6-40 as specified in the QMR or training and technical publications.

b. Have trained observers, using the unaided eye, field glasses, spotting scopes, and other standard observation aids, identify the targets and describe any difficulties encountered.

6.2.5.2 Adjustment to Fire

a. Have trained observers adjust the test projectiles using the prescribed gunnery techniques of FM 6-40 or as specified in the QMR or training and technical publications.

b. At the completion of step a have the observers conduct the adjustment of high explosive shells upon the various targets, using the illumination

provided by the test projectile and record any difficulties encountered.

6.2.5.3 Companion Firings

Repeat the procedures of paragraphs 6.2.5.1 and 6.2.5.2 using standard projectiles and have the observers record their opinions upon effectiveness of the test projectile.

6.2.6 Suitability of Fire Direction Procedures

Determine the proper distance between bursts, and the number of rounds per minute required for continuous illumination as follows:

a. Using the procedures of FM 6-40, or other specified procedures (i.e., QMR, SDR, or other training manuals or technical publications), and the optimum height of burst as determined during the procedures of paragraph 6.2.3, determine the optimum distance between bursts, rounds per minute and height of burst for continuous illumination and record variations from supplied procedures.

b. Photograph the effects of the illumination and record observers' remarks concerning the effectiveness of the continuous illumination.

c. Determine the optimum firing parameters for continuous illumination by repeating the procedures of steps a and b under the following conditions:

1) Increase and decrease the distance between rounds
2) Vary the number of rounds per minute
3) Adjust the height of burst

d. Compare the effectiveness of the test item continuous illumination with standard rounds by repeating the procedures of steps a and b using standard illuminating projectiles.

6.2.7 Field Storage

Determine the effects of field storage on the test item as follows:

a. Record the field storage data of the test items of paragraph 6.1.4.b as described in the applicable sections of MTP 4-3-520.

b. Subject the test items of step a to the accuracy and precision firing procedures of paragraph 6.2.2.

6.2.8 Transportability

Determine the effects of transport upon the test item as follows:

a. Record the transport data of the test items of paragraph 6.1.4.c as described in the applicable sections of MTP 4-3-511.

b. Subject the test items of step a to the accuracy and precision firing procedures of paragraph 6.2.2.

6.2.9 User Reaction

Determine the "user reaction" to the test item during the period of testing as described in the applicable sections of MTP 4-3-504.

6.2.10 Ammunition Functioning Reliability

During the conduct of all firing tests determine the ammunition functioning reliability of the test item and standard item as described in the applicable sections of MTP 4-3-502 and using the data recorded as described in steps a and b of paragraph 6.2.

6.2.11 Maintenance Evaluation

During the period of testing determine the maintenance characteristics of the test item as described in the applicable sections of MTP 4-3-513.

6.2.12 Human Factors Evaluation

Evaluate the effectiveness of the test item-weapon-personnel relationships during the period of testing as described in the applicable sections of MTP 4-3-515.

6.2.13 Safety Hazards

Evaluate the safety aspects of the test item during the period of testing as described in the applicable sections of MTP 4-3-514.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Preoperational Inspection and Physical Characteristics

Record data as described in the applicable sections of MTP 4-3-500.

6.3.1.2 Personnel

Record the following:

a. Adequacy of supplied training literature
b. For all service personnel:

    1) Rank
    2) MOS
    3) Experience in MOS
    4) Training time in MOS

6.3.1.3 Weapons

Record the following for each weapon used:

a. Type

b. Caliber
c. Model Number
d. Physical Condition

6.3.2 Test Conduct

Record the following for each test round fired, as applicable:

a. Test being performed (accuracy and precision, optimum height of burst, etc.).
b. Height of burst in feet.
c. Burning time in minutes.
d. Time from air burst until flare hits ground in minutes
e. Weapon setting.
f. Fuze setting.
g. Line of sight (azimuth) in degrees
h. Malfunction

6.3.2.1 Component Compatability

Record the following:

a. Any difficulty encountered in assembling the test item to the standard components.
b. Any difficulty encountered in setting the fuze and the test rounds

6.3.2.2 Accuracy and Precision and Ballistic Match

Record the following for each round fired:

a. Type of round (test, standard)
b. Current meteorological data
c. Horizontal and vertical location, as determined by flash ranging
d. Charge used
e. Powder temperature

6.3.2.3 Optimum Height of Burst

Record the following for each round fired:

a. Current meteorological data.
b. Charge used.
c. Percent of maximum range fired (50%, 80%).
d. Location of air burst as determined by flash observation.
e. Time of ejection of flare, in seconds.
f. Time from ejection until flare reaches ground in minutes.
g. Burning time, in minutes, for flares that burn out prior to reaching ground.

6.3.2.4 Debris Pattern

Record the following:

a. Weapon quadrant elevation
b. Fuze time setting
c. Current meteorological data
d. Debris pattern location, by parts (see Appendix A).

6.3.2.5 Effectiveness of Illumination

Record the following:

a. Current meteorological data.
b. Degree of darkness during firing.
c. Test (Identification of targets, adjustment to fire, etc.).
d. Projectile used (test, standard).
e. Difficulties encountered, as applicable:

1) Identifying targets
2) Adjusting fire

f. Observer comments on test item effectiveness as compared with standard projectiles.

6.3.2.6 Suitability of Fire Direction Procedures

a. Record the following:

1) Fire direction procedures used (FM 6-40, QMR, SDR, etc.)
2) Changes required in procedures used as regards:

a) Optimum height of burst
b) Distance between rounds
c) Rounds/minute

b. Observer comments on the effectiveness of the test items as compared with standard projectiles.

6.3.2.7 Field Storage

Record the following:

a. Field Storage data as described in the applicable section of MTP 4-3-520.
b. Accuracy and precision firing data as described in paragraph 6.2.2.

6.3.2.8 Transportability

Record the following:

a. Transport data as described in the applicable sections of MTP 4-3-511.

b. Accuracy and precision firing, data as described in paragraph 6.2.2.

6.3.2.9 User Reaction

Record data, collected as described in the applicable sections of MTP 4-3-504.

6.3.2.10 Ammunition Functioning and Reliability

Record the applicable ammunition functioning reliability data for the test item as described in MTP 4-3-502 and the data collected as described in paragraph 6.2.

6.3.2.11 Maintenance Evaluation

Record data, collected as described in the applicable sections of MTP 4-3-513.

6.3.2.12 Human Factors Evaluation

Record data, collected as described in the applicable sections of MTP 4-3-515.

6.3.2.13 Safety Hazards

Record safety data, collected as described in the applicable sections of MTP 4-3-514.

6.4 DATA REDUCTION AND PRESENTATION

a. Data obtained from all subtests covered by applicable referenced MTP's shall be summarized and evaluated according to procedures described in those MTP's. Appropriate charts, graphs and tabulated summaries shall be used to present the data in a clear manner. Special consideration shall be given to any condition or circumstance contributing to any test result.

b. Calculations shall be performed as specified by the referenced individual MTP's, wherever applicable. All photographs shall be retained and suitably identified along with other illustrative material.

c. In addition to the items of steps a and b, the following shall be performed and presented:

1) The average burning time for all flares that burn out before reaching the ground shall be determined by tabulating all obtained data.
2) The rate of descent shall be calculated using those flares that burn out after reaching the ground.
3) Chart all probable errors in range, deflection and height of burst and compare the probable errors of:

a) Test items not stored or transported

b) Test items placed in field storage
c) Test items transported
d) Standard items fired for comparison purposes

4) Analyze and/or categorize for presentation the following:

a) All malfunctions by type
b) Opinions of observers used as regards:

(1) Difficulties encountered in identification of objects and adjustment of fire.
(2) Recommended changes to current gunnery techniques.

5) Compare the test item reliability and present it as a percentage.
6) An overall evaluation of the suitability of the test item for use by the Army shall be made, based on the QMR, SDR, TC or other reliable criteria.

d. Issue a Safety Confirmation, in accordance with USATECOM Regulation 385-6 based on the data collected in paragraph 6.3.2.8.