# TM E9-1901

**WAR DEPARTMENT TECHNICAL MANUAL**



# IDENTIFICATION OF JAPANESE SHELLS AND SHELL FRAGMENTS; LOCATION OF ENEMY BATTERIES





*WAR DEPARTMENT* • *14 MAY 1945*

RESTRICTED

# PART ONE—GENERAL

## Section I

## INTRODUCTION

### 1. PURPOSE.

**a.** This manual is designed to aid counterbattery and other artillery intelligence personnel. Combat experience has proven that the system and techniques presented herein will assist materially in:

(1) Speedy location and silencing of active enemy batteries.

(2) Ready identification of enemy artillery and mortars by caliber and type from shell fragments.

**b.** The methods described in this manual comprise one of the basic means of obtaining information of the existence and location of enemy weapons. These methods are used almost invariably in connection with one or more of the other sources of counterbattery information. The principal sources are:

(1) Crater analysis and fragment identification (via shellreps).

(2) Interpretation of air photos.

(3) Field artillery observation battalions (sound and flash).

(4) Air observers (air OP's) and ground observers.

(5) Interrogation of prisoners of war and friendly civilians.

**c.** Crater analysis and shelling reports (shellreps) are used to check and verify battery locations obtained by these other means. Also these other sources are used to verify information from shelling reports and crater analysis.

### 2. IMPORTANCE.

**a.** Speedy location and identification of enemy artillery and mortars are of paramount importance in counterbattery. Increasing effort and all possible means and methods must be employed to provide *promptly* the information necessary to knock out such enemy weapons. This mission and the gathering of information essential to its accomplishment are of vital interest to all soldiers.

**b.** Information of the location, mass, disposition, and zones of fire, by caliber and type, of the enemy artillery, mortar, and rocket weapons is of great value in estimating enemy tactical capabilities. The success of an entire operation depends to a considerable extent upon the accuracy, completeness, and timeliness of this information.

c. Systematic examination of craters and shell fragments may disclose information about new types of enemy ammunition and weapons, a knowledge of which may permit us to develop early and effective counter measures. This knowledge may also suggest improvements in our own ammunition and weapons.

## Section II

## SHELLING REPORTS (SHELLREPS)

### 3. GENERAL.

a. Whenever or wherever enemy artillery, rocket, or mortar shelling is observed, it must be reported back immediately to where the information can be evaluated and acted upon. These shelling reports, now commonly called "shellreps," are rendered through channels according to a definite procedure and form by the individual or unit observing or experiencing the enemy fire.

### 4. VALUE.

a. Shellreps are basic and extremely valuable information; they are literally the keystone of efficient counterbattery or counter mortar intelligence. In addition to helping locate enemy guns speedily, shellreps:

(1) Tell when enemy guns are firing.

(2) Indicate which batteries are active.

(3) Indicate number, caliber, and type of guns firing.

(4) Report effectiveness of enemy shelling.

(5) Indicate zones of fire of enemy weapons.

(6) Indicate new locations.

(7) Make possible prompt retaliatory fire when location of offending batteries is established.

(8) Serve to alert sound and flash, air OP's, and other agencies.

b. The value of shellreps depends chiefly upon—

(1) Their accuracy and completeness.

(2) Speed of transmission.

(3) Number received.

c. Because silencing of enemy batteries is of vital interest to all soldiers, all should be encouraged to submit shelling reports, regardless of arm or service. However, a smaller number of reports which are complete and accurate are of greater value than many reports of a general nature. The best reports, therefore, are submitted by trained men who have actually surveyed the craters in the shelled area and have either analyzed the available shell fragments or submitted them for analysis along with their reports. Since a high percentage of all

enemy concentrations will fall somewhere near an artilleryman, artillerymen should be especially trained so that their reports will be accurate, complete, and prompt.

## 5. ACCURACY.

**a.** Shellreps are usually based upon hearing, visual observation, or crater analysis, or sometimes a combination of these. Reports based on hearing are generally unreliable as to direction. The human ear is not capable of judging direction better than an accuracy of about 5 degrees, and there are many other factors that will tend to make reports even less accurate. The most reliable, accurate, and informative reports are based on crater analysis, explained in the next section, or based on direct visual observation of the flash of the enemy weapon, measured by an aiming circle, BC scope, or similarly accurate, properly oriented, sighting device.

## 6. SHELLING REPORT FORM.

**a.** A suggested form for observer's report to his headquarters is form "A," page 28. This form is suitable for printing on a card to be glued into the Field Message Book. Form "B," page 29, is suitable for recording this information at battalion and higher headquarters as the reports are received.

**b.** The following is a detailed explanation of the purposes of the information required in the shellrep form (page 28):

(A). Time and unit reporting. Noted for future reference.

(B). Location of observer: Accurate location of the observer is essential in plotting reported azimuths. When crater analysis is made of several craters in same shelling, *average* of coordinates should be given.

(C). Azimuth of direction from which shelling came: This is determined in any of three ways:

*1. Sound.* Estimation of direction by ear is too inaccurate except for very short distances when such inaccuracy is not as important as at greater distances. It should be used for mortar locations only.

*2. Furrow or Crater.* This method is most reliable and most accurate. Experienced observers can get within 5 to 10 mils in a single compass reading which should not require more than 5 minutes. An average of several readings will greatly increase accuracy. Always state the compass reading in magnetic north or grid north. An aiming circle will give more accurate direction.

*3. Flash.* An accurate means of obtaining direction to enemy gun is by direct measurement of the visible gun flash through a properly oriented, accurately located aiming circle or BC scope.

(D). Distance in yards should be given whenever possible. The *slope of fall* in mils, when obtained in crater analysis, is usually of greater value than the estimated distance or location.

(E). Coordinates of the area shelled are valuable as they may indicate the enemy intentions. Accuracy of the locations aids in eliminating duplicate reports.

(F) and (G). Time "From-to": Should be given accurately. It may be that the shelling can be tied into sound or flash locations which were taken at the same time. Also, reports of two or more observers may be tied together, permitting artillery to locate and neutralize the correct gun location immediately without wasting time and ammunition in firing on a dozen different targets with only a "hope."

(H). Number, caliber, and type of guns: The principal method of determining the number of guns is by the time interval between bursts or the number of bursts which come practically simultaneously. Character of sound is sometimes an indication of caliber to experienced personnel, but fragment identification is a positive and more reliable method of determining caliber and sometimes type of enemy guns. Type of gun, whether howitzer or rifle, as well as caliber is valuable information and should be determined whenever possible.

(I). Number and type of shells: Number of shells falling into an area as well as type (HE, smoke, time, etc.) may give us a real clue as to what the enemy is trying to accomplish. It can also indicate the amount of ammunition available or the importance of the target to him.

(J). Nature of fire: Counter battery, registration, harassing, interdiction, OP neutralization, preparation, etc.

(K). Damage: The damage done will often determine counter-battery priority. This information should never be sent "in the clear" on voice radio or if telephone wires may be tapped by the enemy.

(L). Flash-bang (seconds): A flash-bang report is of exceptional value as it not only gives accurate direction but also approximate range to enemy guns. The method is simple. Time is taken at sight of flash (stop watch is highly desirable) then the observer hears the report (bang) of the *gun shooting* (not the ballistic "crack" or sound of the shell in the air) and time is again noted. Since flashes are seen instantaneously, and it is known how fast sound travels (approximately 370 yards per second) the time interval indicates range. Because of lag in individual reaction time, a correction of approximately 200 yards should be deducted from all ranges determined by this method.

(M). Remarks: Enter here anything especially noted.

## 7. REPORTING NEW SHELLS.

**a.** Shells or fragments found to have characteristics unlike those listed in this manual should be reported immediately to proper authorities.

**b.** To be of maximum value, fragments sent to the rear should be tagged with the following information:

(1) Time (date and time of day shell landed, if known).

(2) Location (place where shell was found as accurately as location can be given).

(3) Direction (approximate direction from which shell came and method used in determining that direction (survey of crater, sound, etc.)).

(4) Name and organization of person making report.

(5) References.

## 8. STANDARD OPERATING PROCEDURE.

**a.** A standard operating procedure for shellreps is recommended. The following is a suggested SOP:

(1) GENERAL SHELLREPS. Personnel in units of all branches immediately report hostile shelling, giving the following general information:

*(a)* Time.

*(b)* Where.

*(c)* Apparent direction to enemy gun.

*(d)* Number of guns firing and apparent caliber.

(2) CRATER OR TEAM SHELLREPS. Artillery personnel, learning of this hostile shelling through own observations or through general shellreps, dispatch trained teams immediately to the shelled areas, including those from which general shellreps were submitted by other arms. These teams will make crater analysis and requisite survey.

(3) TEAMS. Each team consists of two men equipped with aiming circle, calipers, flexible steel rule, gunner's quadrant (when available), and dia-meter or substitute. The Compass M2 can substitute for an aiming circle.

(4) Each artillery battalion maintains three teams, each higher headquarters maintains one, and the observation battalions maintain four. In addition, the artillery forward observer, the artillery liaison section, and the infantry company teams also make crater analyses (primarily enemy mortar craters) using prismatic compass only. Unless artillery battalions or higher artillery headquarters direct otherwise, teams automatically assume the following responsibilities:

*(a)* Direct support battalions for areas actually occupied by infantry.

*(b)* General support battalions and higher artillery headquarters for areas within 1,500 yards of their location.

(5) Completed reports are forwarded immediately, usually by telephone, and coded if reported by radio. Time of the actual shelling

is reported accurately. Direct support artillery acts on mortar shelling reports ("mortreps").

(6) Any knowledge of hostile shelling beyond the limits of responsibility listed in step (4), above, is forwarded to suitable artillery headquarters for survey.

## 9. PERSONNEL AND TRAINING REQUIRED.

**a.** A single individual can perform the necessary operations in each area; however, for speed and other practical considerations, a crew of two or three is recommended.

**b.** Inexperienced personnel can get accurate direction from ricochet furrows with very little instruction. More instruction or experience is necessary in the case of craters, certain types of ricochets, and for identification of fragments. Knowledge of the elements of exterior ballistics, Firing Tables, and their use is helpful, but knowledge of enemy ammunition and weapons is definitely necessary. Since the enemy may use captured weapons against us, familiarity with weapons of our allies is important.

**c.** Instruction should be by trained personnel who know shell crater analysis and shell fragmentation identification from actual experience. There are many fine points to crater analysis. For example, the slope of ground, the texture of soil, the over-all detonation pattern, etc., all have definite effects that can be compensated for, if known, in determining direction to the gun. Properly trained soldiers can select at sight craters giving most accurate results, and know where to find, with minimum effort, shell fragments most easily identifiable. Scouting and patroling should be emphasized so that maximum advantage is taken of terrain for protection against enemy fire.

**d.** It is often difficult to differentiate between hostile mortar and artillery shelling. However, there are basically no differences in the techniques for locating enemy mortars and artillery. Therefore instruction of both shellrep and mortrep teams can and should be given at the same time.

---

Section II

# LOCATION OF ENEMY BATTERIES AND MORTARS BY CRATER ANALYSIS

## 10. GENERAL.

**a.** The direction of flight of a projectile frequently can be determined quite accurately from its crater or ricochet furrow. By locating the crater accurately and measuring the direction of flight as indicated in the following paragraphs, back-azimuths can be obtained which will

pass through or very near the actual gun, battery, or battalion position. The position area of a battery can be located by plotting the intersection of the average back-azimuths from two or more widely separated groups of craters, and by other methods described herein. The direction to a battery can be determined with fair accuracy from the back-azimuth obtained from even one ricochet furrow or crater.

## 11. USES AND VALUE.

**a.** By analysis of shell craters, it is possible to:

(1) Verify, as active batteries, suspected locations which have been obtained by other means.

(2) Detect presence and approximate location of enemy batteries not previously suspected.

(3) Obtain an early indication of the general location or direction of the massing of enemy artillery.

(4) Assist air and ground observation in accomplishing counterbattery missions by greatly reducing the sector necessary to search.

(5) While a slow moving or static situation permits maximum employment and benefit of crater analysis and shellfires, crater analysis can be extremely important in a fast moving situation. For example, when advance elements, particularly armored, are held up by unexpected fire from guns that cannot be seen, information on whether the fire is from tank, antitank, or field artillery weapons may determine the next tactical move. As very often the other counterbattery intelligence means are absent or not operating at such a time, crater analysis will be frequently the only means available for speedy location and identification of these enemy guns.

## 12. INSPECTION OF SHELLED AREAS.

**a.** Inspection of shelled areas should be made as soon as possible. Reverse slopes, folds in the terrain, hedgerows, and buildings in shelled areas offer the greatest chance of finding ricochet furrows and other markings most useful in determining direction of flight and slope of fall, and also afford maximum protection for personnel making crater analysis.

## 13. CRATER SURVEY FOR LOCATION.

**a.** The area must be located sufficiently accurately for plotting on firing chart, map, or airphoto. Deliberate survey methods are not essential; hasty survey, by pacing distance and using the aiming circle for direction, usually is sufficient. Frequently a quick, short traverse to a known road junction, the battery position or OP, is all that is necessary. In some cases, the crater, or center of impact, can be located by pin-pricking an airphoto.

## 14. DETERMINATION OF DIRECTION AND ANGLE OF FALL.

**a. Pattern.** The pattern produced on the ground by the detonating shell gives a clear indication of the general direction from which artillery fire is received. This is illustrated in figures 1 and 2.

**b. Factors Affecting Pattern.**

(1) It must be kept in mind that due to irregularities of terrain and soil condition, the "typical" shell crater pattern is the exception, not the rule.

(2) The principal effect from fragmentation is always from side spray, with much less effect from nose spray. Back spray is negligible. The width, angle, and density of the side spray vary with different types of projectiles.

(3) In evaluating direction, due consideration must be given to the way the earth is thrown, the effect of stones, stumps, roots, variations in soil density and type, and the slope of terrain at the point of impact. Out of any group only those craters most clearly defined and nearest to typical should be utilized.

**c. Range Dispersion.** In case the firing has been from a single gun or a very limited number of guns, range dispersion will give a good indication of the direction of fire.

**d. Marks on Vegetation and Other Objects.** The direction from which a round was fired and its angle of fall are often accurately indicated by markings left as it cuts through trees, shrubs, grass, snow, and various objects.

**e. Ricochet Furrows and Duds.**

(1) Ricochet furrows usually furnish the best information. The average direction of a few such furrows from the same gun will give a line within a few mils of the true direction of flight. Ricochet can be found even at extreme ranges, on reverse slopes of hills or on stream banks. Of equal or superior value are grooves in thick grass or bushes, holes through materiel, buildings, trees, and other objects from which angle of fall also frequently may be determined.

(2) TECHNIQUE (fig. 3). Carefully remove loose dirt from furrow with hands, leaving smooth, hard channel intact. Drive two thin stakes or survey pins, one at each end of the usable part of the furrow. Be sure to set the stakes straight and in the center of the channel. These stakes represent the line of fire, the azimuth of which may be measured with an aiming circle placed 5 to 15 feet from the furrow and in line with it. The slope of fall can be determined with a Compass M2 sighted along the bottom of the furrow or entrance hole.

**f. Fuze-quick Craters.**

(1) At small angles of fall, fuze-quick craters furnish information nearly as accurate as that from ricochet furrows. Judging the direction


*Figure 1—Shell Crater With Fuze Skid*

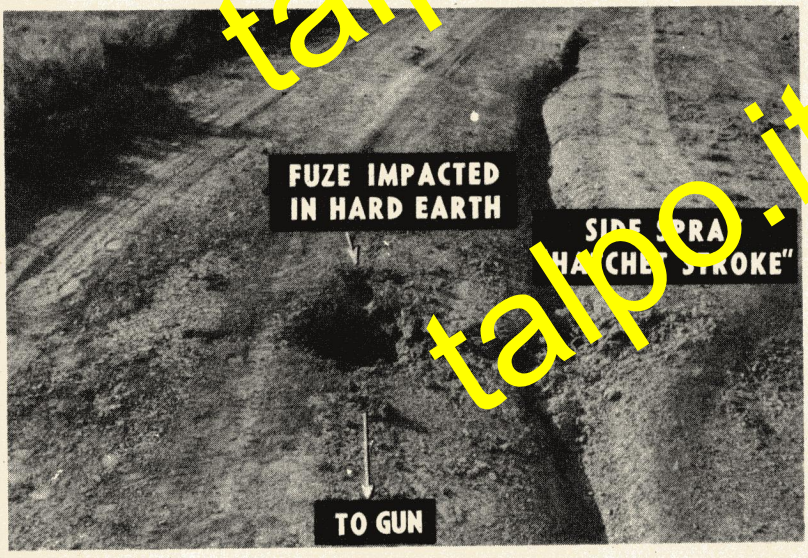



*Figure 2—Shell Crater, Hard Earth*

of the trajectory increases in difficulty with an increase in angle of impact; therefore, for equally practical results, more craters must be analyzed. If the angle of impact is small or moderate, the crater generally is pear-shaped. The crater usually is wider than it is long. If the angle of impact is larger, the crater generally is oval with the least diameter in the direction of flight.

(2) TECHNIQUES (figs. 4 and 5).

*(a) Use of Channel in Ground Where Shell Entered and/or Left.* Place a stake in center of channel. Place a second stake on opposite side of crater. Sight along these to obtain back-azimuth as with ricochet furrows. Position of fuze may give an excellent indication of direction of fire.

*(b) Use of Side Spray Shown by Dirt and Cut Grass.* Place a stake in the center of each line of side spray equally distant from the crater. Setting the aiming circle in the exact center of the crater, measure the angle between the stakes. The bisector of this angle is the approximate line of fire, and its azimuth, or back-azimuth, can be determined.

*(c)* The average of the back-azimuths obtained from steps *(a)* and *(b)*, above, will be more accurate than either method alone.

**g. Deep Craters.** Least reliable directions are from deep craters. However, in soft soil, good approximate direction can be obtained if a nose fuze has been employed and fuze and fragments are located. These will often be found in a tunnel in prolongation of the shell's line of flight. A line can be established from this in conjunction with other characteristics. The crater pattern ordinarily will be oval, narrowest diameter indicating direction of fire, and of varying depths.

**h. Time Fire.** Low air bursts can furnish excellent information of the line of flight of the projectile. In any time concentration there should be some impact bursts from which good directional lines can be obtained.

## 15. LOCATION OF BATTERIES.

**a. General.**

(1) Batteries may be indicated or located approximately from:

*(a)* Single back-azimuth rays plus analysis of terrain along the rays.

*(b)* Single rays plus slopes of fall.

*(c)* Single rays plus time reading from fuzes.

(2) Enemy batteries will be more accurately located by triangulation (long base intersection) from back-azimuths determined in different shelled areas.

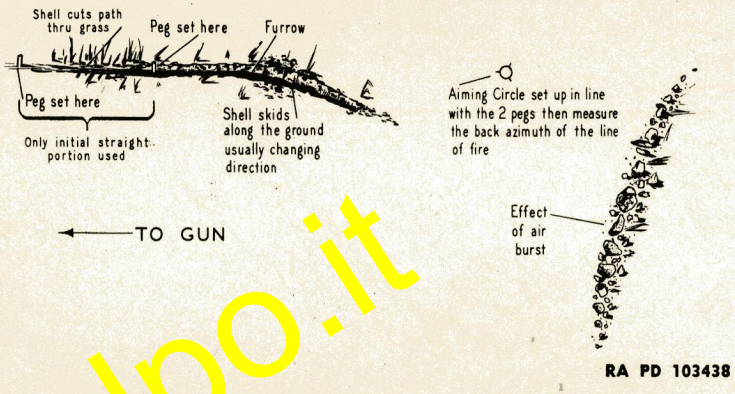



**Figure [illegible]—Typical Ricochet Markings**

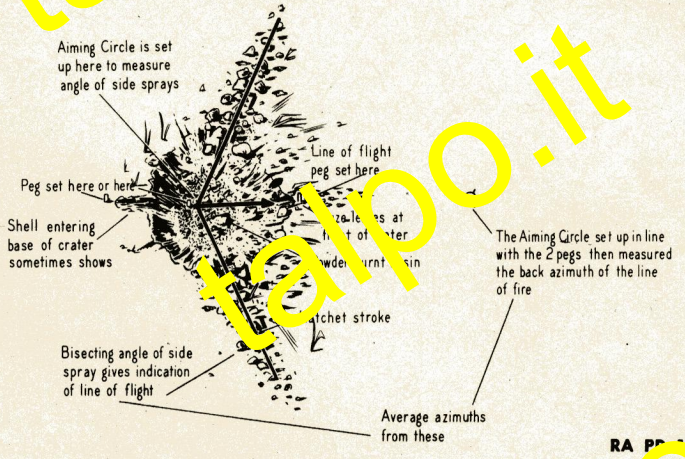



**Figure 4—Typical Shell Crater, FQ (Small Angle of Fall)**

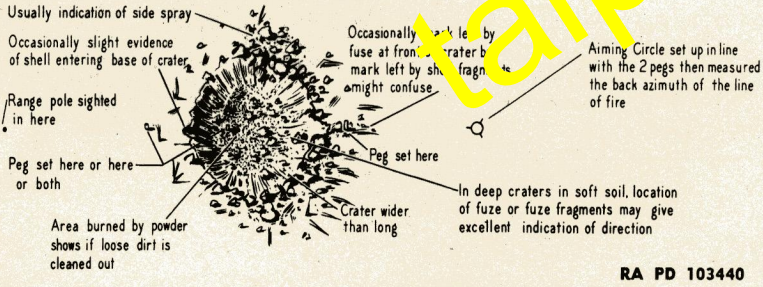



**Figure 5—Typical Shell Crater, FQ (Larger Angle of Fall)**

PROJECTILE: 8 cm (81mm) HE Mortar [Naval]

WEAPONS: 8 cm Model 3 Mortar [Naval]

PROJECTILE:

| | | |
|---|---|---|
| Caliber | : | 81mm |
| Kind | : | Mortar Shell |
| Type | : | HE |
| Weight | : | (Without Fuze) 6.99 lbs. |
| Color | : | Black with red and green nose |
| BANDS | : | None |

CHARGE:

| | | |
|---|---|---|
| Weight | : | Approximately 1.12 lbs. |
| Kind | : | Picric acid and Dinitronaphthalene (Tridite) |

FUZE: Naval Mortar Fuze

REMARKS: The model number of this projectile and that of the fuze have not been determined.

81-M-3

## 8CM (88MM) MODEL 100 HE POINTED AA


ALL DIMENSIONS IN INCHES

RA PD 103481

88-A-1

PROJECTILE: 8 cm (88mm) Model 100 HE Pointed AA

WEAPONS: 8 cm Model 99 AA Gun

PROJECTILE:

| | | |
|---|---|---|
| Caliber | : | 88mm |
| Kind | : | Shell |
| Type | : | HE |
| Weight | : | (With Fuze) 19.9 lbs. |
| Color | : | Black |
| BANDS | : | One yellow |

CHARGE:

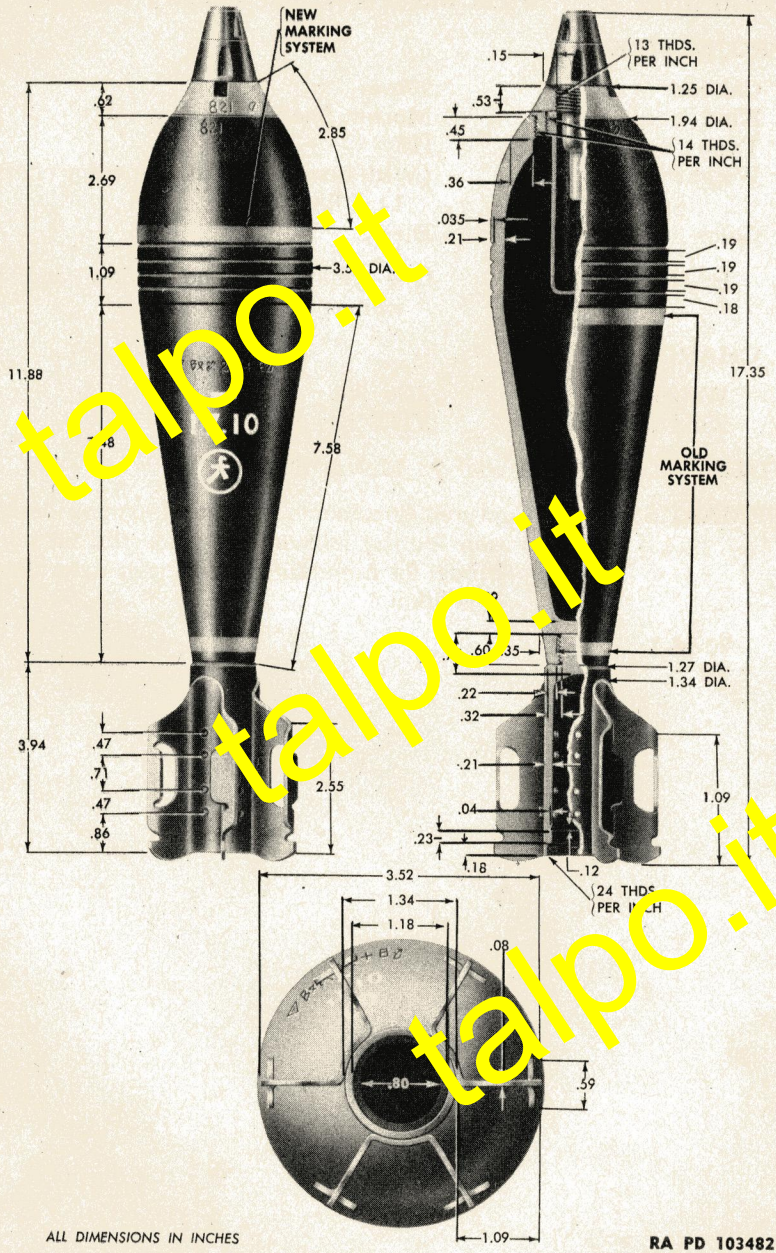
| | | |
|---|---|---|
| Weight | : | 1.98 lbs. |
| Kind | : | TNT has been found |
| TRACER | : | None |

FUZE: Model 100 Mechanical Time Nose Fuze

REMARKS:

88-A-1

## 9CM (90 MM) MODEL 94 HE MORTAR SHELL




ALL DIMENSIONS IN INCHES

RA PD 103482

90-M-1

PROJECTILE: 9 cm (90mm) Model 94 HE Mortar

WEAPONS: 9 cm Model 94 Light Infantry Mortar

PROJECTILE:

| | | |
|---|---|---|
| Caliber | : | 90mm |
| Kind | : | Mortar Shell |
| Type | : | HE |
| Weight | : | (With fuze—without propelling charge) 11.6 lbs. |
| Color | : | Black |
| BANDS | : | One yellow or one yellow and one white |

CHARGE:

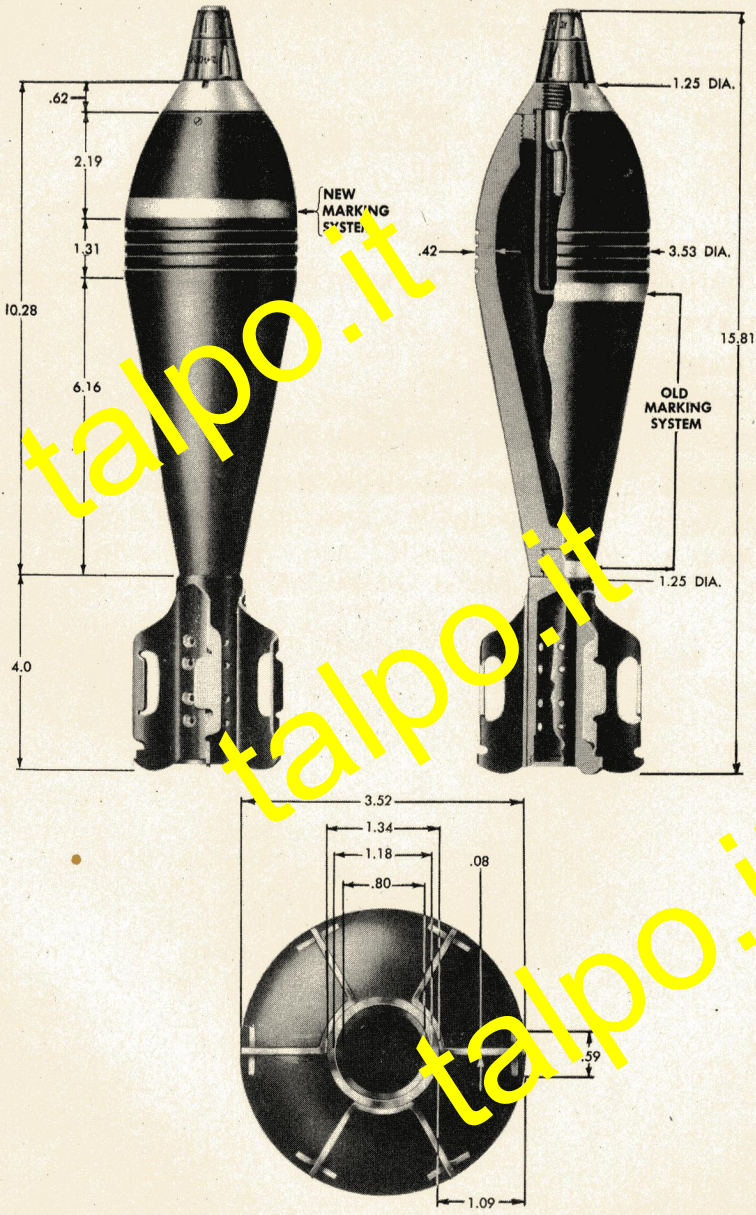
| | | |
|---|---|---|
| Weight | : | 2.36 lbs. |
| Kind | : | TNT has been found |

FUZE: Model 93 Mortar Fuze

REMARKS: Captured documents indicate Japanese designation for the mortar this projectile fires in is Model 94 Light Infantry Mortar even though it is 90mm.

90-M-1

## 9CM (90 MM) HE MORTAR SHELL SEMI-STEEL




ALL DIMENSIONS IN INCHES

RA PD 103483

90-M-2

PROJECTILE: 9 cm (90mm) HE Mortar Semi-steel

WEAPONS: 9 cm Mortar

PROJECTILE:

| | | |
|---|---|---|
| Caliber | : | 90mm |
| Kind | : | Mortar Shell |
| Type | : | HE |
| Weight | : | |
| Color | : | Black |
| BANDS | : | One green or one yellow and one green |

CHARGE:

| | | |
|---|---|---|
| Weight | : | |
| Kind | : | |

FUZES: Model 93 Mortar Fuze

REMARKS: The model number of the mortar from which this projectile is fired has not been determined.

**90-M-2**

## 10CM (105MM) MODEL 91 HE POINTED


ALL DIMENSIONS IN INCHES

RA PD 103484

105-A-1

PROJECTILE: 10 cm (105mm) Model 91 HE Pointed

WEAPONS:
10 cm Model 91 Howitzer
10 cm Model 92 Gun
10 cm Model 14 Gun
10 cm Model 38 Gun

PROJECTILE:

| | | |
|---|---|---|
| Caliber | : | 105mm |
| Kind | : | Shell |
| Type | : | HE |
| Weight | : | (With Fuze) 34.65 lbs. |
| Color | : | Black |
| BANDS | : | One yellow or one yellow and one white |

CHARGE:

| | | |
|---|---|---|
| Weight | : | 5.55 lbs. |
| Kind | : | Mixture of Ammonium Nitrate, Guanidine Nitrate, Cyclonite, or TNT |
| TRACER | : | None |

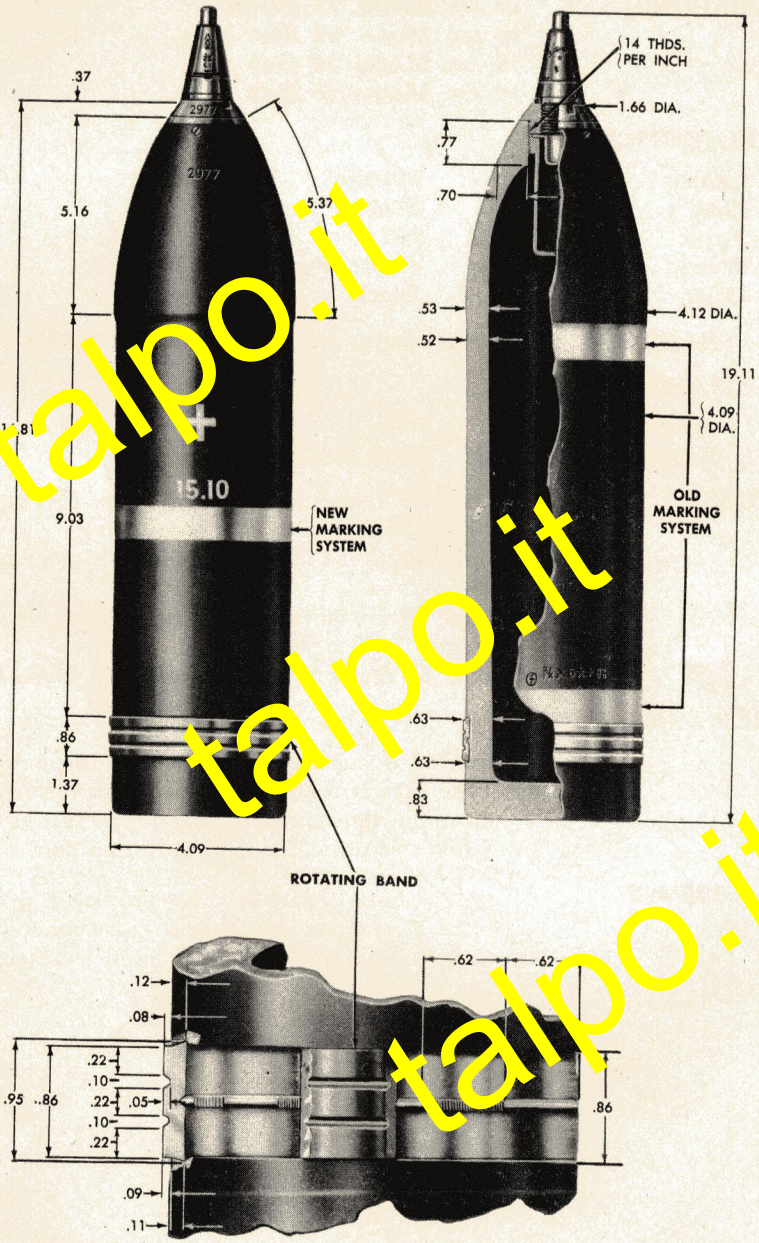
FUZES:
Model 88 Instantaneous (Howitzer-Mortar type) Nose Fuze
Model 88 Short Delay (Howitzer-Mortar type) Nose Fuze
Model 88 Instantaneous (Gun Type) Nose Fuze
Model 88 Short Delay (Gun Type) Nose Fuze

REMARKS:

Captured documents indicate that the howitzer type fuze is used when this projectile is fired from a howitzer and that a gun type fuze is used when this projectile is fired from a gun.

105-A-1

## 10CM (105 MM) MODEL 91 HE




ALL DIMENSIONS IN INCHES

RA PD 103485

105-A-2

PROJECTILE: 12 cm (120mm) HE [Naval]

WEAPONS: 12 cm Low Angle Gun [Naval]

PROJECTILE:

| | | |
|---|---|---|
| Caliber | : | 120mm |
| Kind | : | Shell |
| Type | : | HE (Base Fuzed) |
| Weight | : | (With Fuze) 45.12 lbs. |
| Color | : | Maroon body with red and green nose |
| BANDS | : | One yellow |

CHARGE:

| | | |
|---|---|---|
| Weight | : | 4.6 lbs. |
| Kind | : | Picric acid |

TRACER : None

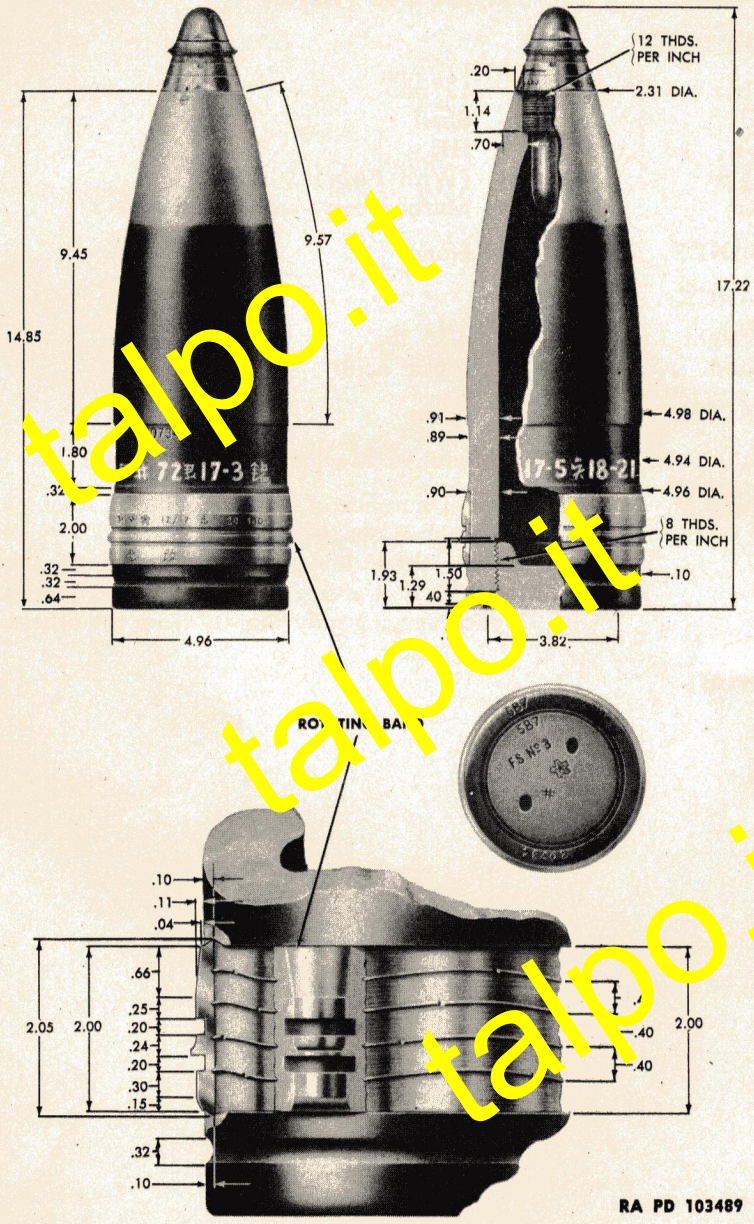
FUZE: Model 3rd Year Base Fuze.

REMARKS:

The model number of the projectile or that of the gun from which fired have not been determined

120-A-3

## 127 MM HE AA [NAVAL]




ALL DIMENSIONS IN INCHES

RA PD 103489

127-A-1

PROJECTILE: 15 cm (150mm) Model 96 HE Mortar

WEAPONS: 15 cm Model 96 Medium Mortar

PROJECTILE:

| | | |
|---|---|---|
| Caliber | : | 150mm |
| Kind | : | Mortar Shell |
| Type | : | HE |
| Weight | : | (With Fuze) 56.6 lbs. |
| Color | : | Black |
| BANDS | : | One yellow or one yellow and one white |

CHARGE:

| | | |
|---|---|---|
| Weight | : | 13 lbs. |
| Kind | | TNT has been found |

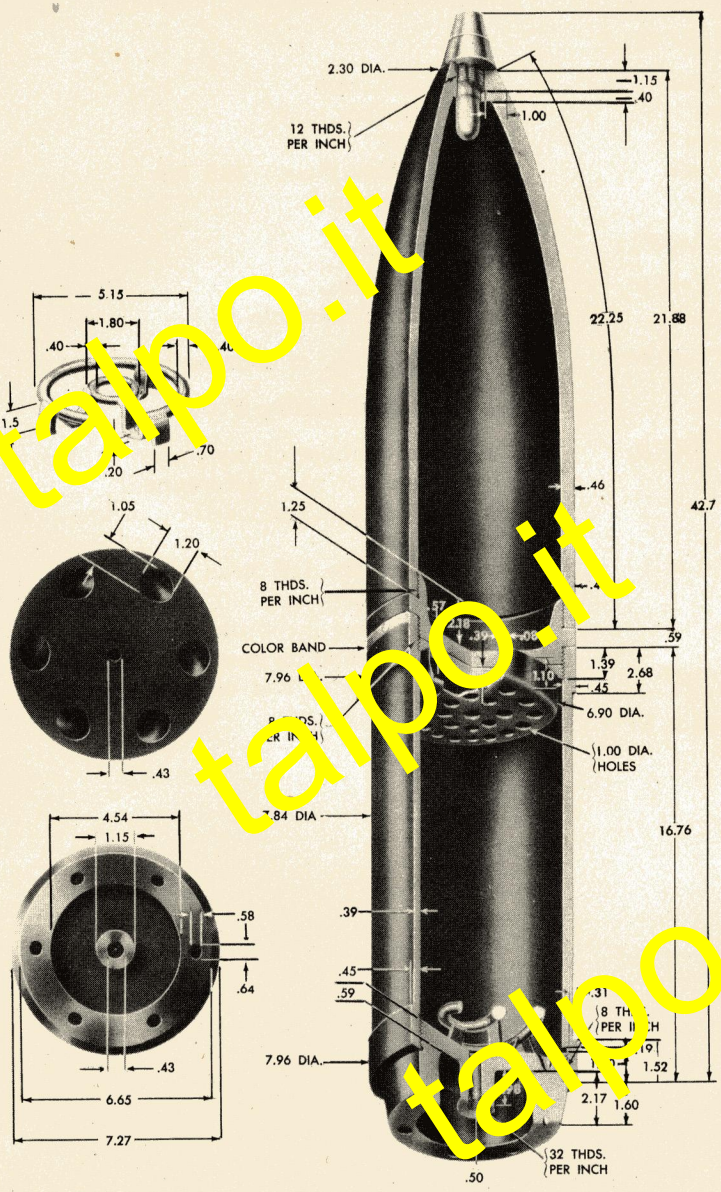
FUZE: Model 93 Mortar Fuze

REMARKS:

The Model 96 is called a Medium mortar although it is 150mm.

**150-M-1**

## 20CM (203.2 MM) HE ROCKET [NAVAL]




ALL DIMENSIONS IN INCHES

RA PD 103496

200-R-1

**PROJECTILE:** 20 cm (203.2mm) Rocket [Naval]

**WEAPONS:** Trough Type Launcher [Naval]

**PROJECTILE:**

| | | |
|---|---|---|
| Caliber | : | 203.2mm |
| Kind | : | Rocket |
| Type | : | HE |
| Weight | : | (With Fuze) 195 lbs. |
| Color | : | Maroon |

**CHARGE:**

| | | |
|---|---|---|
| Weight | : | 34.4 lbs. |
| Kind | : | Trinitroanisole |
| Propellent | : | 18.6 lbs. of Double base powder |

**FUZE:** Point Detonating Nose Fuze

**REMARKS:**

The model number of the rocket or that of the fuze have not been determined.

The rocket is spin stabilized by inclined nozzles in the base.

The case for the HE head is the same as the projectile body on a 20 cm Naval HE Shell and may have a rotating band seat although there is no rotating band. Rockets have been found both with and without the seat.

200-R-1

# APPENDIX I

## CONVERSIONS
### Millimeters to Inches

| MM | IN | MM | IN | MM | IN |
|---|---|---|---|---|---|
| 1 | .03937 | 39 | 1.54 | 77 | 3.03 |
| 2 | .0787 | 40 | 1.58 | 78 | 3.07 |
| 3 | .1181 | 41 | 1.61 | 79 | 3.11 |
| 4 | .1575 | 42 | 1.65 | 80 | 3.15 |
| 5 | .1969 | 43 | 1.69 | 81 | 3.19 |
| 6 | .2363 | 4 | 1.73 | 82 | 3.23 |
| 6.4 | .250 | 44.5 | 1.75 | 82.6 | 3.25 |
| 7 | .27[illegible]5 | 45 | 1.77 | 83 | 3.27 |
| 8 | .[illegible]15 | 46 | 1.81 | 84 | 3.31 |
| 9 | .3[illegible]4 | 47 | 1.85 | 85 | 3.35 |
| 1[illegible] | .39[illegible]7 | 48 | 1.89 | 86 | 3.39 |
| 11 | .433 | 49 | 1.93 | 87 | 3.43 |
| 12 | .473 | 50 | 1.97 | 88 | 3.47 |
| 12.7 | .500 | 50.8 | 2.00 | 88.9 | 3.50 |
| 13 | .512 | 51 | 2.01 | [illegible] | 3.50 |
| 14 | .551 | 52 | 2.05 | 90 | 3.54 |
| 15 | .591 | 53 | 2.09 | [illegible]1 | 3.58 |
| 16 | .63 | 54 | 2.1[illegible] | [illegible] | 3.62 |
| 17 | .67 | 55 | 2.[illegible]7 | 93 | 3.66 |
| 18 | .709 | 56 | 2.[illegible]0 | 94 | 3.70 |
| 19 | .748 | 57 | [illegible].24 | 95 | 3.74 |
| 19.1 | .750 | 57.2 | 2.[illegible]25 | 95.4 | 3.75 |
| 20 | .788 | 58 | 2.28 | 96 | 3.78 |
| 21 | .826 | [illegible] | 2.32 | 97 | 3.82 |
| 22 | .866 | [illegible] | 2.36 | 98 | 3.86 |
| 23 | .906 | 61 | 2.40 | 99 | 3.90 |
| 24 | .945 | 62 | 2.44 | 100 | 3.937 |
| 25 | .985 | 63 | 2.48 | 101 | 3.[illegible]3 |
| 25.4 | 1.00 | 63.5 | 2.50 | 101.6 | 4.00 |
| 26 | 1.02 | 64 | 2.52 | 102 | 4.02 |
| 27 | 1.06 | 65 | 2.56 | 103 | 4.06 |
| 28 | 1.10 | 66 | 2.60 | 104 | [illegible].10 |
| 29 | 1.14 | 67 | 2.64 | 10[illegible] | [illegible].14 |
| 30 | 1.18 | 68 | 2.68 | | |
| 31 | 1.22 | 69 | 2.72 | | |
| 31.8 | 1.25 | 69.8 | 2.75 | | |
| 32 | 1.26 | 70 | 2.[illegible]6 | 200 | 7.874 |
| 33 | 1.30 | 71 | 2.8[illegible] | 300 | 11.811 |
| 34 | 1.34 | 72 | 2.84 | 400 | 15.748 |
| 35 | 1.38 | 73 | 2.88 | 500 | 19.685 |
| 36 | 1.42 | 74 | 2.91 | 600 | 23.622 |
| 37 | 1.46 | 75 | 2.95 | 700 | 27.559 |
| 38 | 1.49 | 76 | 2.99 | 800 | 31.496 |
| 38.1 | 1.50 | 76.2 | 3.00 | 900 | 35.433 |