

MIL- S -13763 (Ord)

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SUPERSEDING

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MILITARY SPECIFICATION

**SHOT, ARMOR-PIERCING, HYPER-VELOCITY;
WITH TUNGSTEN-CARBIDE CORES;
METAL — PARTS ASSEMBLY**

1. SCOPE

1.1 This specification covers hyper-velocity armor-piercing (HVAP) shot, the cores of which are made from tungsten carbide and the carriers of which are made from steel, or aluminum. (See 6.1.)

2. APPLICABLE DOCUMENTS

2.1 The following specifications, together with the Ordnance Corps Drawing and Standard Inspection Procedure pertaining to the shot under contract, and all drawings and specifications referenced thereon, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS

FEDERAL

QQ-M-151 Metals; General Specification For Inspection of

MILITARY

MIL-G-2550 General Specification for Ammunition Except
Small-arms Ammunition
MIL-P-10025 Packing and Marking for Domestic Shipment of
Inert Ammunition Components; General Specifications for
MIL-R-11073 Rotating Band Blanks, Sintered Iron
MIL-B-20292 Blanks, Rotating for Projectiles

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

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3. REQUIREMENTS

3.1 Materials.-Materials and parts shall be in accordance with applicable drawings and specifications.

3.2 Components.-The metal parts shall comply with all requirements specified on the applicable drawing and all drawings referenced thereon, and with all requirements specified in applicable specifications.

3.3 Cores.-Cores shall be manufactured by a commercially acceptable process, and shall comply with all dimension and weight requirements specified on the applicable drawing.

3.4 Assembly of components.-

3.4.1 Body parts.-The bourrelet ring shall be attached to the body by either a press or a shrink fit.

3.4.2 Support of cores.-Core shall be rigidly supported within the metal-parts assembly as shown on the drawing with no movement evident after painting.

3.5 Banding (applicable only to shot having separate rotating bands).-

3.5.1 Band seat.-Prior to banding, the band seats shall be clean and free from oil, grease, dirt, rust, and other foreign material.

3.5.2 Rotating band (gilding metal).-

3.5.2.1 Blanks.-The rotating-band blank shall be in the form of a solid ring, annealed if necessary to comply with the requirements of Specification MIL-B-20292, except that in the case of hot banding at not less than 800° F, no prior annealing shall be necessary.

3.5.2.2 Distortion.-The band shall be applied after final heat treatment of the shot body. It shall be applied in such a manner so as not to distort the walls of the shot. Distortion shall not be considered to have taken place if the band seat, and the shot body immediately adjacent to the band are within drawing tolerances specified.

3.5.2.3 Application.-The bands may be applied either hot or cold, but if applied hot, the contractor shall perform the banding operation in a manner that will hold the scale remaining between the band and the seat to a minimum.

3.5.2.4 Heating.-The bands shall not be heated above 1,600° F to prepare them for application to the shot. The bands shall be heated uniformly throughout and in a manner that will prevent undue oxidation (loose scale).

3.5.2.5 Band seating (applicable to destructive test only).-After seating the rotating band the clearance between the band and band seat shall not exceed .006 inch when tested as specified in 4.6.1.

3.5.2.6 Band seating (applicable to non-destructive test only).-The rotating band shall comply with the requirements specified in Table I when tested as specified in 4.6.2.

TABLE I

CALIBER	SHELL MODEL	INDENTOR SIZE IN INCHES	INDENTOR FACE RADIUS IN INCHES	RAM PRESSURE IN POUNDS (APPROX)	AVERAGE INDICATED DIAMETRICAL CLEARANCE
76MM	T66E3	.3125 x .3125	1.55	9,000	.010

3.5.2.7 Physical properties of rotating bands.-The material for the rotating bands shall have the following physical properties when tested as specified in 4.6.3.

Tensile Strength psi minimum-----32,000
Percent Elongation Min. in 1 inch----- 15

3.5.3 Rotating band (sintered iron).-

3.5.3.1 Band tightness.-The rotating band shall respond with a metallic ringing sound when tested for tightness as specified in 4.7.1.

3.5.3.2 Rockwell hardness.-The Rockwell H reading shall not exceed 100 when tested as specified in 4.7.2.

3.5.3.3 Rotating bands.-The band blanks shall be carefully pressed into band seat so as to have no gap between bottom of band seat and rotating band and so as to make contact with the side walls of the rotating-band seat for minimum distance of 1/2 of the band-seat depth when tested as specified in 4.7.3.

3.5.3.4 Blanks.-The rotating-band blanks shall be in strict compliance with Specification MIL-R-11073.

3.5.4 Protection of rotating band.-The machined rotating bands shall not be nicked, burred, or otherwise damaged and shall be protected from such damage during subsequent handling and storage.

3.6 Pilot-lot requirements.-

3.6.1 The contractor shall produce and submit a pilot-lot sample of a least 40 metal-parts assemblies to the Contracting Officer or representative designated by him, for metallurgical, ballistic, and other tests in order to determine the satisfactoriness of his methods and materials. The pilot lot shall be given 100 percent inspection by gaging and other non-destructive tests. Of this lot, 38 metal parts assemblies shall be assembled by the contractor into complete shot, and forwarded to the Proving Ground for ballistic tests. The remaining 2 metal parts assemblies shall be retained at the inspection arsenal for destructive metallurgical examination as deemed necessary. Production continued under the contract, prior to the approval of the pilot lot, shall be at the risk of the contractor.

3.6.2 Ballistic requirements.-(pilot-lot)

3.6.2.1 Plate penetration.-The Protection Ballistic Limit, BL(P), of the pilot-lot samples shall not exceed the BL(P) of the reference lot samples by more than 100 f/s when tested as specified in 4.8.1.

3.6.2.2 Security.-There shall be no loss, or breakup, of any shot component either in the gun bore or in flight when tested as specified in 4.8.2.

3.7 Ballistic requirement (production lot).-

3.7.1 Plate penetration.-The BL(P) of the production lot samples shall not exceed the BL(P) of the reference lot samples by more than 100 f/s when tested as specified in 4.9.1.

3.7.2 Security.-There shall be no loss, or breakup, of any shot component either in the gun bore or in flight when tested as specified in 4.9.2.

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3.8 Cleanliness. -All parts shall be free of chips, dirt, grease, rust, and other foreign material.

3.8.1 Cleaning before assembly. -The surfaces of all shot parts shall be clean and free of foreign material at the time of assembly. The cleaning method used shall not be injurious to any of the parts nor shall the parts be contaminated by the cleaning agents used.

3.9 Workmanship. -The workmanship shall be of such quality that all parts shall be acceptable under visual inspection and shall meet all dimensional and physical properties prescribed.

4. QUALITY ASSURANCE PROVISIONS

4.1 Lot. -A lot shall consist of all assemblies manufactured by one manufacturer under one contract, in one unchanged process in accordance with the same drawing, same drawing revision, same specification, and same specification revision. Each lot shall contain cores made by one manufacturer, in accordance with one unchanged process and consisting of tungsten-carbide powdered-metal mixture from batches made in accordance with one unchanged process and binder of not more than one type (i.e. cobalt, or a nickel-cobalt mixture, etc.).

4.2 Sampling. -Number of samples, acceptance, and rejection criteria used for determination of lot acceptance for tests specified in 4.4, 4.5, 4.6 and 4.7 shall be in accordance with the applicable Standard Inspection Procedure. Samples for proving ground tests specified in 4.8 and 4.9 shall be selected by the inspector in accordance with Table II.

TABLE II

Proving-ground Samples

A.	Plate Penetration	
	1. Pilot lot	18
	2. Production lot ^a	9
B.	Security	
	1. Pilot lot	10
	2. Production lot	5
C.	Velocity-Accuracy	
	1. Pilot lot	10
	2. Production lot	2 ^b

NOTES:

^aThe manufacturer may wait until the results of the armor plate penetration test are available before proceeding with banding and assembly of the complete lot. Assembly of the lot shall be completed prior to selection and submission of the balance of proving-ground samples.

^bTwo sample shot from each production lot shall be retained by the manufacturer until 10 samples have been accumulated. These samples shall then be shipped to the proving ground for test.

4.3 Inspection.-General inspection shall be as specified in Specification MIL-G-2550 and QQ-M-151. (When applicable)

4.4 Integral rotating-band hardness test.-Sample shot shall be selected and subjected to a hardness test using a Rockwell or similar type of hardness-testing machine to determine that the rotating-band hardness does not exceed the requirement specified on the drawing.

4.5 Core tests.-

4.5.1 Hardness.-Each core shall be tested on the base, or on the cylindrical portion approximately at the center, to determine compliance with the hardness requirement specified on the drawing for the core. A spot may be ground on the cylindrical portion not to exceed .010 inch deep. The hardness of cores shall be shown on the data card, by listing the quantity of cores in each range of not more than two points, Rockwell "A".

4.5.2 Bend.-Each core shall be tested for gross flaws by being subjected to a bending load in the manner specified on the applicable drawing. In the case of minor superficial flaws, the core shall be positioned with the flaw in tension during the application of load. After completion of the bend test each core shall pass freely through a tube of the dimensions specified on the drawing.

4.5.3 Chemical.-A certified chemical analysis of the blended powder produced shall be furnished on the data card by the contractor (see 6.2).

4.6 Rotating-band test (gilding metal).

4.6.1 Destructive method of inspecting rotating-band tightness of shot other than those listed in Table I.-The rotating band of the sample shot shall be tested as follows: Prior to removal, the diameter of the finished band shall be measured on three diameters 60° apart, and on two points along the cylindrical portion of its length (near the front and near the rear edge). This comprises six diametral measurements. These points of measurement shall be marked on the bands as well as the orientation of the band on the shot. The band shall be carefully removed so as to keep deformation to a minimum. After removal, the thickness of the band shall be measured at each of the marked points (a total of twelve measurements) and the diameter of the band seat corresponding to these points shall be also be measured. To each of the diameters of the band seat the sum of the corresponding two thicknesses of the band shall be added and the result subtracted from the corresponding exterior diameter of the band previously determined. The result shall indicate the total diametral clearance between the band and its seat to determine compliance with 3.5.2.5. If the band is well seated, a negative clearance or interference may be indicated on some of the measurements or even on the average of all measurements. When irregular band profile interfere with ease of measurement, the manufacturer shall be authorized to machine the outside of the band in order to obtain an adequate cylindrical surface. The diameter of the machined band shall exceed the bourrelet diameter.

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4.6.2 Non-destructive method of inspecting rotating-band tightness.-The rotating band of the sample shot shall be tested in an approved machine consisting of a hydraulic press having one movable ram capable of exerting a total ram pressure of 12,000 pounds minimum. Two indentors (or anvils) of rectangular cross section, each having a face radius to match the band diameter (see Table I) shall be provided, one on a fixed adjustable post and one on the movable ram of the press but both on a common center line. The press shall be fitted with indicators to show the pressure on ram and the motion of the ram. The band seating shall be inspected by pressing the band between the indentors in two planes (normal to the longitudinal axis of the shot) approximately 90° apart and measuring the travel of the indentors due to the application of pressure. Care shall be exercised so as not to take readings until after full pressure has been applied and the motion of the ram ceased as shown by the dial indicator. Information regarding the types of approved machine and their specific operating instructions may be obtained from the procuring agency. The pressure used (see Table I) shall be great enough to seat the band under the indentors, but not so great that permanent deformation of the shot occurs. The difference in the measured diameter of the rotating band before and after the application of pressure represents the sum of the clearance under the band in that plane. The readings in the two planes shall not exceed the value shown in Table I. The impression left by the indentors shall not be cause for rejection of the shot. The non-destructive test shall be performed after the O.D. band inspection; the slight increase in O.D. over the maximum shall not be cause for rejection. The degree of rotating-band tightness shall be read to determine compliance with 3.5.2.6.

4.6.3 Physical-property tests of rotating bands.-A sample of unmachined bands, from which a light surface cut (.02 maximum) has been taken, shall be removed to provide specimens to be subjected to each of the tests specified in 3.5.2.7. The bands shall be carefully removed from the shot and carefully flattened without hammering. Each test specimen shall be cut along the direction of the flattened length and prepared in such manner as to hold to the minimum any additional cold working. Samples shall be selected and tested in accordance with Specification QQ-M-151 for determination of percent elongation and tensile strength. In addition, test specimens for elongation and tensile strength shall be machined to the form and dimensions specified in Specification MIL-B-20292; for tensile properties of bands less than .5 inch in width a specimen machined to the maximum rectangular cross-section that can be obtained from an unmachined band shall be used.

4.7 Rotating-band test (sintered iron).

4.7.1 Non-destructive method of inspecting rotating-band tightness.-The rotating band of the sample shot shall be subjected to a sonic test. A hammer of copper, bronze, or soft iron shall be caused to give a light clean blow on the soft surface of the band to determine compliance with 3.5.3.1.

4.7.2 Rockwell hardness.-Rockwell "H" readings shall be taken on at least three points around the circumference of the band in accordance with Specification QQ-M-151 to determine compliance with 3.5.3.2.

4.7.3 Destructive method of inspecting rotating-band tightness.-The rotating band sample shot selected shall be tested as follows: Carefully cross-section the shot with a wet abrasion cut-off wheel so as to produce four segments of 90° each. Visual examination of the 16 pieces shall then be conducted to determine compliance with 3.5.3.3.

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4.8 Proving-ground test (pilot-lot).-

4.8.1 Plate penetration.-Prior to firing pilot-lot penetration samples, the BL(P) of a reserve reference lot of the same caliber and model as the pilot lot, shall be determined. The BL(P) is defined as the mean of six velocities, to include three complete and three partial penetrations, the velocity spread of which shall not exceed 100 feet per second. Following determination of the BL(P) of the reference lot, the BL(P) of the pilot lot shall be determined as indicated above, utilizing samples selected in accordance with Table II of 4.2. All samples shall be fired from a gun for which the shot is standard, against homogeneous armor plate, placed approximately 300 feet from the muzzle of the gun. Thickness and obliquity of plate shall be as specified in Table III. A complete penetration shall be considered to have occurred if a fragment of the plate or core is thrown beyond the rear of the plate with sufficient energy to penetrate a 0.020-inch aluminum alloy (24 ST) sheet, or its equivalent, placed parallel to, and one foot behind the plate. When in the proof-officer's opinion, it is possible to observe that these conditions are being complied with, without the use of a sheet, as in testing against heavier plate, the sheet may be omitted. An impact that occurs under the following conditions shall be disregarded and another sample fired in its stead: (Cost of such additional samples and testing will be borne by the Government.) (See 6.4.)

- a. Any core that strikes within three core diameters of the edge of the plate.
- b. Any core that strikes within two core diameters of a previous impact or whose path of penetration intersects a previous hole.
- c. Any shot that strikes in the spalled area of a previous impact.

TABLE III

Caliber (Size)	Thickness (Inches)	Armor Plate Obliquity
76-MM		
Pilot Lot	2"	60°
Production Lot	2"	30° 60°
90-MM		
Pilot Lot	3"	55°
Production Lot	3"	30° 55°

4.8.2 Security test.-The sample shot, selected in accordance with Table II of 4.2, shall be assembled into complete rounds using propellant of a weight calculated to give a pressure equal to the rated maximum pressure of the shot in a new gun for the applicable combination of shot and gun. Five rounds shall be fired hot (125°F), and five rounds shall be fired cold (-40°F). The complete rounds of fixed ammunition shall be held at the proper

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temperature for a period of not less than 24 hours, and shall be fired within two minutes after removal from the conditioning chamber. The shot shall be fired through paper screens situated approximately 100 and 300 feet from the gun, into a target at approximately 1000 yards range. A gun in the last quarter of its service life shall be used. Observation shall be made for evidence of loss, or break-up of any shot component either in the gun or in flight to determine compliance with 3.6.2.2.

4.8.3 Velocity-accuracy test.-The sample shot, selected in accordance with Table II of 4.2, shall be fired from a gun, for which shot is standard, for comparison with a group of tenshot from a reference lot, utilizing the service charge. The sample shot and reference shot shall be fired alternately, and the velocity and accuracy measurement shall be obtained, for information only, at approximately 100-yard range. Accuracy shall be recorded in the firing record in terms of Probable Error (PE) horizontal and vertical. Accuracy data is for information only and will not be used to determine acceptance or rejection of the lot. (See 6.3).

4.8.4 Acceptance.-The pilot lot shall be considered acceptable provided the shot fired comply with the requirements of 3.6.2.1 and 3.6.2.2.

4.9 Proving-ground test (production lot). (See 6.5.)

4.9.1 Plate penetration.-The BL(P) of a reference lot and the BL(P) of the production lot shall be determined in the same manner as specified in 4.8.1, except that production-lot samples shall be used.

4.9.2 Security.-The sample shot, selected in accordance with Table II of 4.2, shall be fired in a gun for which standard, in the last quarter of its service life, with a propellant adjusted to obtain 112 percent of the rated maximum pressure in a new gun. The shot shall be fired through paper screens placed 100 feet and 300 feet from the gun, into a target at approximately 1000 yards range. Observation shall be made for evidence of loss, or break-up, of any shot component either in the gun bore or in flight, to determine compliance with 3.7.2.

4.9.3 Velocity-accuracy.-The procedure for tests shall be conducted in the same manner as specified in 4.8.3, except that production-lot samples shall be used.

4.9.4 Acceptance.-The lot shall be considered acceptable provided the shot fired complies with the requirements of 3.7.1 and 3.7.2. The lot shall be considered eligible for retest under the provisions of 4.9.5 provided:

- a. The BL(P) of the production lot is greater than 100 f/s of the BL(P) of the reference lot or
- b. not more than one shot shows a loss, or breakup, of its component parts in the gun bore or in flight.

The shot shall be rejected if the limits for eligibility for retest are exceeded.

4.9.5 Retest.-The retest shall be limited to the phase in which failures occur, i.e. plate penetration, or security.

4.9.5.1 Plate penetration.-A retest as provided for in 4.9.4 may be made if requested by the contractor by using eighteen sample shot. The BL(P) shall be determined twice, independently. The lot shall be considered acceptable on retest provided the BL(P) of each of the two groups is not greater than 100 f/s above the BL(P) of the reference lot.

4.9.5.2 Security. -A retest as provided for in 4.9.4 may be made if requested by the contractor by using double the number of samples. The lot shall be considered acceptable on retest provided the shot fired complies with the requirement of 3.7.2.

4.10 Reprocessing. -In the event of failure attributable to cores, the manufacturer may reprocess the cores in a lot by re-sintering, repressing, or re-inspecting and submit the lot for retest. A lot of shot may be reprocessed not more than twice, and after each reprocessing submitted but once to the proving ground for test.

5. PREPARATION FOR DELIVERY

5.1 Packing, labeling, and marking. -Packing, labeling, and marking shall be as specified in Specification MIL-P-10025.

5.2 Data cards. -Data-card information shall be as specified in MIL-G-2550. In addition the data cards shall contain on the reserve side the following information:

1. Name of core manufacturer.
2. Name of carrier manufacturer.
3. Chemical composition of core. (See 6.2.)
4. Hardness of cores in range of two points Rockwell "A".
5. Method of core manufacture (hot-press, cold-press, or specify other means.)
6. Details of reprocessing, when applicable.
7. Category, in accordance with 4.2, when applicable.

6. NOTES

6.1 Ordering data. -Procurement documents should specify the title, number and date of this specification.

6.2 Chemical composition. -While the chemical composition given on the applicable drawing is advisory rather than mandatory, a complete analysis will be included on the data card for informational purposes only. The composition given on the drawing represents that with which past experience indicates best results are obtainable.

6.3 Velocity and accuracy requirements. -Proving-ground tests for velocity and dispersion, are not acceptance tests. Firing of shot from each of the test lots will be interspersed with one of a reference lot, continuing until test is completed.

6.4 Replacement samples. -To cover the possibility of unfair impacts in the armor-plate penetration test, the necessity of obtaining replacement samples, and the consequent delay in obtaining ballistic test results, additional samples for the plate penetration test may be shipped to the proving ground with the original sample. Unused sample will be returned to the contractor, or the contractor will be reimbursed for the cost of samples used to replace those that impacted unfairly.

6.5 Defective cores. -Cores rejected for minor defects not affecting dimensions or weight may be supplied for security and velocity tests of production lots. Shot so assembled will be suitably marked.

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