

INCH-POUND

MIL-DTL-60547G (AR)

17 December 2008

SUPERSEDING

MIL-P-60547F (AR)

25 August 1986

DETAIL SPECIFICATION

PROJECTILE, 105MM, HE, M1 AND M760  
METAL PARTS ASSEMBLY

Inactive for new design after 9 February 1996.

This specification is approved for use by the U.S. Army Armament Research Development and Engineering Center (ARDEC), and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification contains requirements not covered by the drawings for the fabrication and assembling of metal parts for Projectile, 105MM, HE, M1 and M760. (see 6.1).

Comments, suggestions, or questions on this document should be addressed to the Commander, U.S. Army ARDEC, ATTN: AMSRD-AAR-QES-E, Picatinny, NJ 07806-5000 or emailed to [ardecstdzn@conus.army.mil](mailto:ardecstdzn@conus.army.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil>.

AMSC N/A

FSC 1315

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distribution is unlimited

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## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to assure the completeness of this list, document users are cautioned that they must meet all requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards and handbooks. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

## FEDERAL SPECIFICATIONS

TT-C-490 - Chemical Conversion Coatings and Pretreatments for Ferrous Surfaces (Base for Organic Coatings)

## DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1168 - Ammunition Lot Numbering and Ammunition Data Card  
MIL-STD-1916 - DoD Preferred Methods for Acceptance of Product

(Unless otherwise indicated, Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation or contract.

## US ARMY ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (ARDEC) DRAWINGS

9280429 - Rotating Band Seat Tester

12991876 - Ultrasonic Inspection Standard, Longitudinal and Radial Cracks, 105MM, M1 and M760 Body

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- 12991877 - Ultrasonic Inspection Standard, Circumferential and Piping Defects, 105MM, M1 and M760 Body
- 12991878 - Envelope Drawing, Ultrasonic Inspection Equipment and Procedure for Body Machined, 105MM, M1
- 10535876 - Projectile, 105MM, HE, M1, Metal Parts Assembly
- 12551742 - Projectile, 105MM, HE, M760, Metal Parts Assembly
- 10535877 - Body Assembly, M1
- 12551741 - Body Assembly, M760
- 10535878 - Body, M1
- 12551740 - Body, M760
- 8594851 - Blank, Rotating Band

(Copies of these drawings may be requested online at [pica.drawing.request@conus.army.mil](mailto:pica.drawing.request@conus.army.mil) or from U.S. Army ARDEC, ATTN: AMSRD-AAR-AIS-TD, Picatinny, NJ 07806-5000.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL (ASTM)

- ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus
- ASTM E8 - Standard Test Method for Tension Testing of Metallic Materials
- ASTM E10 - Standard Test Method for Brinell Hardness of Metallic Materials
- ASTM E103 - Standard Test Method for Rapid Indentation Hardness Testing of Metallic Materials

(Copies of ASTM standards are available online at <http://www.astm.org> or from American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- ANSI-B46.1 - Surface Texture, Surface Roughness, Waviness, and Lay

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(Copies of ANSI standards are available online at <http://www.ansi.org/> or from American National Standards Institute, 25 West 43<sup>rd</sup> Street, New York, NY 10036)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

#### 3.1 Required inspections.

3.1.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.2.

3.1.2 Conformance. A sample shall be subjected to conformance inspection in accordance with 4.3.

3.2 Components and assemblies. The components and assemblies shall comply with all requirements specified on drawing 10535876 for the M1, or drawing 12551742 for the M760.

3.2.1 Body (prior to nosing). The materials, components and assemblies shall be in accordance with drawing 10535878 for the M1, or drawing 12551740 for the M760.

3.2.2 Body (prior to band seat machining and threading nose). The materials, components and assemblies shall be in accordance with drawing 10535878 for the M1, or drawing 12551740 for the M760.

3.2.3 Body. The materials, components and assemblies shall be in accordance with drawing 10535878 for the M1, or drawing 12551740 for the M760.

3.2.4 Body assembly. The materials, components and assemblies shall be in accordance with drawing 10535877 for the M1, or drawing 12551741 for the M760.

3.2.5 Projectile, 105MM, HE, M1 or M760 (as applicable) Metal Parts Assy. The materials, components and assemblies shall be in accordance with drawing 10535876 for the M1, or drawing 12551742 for the M760.

3.2.6 Projectile, 105MM, HE, M1 or M760 (as applicable) metal parts assembly destructive lot acceptance. The materials, components and assemblies shall be in accordance with drawing 10535876 for the M1, or drawing 12551742 for the M760.

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3.3 Ammunition lot numbering. Ammunition lot numbers shall be assigned in accordance with MIL-STD-1168.

3.4 Mechanical properties. Heat treatment or stress relief applied shall be uniform throughout each lot of projectiles and shall be so performed and controlled as to produce in the projectile the mechanical properties specified in drawing 10535878 for the M1, or drawing 12551740 for the M760.

3.4.1 Rotating band mechanical properties. After application and subsequent removal, the rotating band shall have the following mechanical properties:

- a. Tensile strength - 30,000 lbs per square inch (PSI) minimum
- b. Elongation - 15 percent in one inch of gage length, minimum

3.5 Projectile material defects.

3.5.1 Projectile cavity. The projectile cavity shall be free from scale, fins, burrs, draw marks, laminations, imbedded foreign matter, pits, and sharp edges (see 6.5).

3.5.2 Projectile. The projectile, including the cavity, shall be free from cracks, splits, bursts, cold shuts, pipe, porosity, inclusions, folds, seams, and other metal defects (see 6.5).

3.6 Rotating band.

3.6.1 Foreign matter on band seat. Prior to banding, the band seat shall be free from oil, grease, dirt, rust or other foreign matter. Shot or sandblasting shall not be permitted for cleaning the band seat.

3.6.2 Band blank. The rotating band blank shall be in the form of a solid ring, annealed if necessary to comply with the requirements of drawing 8594851.

3.6.3 Application. The rotating band shall be applied after final heat treatment of the body, by carefully pressing the band blank into the band seat so as to make contact with the sidewalls for a minimum of eight-tenths of the band seat depth. There shall be no gap between the rotating band and the sidewalls of the band seat, after the rotating band has been machined to final dimension. The band shall be applied in such a manner as not to distort the body wall.

3.6.4 Band seating. The diametrical clearance between the rotating band and band seat shall not exceed 0.006 inches, when the destructive method of testing is used, or 0.009 inches when the non-destructive method of testing is used.

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3.7 Ultrasonic test. Projectiles shall be free of any discontinuities equal to or in excess of the ultrasonic inspection criteria for the respective zones. The inspection criteria are notches and holes in standards (on dwg. 12991876 and dwg. 12991877) which simulate larger metal defects. Ultrasonic inspection is to be performed in accordance with drawing 12991878 prior to band seat and thread machining.

3.8 Interior cavity finish. The interior cavity after painting shall be free from bare spots, blisters, grease, dirt and other foreign matter. There shall be no pool of paint in the bottom of the cavity.

3.9 Workmanship. The requirements for workmanship are as follows:

3.9.1 Surface preparation. Preparation of metal surfaces shall be as specified on drawing 10535878 for the M1, or drawing 12551740 for the M760. Where cleaning and preparation are required by component details, the finish specified shall apply to the indicated surfaces regardless of contour configuration.

3.9.2 Painting. Painting shall comply with the requirements of drawing 10535876 for the M1, or drawing 12551742 for the M760. All paint shall be dry to the touch before packing for shipment. Drying time prior to packing shall be in accordance with drawing 10535876 for the M1, or drawing 12551742 for the M760.

3.9.3 Burr. No part shall have a burr which might interfere with the assembly or function of the round or which might be injurious to personnel handling the item.

3.9.4 Threads. The threads shall be full and undamaged for the entire minimum length or depth as specified on drawing 10535878 for the M1, or drawing 12551740 for the M760.

3.9.5 Foreign matter. No part of the assembly shall contain dirt, grease, chips, rust, corrosion or other foreign matter.

3.9.6 Protection of rotating band. The machined rotating band shall be protected from being nicked, burred or otherwise damaged in subsequent handling prior to shipment.

3.10 Ballistics test. The projectile assembly shall reveal no evidence of metal parts failure. Metal parts failure shall be defined as:

3.10.1 Breakup. There shall be no loss or breakup of metal parts components in the gun bore or in flight.

3.10.2 Rotating band failure. There shall be no loss or fanning of the rotating band.

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3.10.3 Shearing of rotating band. There shall be no shear of the rotating band as evidenced by complete lack of engraving.

## 4. VERIFICATION

TABLE I Requirement/verification cross reference matrix.

Methods of Verification N/A - Not Applicable 1 - Analysis 2 - Demonstration 3 - Examination 4 - Test						Classes of Verification A- First Article B- Acceptance			
Section 3 Requirements	Description	Verification Method				Verification Class		Section 4 Verification	
		N/A	1	2	3	4	A	B	
3.1.1	First article				X	X	X		4.2
3.1.2	Conformance				X	X		X	4.3
3.2	Components and assemblies				X	X	X	X	4.3
3.2.1	Body (prior to nosing)				X	X	X	X	4.3.2.1
3.2.2	Body (prior to band seat machining and threading nose)				X	X	X	X	4.3.2.2
3.2.3	Body				X	X	X	X	4.3.2.3
3.2.4	Body assembly				X	X	X	X	4.3.2.4
3.2.5	Projectile, 105MM, HE, M1 or M760 (as applicable) metal parts assembly.				X	X	X	X	4.3.2.5/4.4.5/ 4.4.6
3.2.6	Projectile, 105MM, HE, M1 or M760 (as applicable) metal parts assembly destructive lot acceptance				X	X	X	X	4.3.2.6
3.3	Ammunition lot numbering				X		X	X	4.3.1

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TABLE I Requirement/verification cross reference matrix-Continued

Methods of Verification N/A - Not Applicable 1 - Analysis 2 - Demonstration 3 - Examination 4 - Test						Classes of Verification A- First Article B- Acceptance		
Section 3 Requirements	Description	Verification Method				Verification Class		Section 4 Verification
3.4	Mechanical properties (projectile)				X	X	X	4.4.2.1/4.4.2.2
3.4.1	Mechanical properties (rotating band)				X	X	X	4.4.3.2
3.6.1	Foreign matter on band seat			X		X	X	4.3.2.3/4.3.2.4
3.6.2	Band blank			X		X	X	4.4.3.1
3.9	Workmanship			X		X	X	4.3.2.1/ 4.3.2.3- 4.3.2.5
3.10	Ballistic test				X	X	X	4.3.2.6/4.4.7

4.1 Classification of verification. The verification requirements specified herein are classified as follows:

- a. First article inspection (see 4.2).
- b. Conformance inspection (see 4.3).

4.2 First article inspection.

4.2.1 First article quantity. First article verification shall be performed on the quantity of items as indicated in Table II.

4.2.2 Inspections to be performed. The first article verification shall be performed in accordance with Table II.

4.2.3 First article rejection. If any item fails to comply with requirements, the first article sample shall be rejected.



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TABLE II. First article inspection

EXAMINATION OR TEST	NUMBER OF SAMPLES	REQUIREMENT PARAGRAPH	INSPECTION METHOD REFERENCE
<u>Projectile, 105MM, HE, M1 or M760 metal parts assembly</u> Dwg. 10535876 or 12551742 (as applicable) Ballistic performance for structural integrity Examination for defects Salt spray testing Protective coating thickness	50 5 (note 1) 5 (note 1) 5 (note 1)	3.10 3.2.5 3.2.5 3.2.5	4.4.3.6/4.4.7 4.3.2.5 4.4.6 4.4.5
<u>Body assembly</u> Dwg. 10535877 or 12551741 (as applicable) Examination for defects Band seating Mechanical properties - rotating band	5 5 5	3.2.4 3.6.3/3.6.4 3.4.1	4.3.2.4 4.4.3.3 4.4.3.2
<u>Body</u> Dwg. 10535878 or 12551740 (as applicable) Examination for defects Yield strength and elongation test	5 2	3.2.3 3.4	4.3.2.3 4.4.2.2
NOTES: 1. These 5 samples can be used for all item tests.			

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TABLE II. - First article inspection - Continued

EXAMINATION OR TEST	NUMBER OF SAMPLES	REQUIREMENT PARAGRAPH	INSPECTION METHOD REFERENCE
<u>Body (prior to band seat machining and threading nose)</u> Dwg. 10535878 or 12551740 (as applicable) Examination for defects Ultrasonic testing  <u>Body (prior to nosing)</u> Dwg. 10535878 or 12551740 (as applicable) Examination for defects  <u>Blank, rotating band</u> Dwg. 8594851 Mechanical properties	   5 5   5   5	   3.2.2 3.7   3.2.1   3.6.2	   4.3.2.2 4.4.4   4.3.2.1   4.4.3.1

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#### 4.3 Conformance inspection.

4.3.1 Lot formation. Lot formation shall be in accordance with lot formation requirement of MIL-STD-1916 (formation and identification of lots or batches).

4.3.1.1 Heat treatment inspection lot. Heat treatment inspection lots shall not exceed one mill heat of steel. Whenever a break in heat treating of eight (8) hours or more occurs or a furnace is shut down for any length of time, the heat treatment inspection lot will be terminated and a new lot shall start. Additionally, heat treatment inspection lots shall be restricted to components heat treated in the same heat treating equipment, at the same temperature, for the same length of time and in one unchanged process. Test samples shall be selected from the heat treatment inspection lot after final heat treatment. Components in heat treatment inspection lots shall remain grouped together and identified by inspection lot until mechanical property tests have been completed.

4.3.1.1.1 Heat treatment inspection lot for batch furnaces. When a batch type furnace is used, the heat treatment inspection lot shall be further restricted to those components heat treated at the same time in one batch. Batches may be combined into larger heat treatment inspection lots after qualifying with individual batches (see 6.14), and provided the restrictions detailed in this paragraph and in paragraph 4.3.1.1 are met.

4.3.1.2 Miscellaneous lots. Small lots (such as bodies manufactured from abnormally small heats of steel, or bodies that have become separated from previously delivered lots, etc.) may at the discretion of the supplier be grouped into miscellaneous heat treatment lots. Such lots shall be identified by a miscellaneous lot number. Test samples shall be selected from the heat treatment inspection lot after final heat treatment. Components in heat treatment inspection lots shall remain grouped together and identified by inspection lot until mechanical property tests have been completed. The miscellaneous lot thus constituted shall be the basis for the selection of samples for the tension test hereinafter prescribed.

4.3.1.3 Projectile lots. When it has been determined that bodies of a heat treated lot have complied with the mechanical properties requirement of drawing 10535878 for the M1, or drawing 12551740 for the M760, they may be grouped for further processing.

#### 4.3.2 Classification of characteristics.

a. Sampling requirements. Inspection sampling requirements for critical, major and minor characteristics are defined in MIL-STD-1916. Unless specified otherwise, inspection level IV shall

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be used for all characteristics defined as majors and inspection level II for all minor characteristics; critical characteristics shall be addressed in accordance with MIL-STD-1916.

b. Conformance inspection. Conformance inspection shall be performed in accordance with paragraph 4.3.2.1 through 4.3.2.6. For all conformance inspections the same sample specimen may be used for all non-destructive examinations or tests.

c. Alternative inspections. Alternative conformance inspections may be submitted and approved in accordance with MIL-STD-1916.

d. Tool control. Dimensions marked tool control on dwgs. 10535878 and 12551740 shall be gaged at the beginning of production and whenever tooling is replaced. Where destruction of components is necessary to inspect these dimensions, measurements of the tool may be substituted provided there is an established correlation between the tool dimensions and the component dimensions prior to the start of production. There shall be adequate sampling to assure that the drawing requirements are being met.

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Conformance inspection by classification of characteristics

PARAGRAPH 4.3.2.1	TITLE Body (prior to nosing)	SHEET 1 OF 1		DRAWING NUMBER 10535878 or 12551740 (as applicable)
				NEXT HIGHER ASSEMBLY 10535877 or 12551741 (as applicable)
CLASSIFICA TION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	INSPECTION METHOD REFERENCE
<u>Critical</u>	None defined			
<u>Major</u> 101	Diameter of charge cavity at forward bourelet location	Level IV	3.2.1	AIE
102	Length from base of charge cavity to inside basic diameter	Level IV	3.2.1	AIE
103	Visual indication of metal defects in the body cavity	100%	3.5.1	4.4.1/Visual
<u>Minor</u> 201	Evidence of poor workmanship	Level II	3.9	Visual

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Conformance inspection by classification of characteristics

PARAGRAPH 4.3.2.2	TITLE Body (prior to band seat machining and threading nose)	SHEET 1 OF 1		DRAWING NUMBER 10535878 or 12251740 (as applicable)
				NEXT HIGHER ASSEMBLY 10535877 or 12551741 (as applicable)
CLASSIFICA TION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	INSPECTION METHOD REFERENCE
<u>Critical</u> 1	Ultrasonic test	100%	3.7	4.4.4
<u>Major</u> 101	Ultrasonic test stamp missing, see note 1	100%	3.2.2	Visual
<u>Minor</u>	None defined			
NOTES: 1. Any part found without the required test stamp shall be ultrasonically tested to determine if the part fails the critical test. If the part fails the critical test it shall be treated as a critical nonconformance. If the part passes the critical test it shall be treated as a major nonconformance.				

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Conformance inspection by classification of characteristics

PARAGRAPH	TITLE	SHEET 1 OF 3		DRAWING NUMBER
4.3.2.3	Body			10535878 or 12251740 (as applicable)
				NEXT HIGHER ASSEMBLY 10535877 or 12551741 (as applicable)
CLASSIFICATION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	INSPECTION METHOD REFERENCE
<u>Critical</u>	None defined			
<u>Major</u>				
101	Length from edge of band seat to rear rib	Level IV	3.2.3	AIE
102	Length between rear and middle ribs	Level IV	3.2.3	AIE
103	Length between middle and front ribs	Level IV	3.2.3	AIE
104	Angle of ribs in profile	Level IV	3.2.3	AIE
105	Height of ribs, min.	Level IV	3.2.3	AIE
106	Width of band seat	Level IV	3.2.3	AIE
107	Runout of pitch diameter of thread with bourrelets and front face	Level IV	3.2.3	AIE
108	Runout of ogive with bourrelets	Level IV	3.2.3	AIE
109	Runout of body with bourrelets	Level IV	3.2.3	AIE
110	Runout of boattail with bourrelets	Level IV	3.2.3	AIE
111	Diameter of bourrelets, min.	Level IV	3.2.3	AIE
112	Diameter of bottom band seat	Level IV	3.2.3	AIE
113	Length to band seat	Level IV	3.2.3	AIE
114	Pitch diameter, max.	Level IV	3.2.3	AIE
115	Minor diameter, max.	Level IV	3.2.3	AIE
116	Length of threads, min.	Level IV	3.2.3	AIE

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Conformance inspection by classification of characteristics

PARAGRAPH 4.3.2.3	TITLE Body (continued)	SHEET 2 OF 3		DRAWING NUMBER 10535878 or 12251740 (as applicable)
				NEXT HIGHER ASSEMBLY 10535877 or 12551741 (as applicable)
CLASSIFICA TION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	INSPECTION METHOD REFERENCE
<u>Major</u>				
117	Variation in wall thickness	Level IV	3.2.3	AIE
118	Thickness through base	Level IV	3.2.3	AIE
119	Scoring missing or inadequate	Level IV	3.2.3	Visual
120	Radius or chamfer missing from rear surface	Level IV	3.2.3	Visual
121	Band seat contains foreign matter or evidence of shot or sand blasting	Level IV	3.2.3/3.6.1 /3.9	Visual
122	Visual indication of metal defects in the body or body cavity	100%	3.5	Visual
<u>Minor</u>				
201	Diameter of body	Level II	3.2.3	AIE
202	Diameter of nose end	Level II	3.2.3	AIE
203	Length to basic outside diameter at nose end	Level II	3.2.3	AIE
204	Length to basic diameter near juncture of boattail and body diameter	Level II	3.2.3	AIE
205	Length at rear-most basic diameter	Level II	3.2.3	AIE
206	Length to rear of bourrelet	Level II	3.2.3	AIE



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Conformance inspection by classification of characteristics

<b>PARAGRAPH</b> 4.3.2.3	<b>TITLE</b> Body (continued)	<b>SHEET 3 OF 3</b>		<b>DRAWING NUMBER</b> 10535878 or 12251740 (as applicable)
				<b>NEXT HIGHER ASSEMBLY</b> 10535877 or 12551741 (as applicable)
<b>CLASSIFICA TION</b>	<b>EXAMINATION OR TEST</b>	<b>CONFORMANCE CRITERIA</b>	<b>REQUIREMENT PARAGRAPH</b>	<b>INSPECTION METHOD REFERENCE</b>
<u>Minor</u> 207 208  209 210 211 212	Total length Depth from front face to charge cavity, max. Diameter of thread lead in angle Surface finish improper Radii or chamfers missing or incorrect Evidence of poor workmanship	Level II Level II  Level II Level II Level II Level II	3.2.3 3.2.3  3.2.3 3.2.3 3.2.3 3.9	AIE AIE  AIE Visual-ANSI B46.1 Visual Visual

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Conformance inspection by classification of characteristics

PARAGRAPH 4.3.2.4	TITLE Body assembly	SHEET 1 OF 2		DRAWING NUMBER 10535877 or 12551741 (as applicable)
				NEXT HIGHER ASSEMBLY 10535878 or 12551742 (as applicable)
<b>CLASSIFICA TION</b>	<b>EXAMINATION OR TEST</b>	<b>CONFORMANCE CRITERIA</b>	<b>REQUIREMENT PARAGRAPH</b>	<b>INSPECTION METHOD REFERENCE</b>
<u>Critical</u>	None defined			
<u>Major</u>				
101	Length of rotating band	Level IV	3.2.4	AIE
102	Runout of rotating band with bourrelets	Level IV	3.2.4	AIE
103	Outside diameter of rotating band	Level IV	3.2.4	AIE
104	Width of rotating band	Level IV	3.2.4	AIE
105	Length of outside diameter of rotating band	Level IV	3.2.4	AIE
106	Angle adjacent to outside diameter of rotating band	Level IV	3.2.4	AIE
107	Width of relief groove, min.	Level IV	3.2.4	AIE
108	Diameter of relief groove, max.	Level IV	3.2.4	AIE
109	Undercut exceeds permissible maximum	Level IV	3.2.4	AIE
110	Gap between sidewall of band seat and band	Level IV	3.6.3	AIE
111	Foreign matter in band seat prior to banding	100%	3.6.1	Visual
112	Foreign matter in body cavity	Level IV	3.8	Visual
113	Weight	Level IV	3.2.4	Balance/Scale

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Conformance inspection by classification of characteristics

PARAGRAPH 4.3.2.4	TITLE Body assembly (continued)	SHEET 2 OF 2		DRAWING NUMBER 10535877 or 12551741 (as applicable)
				NEXT HIGHER ASSEMBLY 10535878 or 12551742 (as applicable)
CLASSIFICA TION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	INSPECTION METHOD REFERENCE
<u>Minor</u> 201	Angle from rear of rotating band relief groove	Level II	3.2.4	AIE
202	Marking missing, incorrect or illegible	Level II	3.2.4	Visual
203	Evidence of poor workmanship	Level II	3.9	Visual

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Conformance inspection by classification of characteristics

PARAGRAPH	TITLE	SHEET 1 OF 1		DRAWING NUMBER
4.3.2.5	Projectile, HE, 105MM, M1 or M760 (as applicable) metal parts assembly.			10535876 or 12551742 (as applicable)
				NEXT HIGHER ASSEMBLY -
CLASSIFICATION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	INSPECTION METHOD REFERENCE
<u>Critical</u>	None defined			
<u>Major</u>				
101	Diameter of bourrelets, max (after painting)	100%	3.2.5	AIE
102	Rotating band damaged	Level IV	3.2.5	Visual
103	Foreign matter in cavity	Level IV	3.8	Visual
104	Protective coating thickness	4.4.5	3.2.5	Test
105	Salt spray test	4.4.6	3.2.5	4.4.6.1
106	Pool of paint in cavity	100%	3.2.5	Visual
107	Visual indication of metal defects in body cavity	100%	3.5.1	Visual
108	Thread damaged	Level IV	3.9.4	Visual (see 6.8)
<u>Minor</u>				
201	Paint on threads or on forward surface	Level II	3.2.5	Visual
202	Paint on rotating band surface	Level II	3.2.5	Visual
203	Paint not dry	Level II	3.9.2	Manual
204	Protective coating in cavity inadequate or damaged	Level II	3.2.5	Visual
205	Protective coating on exterior surfaces inadequate or damaged	Level II	3.2.5	Visual
206	Marking missing incorrect or illegible	Level II	3.2.5	Visual
207	Hex plug missing	Level II	3.2.5	Visual
208	Evidence of poor workmanship	Level II	3.9	Visual

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Conformance inspection by classification of characteristics

PARAGRAPH 4.3.2.6	TITLE Projectile, 105MM, HE, M1 or M760 (as applicable) metal parts assembly destructive lot acceptance	SHEET 1 OF 1		DRAWING NUMBER 10535876 or 12551742 (as applicable)
				NEXT HIGHER ASSEMBLY -
<b>CLASSIFICATION</b>	<b>EXAMINATION OR TEST</b>	<b>CONFORMANCE CRITERIA</b>	<b>REQUIREMENT PARAGRAPH</b>	<b>INSPECTION METHOD REFERENCE</b>
<u>Critical</u> 1	Ballistic test failure, projectile break-up or component separation in-bore or in flight	Note 1	3.10.1	4.4.7
2	Ballistic test failure, rotating band failure	Note 1	3.10.2	4.4.7
3	Ballistic test failure, shearing of rotating band	Note 1	3.10.3	4.4.7
<u>Major</u>	None defined			
<u>Minor</u>	None defined			
NOTES: 1. This test shall be stopped and the lot rejected upon encountering one (1) defective assembly.				

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4.4 Testing.

4.4.1 Visual examination for material defects. The internal cavity of the projectile shall be inspected visually prior to nosing using probe lighting to assure conformance with 3.5. Visual standards in accordance with 3.5 shall be set up for use during this inspection. Any projectile failing to meet the applicable requirements of 3.5 shall be classed defective and removed from the lot.

4.4.2 Mechanical properties of the projectile body.

4.4.2.1 Hardness. Each final heat treated projectile from a heat treated lot shall be identified and subjected to a hardness test on the surface between the rear of the rotating band seat to 1/2 inch forward of the rotating band. One (1) hardness reading shall be taken. The hardness reading obtained shall be used as the basis for selecting the tension test sample of paragraph 4.4.2.2.

4.4.2.1.1 Hardness test. The hardness test shall be conducted in accordance with ASTM Method E103 and the following:

a. The surface of the body in the area designated to be hardness tested shall be prepared by grinding a flat to a sufficient depth, 0.015 inch minimum, to remove scale and get below the decarburization zone. The preparation process to be used shall require approval as part of the AIE submittal. Manual grinding shall not be used. The surface preparation requirement may be eliminated if the conditions of 6.12 are met.

b. Hardness tester periodic verification shall be performed using Brinell test standards manufactured in accordance with ASTM E10 methods in lieu of production samples.

c. The hardness tester shall use a standard 10mm Brinell ball. The body shall be securely supported so that no rocking or shifting of the body will occur during the test. The tester shall apply a preload followed by application of the full load. The preload shall not exceed 10% of the major load of 3000kg. The amount of penetration of the indenter (10mm ball) during that time period when the major load is applied including the dwell time at the end of the load application shall be automatically measured. The tester shall be provided with a means to compensate for any flexing of the test item that may occur during application of the major load. The hardness number shall be automatically displayed at the conclusion of the test.

d. One hardness reading shall be taken.

e. All hardness test measurements shall be automatically recorded.

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4.4.2.2 Yield strength and elongation. Two final heat treated projectiles from a heat treated inspection lot shall be selected for the tension test. The projectiles selected shall be those which have the highest and the lowest hardness reading from 4.4.2.1. From each of these projectiles two specimens shall be tested in accordance with 4.4.2.2.1. In the event of rejection, new samples of higher or lower hardness values or both, as applicable, may be selected and tested in order to establish an acceptable hardness range. Once this range has been established all projectiles whose hardness values fall outside the range shall be rejected or subjected to re-temper or heat treat cycle if approved by the Contracting Officer. An acceptable hardness range is one which will provide acceptable yield and elongation results.

4.4.2.2.1 Yield strength and elongation method. The two projectiles selected for testing shall have two specimens taken from each and tested. Two longitudinal specimens shall be taken 180° apart from the sidewall. Location shall be centered under the rotating band seat and in the middle of the wall thickness in that area. Elongation shall be measured to the nearest 0.001 inch and converted to elongation to the nearest 0.1 percent. Failure of any specimen to comply with the applicable drawing requirement shall be cause for rejection of the heat treated inspection lot. Testing shall be conducted in accordance with ASTM E8 with the largest substandard size round specimen possible.

#### 4.4.3 Rotating band.

4.4.3.1 Mechanical properties of rotating band blank. The band shall be cut from front to rear and flattened, without cold working the material (for example, hammering), and the largest obtainable flat type specimen shall be cut from the band, the length of which shall provide a one inch gage length, plus adequate material at each end to accommodate the grips of the tensile testing machine. This method should yield a 0.500 inch gage width. In any event, the gage cross section shall be determined to the nearest 0.001 square inch, and utilized to calculate the tensile strength and elongation. Testing shall be conducted in accordance with ASTM E8.

4.4.3.2 Mechanical properties of disassembled rotating bands. One body assembly shall be randomly selected from each four (4) hours' production shift or fraction thereof per banding machine in operation and subjected to this test to determine compliance with 3.4. Failure to comply shall be cause for rejection of the assemblies represented by the sample. The sample provide shall have the rotating band removed and carefully flattened so as to hold a minimum to any additional cold working. The specimen blank shall be machined so that all serration marks from the band seat are removed. A test specimen having a one inch gage length, and grip ends of sufficient length to accommodate the tensile machine shall be removed from the blank

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and tested in accordance with the procedure prescribed by ASTM Method E8.

#### 4.4.3.3 Band Seating

4.4.3.3.1 Tightness, non-destructive method. Five body assemblies from each 1-hour production or fraction thereof per banding machine in operation shall be subjected to this test. Failure of one or more bands to comply with 3.6.3 shall be cause for the rejection of the assemblies represented by the samples. The samples provided by 4.4.3.3.1 shall be tested utilizing the equipment and procedures described in drawing 9280429.

4.4.3.3.2 Tightness, destructive method. When the non-destructive equipment is not available, one body assembly from each regular production shift or fraction thereof from each banding machine in operation shall be subjected to this test to determine compliance with 3.6.3. Failure to comply shall be cause for rejection of the assemblies represented by the failing sample. The body assembly selected should not be processed through the machining line, although each band should have a light surface cut to true up the surface prior to measuring. The diameter of each band shall be measured at 3 locations, 60 degrees apart, on the points along the cylindrical portion of their length, near the front and rear edges. This comprises 6 diametrical measurements per band. These points of measurement shall be marked on the bands and on the projectile body adjacent thereto in such a manner as to permit proper body and band orientation after removal. The bands shall be carefully removed so as to keep deformation to a minimum. The bands shall be measured at each of the marked points (a total of 12 measurements) and the diameter of the band seat corresponding to these points shall also be measured. Add to each of the diameters of the band seat the sum of the corresponding 2 thicknesses of the band; the results obtained shall be subtracted from the previously determined diameters over the band. The resulting dimension represents the gap between the body band seat and the rotating band.

4.4.3.3.3 Sidewall contact. Rotating bands removed as specified under 4.4.3.2 shall be examined to determine compliance with 3.6.3 Failure to comply shall be cause for rejection of assemblies represented by the sample. The samples shall be sectioned by cutting through two planes normal to the longitudinal axis one-half inch forward and rear of the rotating band. The cylindrical portion containing the rotating band shall be sectioned approximately in half through a plane parallel to its longitudinal axis. One of the two halves shall be used for establishment of mechanical properties of the band; the other section shall be sectioned into two other parts, thus exposing four surfaces each of which reveals a view of the band swaged into the band seat. The exposed surfaces shall be subjected to a light grinding operation to remove the metal smear effects of saw



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cuts prior to measurements for depth of sidewall contact to determine compliance with the requirements of 3.6.3

4.4.4 Ultrasonic inspection. The projectile body shall be ultrasonically inspected prior to band seat machining and nose threading using equipment detailed in 4.4.4.1. Ultrasonic energy shall be used at right angles to assure that orientation does not prevent detection of a defect. Any projectile failing to meet the requirements of 3.7 shall be classed defective and removed from the lot. All projectiles rejected by ultrasonic inspection shall be visually inspected at the location of the ultrasonic indication. An ultrasonic critical defect shall be defined as any ultrasonic reject that has a visual crack or pipe or a visual defect other than a crack or pipe (lap, fold, seam, etc.) that has an ultrasonic signal that is twice the level of the ultrasonic standard notch for that area. Visual defects other than cracks or piping shall be statically evaluated by a level II (or higher) qualified inspector to determine if a critical defect exists. Visual defects other than cracks or piping with less than twice the level of the ultrasonic standard notch for that area are not considered critical, but shall be rejected as major defects. Critical defect determination will be accomplished within 24 hours of the observation. Stamp the letter "U" on each projectile accepted by ultrasonic inspection.

4.4.4.1 Ultrasonic test equipment and procedures. The ultrasonic inspection shall be performed in accordance with drawing 12991878 with the use of a liquid to assure a reliable coupling to transmit ultrasonic energy. Should a stream or thin film of liquid be used to couple this energy, controls shall be used to monitor the coupling and assure its effectiveness. Such monitoring is not required if submergence in a liquid is used. Using ultrasonic energy at right angles requires at least two separate sources of ultrasonic energy. This means that in the wall and bourrelet ultrasonic regions, ultrasonic energy shall move within the walls of the projectile with separate significant axial or circumferential components of velocity to detect flaws located on the outside, inside or within the walls. For the base region, significant ultrasonic velocity components shall separately be radial and circumferential. Criteria for detection of cracks are machined notches which simulate actual larger cracks. Details are contained on drawings 12991876 and 12991877. All notches machined on the standard are targets for rejection. That is, any projectile that sends back an echo signal that is greater than or equal to the signal from the standard shall be rejected. Relief portions of radially oriented notches where the full depth approaches the surface are not inspection criteria.

4.4.5 Protective coating - thickness. Two samples shall be selected at random to represent each shift or fraction thereof, of continuous paint production. The sample projectiles shall be inspected for paint coating thickness at a minimum of four

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separate locations on each projectile. Any projectile failing to meet the applicable requirements shall be classed defective and every projectile painted since the last acceptable sample shall be rejected.

4.4.6 Salt spray. After qualification in accordance with TT-C-490 or approved commercial equivalent, two(2) salt spray samples shall be taken each week, one during the first 30 minutes of production and a second at any other time. Failure to comply with the requirements of 3.2.4 shall be cause for taking the corrective action prescribed in TT-C-490.

4.4.6.1 Salt spray testing. Salt spray testing shall be accomplished on production projectiles or sectioned projectiles that were acceptable at the time of painting and were sectioned subsequent to painting. If sectioned projectiles are used, sectioning shall be accomplished to allow testing of all major areas of the projectiles on an alternating basis. The salt spray test shall be performed utilizing the equipment and procedures specified by ASTM B117 and TT-C-490 or approved commercial equivalent, with the exception that test samples shall be selected in accordance with 4.4.6.

4.4.7 Ballistic performance test for structural integrity. These tests shall be performed at a proving ground. The projectile metal parts assembly shall be inert loaded to a weight that falls within the weight zones specified on dwg. 9211610 and the applicable weight zone marking applied to the projectile as shown on dwg. 9211610. For these tests, the weight of each round in the sample shall be adjusted to assure that the entire sample conforms to one weight zone. A dummy fuze, with weight compensation as required, shall be assembled to the inert loaded projectile and assembled to a cartridge which is standard for this round. The following information pertaining to this test will be obtained and reported for all phases as specified below:

a. Photographic coverage. Photographic coverage will be adequate to assure compliance with 3.12.

b. Radar coverage. Doppler radar will be used.

4.4.7.1 M1 Projectile. The M1 projectile shall be fired from an M20 series cannon using an M67 propelling charge which will produce an average piezo equivalent pressure between 40,000 psi and 42,000 psi pressure. The rounds shall be fired in an acceptable gun, based upon current gun tube condemnation criteria. The test values can, at the option of the proving ground, be obtained by either the addition of propellant or by heating of the cartridge to obtain the pressures required. The projectiles shall be uniformly temperature conditioned at 70°F ± 2.5 degrees for a minimum of 24 hours prior to testing.

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4.4.7.2 M760 Projectile. The M760 projectile shall be fired from an M20 series cannon using a PXR 200-1 or M200 propelling charge producing an average piezo equivalent pressure of 54,500 psi to 57,000 psi. The rounds shall be fired in an acceptable gun, based upon current gun tube condemnation criteria. The excess pressure test rounds (charges and projectiles) shall be uniformly temperature conditioned at  $70^{\circ}\text{F} \pm 2.5$  degrees for a minimum of 24 hours prior to testing. The as fired fuze projectile weight shall be  $33 \pm 0.2$  pounds.

4.4.7.3 Initial inspection. Beginning with the first lot produced and continuing until three consecutive lots have complied with requirements specified, 20 sample projectiles shall be randomly selected for this test. The 20 sample projectiles shall be observed for structural integrity of parts when tested in accordance with 4.4.7. If any sample projectiles fail to comply with the requirements for structural integrity of parts, the lot shall be rejected.

4.4.7.4 Reduced inspection. After three consecutive lots have complied with 4.4.7.3, 10 sample projectiles shall be randomly selected from each lot for this test. The 10 sample projectiles shall be observed for structural integrity of parts. If any of the sample projectiles fail to comply with the requirement for structural integrity of parts, the lot shall be rejected. If the lot is rejected the inspection criteria reverts to paragraph 4.4.7.3.

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DOD personnel or in-house contractor personnel these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department of Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The components covered by this specification are intended for use on the Cartridge, 105MM, HE, M1 and M760. This specification contains requirements suitable for production.

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6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. For acquisition purposes, the contract or order should specify packaging requirements. The projectiles should be palletized and marked in accordance with drawing 8837835, and be ordered by the applicable stock number. Marking should be in accordance with ASTM D3951 (Standard Practice for Commercial Packaging). If not otherwise specified in acquisition documents, the pallet markings should also include lot number, gross weight, and contract number. The minimum height of markings is 7/16 inch.
- c. Requirements for submission of first article sample.
- d. Submission of contractor acceptance inspection equipment (AIE) (see 6.3).
- e. Provisions for certification of Nondestructive Test (NDT) personnel (see 6.4).
- f. Establishment of visual defect standards (see 6.5).
- g. Submission of ballistic test data and ammunition data cards (see 6.6).
- h. Provisions for critical characteristic controls (see 6.9).
- i. Provisions for projectile cavity characteristic controls (see 3.5.1).

6.3 Submission of contractor acceptance inspection equipment (AIE) designs for approval. Submit copies of designs as required to: Commander, U.S. Army TACOM-ARDEC, ATTN: AMSRD-AAR-QEM-A, Picatinny Arsenal, NJ 07806-5000. This address will be specified on the Contract Data Requirements List (CDRL), DD Form 1423 in the contract.

6.3.1 Inspection of band seat.

6.3.1.1 Rotating band seat location and runout. The Contractor may use any control method that should assure the band seat meets the dimensional requirements of the applicable drawing. The inspection plan should include all the required criteria to assure the dimensional aspects of the drawing should be equal to the characteristics defined in 4.3.2.4. When the contractor establishes a control method, the manufacturing procedure, and inspection plan should be forwarded to the technical agency as part of the AIE submittal prior to use in

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accordance with 6.3. No change to these controls should be made once established without approval from the contracting officer.

6.4 Personnel qualification and certification for non-destructive testing (NDT). Personnel performing the ultrasonic testing should be qualified and certified in accordance with recommended practice NAS-410 and procedures approved by ARDEC. Minimum qualification levels should be as follows:

Level III: Review and approval of NDT procedures, equipment and personnel certification plus the following;

Level II: Set-up, calibration, modification of NDT equipment and procedures plus the following;

Level I: Operation of NDT equipment.

6.5 Visual standards. Visual standards for evaluation of metal defects will be established for each contract after the first month of production. However, establishment of visual standards will not waive the requirements for compliance with 3.5.

6.6 Submission of ballistic test data and ammunition data cards. In addition to the normal distribution of records for items procured by the Department of the Army, one copy of all ballistic test data and ammunition data cards should be forwarded to Commander, TACOM-ARDEC, ATTN: AMSRD-AAR-QEM-A, and AMSRD-AAR-MEM-C, Picatinny Arsenal, NJ 07806-5000.

6.6.1 Range and deflection. Range and deflection are not technical requirements of this specification. They are mandatory performance requirements that are achieved by design and are affected by variability in the manufacturing process that may not be completely controlled by the present TDP.

6.7 Inspection lots. It is noted that the size of inspection lots of components, assemblies or items of delivery may differ from the actual quantities contractually scheduled for delivery. However, in order to facilitate scheduling of tests or deliveries, inspection lots of items of delivery may be equivalent to such contract quantities provided all of the lot formation criteria per MIL-STD-1168 and sampling provisions of this specification are maintained.

6.8 Visual examination qualification. When compliance with the applicable requirement is in doubt as a result of visual examination the characteristic may be measured or gaged to determine acceptability.

6.9 Critical characteristic controls. All production contracts should contain requirements for handling critical defects. As part of all proposals, suppliers should be asked to

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describe policies, procedures and controls for all operations associated with safety characteristics, how they are documented and maintained under the supplier's integrated management system.

#### 6.10 Steel quality.

a. It is the responsibility of the manufacturer of the projectile metal parts to select a fully-killed carbon steel of a grade compatible with the abilities of the equipment and the methods of processing the metal within the operation of the shops of the forger and machinist to produce the projectile to the dimension and mechanical properties and metal integrity specified as an end item requirement.

b. The supplier of the selected steel raw material is responsible only for furnishing a metal composition, grade and, type with dimensions, weight, soundness and freedom from metallurgical or mechanical defect limitations identifiable with the standard AISI grade selected by the projectile manufacturer and complying with the specific ASTM designation and tests selected by the projectile manufacturer.

c. In the application of carbon steel, blooms, billets, slabs and bars, forging quality processing techniques adapted to use of the selected steel should be applied with the expectation that there will be variables in the metal cross-sectional dimension in weight per unit length, in the hardenability variance from heat to heat, in the mechanical condition of the surface, and in the straightness of the raw material. Economic advantages will be realized if the process and equipment within the shops of the forger and the machinist have been engineered in terms of equipment sequence of operations, tooling designs, handling devices and processing techniques having capabilities of compensating for such variables.

#### 6.11 Definitions

a. Acceptance Inspection Equipment (AIE). Any measuring device that is traceable to the national or international standard which is used to assure conformance of material to the contract requirements.

b. Heat treatment. Heat treatment is understood to be any thermal process which brings about a modification in the mechanical and metallurgical properties of the metal involved.

6.12 Hardness test. The surface preparation requirement of 4.4.2.1.1 may be eliminated if the following conditions are met:

(1) Lab results confirm that current production process produces a decarburized zone of 0.003 inch maximum in the test area. The contractor should provide samples, or photo-micrographs, of high and low hardness samples to the Government for approval. Samples may be the same as for 4.4.2.2.

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(2) A controlled atmosphere is maintained in the austenitizing furnace.

#### 6.13 Critical classification notes.

6.13.1 Ultrasonic test. Metal parts defects, except rotating band gaps, large enough to fail by ultrasonic inspection of the projectile are likely to cause premature functioning from break-up of the projectile in the gun during firing.

6.13.2 Ballistic lot acceptance test. Any premature projectile function or metal parts separation in the gun or in flight is likely to cause injury or death for the Soldier firing or supported by the howitzer.

6.13.3 Rotating band failure. Loss of a rotating band in flight or in bore may result in projectile instability and subsequently a short round potentially resulting in injury or death for Soldiers in the field.

6.13.4 Shearing of rotating band. A sheared rotating band may result in a failure of the projectile to fully spin up, resulting in projectile instability and subsequently a short round potentially resulting in injury or death for Soldiers in the field.

6.14 Heat treatment batch qualification for combination into larger heat treatment inspection lot. Submit qualifying procedures for approval to: Commander, U.S. Army TACOM-ARDEC, ATTN: AMSRD-AAR-QEM-A, Picatinny Arsenal, NJ 07806-5000.

6.15 Packaging drawings. Drawings listed in this section are for reference only. The government's current packaging for the M1 and M760 Metal Parts Assembly as defined by Technical Data Package (TDP) drawing 8837835, is included for reference. If the contractor chooses to build to the current approved TDP (drawing 8837835) the Government will waive the testing required to meet the First Article performance test requirements of the packaging specification. The contractor may use the information contained in the TDP as guidance for its own design. Unless otherwise noted, the custodian of the following drawings is the U.S. Army Tank-Automated Command- Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ 07806-5000;

8837835 - Pallet for Projectiles and Projectile  
Metal Parts

6.16 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.



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6.17 Subject term (keyword) listing.

Ammunition  
Ballistic testing  
Rotating band seating

Custodian:  
Army - AR

Preparing Activity:  
Army - AR  
(Project 1315-2008-007)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <http://assist.daps.dla.mil>.