

INCH-POUND

MIL-DTL-60547G (AR)

W/AMENDMENT 3

11 January 2016

SUPERSEDING

MIL-DTL-60547G (AR)

w/AMENDMENT 2

10 January 2013

## 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 of 105MM, HE, M1 Body, M1 High Fragmentation (HF-1) and M760, as applicable. (see 6.1).

Comments, suggestions, or questions on this document should be addressed to the Commander, U.S. Army ARDEC, ATTN: RDAR-QES-E, Picatinny Arsenal, NJ 07806-5000 or emailed to [usarmy.picatinny.ardec.list.ardec-stdzn-branch@mail.mil](mailto:usarmy.picatinny.ardec.list.ardec-stdzn-branch@mail.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.

AMSC N/A

FSC 1315

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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 <https://assist.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.

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

- 9280429 - Rotating Band Seat Tester
- 9280446 - Ultrasonic Inspection Standard,  
Longitudinal and Radial Cracks, 105MM, HF  
M1-MOD, Body
- 9280447 - Ultrasonic Inspection  
Standard, Circumferential and Piping Defects  
105MM, HF M1-MOD, Body
- 12991876 - Ultrasonic Inspection Standard,  
Longitudinal and Radial Cracks, 105MM, M1  
and M760 Body
- 12991877 - Ultrasonic Inspection Standard,  
Circumferential and Piping Defects, 105MM,  
M1 and M760 Body
- 12991878 - 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
- 10535876-2 - Projectile, 105MM, H.E., M1 Metal Parts  
Assembly, M1 HF-1
- 10535877-2 - Body Assembly, M1 HF-1
- 10535878-2 - Body, M1 High Fragmentation, Modified  
Bandseat
- 12551740 - Body, M760
- 8594851 - Blank, Rotating Band

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(Copies of these drawings maybe requested online at [usarmy.picatinny.ardec.list.drawing-request-help-desk@mail.mil](mailto:usarmy.picatinny.ardec.list.drawing-request-help-desk@mail.mil) or from US Army ARDEC, ATTN: RDAR-EIS-PE, Picatinny Arsenal, 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/E8M- 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
- ASTM E 399- Standard Test Method for Plain-Strain Fracture Toughness 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

(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.

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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 carbon steel, drawing 10535876-2 for the M1 HF-1 or drawing 12551742 for the M760.

3.3 Ammunition lot numbering. Ammunition lot numbers shall be assigned and ammunition data cards be submitted 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 carbon steel, drawing 10535878-2 for the M1 HF-1 or drawing 12551740 for the M760. No projectile shall be reheat treated if it fails to meet the applicable drawing without prior Government approval.

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

3.4.2 Body plain strain fracture toughness for the M1 HF-1. The minimum fracture toughness shall be  $23 \text{ KSI}\sqrt{\text{in.}}$  (thousand pounds per square inch square root inch) in the base and  $27 \text{ KSI}\sqrt{\text{in.}}$  (thousand pounds per square inch square root inch) in the side wall beneath the rotating band.

3.5 Projectile material defects.

3.5.1 Projectile cavity. The projectile cavity shall be free from scale, fins, burrs, draw marks, laminations, imbedded

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foreign matter, pits, sharp edges and any other surface discontinuities. (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).

3.5.3 Visual standards. Visual standards for evaluation of material defects shall be established. However, establishment of visual standards will not waive the requirements for compliance with 3.5.1 and 3.5.2. Visual standards shall be distinguishable from explosive cast 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 band should make full contact with the band seat. Any individual inspection measurement between the rotating band and band seat shall not exceed .006 inch when the destructive method of testing is used.

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 for the M1 and M760 bodies and on dwg. 9280446 and 9280447 for the M1 HF1) which simulate larger metal defects. Ultrasonic inspection is to be performed in accordance with drawing 12991878 prior to band seat and thread machining.

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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 or paint blisters 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 carbon steel, or drawing 10535876-2 for the M1 HF-1 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 carbon steel, drawing 10535878-2 for the M1 HF-1 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.

3.11 Hydrostatic test. The projectile shall withstand an internal hydrostatic pressure in accordance with Drawing (dwg.) 10535878 requirements without evidence of leakage, cracks, ruptures or permanent distortion. (High Fragmentation Variant only)



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#### 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
		1	2	3	4	A	B
3.1.1	First article			X	X	X	4.2
3.1.2	Conformance			X	X		4.3
3.2	Components and assemblies			X	X	X	4.3
3.3	Ammunition lot numbering			X		X	4.3.1
3.4	Mechanical properties (projectile)				X	X	4.4.2.1/4.4.2.2
3.4.1	Mechanical properties (rotating band)				X	X	4.4.3.2
3.4.2	Body plain strain fracture toughness for the M1 HF-1				X	X	4.4.2.3
3.5.1	Material defects (projectile cavity)			X		X	4.3.2.1/ 4.3.2.3/4.4.1
3.5.2	Material defects (projectile)			X		X	4.3.2.3/4.4.1
3.6.1	Foreign matter on band seat			X		X	4.3.2.3/4.3.2.4
3.6.2	Band blank			X		X	4.4.3.1
3.6.3	Rotating band application			X		X	4.4.3.3.3
3.6.4	Rotating band seating			X		X	4.4.3.3
3.7	Ultrasonic test			X	X	X	4.3.2.2/4.4.4
3.8	Interior cavity finish			X		X	4.3.2.4/ 4.3.2.5
3.9	Workmanship			X		X	4.3.2.1/ 4.3.2.3- 4.3.2.5
3.10	Ballistic test				X	X	4.3.2.6/4.4.7
3.11	Hydrostatic test				X	X	4.3.2.2/4.4.8

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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, 10535876-2 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 3.2/3.8/3.9 3.2 3.2.5	4.3.2.6/4.4.7 4.3.2.5 4.4.6 4.4.5
<u>Body assembly</u> Dwg. 10535877, 10535877-2 or 12551741 (as applicable) Examination for defects  Band seating  Mechanical properties - rotating band	5  5 5	3.2/ 3.6.1/3.8 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, 10535878-2 or 12551740 (as applicable) Examination for defects Yield strength and elongation test  Fracture toughness (High Fragmentation Variant ONLY)	5 2 2	3.2 3.4 3.4.2	4.3.2.3 4.4.2.1.1/4.4.2.2 4.4.2.3
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, 10535878-2 or 12551740 (as applicable) Examination for defects Ultrasonic testing	  5 5	  3.2 3.7	  4.3.2.2 4.4.4
<u>Body (prior to nosing)</u> Dwg. 10535878, 10535878-2 or 12551740 (as applicable) Examination for defects	  5	  3.2/3.5	  4.3.2.1
<u>Blank, rotating band</u> Dwg. 8594851 Mechanical properties	  5	  3.6.2	  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 6.15), 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 carbon

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steel, drawing 10535878-2 for the M1 HF-1, 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 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, 10535878-2 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 See Note 1	
				NEXT HIGHER ASSEMBLY See Note 2	
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 bourrelet location	Level IV	3.2	AIE	
102	Length from base of charge cavity to inside basic diameter	Level IV	3.2	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	
Notes: 1. 10535878, 10535878-2 or 12551740 (as applicable) 2. 10535877, 10535877-2, 12551741 (as applicable)					

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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 See Note 2
				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
2	Hydrostatic test (HF-1 ONLY)	100%	3.11	4.5
<u>Major</u>				
101	Ultrasonic test stamp missing, see note 1	100%	3.2	Visual
102	Hydrostatic test stamp missing (HF-1 ONLY)	100%		
		100%	3.2	Visual
<u>Minor</u>	None defined			
<p>NOTES:</p> <p>1. Any part found without the required ultrasonic test stamp shall be ultrasonically tested to determine if the part fails the critical test. Any part found without the required hydrostatic test stamp shall be hydrostatically 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.</p> <p>2. Drawings 10535878, 10535878-2 or 12251740 (as applicable)</p>				



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Conformance inspection by classification of characteristics

PARAGRAPH 4.3.2.3	TITLE Body	SHEET 1 OF 3		DRAWING NUMBER See Note 1
				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	Width of band seat	Level IV	3.2	AIE
102	Runout of pitch diameter of thread with bourrelets and front face	Level IV	3.2	AIE
103	Runout of ogive with bourrelets	Level IV	3.2	AIE
104	Runout of body with bourrelets	Level IV	3.2	AIE
105	Runout of boattail with bourrelets	Level IV	3.2	AIE
106	Diameter of bourrelets, min.	Level IV	3.2	AIE
107	Diameter of bottom band seat	Level IV	3.2	AIE
108	Length to band seat	Level IV	3.2	AIE
109	Pitch diameter, max.	Level IV	3.2	AIE
110	Minor diameter, max.	Level IV	3.2	AIE
111	Length of threads, min.	Level IV	3.2	AIE
112	Variation in wall thickness	Level IV	3.2	AIE
113	Thickness through base	Level IV	3.2	AIE
114	Scoring missing or inadequate	Level IV	3.2	Visual
115	Radius or chamfer missing from rear surface	Level IV	3.2	Visual
Notes:				
1. Drawings 10535878, 10535878-2 or 12251740 (as applicable)				

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PARAGRAPH 4.3.2.3	TITLE Body (continued)	SHEET 2 OF 3		DRAWING NUMBER See Note 1
				NEXT HIGHER ASSEMBLY 10535877 or 12551741 (as applicable)
CLASSIFICATION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	INSPECTION METHOD REFERENCE
<u>Major</u> 116	Band seat contains foreign matter or evidence of shot or sand blasting	Level IV	3.6.1	Visual
117	Visual indication of metal defects in the body or body cavity	100%	3.5.1/ 3.5.2	4.4.1/Visual
118	Mechanical properties of the projectile body	4.4.2	3.4	4.4.2
119	Fracture toughness (if applicable)	4.4.7.2	4.4.7.2	4.4.7.2
<u>Minor</u> 201	Diameter of body	Level II	3.2	AIE
202	Diameter of nose end	Level II	3.2	AIE
203	Length to basic outside diameter at nose end	Level II	3.2	AIE
204	Length to basic diameter near juncture of boattail and body diameter	Level II	3.2	AIE
205	Length at rear-most basic diameter	Level II	3.2	AIE
206	Length to rear of bourrelet	Level II	3.2	AIE
207	Total length	Level II	3.2	AIE
Notes: 1. Drawings 10535878, 10535878-2 or 12251740 (as applicable)				

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PARAGRAPH 4.3.2.3	TITLE Body (continued)	SHEET 3 OF 3	DRAWING NUMBER See note 1	
			NEXT HIGHER ASSEMBLY 10535877 or 12551741 (as applicable)	
CLASSIFICA TION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	INSPECTION METHOD REFERENCE
Minor 208	Depth from front face to charge cavity, max.	Level II	3.2	AIE
209	Diameter of thread lead in angle	Level II	3.2	AIE
210	Surface finish improper	Level II	3.2	Visual-ANSI B46.1
211	Radii or chamfers missing or incorrect	Level II	3.2	Visual
212	Evidence of poor workmanship	Level II	3.9	Visual
213	Length from aft edge of band seat to rear rib	Level IV	3.2	AIE
214	Length between rear and middle ribs	Level IV	3.2	AIE
215	Length between middle and front ribs	Level IV	3.2	AIE
216	Angle of ribs in profile	Level IV	3.2	AIE
217	Height of ribs, min.	Level IV	3.2	AIE
218	Angle of Bandseat Undercut Wall (2 places)	Level IV	3.2	AIE
Notes: 1. 10535878, 10535878-2, or 12251740 (as applicable)				

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Conformance inspection by classification of characteristics

PARAGRAPH 4.3.2.4	TITLE Body assembly	SHEET 1 OF 2		DRAWING NUMBER See Note 1
				NEXT HIGHER ASSEMBLY 10535878 or 12551742 (as applicable)
CLASSIFICA TION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	INSPECTION METHOD REFERENCE
<u>Critical</u>	None defined			
<u>Major</u>				
101	Length of rotating band	Level IV	3.2	AIE
102	Runout of rotating band with bourrelets	Level IV	3.2	AIE
103	Outside diameter of rotating band	Level IV	3.2	AIE
104	Width of rotating band	Level IV	3.2	AIE
105	Length of outside diameter of rotating band	Level IV	3.2	AIE
106	Angle adjacent to outside diameter of rotating band	Level IV	3.2	AIE
107	Width of relief groove, min.	Level IV	3.2	AIE
108	Diameter of relief groove, max.	Level IV	3.2	AIE
109	Undercut exceeds permissible maximum	Level IV	3.2	AIE
110	Gap between sidewall of band seat and band	Level IV	3.6.3	4.4.3.3.3/AIE
Notes:				
1. Drawings 10535877, 10535877-2, or 12251741 (as applicable)				

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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, 10535877-2 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>Major</u> 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	Balance/Scale
114	Mechanical properties of disassembled rotating band	4.4.3.2	3.4.1	4.4.3.2
115	Band seating	4.4.3.3	3.6.4	4.4.3.3
<u>Minor</u> 201	Angle from rear of rotating band relief groove	Level II	3.2	AIE
202	Marking missing, incorrect or illegible	Level II	3.2	Visual
203	Evidence of poor workmanship	Level II	3.9	Visual

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Conformance inspection by classification of characteristics

PARAGRAPH 4.3.2.5	TITLE Projectile, HE, 105MM, M1 Body, M1 High Fragmentation (HF-1) and M760, as applicable.		SHEET 1 OF 1	DRAWING NUMBER See Note 1
				NEXT HIGHER ASSEMBLY -
CLASSIFICA TION	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	AIE
102	Rotating band damaged	Level IV	3.2	Visual
103	Foreign matter in cavity	Level IV	3.8	Visual
104	Protective coating thickness	4.4.5	3.2	AIE
105	Salt spray test	4.4.6	3.2	4.4.6.1
106	Pool of paint in cavity	100%	3.8	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)
Notes: 1. 10535876, 130535876-2, or 12551742 (as applicable)				

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Conformance inspection by classification of characteristics

PARAGRAPH 4.3.2.5	TITLE Projectile, HE, 105MM, M1 Body, M1 High Fragmentation (HF-1) and M760, as applicable.		SHEET 2 OF 2	DRAWING NUMBER See Note 1
				NEXT HIGHER ASSEMBLY -
CLASSIFICA TION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	INSPECTION METHOD REFERENCE
<u>Minor</u>				
201	Paint on threads or on forward surface	Level II	3.2	Visual
202	Paint on rotating band surface	Level II	3.2	Visual
203	Paint not dry	Level II	3.9.2	Manual
204	Protective coating in cavity inadequate or damaged	Level II	3.8	Visual
205	Protective coating on exterior surfaces inadequate or damaged	Level II	3.2	Visual
206	Marking missing incorrect or illegible	Level II	3.2	Visual
207	Hex plug missing	Level II	3.2	Visual
208	Evidence of poor workmanship	Level II	3.9	Visual
Notes: 1. 10535876, 130535876-2, or 12551742 (as applicable)				

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Conformance inspection by classification of characteristics

PARAGRAPH 4.3.2.6	TITLE Projectile, 105MM, HE, M1 Body, M1 High Fragmentation (HF-1) and M760, as applicable metal parts assembly destructive lot acceptance	SHEET 1 OF 1	DRAWING NUMBER See Note 2	
			NEXT HIGHER ASSEMBLY -	
CLASSIFICAT ION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMEN T PARAGRAPH	INSPECTION METHOD REFERENCE
<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. 2. 10535876, 130535876-2 or 12551742 (as applicable)				



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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 6.14 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

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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.

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.

4.4.2.2.2 Independent verification of mechanical properties. Once per year, two additional samples shall be taken from each of the highest and the lowest hardness reading samples selected in 4.4.2.2 and sent to a certified lab for independent analysis of mechanical properties. The samples shall be taken adjacent to the original samples. If the independent analysis indicates that any sample fails to meet either the minimum yield strength or percent elongation, all product represented by the independent sample shall be rejected.

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4.4.2.3 Plain strain fracture toughness. Beginning with the first heat lot produced and continuing until three consecutive heat treat lots have complied with the applicable minimum requirement specified, one final heat treated projectile from each heat treated lot shall be subjected to the plain strain fracture toughness test. The projectile selected shall be of the highest hardness reading from 4.4.2.4.1 and may be the same as used in 4.4.2.2.1. Four specimens shall be tested. No individual fracture toughness shall be less than the requirements of 3.4.2. If one test is invalid, acceptance may be based on the fracture toughness of the valid sample. If either individual fracture toughness is below the minimum allowable, the heat-treated lot represented shall be rejected, or subjected to retemper and retest, for all mechanical properties. After three consecutive heat treated lots have been accepted, the test shall be discontinued. The test shall be reinstituted, until three consecutive heat treated lot shave complied with the applicable requirements, if any of the following ofccur:

- a. Steel is procured from a different producer, or from a substantially different process as determined by the Government.
- b. Forgings are procured from a different producer.
- c. A substantial change is made in the forging process or configuration, as determined by the Government.
- d. A change is made in heat treatment contractors.
- e. A substantial change is made in the heat treatment process, as determined by the Government.

4.4.2.3.1 Method of inspection. The four specimens shall be taken from locations adjacent to the tensile test samples. Two samples shall be taken from the base and two from the side wall. The test shall be conducted at a specimen temperature of -65 degrees Fahrenheit. The test shall be conducted in accordance with ASTM E 399 with the notches machined across the rear face of the base specimen and the outside diameter of the side wall specimen.

4.4.2.3.2 Independent verification of Plane-Strain Fracture Toughness. Once per year, two additional samples shall be taken from each of the base and side wall samples selected in 4.4.2.3 and sent to a certified lab for independent Plane-Strain

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Fracture Toughness. The samples shall be taken adjacent to the original samples. If the independent analysis indicates that any sample fails to meet Plane-Strain Fracture Toughness, all product represented by the independent sample shall be rejected.

#### 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, prior to machining of rotating band, shall be randomly selected from each 1/2 shift of production 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 and tested in accordance with the procedure prescribed by ASTM Method E8.

#### 4.4.3.3 Band Seating

4.4.3.3.1 Non-destructive method. The non-destructive method for measuring rotating band diametrical clearance shall not be used as an acceptable method of testing.

4.4.3.3.2 Rotating band seating diametrical clearance, destructive method. 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 3.6.4. Failure to comply shall be cause for rejection of the assemblies represented by the failing sample.

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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 around the circumference, 60 degrees apart. At each of those three diametrical locations, the diameter shall be measured at four points along the cylindrical portion of their length corresponding to location of the knurling of the band, near the front, forward-middle, rear-middle, and rear edges (see Figure 1). This comprises 12 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 measurement of the corresponding band thickness and band seat diameter after removal. The bands shall be carefully removed so as to keep deformation to a minimum. The thickness of the bands shall be measured at each of the marked points (a total of 24 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. Each of the resulting twelve (12) dimensions is the inspection measurement individually used to determine compliance with 3.6.4.

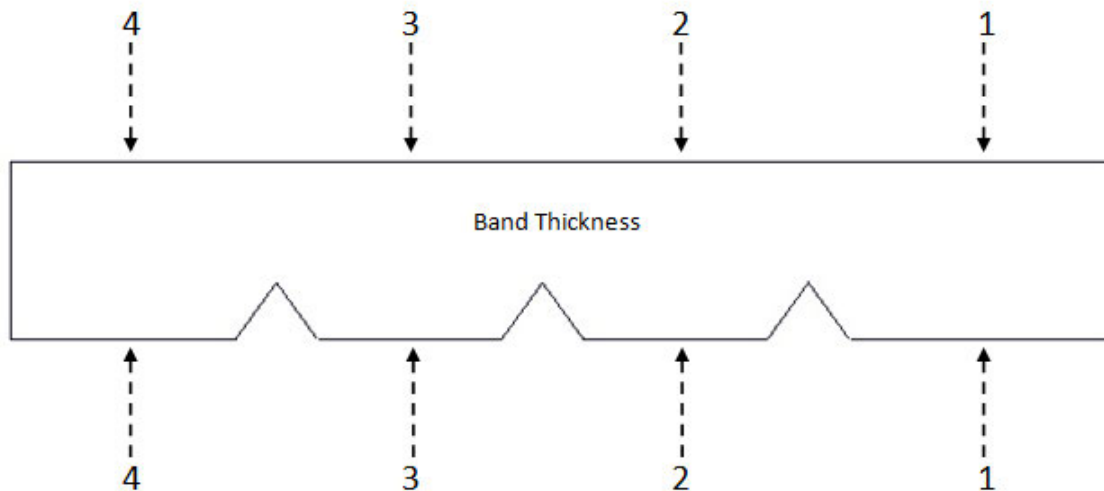


Figure 1. Schematic diagram (not to scale) of cross-section of removed rotating band, with surface cut true, depicting the four measurement locations, near the front (1), forward-middle (2), rear-middle (3), and rear edges (4) of the band thickness.

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4.4.3.3.2.1 Rotating band seating diametrical clearance (M1HF1 w/ Modified Bandseat Only), destructive method. 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 3.6.4. 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 around the circumference, 60 degrees apart. At each of those three diametrical locations, the diameter shall be measured at two points along the cylindrical portion of their length corresponding to location of the knurling of the band, near the forward-middle and rear-middle (see Figure 1). 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 measurement of the corresponding band thickness and band seat diameter after removal. The bands shall be carefully removed so as to keep deformation to a minimum. The thickness of 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. Each of the resulting six (6) dimensions is the inspection measurement individually used to determine compliance with 3.6.4.

4.4.3.3.3 Rotating band sidewall contact. Rotating bands 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 cuts prior to

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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, 12991877, 9280446 or 9280447, as applicable. 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.

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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 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 10535876, 10535876-2 or 12551742, as applicable, 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:



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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 Carbon Steel 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  $70^{\circ}\text{F} \pm 2.5$  degrees for a minimum of 24 hours prior to testing.

4.4.7.2 M1 HF-1 Projectile. The M1 HF-1 projectile shall be fired with propelling charges adjusted to give a pressure of  $42,000 \text{ psi} \pm 1500 \text{ psi}$  in a weapon with M20 cannon. In addition, for the first three production lots from each manufacturer (loading facility), a smear camera shall be used to observe the projectile flight in order to record any possible malfunctioning. (Cartridges furnished without fuzes shall be assembled with live or dummy fuzes for this test.)

4.4.7.3 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.

4.4.7.4 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.

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4.4.7.5 Reduced inspection. After three consecutive lots have complied with 4.4.7.4, 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.

4.4.8 Hydrostatic test. Hydrostatic testing shall be conducted before ultrasonic testing. Prior to ultrasonic testing, the unpainted projectile shall be mounted in a suitable test fixture and be subjected to the pressure specified on the applicable drawing. If any of the sample projectiles fail to comply with the requirement for hydrostatic testing, the projectile shall be classed defective and removed from the lot. Retesting of a projectile is allowable if test equipment failure has caused the reject.

## 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 Body, M1 High Fragmentation (HF-1) and M760. This specification contains requirements suitable for production.

6.2 Acquisition requirements. Acquisition documents should specify the following:

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- 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).

6.2.1 Requirements for Process Control Document (PCD). The contractor quality program should include the PCD for the base cover welding operation. This document should include a description of procedures, equipment, process parameters, monitoring practices, calibration procedures and frequencies of testing for all listed control parameters. The PCD, including revisions thereto, should be submitted to the contracting officer for review and approval by the technical agency. (in accordance with the approved Data Item Description specified on the Contract Data Requirements List (DD1423) in the contract.)

At a minimum, the following process parameters should be addressed in the base cover welding PCD:

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- a. Configuration of component parts to be welded
- b. Faying surface preparation (Method of cleaning)
- c. Cycle time
- d. Degrees of rotation (amount of overlap)
- e. RPMs
- f. Force
- g. Current

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: RDAR-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 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. Visual standards shall be submitted

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to ARDEC for radiographic inspection. Acceptance or rejection of visual standards will be based on whether any surface feature creates an X-Ray indication that may or may not be distinguishable from an explosive cast defect. Establishment of visual standards will not waive the requirements for compliance with 3.4.

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: RDAR-QEM-A, and RDAR-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 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 Ballistic Sample Radiography. Each sample submitted in accordance with Paragraph 4.4.7 "Ballistic performance test for structural integrity" should undergo a radiographic inspection

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prior to firing. Projectiles would be inspected for material defects, rotating band gaps, and any potential metal parts anomalies. Any projectile that exhibits a potential non-conformance with the Metal Parts requirements would be returned to the contractor for additional testing. Any sample in question would be inspected in accordance with the Metal Parts requirements and the approved Acceptance Inspection Equipment (AIE). If the metal part is cleared of defects at the Metal Parts facility, the ballistic testing would proceed. If the anomaly is confirmed to be a defect it would be treated as a non-conformance based upon the appropriate classification of characteristics.

#### 6.11 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 materiel 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.

6.12 Qualification of the base cover welding operation.  
Prior to production and approval of the Process Control Document

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(PCD) for the base cover welding operation (see 6.2.1), the operation should be qualified. From a sample of 5 or more assemblies welded in continuous operation in accordance with the PCD, the first and last assemblies shall be tested as follows (This sample of 5 or more need not be exclusive to qualifying the welding operation.):

6.12.1 Metallographic Examination. Two (2) assemblies representing the first and last of a run of five (5) or more assemblies shall be sectioned to obtain a specimen representing the longitudinal cross section through the diameter of the assembly. Two specimens from each shell, 180° apart, containing the weld and the entire heat affected zone shall be prepared metallographically to reveal the microstructure (ground, polished, and etched) in accordance with ASTM E3. The weld when examined under magnification should exhibit a bond that is uniform and free of cracks, inclusions, and unbonded areas. Failure of any specimen to comply with any of these requirements should result in rejection and re-qualification of the base cover weld operation.

6.12.2 Heat-affected zone hardness test. The same four (4) metallographic specimens (two from each of two shells) prepared in accordance with 6.12.1 shall be subjected to a Vickers microhardness test in accordance with ASTM E 384. A trace of equally spaced microhardness readings approximately two indent widths apart should be made starting at the weld and traversing towards the internal cavity. A sufficient number of indents should be made such that it is clear the indents are out of the heat affected zone and are measuring the bulk hardness of the base of the shell body. This microhardness trace in conjunction with the microstructure shall be used to quantify the depth of the heat affected zone. The measured depth of the heat affected zone shall not exceed 1/4 inches. Failure of these specimens to comply with any of these requirements should result in rejection and re-qualification of the base cover weld operation.

### 6.13 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.

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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.

6.14 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.

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

6.15 Critical classification notes.

6.15.1 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.

6.15.2 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.

6.15.3 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.

6.15.4 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.

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



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

6.17 Packaging drawings. Drawings listed in this section are for reference only. The government's current packaging for the M1 Body, M1 High Fragmentation (HF-1) 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

6.18 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.

6.19 Subject term (keyword) listing.

Ammunition  
Ballistic testing  
Rotating band seating

6.20 Amendment notations. The margins of this specification are marked with vertical lines to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

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Custodian:  
Army - AR

Preparing Activity:  
Army - AR  
(Project 1315-2016-005)

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 <https://assist.dla.mil>.