

INCH-POUND

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SUPERSEDING

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PERFORMANCE SPECIFICATION

BALL SCREW LINEAR ACTUATOR (BSLA)

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1. Scope. This specification covers a Ball Screw Linear Actuator (BSLA) for deployment of stabilizing outriggers for the M8601 Patriot Semitrailer (see 6.1).

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

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-TR-E/BLOCK, Warren, MI 48397-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

AMSC N/A

FSC 5945

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

- QQ-P-35 - Passivation Treatments for Corrosion-Resistance Steel.
- QQ-C-320 - Chromium Plating (Electrodeposited).
- P-C-437 - Cleaning Compound, High Pressure (Steam) Cleaner.
- TT-C-490 - Cleaning Methods for Ferrous Surfaces and Pretreatments for Organic Coatings.

DEPARTMENT OF DEFENSE

- MIL-T-704 - Treatment and Painting of Materiel.
- MIL-H-5606 - Hydraulic Fluid, Petroleum Based, Aircraft Missile and Ordnance.
- MIL-F-13927 - Fungus Resistance Test, Automotive Components.
- MIL-G-23827 - Grease, Aircraft and Instrument, Gear and Actuator Screw, NATO Code Number G354, Metric.
- MIL-A-46106 - Adhesive-Sealants, Silicone, RTV, One Component.
- MIL-C-46168 - Coating Aliphatic Polyurethane Chemical Agent Resistant.

STANDARDS

DEPARTMENT OF DEFENSE

- MIL-STD-193 - Painting Procedures and Marking for Vehicles, Construction Equipment, Material Handling Equipment and Spare Parts.
- MIL-STD-461 - Control of Electromagnetic Interference Emissions and Susceptibility, Requirements for.
- MIL-STD-462 - Electromagnetic Interference Characteristics, Measurement Of.
- MIL-STD-810 - Environmental Test Methods and Engineering Guidelines.

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HANDBOOKS

MIL-HDBK-781 - Reliability Test Methods, Plans and Environments for Engineering Development, Qualification and Production.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Government drawings. The following Government drawings form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DRAWINGS

ARMY

11686299 - Ball Screw Linear Actuators (BSLA).
12343383 - Relay Control Box Schematic Wiring Diagram (Ref).

(Copies of these drawings are available from the U.S. Army Tank-automotive and Armaments Command, AMSTA-TR-E/BLUE, Warren, MI 48397-5000.)

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 the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/SAE AS478 - Identification and Marking Methods (DoD Adopted).

(Application for copies should be addressed to American National Standards Institute, 11 West 42nd 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.

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3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.4.

3.2 Materials. Materials used in the manufacture of the BSLA shall be as specified herein and in the referenced drawings, specifications, and standards. Radioactive material is not to exceed 0.002 microcuries per gram or 0.01 microcuries total activity for the item (see 4.6.1).

3.2.1 Hazardous materials. Hazardous materials as defined in SD-14 shall not be used in any part of this item (see 4.6.1).

3.2.2 Fungus resistant products. Materials used in the BSLA shall be fungus resistant conforming to MIL-F-13927 (see 4.6.1).

3.2.3 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs (see 4.6.1 and 6.4.1).

3.2.4 Qualified products. The contractor shall be responsible for using all assemblies and parts necessary in construction that are listed as qualified products on the Qualified Products Lists (QPL's) and those approved for inclusion on the QPL's. Assemblies and parts determined as QPL items shall appear on the engineering parts list. The contractor's manufacturing inspection records shall specifically list all QPL items by part or drawing number(s), name of supplier(s) and number and date of the QPL. When assemblies and parts are approved as qualified products, but not yet listed on QPL's, the contractor shall list the products by number and date of the approval document with name of supplies (see 4.6.1).

3.3 Design and construction. The design and construction of the BSLA shall conform to Drawing 11686299, its subordinate drawings, and as specified herein (see 4.6.1 and 4.6.2).

3.3.1 Configuration. The BSLA and sub-assemblies shall conform to Drawing 11686299. All parts that are identified shall be identified in accordance with ANSI/SAE AS478. The fabrication and manufacture of equipment (i.e., system, subsystem, components) shall be executed in a manner commensurate with the intended use of the end item and accepted Government standards and specifications delineated herein. Where Government standards and specifications are not stated, accepted industry practices shall be used in the absence of applicable military standards and specifications (see 4.6.1 and 4.6.3).

3.3.2 BSLA lubrication. The BSLA ballnut and screw shall be lubricated with grease conforming to MIL-G-23827 (see 4.6.1).

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3.3.2.1 Ballnut lubrication. The ballnut shall have an external zerk fitting which shall permit the lubrication of the ballnut and screw assembly (see 4.6.1).

3.3.2.2 Lubricant leakage during operation. Actuator lubricant leakage past the external ball screw nut, the manual override drive seal, or at other locations of the ball screw shall not exceed three drops per hour. There shall be no (zero) leakage of lubricant into the drive motor. This leakage requirement applies to all orientations of the BSLA when mounted on the semitrailer (see 4.6.1 and 4.12.2).

3.3.2.3 Lubricant leakage during storage. There shall be no (zero) actuator lubricant leakage from the BSLA during packaging, shipping, or storage of the BSLA in any position over a 24 hour period (see 4.6.1 and 4.12.2).

3.3.3 Gear case lubrication. The gear case shall be filled with a petroleum based lubricant conforming to MIL-H-5606. Provisions shall be made and shall be readily accessible to allow periodic maintenance to externally add/drain the lubricant (see 4.6.1 and 4.6.2).

3.3.3.1 Oil level indicator. An oil level indicator shall be provided to indicate sufficient safe operating lubricant level visible in the BSLA gear box when the BSLA is in the stowed position of 20 degrees from the vertical with the rod end up (see 4.6.2).

3.3.4 Ball and thread. The ball screw shall be provided with a safety stop to prevent exceeding the maximum limits of the BSLA in the fully extended or retracted position (see 4.6.2 and 4.6.5).

3.3.4.1 Ball screw scoring. There shall be no evidence of scoring of the ball screw throughout its entire length after 1150 reliability/maintainability (R/M) duty cycles (see 4.11 and 4.12.2.1).

3.3.5 Drive motor. The motor shall be a 28 volt direct current, reversible, electric drive motor, and shall operate with the relay control box conforming to Drawing 12343383 for changing rotation direction. The motor, when installed on the actuator, shall be water resistant, and shall meet the performance requirements over the full range of BSLA operating characteristics (see 4.6.3.1).

3.3.5.1 Current draw. During intermittent duty operation of 20 second increments in forward and reverse operation, the current draw of the drive motor shall not exceed 180 amperes under all environmental conditions (see 4.6.3.2).

3.3.5.2 Thermal overload protection. A thermal overload switch or other self-resetting protective device shall be provided to prevent damage to the drive motor during operation (see 4.6.3.3).

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3.3.5.3 Drive motor interface. The drive motor shall be an independent component which shall be bolted to the ball screw actuator assembly at the mounting interface, leaving the remaining ball screw actuator assembly as a complete operational independent component (see 4.6.3.4).

3.3.6 Manual override. An external shaft for manual extension and retraction of the BSLA shall be provided in the event of the drive motor failure, using a standard English type six point socket and/or a wrench (see 3.4.6.1 and 4.6.4).

3.3.7 Ventilation. The BSLA gear case shall be vented to atmosphere without allowing water entry by means of a relief valve installed on the BSLA casting. The valve shall be located approximately 11 inches (27.9 centimeters (cm)) vertically above the centerline of the hole in the mounting clevis of the BSLA when positioned 20 degrees from vertical (see 4.6.2).

3.3.7.1 Water intrusion. The BSLA design shall be capable of meeting the vehicle fording requirement of 31 inches (78.7 cm). This design shall not allow water to enter the ball screw assembly in the area measured along the axis of the tube eleven inches up from the center of the hole of the lower mounting clevis pin when the BSLA is placed 20 degrees from vertical (see 4.6.2).

3.3.8 Seals. Ice scraper and wiper seals shall be provided to prevent the entry of water or other foreign matter into the ball nut mechanism (see 4.6.2 and 4.12.2).

3.3.8.1 Water exclusion. The total accumulation of water in the ball screw tube shall not be more than 2 ounces (57 grams (g)). There shall be no water intrusion into the BSLA housing assembly (see 3.3.7.1, 4.6.6, 4.7.5, and 4.12.2).

3.3.9 Rod end sealant. Sealant conforming to MIL-A-46106 or equivalent shall be applied to the rod end threads, keyway, and face of screw prior to assembly into the screw to prevent the entry of water into the threaded insert cavity of the screw (see 4.6.1, 4.6.2, and 4.12.2).

3.3.10 Ease of installation and operation. The BSLA shall be capable of being easily installed and removed from the semitrailer and shall be free from installation interferences. While installed on the semitrailer, the BSLA shall be capable of operating smoothly under a 27 000 pound (lb) (12 247 kilogram (kg)) payload along the full extension and retraction of the BSLA (see 4.12).

3.3.11 Rod end. The rod end shall provide means to hold the bearing cage in line with the interfacing clevis to prevent torque impact of the BSLA when installed on the trailer (see 4.6.2).

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3.4 Performance.

3.4.1 Dynamic load. Actuator shall be capable of operating at a starting tensile load of 52 000 lbs (23 587 kg) at any point along the full range of extension and/or retraction of the screw and operating for a period of not less than five (5) seconds (see 4.7.1).

3.4.2 Static load. The BSLA shall be capable of sustaining a 105 600 lb (47 899 kg) static tensile load for a minimum of five seconds duration without structural damage to the BSLA assembly. Subsequently, the unit shall be capable of operating two complete extension and retraction cycles (see 4.7.2).

3.4.3 Reverse drive. The BSLA shall hold and not reverse drive upon stopping a 52 000 lb (23 587 kg) dynamic tensile load on the screw (see 4.7.3).

3.4.4 Slip clutch. The slip clutch setting shall be such that the BSLA shall retain a minimum 65 000 lb tensile load on the screw. The clutch shall prevent damage to the ball screw assembly when exceeding the 65 000 lb dynamic tensile load (see 4.7.4).

3.4.5 Steam and water jet cleaning. The BSLA shall be capable of being cleaned with high pressure steam and with a high pressure water jet without damage or leakage past the seals. There shall be no deterioration of the seals (see 4.7.5).

3.4.6 Manpower and personnel integration (MAN PRINT).

3.4.6.1 Human engineering factors. The manual override shall not require operator forces that exceed the strength limits of the 5th percentile female specified for high force controls for arm, hand, and thumb-finger controls when using the socket wrench specified in 3.3.6 (see 4.8.1).

3.4.6.2 Safety. The BSLA shall not have any condition which may create a safety hazard to operating, maintenance, and other personnel (see 4.8.2 and 4.12.2.1).

3.4.7 Electromagnetic interference. The BSLA shall meet the electromagnetic emissions requirements CE102 and RE102 of MIL-STD-461 for army ground vehicles (see 4.9).

3.5 Mission essential functions (MEF). The BSLA's primary function is that of stabilizing outriggers for the M860A1 semitrailer. The BSLA shall provide the MEFs listed below to successfully complete its mission. These functions shall be accomplished without causing damage to the M860A1 semitrailer, the primemover, or the payload (see 4.12).

- a. Safely begin and continue movement under its own power without outside assistance.

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- b. Raise and lower a weight of 52 000 lbs over 37 inches (94 cm) of retraction within 1.5 minutes extension or retraction.

3.6 Operational reliability. The BSLA shall conform to the load, cycling rates, holding load, and temperatures as specified in 3.4.1, 3.4.3, 3.6.1, and 3.6.4.2 after 1150 cycles of operation.

3.6.1 Cycling rate. A cycle shall consist of one full extension and full retraction of the BSLA and shall be performed within the following time frames. A complete operating cycle shall not exceed three minutes.

Extension cycle	1.5 minutes maximum
Hold	6 minutes
Retraction cycle	1.5 minutes maximum
Hold	21 minutes
Complete cycle	30 minutes maximum

3.6.2 Reliability conformance. The BSLA shall demonstrate a combined mean cycle between failure (MCBF) of no less than 2000 cycles. Test incidents shall be assessed during operational, reliability cycle testing as defined in 4.12.

3.6.3 Maintainability. During the reliability conformance testing, there shall be no more than one (1) manhour per BSLA of active scheduled/preventative maintenance performed (see 4.12.2.3).

3.6.4 Environmental conditions.

3.6.4.1 Dust. The BSLA shall be capable of operating in a blowing dust environment (see 4.10.1).

3.6.4.2 Temperature. The BSLA shall be capable of operation in ambient air temperatures from -50 degrees Fahrenheit (°F) to +120°F (-46 degrees Celsius (°C)) to +49°C). When in storage, the BSLA shall withstand temperatures from -50 to +160°F (-46 to 71°C) without deterioration that causes any BSLA component to fail (see 4.10.2 and 4.12.1).

3.7 Surface finishes.

3.7.1 Ball screw and thread. Each ball screw shall have a nominal diameter of 0.375 inch (9.53 millimeter (mm)) and each ball screw shall have a thread diameter of 2.50 inch (63.5 mm) with a lead of 0.50 inch (12.7 mm). Threads shall be treated and coated to resist corrosion

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without the use of chromium but shall meet the equivalent physical, performance and environmental requirements of QQ-C-320, class 2 (see 4.6.1 and 4.6.2).

3.7.2 Passivating. Stainless steel surfaces shall be protected against contamination in accordance with QQ-P-35 (see 4.6.1 and 4.6.2).

3.7.3 Cleaning and treatment. Non-stainless steel surfaces shall be cleaned and treated in accordance with TT-C-490, method I or III (see 4.6.1 and 4.6.2).

3.7.4 Painting. Except as otherwise specified herein, the external surfaces of the BSLA shall be cleaned, treated, primed, and painted with Chemical Agent Resistant Coating (CARC) (see 4.13.2). Items to be free of prime and paint are identified in Drawing 11686299.

3.7.4.1 Primer. The BSLA shall be primed in accordance with MIL-T-704 to a dry film thickness of 2 to 3 mils except for the areas noted on Drawing 11686299 (see 4.13.1).

3.7.4.2 Topcoat. The BSLA shall be painted with CARC type F of MIL-T-704, except that the minimum film thickness for MIL-C-46168 or equivalent shall not exceed 3 mils of color green 383, chip no. 34094, except for areas noted on drawing 11686299.

3.8 Identification marking. All parts that are identified shall be identified and marked in accordance with ANSI/SAE AS478 (see 4.6.2).

3.9 Servicing and adjusting. Prior to acceptance, the contractor shall service and adjust each BSLA for operational use including but not limited to the following: Check the electrical system for proper operation, the gear box for proper amount and grade of lubricant, and provide operating limit constraints on the screw assembly to prevent damage to the BSLA prior to installation (see 4.6.2).

3.10 Workmanship. The BSLA shall be free of defects which are detrimental to the appearance, serviceability, or capability of the BSLA such as cracks, dents, scratches, burrs, sharp edges, loose parts, foreign matter, misalignment, deformation, unauthorized use of used or reworked items, or improper assembly (see 4.6.2).

4. VERIFICATION

4.1 Inspection equipment. Unless otherwise specified (see 6.2), the contractor shall be responsible for the provision and maintenance of all inspection equipment necessary to assure that suppliers and services conform to contract requirements. Inspection equipment shall be capable of repetitive measurements to an accuracy of 10% of the measurement tolerance.

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4.2 Classification of inspection. The inspection requirements specified herein are classified as follows:

- a. First article inspection (see 4.4).
- b. Conformance inspection (see 4.5).

4.3 Inspection conditions. Unless otherwise specified (see 6.2), all inspections shall be conducted under the following conditions:

- a. Air temperature: $73 \pm 18^{\circ}\text{F}$ ($23 \pm 10^{\circ}\text{C}$).
- b. Barometric pressure: 28.5 ± 2 inches of mercury (96.5 ± 6.5 kiloPascals (kPa)).
- c. Relative humidity: $50 \pm 30\%$.

4.4 First article inspection. First article inspection shall be performed on preproduction and initial production samples as specified herein. Approval of the first article sample by the Government shall not relieve the contractor of the obligation to supply BSLAs that are fully representative of those inspected as a first article sample. Any changes or deviations of the production units from the first article sample shall be subject to the approval of the contracting officer.

4.4.1 In-process inspection. The first production BSLA shall be inspected during fabrication to determine conformance of materials and workmanship to specified requirements. These inspections shall precede application of primer and paint.

4.4.2 Preproduction inspection. When specified (see 6.2), the preproduction sample shall consist of four BSLAs which shall be subjected to the installation and operation check tests (see 4.4.2.1). Upon successful completion of the check tests, four of the BSLA's shall be randomly selected and shall be subjected each to the conformance inspections specified in table I (see 4.5). Location of inspection shall be at the contractor plant unless otherwise specified by the contracting officer.

4.4.2.1 Preproduction BSLA(s) samples. The contractor shall submit four (4) preproduction BSLA samples to ensure form, fit and functional operation on a fully loaded patriot trailer, at a place to be determined by the Government. Form fit and function requirements shall be satisfied prior to first article testing. Each BSLA shall meet the following requirements (see 4.4.2).

- a. Each BSLA shall complete 25 cycles with max payload of 27 000 lbs on the M860A1 semitrailer.
- b. Each BSLA shall be inspected for ease of installation and removal.
- c. Each BSLA shall be inspected for smooth operation in extension, retraction, and installation interferences.

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4.4.3 First or initial production BSLA(s). Unless otherwise specified (see 6.2), the Government shall randomly select four (4) BSLAs from the first 10 BSLAs produced under the production contract for initial production inspection. The initial production sample shall be inspected as specified in table I. The BSLA(s) selected as first or initial production BSLA shall be furnished under the contract with all current modifications included. The BSLA(s) shall be submitted for inspection and tests to determine conformance to the contract and this specification. If submitted, BSLA(s) shall meet all requirements of the contract and of this specification, no modification shall be applied to subsequent BSLA(s) to be produced under contract without prior approval by the Government procuring activity.

4.4.4 First article inspection failure. Deficiencies found during, or as a result of, the first article inspection sample shall be cause for rejection of the first article sample until evidence has been provided by the contractor that corrective action has been taken to eliminate the deficiency. Any deficiency found during, or as a result of the first article inspection shall be evidence that all items already produced prior to completion of the first article test are similarly deficient unless contrary evidence satisfactory to the contracting officer is furnished by the contractor. Such deficiencies on all items shall be corrected by the contractor. The Government will not accept products until first article inspection is completed to the satisfaction of the Government.

TABLE I. Classification of inspections.

Title	Requirement	Inspection	First article	Conformance	
				Examination	Test
Materials, design and construction	3.2 thru 3.3.11	4.6.1	X		
Defects	3.3, 3.3.3, 3.3.3.1, 3.3.4, 3.3.7 thru 3.3.9, 3.3.11, 3.7.2, 3.7.3, and 3.8 thru 3.10	4.6.2	X	X	
Ballnut lubrication	3.3.2.1	4.6.1	X		
Gear case	3.3.3	4.6.2	X	X	
Oil level indicator	3.3.3.1	4.6.2	X	X	
Ball and thread	3.3.4	4.6.5	X	X	
Scoring	3.3.4.1	4.11	X		
Drive motor	3.3.5	4.6.3.1	X		X
Current draw	3.3.5.1	4.6.3.2	X		X
Thermal overload protection	3.3.5.2	4.6.3.3	X		
Motor interface	3.3.5.3	4.6.3.4	X		

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TABLE I. Classification of inspections - Continued.

Title	Requirement	Inspection	First article	Conformance	
				Examination	Test
Manual override	3.3.6	4.6.4	X		
Ventilation	3.3.7	4.6.2	X		
Seals	3.3.8	4.12.2	X		
Water exclusion test	3.3.8.1	4.12.2	X		
Ease of installation and operational	3.3.10	4.12	X		
Dynamic load	3.4.1	4.7.1	X		X
Static load	3.4.2	4.7.2	X		
Reverse drive	3.4.3	4.7.3	X		X
Slip clutch	3.4.4	4.7.4	X		X
Steam and water jet cleaning	3.4.5	4.7.5	X		
Human engineering factors	3.4.6.1	4.8.1	X		
Safety	3.4.6.2	4.8.2	X		
Electromagnetic interference	3.4.7	4.9	X		
Dust	3.6.4.1	4.10.1	X		
Temperatures	3.6.4.2	4.10.2	X		
Reliability and maintainability	3.6	4.12	X <u>1/</u>		
Reliability conformance	3.6.2	4.12	X <u>1/</u>		
Maintainability	3.6.3	4.12.2.3	X		
Ball screw	3.7.1	4.6.1, 4.6.2	X		
Passivating	3.7.2	4.6.1, 4.6.2	X		
Cleaning and treatment	3.7.3	4.6.1, 4.6.2	X	X	
Painting	3.7.4	4.13.2	X		
Primer	3.7.4.1	4.13.1	X	X	
Topcoat	3.7.4.2	4.13.2	X	X	
Identification marking	3.8	4.6.2	X	X	
Servicing and adjusting	3.9	4.6.2	X	X	
Workmanship	3.10	4.6.2	X	X	

1/ Not required for preproduction inspection.

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4.5 Conformance inspection. Conformance inspection shall be conducted on each BSLA (100% inspection) and shall include the examination of 4.5.1 and the tests of 4.5.2. Noncompliance with any of the specified requirements in sections 3 and 5 shall be cause for rejection of the item.

4.5.1 One hundred percent (100%) final inspection/examination. Each BSLA produced shall be subjected to one complete final inspection by the contractor as depicted in table I and described in 4.5.2 and 4.5.3. Conformance inspection shall be conducted at a site selected by the contractor.

4.5.2 Tests. Each BSLA shall be subjected to the conformance tests specified in table I.

4.5.3 Conformance failure. Failure of the BSLA to pass the conformance examination and tests shall be cause for the Government to refuse acceptance of the item. Any item containing one or more defects either shall not be submitted for Government acceptance or shall be corrected and re-examined or retested and resubmitted without defects for Government acceptance. Resubmitted items shall be kept separate from new items and shall be clearly identified as resubmitted items.

4.5.4 Sampling. Random sampling shall not be allowed for inspection and tests referenced in this specification.

4.6 Methods of inspection.

4.6.1 Materials, design and construction. Conformance to 3.2 thru 3.3.11 shall be determined by inspection of contractor records providing proof or certification that design, construction, processing, and materials conform to requirements. Applicable records shall include drawings, specifications, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data.

4.6.2 Defects. Conformance to 3.3, 3.3.3, 3.3.3.1, 3.3.4, 3.3.7 thru 3.3.9, 3.3.11, 3.7.2, 3.7.3, 3.8 thru 3.10, shall be determined by examination for defects listed in table II. Examination shall be visual, tactile, or by measurement with standard inspection equipment.

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TABLE II. Classification of defects.

Category	Defect	Method of examination
Critical	None	
<u>Major:</u>		
101	Dimensions - out of tolerance affecting interchangeability (see 3.3).	SIE 1/
102	Lubricants - improper amount (see 3.3.2, 3.3.3, and 3.9).	Visual
103	Ventilation - improper valve, sticking (see 3.3.7).	Visual and functional
104	Safety stop missing or not as specified (see 3.3.4).	Visual and functional
105	Seals improper application, not preventing water entry (see 3.3.8).	Visual
106	Sealant - improper application not preventing water entry (see 3.3.9).	Visual
107	Paint - improper paint, improper application (see 3.7.4).	Visual
108	Servicing and adjusting - incomplete/inadequate (see 3.9).	SIE/Visual and functional
109	Workmanship - faulty affecting performance (see 3.10).	Visual
<u>Minor:</u>		
201	Electrical system - inoperative, improper connections, bent or broken pins (see 3.3 and 3.10).	Visual
202	Lubricants - improper grade and application (see 3.3.2 and 3.3.3).	Visual
203	Oil level indicator - damaged or not as specified (see 3.3.3.1).	Visual
204	Surface finish - improper application, cover or color (see 3.7).	Visual
205	Identification marking - missing, not legible or improper location (see 3.8).	Visual
206	Workmanship - improper appearance (see 3.10).	Visual

1/ SIE = Standard Inspection Equipment.

4.6.3 Design, construction, and configuration.

4.6.3.1 Drive motor. To determine conformance to 3.3.5, each drive motor shall be operated for not less than 20 seconds in forward and 20 seconds in reverse direction.

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4.6.3.2 Current draw. To determine conformance to 3.3.5.1, the current draw shall be measured under a 52 000 lb (23 581 kg) load at ambient room temperature.

4.6.3.3 Thermal overload protection. To determine conformance to 3.3.5.2, the thermal overload protection device shall be checked for malfunctions. A test shall be performed on the drive motor which shall cause the thermal device to open in accordance with its design. Failure of the switch or device to trip before drive motor damage occurs shall be cause for rejection.

4.6.3.4 Drive motor interface. To determine conformance to 3.3.5.3, the motor shall be removable from the BSLA by standard fasteners and the motor drive shaft shall separate at the mounting surface.

4.6.4 Manual override. To determine conformance to 3.3.6, the BSLA shall be extended and retracted one time and checked for smooth operation using a standard English size socket wrench which may be attached to a drill motor.

4.6.5 Ball screw. To determine conformance to 3.3.4, the backlash shall not exceed 0.013 inch (0.033 mm).

4.6.6 Water exclusion. To determine conformance to 3.3.8.1, water seal test shall be performed after completion of the reliability test. The test shall be performed with the BSLA screw extended (exposed) twenty inches from the rod end of the ball screw actuator. The BSLA shall be placed in a vertical position with the rod end pointing up with all casting vents, lubrication fittings, plugs and access holes in a closed position. The BSLA shall be subjected to a constant flow of water running down the screw at a rate of one gallon per hour for a three hour period. Accumulation of water inside the ball screw actuator assembly in excess of two ounces is unacceptable. Water accumulation shall be determined by water extracted from the actuator by removing plugged holes from the chamber and disassembly of the BSLA.

4.6.7 Actuator lubricant. To determine conformance to 3.3.2.2, the zero lubricant leakage shall be verified in conjunction with the evaluation of the BSLA's reliability (4.12.2).

4.7 Performance tests.

4.7.1 Dynamic load. To determine conformance to 3.4.1, the BSLA shall be cycled three times at a 52 000 lb load, at the 10 inch (25.4 cm), 15 inch (38 cm), and 25 inch (63.5 cm) position along the screw.

4.7.2 Static load. To determine conformance to 3.4.2, the BSLA shall be subjected to a 105 600 lb tensile load. Structural and operating integrity shall not be degraded as determined by a visual inspection and two cycle operation of the complete assembly upon completion of this test.

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4.7.3 Reverse drive. To determine conformance to 3.4.3, the BSLA shall be held for ten seconds when subjected to a 52 000 lb tensile load. The BSLA shall not reverse drive at the specified load.

4.7.4 Slip clutch. To determine conformance to 3.4.4, the BSLA shall be subjected to a 65 000 lb dynamic tensile load for 2 minutes after testing in accordance with 4.7.1. The slip clutch shall not slip at the specified load after completion of the BSLA reliability test (see 4.12.2).

4.7.5 Steam and water jet cleaning. To determine conformance to 3.4.5, using a cleaner conforming to P-C-437, the BSLA shall be cleaned for 10 minutes each as specified. Water exclusion as specified in 3.3.8.1 and performance shall not deteriorate due to cleaning. The procedure for steam and water jet cleaning shall be as follows: The jet shall be applied perpendicular to and not more than one foot from the surface to be cleaned for steam or water jet cleaning. The cleaning rate shall be one square foot per minute and the jet pressure not less than 100 psi (689.5 kPa) nor more than 110 psi (758.4 kPa) (see 3.3.7.1).

4.8 MANPRINT evaluations.

4.8.1 Human engineering factors. To determine conformance to 3.4.6.1, the force required to operate the manual override shall not exceed 23 lbs.

4.8.2 Safety. To determine conformance to 3.4.6.2, the BSLA shall be continuously evaluated for safety hazards throughout the R/M test.

4.9 Electromagnetic interference. To determine conformance to 3.4.7, the BSLA shall be tested in accordance with MIL-STD-462.

4.10 Environmental conditions. The mission essential functions of the BSLA shall be verified under the dust and low and high temperature environmental conditions specified herein.

4.10.1 Dust. To determine conformance to 3.6.4.1, the BSLA shall be subjected to dust contamination for one exposure cycle in accordance with Method 510 of MIL-STD-810 and tested without being cleaned in conjunction with the R/M tests. Prior to conducting the mission essential functions of 3.5, the BSLA in the fully extended position shall be tested for dust contamination. The BSLA shall not be cleaned until the R/M verification is completed. An evaluation shall then be made to verify that the BSLA's mission essential functions and reliability/maintainability are not adversely affected by exposure to a dust laden environment.

4.10.2 Temperature. To determine conformance to 3.6.4.2, the BSLA shall be subjected to the specified operating and storage temperatures in conjunction with the R/M tests. An evaluation shall then be made to verify that the mission essential functions and reliability/

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maintenance are not adversely affected by exposure to operating and storage temperature ranging from -50°F to +160°F, in accordance with Methods 501 and 502 of MIL-STD-810.

4.11 Scoring. To determine conformance to 3.3.4.1, the test specified in 4.12 shall be completed. Subsequently, the entire length of the ball screw shall be checked for any evidence of scoring using 10X magnification inspection.

4.12 R/M test. To determine conformance to 3.6, each BSLA shall be subjected to an operational reliability test of 1150 cycles in accordance with the following procedures (see 3.3.10 and 4.12.2.1):

- a. Two locations on each sample system shall be selected to conduct the scribe tape test as specified in MIL-T-704. The precise location shall be as obscure as possible and acceptable to the Government. The test surface shall be sufficiently warm and dry to assure adhesion of the tape. If a failure is detected using the criteria described in the test, then the entire lot shall be screened for a similar deficiency in a like manner. All BSLA's which fail the paint adhesion test shall be entirely stripped to bare metal and the entire clean, treat, and paint process reapplied. Upon successful completion of the test, the scribe mark shall be feathered out with sandpaper and touched up with the required top coat.
- b. The film thickness of the paint shall be examined, spot checking sufficient locations to ensure paint finish uniformity. The paint film thickness shall be verified in accordance with MIL-STD-193. Paint film thickness failure shall be described in MIL-STD-193. If a failure is detected then the entire lot shall be screened for a similar deficiency in a like manner. All BSLA's which fail film thickness test shall be stripped to bare metal and the entire clean, treat, and paint process reapplied (see 3.7.4.2).
- c. The paint permeability shall be accomplished by using a white paper towel wet with acetone and rubbed in opposite directions, with normal scrubbing pressure, three times each (total 6) on a flat portion of the painted surface. If the paint or pigment sticks to the towel, repeat the above procedure after the surface has dried. If, subsequent to the second attempt, paint or pigment continues to stick to the towel or if the paint can be scrapped or rolled off with a fingernail then the BSLA's paint shall have failed the test. All actuators which fail the paint permeability test shall be entirely stripped to bare metal and the entire finish reapplied.

4.12.1 R/M duty cycles. The duty cycles for demonstrating R/M (see 4.12) shall be conducted under the following temperatures and in the order specified (see 4.10.2).

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<u>Duty cycle no.</u>	<u>Temperature</u>
1 to 920 (operating)	-65°F to 80°F (18°C to 27°C)
Storage -24 hours (nonoperating)	-50°F
921 to 1035 (operating)	-50°F
Storage - 24 hours (nonoperating)	160°F
1036 to 1150 (operating)	120°F

4.12.2 R/M failure criteria.

4.12.2.1 Reliability verification. For reliability verification, failures shall be categorized as follows:

- a. Malfunction. A malfunction is any occurrence that prevents further operation of a major BSLA component and requires that the component be replaced or repaired. The major components are the motor, drivetrain, screw, housing, rod end bearing, and ball return assembly.
- b. Incident. An incident is any occurrence which causes or could cause the BSLA from performing/completing one or more of its mission essential functions; which poses a safety hazard to personnel; or which causes or could cause catastrophic failure of the BSLA, semitrailer, or associated equipment.
- c. Examples of malfunctions/incidents:
 - (1) Lubricant leaks during operation and storage (see 3.3.2.2, 3.3.2.3, 3.3.8, and 4.7.1).
 - (2) Water in excess of two ounces in the ball screw (see 3.3.8.1).
 - (3) Ball screw shows evidence of scoring (see 3.3.4.1).
 - (4) Rod end sealant permits water to enter threaded insert cavity of the screw (see 3.3.9).
 - (5) Slip clutch back drives in retraction or extension in less than 10 seconds (see 3.4.4).
 - (6) Safety stop does not prevent screw from damaging the ball screw (see 3.3.4).
 - (7) Drive motor is not water resistant or is inadequate (see 3.3.5).

Failures are defined as incidents (see 4.12) that prevent the BSLA from successfully completing a mission essential function (see 3.5) or as otherwise identified in 4.12.2.2 (see 4.12.2.3).

4.12.2.2 Operational reliability failure (ORF). An ORF is any malfunction that prevents further operation of a major BLSA component and requires that the component must be replaced or repaired. The major components are the motor, drivetrain, screw, housing, rod end bearing, and ball return assembly. An ORF is also any incident or malfunction (actual, intermittent, or incident) of the BSLA system which causes or could have caused the inability to perform one or

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more mission essential functions, or is a critical or catastrophic hazard to personnel or equipment. The operational reliability cycle shall be used to verify the reliability and maintainability requirements specified (see 3.6.1, 3.6.2 and 4.12).

4.12.2.2.1 Operational reliability. Starting from the fully extended position (overall length 86 inches (218 cm)), the BSLA shall be operated with a starting load of 10 000 lbs (4536 kg) tensile force over the initial 10 inches (25.4 cm) of retraction. During the next 20 inches (50.8 cm) of retraction, the load shall be increased linearly from 10 000 lbs to 52 000 lbs during the remaining length of the screw retraction. The load shall be maintained at 52 000 lbs load (overall length 49 inches (124 cm)), the BSLA shall exert a 52 000 lb tensile force over 20 inches of extension, then linearly reducing the load to a 10 000 lbs tensile force over the full range of extension. The BSLA shall be capable of stopping and starting at any position under load during the cycle tests. Auxiliary ambient air flow on the BSLA motor is permitted to meet the complete cycle time for reliability testing.

4.12.2.2.2 Reliability. To determine conformance to 4.12, test plan 10-1 of MIL-HDBK-781 shall be used to verify that the Mean Cycle Between Failure (MCP) for the BSLA as specified has been attained. The reliability requirement shall be verified using the accept-reject criteria of test plan 10-1, with a confidence level of 90% and a risk factor of 10%. Each of the four BSLAs shall be tested for a total of 1150 operational reliability cycles, which equates to 4600 total operational reliability cycles. The testing shall verify requirements of 4.12, 4.12.1, and 4.12.2.2. Classification of all test incidents will be performed by Government personnel and will constitute official results of the test for contractual compliance, based upon 3.5 and 4.12.2.2. Failure of any one BSLA to meet the requirements specified shall constitute the failure of the entire test. If any modification is made to one test sample, each of the test samples will be required to undergo complete retest with the same configuration changes.

4.12.2.3 Maintainability verification. To determine conformance to 3.6.5, failure occurs when the total maintenance manhours expended to perform active scheduled and unscheduled maintenance per BSLA exceeds one manhour or when safety hazards to personnel/unsafe conditions develop that require corrective (unscheduled) maintenance action.

4.13 Surface finishes.

4.13.1 Primer. To determine conformance to 3.7.4.1, the BSLA shall be checked for proper thickness and for proper application of primer, except for those areas noted in Drawing 11686299 to be free of primer. Primer thickness shall be checked prior to painting.

4.13.2 Paint. To determine conformance to 3.7.4 and subsequent to application and and ball return assembly. An OKF is also any incident or malfunction (actual, intermittent, or incident) of the BSLA system which causes or could have caused the inability to perform one or

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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, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or 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 which may be helpful, but is not mandatory.)

6.1 Intended use. The intended use of the BSLA covered by this specification is to raise and lower the stabilizing outriggers of the M860A1 semitrailer outfitted with the PATRIOT Radar and Launcher System. This is accomplished by retracting and extending the (ball) screw over a range of 37 inches (94 cm) under a load of 52 000 lbs.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
- c. If first article inspection is required (see 3.1).
- d. If responsibility of inspection equipment should be other than as specified (see 4.1).
- e. If inspection conditions should be other than as specified (see 4.3).
- f. If preproduction inspection is required (see 4.4.2).
- g. Location for conducting preproduction inspection (see 4.4.2).
- h. If initial production inspection is not required (see 4.4.3).
- i. Packaging requirements (see 5.1).

6.3 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a first article sample, or a standard production item from the contractor's current inventory and the number of items to be tested as specified in 4.4. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders

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offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4 Definitions.

6.4.1 Recovered materials. Recovered materials means materials that have been collected or recovered from solid waste (see 3.2.3 and 6.4.2).

6.4.2 Solid waste. "Solid waste" means (a) any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility; and (b) other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved material in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Clean Water Act, (33 U.S.C. 1342 et. seq.), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 U.S.C. 2011 et. seq.) (Source: Federal Acquisition Regulations, section 23.402).

6.5 Subject term (key word) listing.

M8601 semitrailer
 Outriggers
 Patriot
 Radar and launcher system
 Return assembly
 Rod end bearing
 Stabilizing

6.6 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.

Custodians:
 Army - AT
 Navy - MC

Preparing Activity:
 Army - AT

(Project 5945-0988)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
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I RECOMMEND A CHANGE:		1. DOCUMENT NUMBER MIL-PRF-62542B	2. DOCUMENT DATE (YYMMDD) 960625
3. DOCUMENT TITLE Ball Screw Linear Actuator (BSLA)			
4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)			
5. REASON FOR RECOMMENDATION			
E. SUBMITTER			
a. NAME (Last, First, Middle Initial)		5. ORGANIZATION	
c. ADDRESS (Include Zip Code)		d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)
B. PREPARING ACTIVITY			
a. NAME		b. TELEPHONE (Include Area Code) (1) Commercial (810) 574-8745	(2) AUTOVON 786-8745
c. ADDRESS (Include Zip Code) Commander U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-TR-E/BLUE, Warren, MI 48397-5000		IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 AUTOVON 289-2340	