

INCH-POUND

MIL-B-62542A(AT)

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SUPERSEDING

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MILITARY SPECIFICATION

BALL SCREW LINEAR ACTUATOR (BSLA)

This specification is approved for use within the U.S. Army Tank-Automotive Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers a Ball Screw Linear Actuator (BSLA) for deployment of stabilizing outriggers for the M860A1 Patriot Semitrailer (see 6.1).

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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).

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 Command, ATTN: AMSTA-GDS, Warren, MI 48397-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

AMSC N/A

FSC 5945

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SPECIFICATIONS

FEDERAL

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|----------|---|
| 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. |

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| MIL-H-5606 | - Hydraulic Fluid, Petroleum Base; Aircraft, Missile and Ordnance. |
| MIL-F-13927 | - Fungus Resistance Test, Automotive Components. |
| MIL-G-23827 | - Grease, Aircraft and Instrument, Gear and Actuator Screw. |
| MIL-P-26915 | - Primer Coating, Zinc Dust Pigmented, for Steel Surfaces. |
| MIL-A-46106 | - Adhesive-Sealants, Silicone, RTV, One Component. |
| MIL-C-46168 | - Coating Aliphatic Polyurethane Chemical Agent Resistant. |
| MIL-P-53022 | - Primer, Epoxy Coating, Corrosion Inhibiting, Lead and Chromate Free. |
| MIL-P-53030 | - Primer Coating, Epoxy, Water Reducible, Lead and Chromate Free. |
| MIL-C-53039 | - Coating Aliphatic Polyurethane Chemical Agent Resistant. |

STANDARDS

MILITARY

- | | |
|-------------|---|
| MIL-STD-130 | - Identification Marking of U.S. Military Property. |
| MIL-STD-193 | - Painting Procedures and Marking for Vehicles, Construction Equipment and Material Handling Equipment. |
| MIL-STD-454 | - Standard General Requirements for Electronic Equipment. |
| MIL-STD-461 | - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference. |
| MIL-STD-462 | - Electromagnetic Interference Characteristics, Measurement of. |
| MIL-STD-781 | - Reliability Testing for Engineering Development, Qualification, and Production. |

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- MIL-STD-810 - Environmental Test Methods and Engineering Guidelines.
- MIL-STD-1472 - Human Engineering Design Criteria for Military Systems, Equipment, and Facilities.
- MIL-STD-45662 - Calibration Systems Requirements.

HANDBOOKS

MILITARY

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

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Navy Publication and Printing Services Office, Standardization Documents Order Desk, Bldg 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 Government drawings. The following Government drawings form a part of this specification to the extent specified herein. Unless otherwise specified, the issue shall be that in effect on the date of the solicitation.

DRAWINGS

ARMY

- 8750050 - PATRIOT, Semitrailer, Flatbed, M860A1 (Ref).
- 11686299 - Ball Screw Linear Actuators (BSLA).
- 12343383 - Relay Control Box Schematic Wiring Diagram (Ref).

(Copies of drawings required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the Contracting Officer.)

2.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.a. Preproduction BSLA(s) samples. The contractor shall submit four (4) preproduction BSLA's samples to insure 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 (see 4.4.2).

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.3 and 4.4.

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3.1.1 First or initial production BSLA(s). 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 four 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.

3.2 Materials. Materials used in the manufacture of the BSLA specified herein and in the referenced drawings, specification, and standards shall be new and free from defects and imperfections (see 4.7.1).

3.2.1 Radioactive materials. No radioactive material shall be used in any part of this item. Radioactive material is that material in excess of 0.002 microcuries or greater of activity as defined in domestic licensing of source material (see 4.7.1).

3.2.2 Fungus resistant products. Material susceptible to fungus shall meet the requirements of MIL-F-13927 (see 4.7.13 and 4.7.1).

3.2.3 Recycled, virgin and reclaimed materials. There are no requirements for the exclusive use of virgin materials. The use of recycled or reclaimed (recovered) materials is acceptable provided that all other requirements of this specification are met (see 4.7.1 and 6.4.1).

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 4.7.1 and 4.7.2).

3.3.1 Design requirements. The BSLA shall be designed to meet the rigorous set of physical requirements and climatic conditions of operation. The characteristics of the BSLA thus established shall be maintained throughout the material life cycle. Proposed configuration changes shall not be made unless prior approval is obtained from the procuring activity (see 4.7.1).

3.3.1.1 Configuration. The BSLA and sub-assemblies shall conform to Drawing 11686299. All parts that are identified, shall be identified in accordance with MIL-STD-130. 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 are to be used in the absence of applicable military standards and specification (see 4.7.1 and 4.7.3).

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3.3.2 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 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 4.7.1).

3.3.3 BSLA lubrication. The BSLA ballnut and screw shall be lubricated with grease conforming to MIL-G-23827 (see 4.7.1).

3.3.3.1 Ballnut lubrication. The ballnut shall have an external zerk fitting which shall permit the lubrication of the ballnut and screw assembly (see 4.7.1 and 4.7.3.1).

3.3.3.2 Lubricant leakage during operation. Actuator lubricant leakage past the external ball screw nut, the manual override drive seal, or at other locations of the ballscrew 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 and it shall be verified in conjunction with the evaluation of the BSLA's reliability (see 3.7.3 and 4.7.1).

3.3.3.3 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. This leakage requirement shall be verified in conjunction with the evaluation of the BSLA's reliability (see 3.7.3 and 4.7.1).

3.3.4 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 4.7.2 and 4.7.3.2).

3.3.4.1 Oil level indicator. A refracting prism type 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 4.7.2 and 4.7.3.3).

3.3.5 Ball and thread. The ball screw shall be provided with a safety stop to prevent the screw from damaging the ball screw assembly when exceeding the maximum limits of the BSLA in the fully extended or retracted position. The maximum allowable backlash shall be 0.013 inch (see 4.7.1 and 4.7.4).

3.3.5.1 Ball screw scoring. There shall be no evidence of scoring of the ball screw throughout its entire length when viewed under 10X magnification after 1,150 R/M duty cycles (see 4.7.2 and 4.7.14).

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3.3.6 Drive motor. The motor shall be a 28 volt direct current, reversible, electric drive motor, required to operate in conjunction with the configured relay control box dwg 12343383 schematic 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 3.7.3 and 4.7.5).

3.3.6.1 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 while the BSLA is under a 52,000 pound (lb) tensile load and under all environmental conditions (see 4.7.5.1).

3.3.6.2 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 4.7.5.2).

3.3.6.3 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 4.7.5.3).

3.3.7 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 4.7.6).

3.3.8 Ventilation. The BSLA gear case shall be vented to atmosphere by means of a 0.25 to 1.0 pound per square inch (psi) relief valve installed on the BSLA casting. The valve shall be positioned to allow a fording depth of 31 inches without allowing water to enter the BSLA assembly, the valve location will be approximately eleven inches vertically above the centerline of the hole in the mounting clevis of the BSLA when positioned 20 degrees from vertical (see 4.7.7 and 4.7.2).

3.3.8.1 Water intrusion. The BSLA design shall be capable of meeting the vehicle fording requirement of 31 inches. This relates to a design which will not allow water to enter the ballscrew 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.

3.3.9 Seals. Ice scraper and rubber wiper seals shall be provided to preclude the entry of water or other foreign matter into the ball nut mechanism. The adequacy of the seals to prevent leakage shall be verified in conjunction with the evaluation of the BSLA's reliability (see 3.7.3 and 4.7.8).

3.3.9.1 Water exclusion. When tested as specified in 4.7.9.5 and 4.7.8.1 the total accumulation of water in the ballscrew tube shall not be more than 2 ounces. There shall be no water intrusion into the BSLA housing assembly (see 3.7.3 and 4.7.8.1).

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3.3.10 Rod end sealant. Sealant conforming to MIL-A-46106 shall be applied to the rod end threads, keyway, and face of screw prior to assembly into the screw to preclude the entry of water into the threaded insert cavity of the screw. The adequacy of the sealant application shall be verified in conjunction with the evaluation of the BSLA's reliability (see 3.7.3 and 4.7.2).

3.3.11 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 lb payload along the full extension and retraction of the BSLA. This requirement shall be verified in conjunction with the R/M test (see 4.7.13.1).

3.3.12 Rod end. The rod end shall have a boss on each side of the bearing cage to hold the cage in line with the interfacing clevis to prevent torque impact of the BSLA when installed on the trailer.

3.4 Performance.

3.4.1 Dynamic load. Actuator shall be capable of operating at a starting load of 52,000 lbs 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 4.7.9.1).

3.4.2 Static load. The BSLA shall be capable of sustaining a 105,600 lb 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 4.7.9.2).

3.4.3 Reverse drive. The BSLA shall not reverse drive upon stopping a 65,000 lb dynamic tensile load on the screw. There shall be no reverse rotation of the assembly when the motor stops (see 4.7.9.3).

3.4.4 Slip clutch. The slip clutch setting shall be such that the BSLA shall retain a minimum 65,000 lb dynamic tensile load on the screw. The clutch shall prevent damage to the ball screw assembly when exceeding the 65,000 lb dynamic tensile load. Upon completion of the test of the BSLA's reliability, the slip clutch torque shall not be degraded below the 65,000 lb load (see 4.7.9.4).

3.4.5 Steam and water jet cleaning. The BSLA shall be capable of being cleaned with high pressure steam using a cleaner conforming to P-C-437 and with a high pressure water jet without damage or leakage past the seals. There shall be no deterioration of the seals, gaskets, or other defects. Paint removal will not be a basis for rejection. The procedure for steam and water jet cleaning is 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 nor more than 110 psi (see 4.7.9.5).

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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 through 95th percentile male specified for high force controls for arm, hand, and thumb-finger controls of MIL-STD-1472 when using the socket wrench specified in 3.3.5 (see 4.7.10.1).

3.4.6.2 Safety. The BSLA shall not have any condition which may create a safety hazard to operating, maintenance, and other personnel. These safety factors shall be verified on a continuous basis in conjunction with the evaluation of the BSLA's reliability/maintainability (see 3.7.3.1 and 4.7.10.2).

3.4.7 Electromagnetic interference. The BSLA shall meet the electromagnetic compatibility requirements for tactical vehicles, class IIC, RE02 and CE03 of MIL-STD-461 (see 4.7.11).

3.5 Mission essential functions (MEF). The BSLA's primary function is that of stabilizing outriggers for the M860A1 semitrailer. It must provide the MEFs listed below to successfully complete its mission. These functions must be accomplished without causing damage to the M860A1 semitrailer, the primemover, or the payload (see 3.6 through 3.7.3.2).

- a. Safely begin and continue movement under its own power without outside assistance.
- b. Raise and lower a weight of 52,000 lbs over 37 inches of retraction within 1.5 minutes extension or retraction.

3.6 Reliability and maintainability (R/M). The reliability and maintainability test shall consist of 1150 cycles each of BSLA operation. The operational reliability cycle shall be used to verify the reliability and maintainability requirements specified (see 3.6.3, 3.6.4, and 4.7.15).

3.6.1 Operational reliability. Starting from the fully extended position (overall length 86 inches), the BSLA shall be operated with a starting load of 10,000 lbs tensile force over the initial 10 inches of retraction. During the next 20 inches 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 for the cycling time stated. Starting from the fully retracted position while under the 52,000 lb load (overall length 49 inches), the BSLA shall exert a 52,000 lb compressive force over 20 inches of extension, then linearly reducing the load to a 10,000 lbs compressive 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 (see 4.7.2).

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3.6.1.1 Cycling rate. A cycle shall consist of one full extension and full retraction of the BSLA and 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 Hold position. At any point of the retraction and extension portion of the cycle defined in 3.6.1.1, the 52,000 lb load shall be held for ten seconds to demonstrate that the BSLA will not back drive.

3.6.3 Reliability and maintainability test: The reliability and maintainability indices of the BSLA shall be determined when operated for a total of 1150 operational reliability cycles per unit under the conditions specified (see 3.6).

3.6.4 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 4.7.7.6. Failures are defined as incidents (paragraph 3.6) that prevent the BSLA from successfully completing a mission essential function (3.5) or as otherwise identified in 3.6.4.1 (see 4.7.16).

3.6.4.1 Operational reliability failure (ORF). An ORF is any malfunction that precludes further operation of a major BSLA 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 more mission essential functions, or is a critical or catastrophic hazard to personnel or equipment.

3.6.5 Maintainability. During the reliability conformance testing, there shall not be more than one (1) manhour per BSLA of active scheduled/preventative maintenance performed (see 4.7.17).

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

3.7.1 Dust. The BSLA shall be capable of operating in a blowing dust environment. Prior to conducting the mission essential functions of 3.5, the BSLA in the fully extended position shall be subjected to dust contamination for one exposure cycle in accordance with Method 510, "Blowing Sand and Dust", of MIL-STD-810. The BSLA shall not be cleaned until the R/M verification is completed (see 4.7.12.1).

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3.7.2 Temperature. The BSLA shall be capable of operation in ambient air temperature from minus 50 degrees Fahrenheit (°F) to plus 120°F. When in storage, the BSLA shall withstand temperatures from minus 50°F to plus 160°F without deterioration that causes any BSLA component to fail. The ability of the BSLA to function under these extreme temperatures shall be verified in accordance with Methods 501 and 502, "High and Low Temperatures", of MIL-STD-810. The duty cycles for demonstrating R/M (see 3.6) shall be conducted under the following temperatures and in the order specified (see 4.7.12.2):

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

3.7.3 R/M failure criteria.

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

a. **Malfunction.** A malfunction is any occurrence that precludes 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 3.3.3.2, 3.3.3.3, 3.3.9, and 4.7.1).
- (2) Water in excess of two ounces in the ball screw (see 3.3.9.1).
- (3) Ball screw shows evidence of scoring (see 3.3.5.1).
- (4) Rod end sealant permits water to enter threaded insert cavity of the screw (see 3.3.10).
- (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 3.3.5).
- (7) Drive motor is not water resistant or is inadequate (see 3.3.6).

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

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3.8 Surface finishes.

3.8.1 Ball screw. Threads shall be chromium plated in accordance with QQ-C-320, Class 2, and coated to resist corrosion (see 4.7.2).

3.8.2 Passivating. Stainless steel surfaces shall be passivated in accordance with QQ-P-35 (see 4.7.2).

3.8.3 Cleaning & treatment. Non stainless steel surfaces shall be cleaned and treated in accordance with TT-C-490, Method I or III (see 4.7.2).

3.8.4 Painting. Except as otherwise specified herein, the external surfaces of the BSLA shall be cleaned, treated, primed, and painted in accordance with MIL-STD-193 for chemical agent resistant coating (CARC) and the following (see 4.7.19.2):

- a. Items to be free of prime and paint are identified in Dwg 11686299.

3.8.4.1 Primer. Prime per MIL-P-52192 or MIL-P-53030, 2.0 to 3.0 mils dry film thickness except for the areas noted on drawing 11686299 (see 4.7.19.1).

3.8.4.2 Topcoat. The BSLA shall be painted with chemical agent resistant coating as specified (except for areas noted on drawing 11686299) with polyurethane per MIL-C-46168 or MIL-C-53039, 2.0 to 3.0 mil dry film thickness, color green 383, chip no. 34094.

3.9 Identification marking. All parts that are identified shall be identified and marked in accordance with MIL-STD-130 (see 4.7.2).

3.10 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 4.7.18).

3.11 Workmanship. The BSLA workmanship shall be in accordance with the manufacture of a high quality product. This shall be evidenced by the absence 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 4.7.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the

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performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance shall comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements; however, this does not authorize the submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.1.2 Inspection equipment. Unless otherwise specified in the contract (see 6.2). The contractor is responsible for the provision and maintenance of all inspection equipment necessary to assure that supplies and services conform to contract requirements. Inspection equipment must be capable of repetitive measurements to an accuracy of 10% of the measurement tolerance. Calibration of inspection equipment shall be in accordance with MIL-STD-45662.

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

- a. First article inspection (see 4.4).
 - 1. In-process inspection (see 4.4.1).
 - 2. Preproduction inspection (see 4.4.2).
 - 3. Initial production (see 4.4.3).
- b. Quality conformance inspection (QCI) (see 4.5).
 - 1. Examination (see 4.5.1).
 - 2. Tests (see 4.5.2).
- c. Control tests (see 4.6).

4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be conducted under the following conditions:

- a. Air temperature $73 \pm 18^{\circ}\text{F}$.
- b. Barometric pressure 28.5 ± 2 inches mercury (Hg).
- 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

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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. Processing and welding procedures, the quality system, inspection records, calibration procedures, radiographic procedures, and welder certifications shall be reviewed and evaluated.

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, randomly select four of the BSLA's and subject each to the QCI specified in table I (see 4.5).

4.4.2.1 Preproduction samples. The preproduction sample shall consist of four each BSLA's which shall meet the following requirements:

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 and retraction, and installation interferences.

4.4.3 Initial production inspection. 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.

4.4.4 First article inspection failure. Deficiencies found during, or as a result of, the first article inspection 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.

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TABLE I. Classification of inspections.

Title	Requirement	Inspection	First article	QCI		Control
				Examination	Test	
<u>Group A:</u>						
Materials, design and construction	3.2 thru 3.3.3.3 and 3.3.5	4.7.1	X			
Defects	3.3.4, 3.3.4.1, 3.3.5.1, 3.3.8, 3.3.10, 3.6.1, 3.8, 3.9, and 3.11	4.7.2	X	X		
Ball nut lubrication	3.3.3.1	4.7.3.1	X			
Gear case	3.3.4	4.7.3.2	X	X		
Oil level indicator	3.3.4.1	4.7.3.3	X	X		X
Ball and thread	3.3.5	4.7.4	X	X		X
Scoring	3.3.5.1	4.7.14	X			X
Drive motor	3.3.6	4.7.5	X		X	X
Current draw	3.3.6.1	4.7.5.1	X		X	X
Thermal overload protection	3.3.6.2	4.7.5.2	X			X
Motor interface	3.3.6.3	4.7.5.3	X			
Manual override	3.3.7	4.7.6	X			X
Ventilation	3.3.8	4.7.7	X			X
Seals	3.3.9	4.7.8	X			X
Water exclusion	3.3.9.1	4.7.8.1	X			X
Ease of installation and operational	3.3.11	4.7.13.1				
<u>Group B (performance):</u>	4.7.4					
Dynamic load	3.4.1	4.7.9.1	X		X	X
Static load	3.4.2	4.7.9.2	X			
Reverse drive	3.4.3	4.7.9.3	X		X	X
Slip clutch	3.4.4	4.7.9.4	X		X	X
Steam and water jet cleaning	3.4.5	4.7.9.5	X			X
Human engineering factors	3.4.6.1	4.7.10.1	X			
Safety	3.4.6.2	4.7.10.2	X		X	X
Electromagnetic interference	3.4.7	4.7.11	X			

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TABLE I. Classification of inspections - Continued.

Title	Requirement	Inspection	First article	QCI		Control
				Examination	Test	
Group C (<u>environmental</u>):						
Environmental conditions	3.7	4.7.12	X			
Dust	3.7.1	4.7.12.1	X			
Temperatures	3.7.2	4.7.12.2	X			
Group D (<u>life</u>):						
Reliability and Maintainability	3.6	4.7.15	X 1/			
Reliability conformance	3.6.4	4.7.16	X 1/			
Maintainability	3.6.5	4.7.17				
Ball screw	3.8.1	4.7.2	X			X
Passivating	3.8.2	4.7.2	X			X
Cleaning and treatment	3.8.3	4.7.2	X	X		X
Painting	3.8.4	4.7.19.2	X			X
Primer	3.8.4.1	4.7.19.1	X	X		X
Topcoat	3.8.4.2	4.7.19.2	X	X		X
Identification marking	3.9	4.7.2	X	X		X
Servicing and adjusting	3.10	4.7.18	X	X		X
Workmanship	3.11	4.7.2	X	X		X

1/ Not required for preproduction inspection.

4.5 QCI 100% inspection. QCI 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. 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. Quality conformance inspection shall be conducted at a site selected by the contractor.

4.5.2 Tests. Each BSLA shall be subjected to the (QCI) tests specified in table I.

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4.5.3 QCI failure. Failure of the BSLA to pass the QCI 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.

TABLE II. Classification of defects.

Category	Defect	Method of examination
Critical	None	
Major		
101	Dimensions - out of tolerance affecting interchangeability (see 3.3).	SIE 1/
102	Lubricants - improper amount (see 3.3.4, 3.3.3, and 3.10).	Visual
103	Ventilation - improper valve, sticking (see 3.3.8).	Visual and functional
104	Seals - improper application, not preventing water entry (see 3.3.9).	Visual
105	Sealant - improper application not preventing water entry (see 3.3.10).	Visual
106	Paint - improper paint, improper application (see 3.8.4).	Visual
107	Servicing and adjusting-incomplete/inadequate (see 3.10).	SIE and functional Visual and functional
108	Workmanship - faulty affecting performance (see 3.11).	Visual
Minor		
201	Electrical system - inoperative, improper connections, bent or broken pins (see 3.3 and 3.10).	Visual
202	Lubricants - improper grade and application (see 3.3.4.1 and 3.10).	Visual
203	Oil level indicator - damaged (see 3.3.4.1).	Visual
204	Surface finish - improper application, cover or color (see 3.8).	Visual
205	Identification marking - missing, not legible or improper location (see 3.9).	Visual
206	Workmanship - improper appearance (see 3.11).	Visual

1/ SIE = Standard Inspection Equipment.

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4.6 Control tests. Control tests shall be conducted on one BSLA from each lot of 50 items consecutively produced, or two production months, whichever occurs first. The BSLA shall be subjected to the control tests specified in table I, except that the reliability test shall consist of 100 duty cycles (see 3.5).

4.6.1 Control test failure. Failure of any BSLA to pass any of the control tests specified in table I shall be cause for the Government to refuse acceptance of the production quantity represented, until action taken by the contractor to correct defects and prevent recurrence has been approved by the Government.

4.7 Methods of inspection.

4.7.1 Materials, design and construction. Conformance to 3.2 thru 3.3.3.3, and 3.3.5 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.

4.7.2 Defects. Conformance to 3.3.4, 3.3.4.1, 3.3.5.1, 3.3.8, 3.3.10, 3.6.1, 3.8, 3.9 and 3.11 shall be determined by examination for defects listed in table II. Examination shall be visual, tactile, or by measurement with standard inspection equipment.

4.7.3 Design, construction, and configuration.

4.7.3.1 Ball nut lubrication. To determine conformance to 3.3.3.1, the contractor shall provide certification of laboratory analysis that the lubricant provided conforms to MIL-G-23827. Check for zerk fitting and operation per 3.3.3.1.

4.7.3.2 Gear case lubrication. The contractor shall provide certification of laboratory analysis that the lubricant used conforms to MIL-H-5606. Lubrication shall be measured to determine conformance per paragraph 3.3.4.

4.7.3.3 Oil level indicator. To determine conformance to 3.3.4.1 check shall be made to determine than an oil level indicator is provided and reflects the oil level.

4.7.4 Ball and thread. To determine conformance to 3.3.5, each ball shall have a nominal diameter of 0.375 inch and each ball screw shall have a thread diameter of 2.500 inch with a lead of 0.500 inch. The backlash shall not exceed .013 inch.

4.7.5 Drive motor. To determine conformance to 3.3.6, each drive motor shall be operated for not less than 20 seconds in forward and 20 seconds in reverse direction.

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4.7.5.1 Current draw. To determine conformance to 3.3.6.1, the current draw shall be measured under a 52,000 lb load at ambient room temperature.

4.7.5.2 Thermal overload protection. To determine conformance to 3.3.6.2, 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.

4.7.5.3 Motor interface. To determine conformance to 3.3.6.3 the motor shall be removable from the BSLA by standard fasteners and the motor drive shaft shall separate at the mounting surface.

4.7.6 Manual override. To determine conformance to 3.3.7, the BSLA shall be extended and retracted one time and checked for smooth operation during operation using a standard English size socket wrench.

4.7.7 Ventilation. To determine conformance to 3.3.8, the gear case vent valve shall be removed and the relief pressure level measured, and the location checked.

4.7.8 Seals. To determine conformance to 3.3.9, the functional operation of the ice scraper and rubber wiper seals shall be verified.

4.7.8.1 Water exclusion. To determine conformance to 3.3.9.1, 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 subject 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 ballscrew 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.

4.7.9 Performance tests.

4.7.9.1 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, 15 inch, and 25 inch position along the screw.

4.7.9.2 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.

4.7.9.3 Reverse drive. To determine conformance to 3.4.3, the BSLA shall be subjected to a 65,000 lb tensile load. The BSLA shall not reverse drive at the specified load.

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4.7.9.4 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 paragraph 3.4.1. The slip clutch shall not slip at the specified load.

4.7.9.5 Steam and water jet cleaning. To determine conformance to 3.4.5, the BSLA shall be cleaned for ten minutes each as specified. Water exclusion 3.7.7 and performance shall not deteriorate due to cleaning.

4.7.10 MANPRINT evaluations.

4.7.10.1 Human engineering factors. To determine conformance to 3.4.6.1, the torque required to operate the manual override shall be measured and checked for conformance to capabilities of 5th through 95th percentile males and females as specified in MIL-STD-1472.

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

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

4.7.12 Environmental conditions.

4.7.12.1 Dust. To determine conformance to 3.5.2.1, the BSLA shall be subjected to dust contamination in accordance with Method 510 of MIL-STD-810 and tested without being cleaned in conjunction with the R/M tests. 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.

4.7.12.2 Temperature. To determine conformance to 3.5.2.2, 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/maintainability are not adversely affected by exposure to operating and storage temperature ranging from minus 50°F to plus 160°F.

4.7.13 Fungus resistant products. To determine conformance to 3.3.2, materials susceptible to fungus shall conform to MIL-STD-454, requirement 4.

4.7.14 Scoring. To determine conformance to 3.3.5.1 and after the completion of the test specified in 4.7.15, the entire length of the ball screw shall be checked for any evidence of scoring using 10X magnification inspection.

4.7.15 Reliability/maintainability. To determine conformance to 3.6, each BSLA shall be subjected to an operational reliability test of 1150 cycles. The loads, cycling rates, holding load, and temperatures shall be as specified in 3.6.1, 3.6.1.1, 3.6.2 and 3.7.2.

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4.7.16 Reliability. To determine conformance to 3.6.3, test plan 10-1, ref. MIL-HDBK-781, shall be used to verify that the Mean Cycle Between Failure (MCP) for the BSLA as specified in paragraph 3.6.3, 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 are to be tested for a total of 1,150 operational reliability cycles, which equates to 4600 total operational reliability cycles. The testing shall be in accordance with 3.7.1, 3.7.2 and 3.6 through 3.6.2. 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 3.6.3.1. 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 other test samples will be required to undergo complete retest with the same configuration changes.

4.7.17 Maintainability. To determine conformance to 3.6.4, the sum of all scheduled maintenance actions for each BSLA shall not exceed 1.0 man hour per BSLA.

4.7.18 Servicing and adjustment. To determine conformance to 3.10, each BSLA shall be inspected for adjustments, functional operation, and recorded.

4.7.19 Surface finishes.

4.7.19.1 Primer. To determine conformance to 3.8.4.1; 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.

4.7.19.2 Paint. To determine conformance to 3.8.4 and subsequent to application and complete curing, the paint shall be tested for total paint thickness, adhesion and permeability as specified herein. The use of test panels in lieu of actual production units is prohibited.

- a. Two locations on each sample system shall be selected to conduct the "Scribe tape test" described in MIL-STD-193. 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.

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- 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 except that the maximum film thickness for MIL-C-46168 and MIL-C-53039 shall not exceed 3 mils. Paint film thickness failure shall be as 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 the film thickness test shall be stripped to bare metal and the entire clean, treat, and paint process reapplied.
- c. The paint permeability test 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.

5. PACKAGING

5.1 Preservation, packaging, packing, and marking. Preservation, packaging, packing, and marking for the desired level shall be in accordance with the applicable packaging requirements specified by the contracting authority (see 6.2).

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 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 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. If first article inspection is not required (see 3.1).
- c. If responsibility for inspection shall be other than as specified (see 4.1).
- d. If responsibility of inspection equipment shall be other than as specified (see 4.1.2).
- e. If inspection conditions shall be other than as specified (see 4.3).
- f. If preproduction inspection is required (see 4.4.2).

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- g. Location for conducting preproduction inspection (see 4.4.2).
- h. If initial production inspection is not required (see 4.4.3).
- i. If control tests are not required (see 4.6).
- j. Selection of applicable level and packaging requirements (see 5.1).

6.3 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerers whether the item(s) should be a first article sample, 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 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 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.

- Ball nut
- Ball return assembly
- Drive motor
- Drive train
- Gear case
- Housing
- Rod end bearing

6.6 Supersession data. This military specification supersedes MIL-B-62542(AT), dated 20 January 1988.

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6.7 AMC policy on AQLs/LTPDs. This specification is certified to be in compliance with current Army Material Command (AMC) policy for the elimination of AQLs/LTPDs (Acceptable Quality Levels/Lot Tolerance Percent Defectives) from military specifications.

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

Custodian:
Army - AT

Preparing activity:
Army - AT

User activity:
Navy - MC

(Project 5945-A725)

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.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:		1. DOCUMENT NUMBER MIL-B-62542A(AT)	2. DOCUMENT DATE (YYMMDD) 920612
3. DOCUMENT TITLE Ball Screw Linear Actuator			
4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)			
5. REASON FOR RECOMMENDATION			
6. SUBMITTER			
a. NAME (Last, First, Middle Initial)		b. ORGANIZATION	
c. ADDRESS (Include Zip Code)		d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)
8. PREPARING ACTIVITY			
a. NAME		b. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON	
c. ADDRESS (Include Zip Code) COMMANDER U.S. ARMY TANK - AUTOMOTIVE COMMAND ATTN: AMC WARREN, MICI		(313) 574-8774 786-8774	
		IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 13, Falls Church, VA 22041-3466 TOVON 289-2340	