



M2-PD-S-62534 REV D

SHIFT TOWER ASSEMBLY:

TRANSMISSION ELECTRONIC CONTROL SYSTEM (BFV)

REVISED BY: GENERAL DYNAMICS DEFENSE SYSTEMS

CONTRACT NO: TACOM DAAE07-97-C-T158

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RECORD OF REVISIONS

REVISION	RESULT OF	PAGES AFFECTED	APPROVAL/DATE
-	Initial Release	ALL	11-30-92
A	ECP R8682	ALL	JMG 9-3-93
B	ECP 1280	ALL	JMG 12-12-94
C	ECP T1381 RD-M2-PD-S-62534-C	ALL	DCJ 5-15-97
D	GEC-T1368 RD-M2-PD-S-62534-D	ALL	<i>[Signature]</i> 98-04-03 DD

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INCH-POUND

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SUPERSEDING  
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15 MAY 1997

## MILITARY SPECIFICATION

### SHIFT TOWER ASSEMBLY: TRANSMISSION ELECTRONIC CONTROL SYSTEM (BFV)

This specification is approved for use by the US 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 shift tower assembly for use with the Bradley Fighting Vehicle System (BFV) operating with the Transmission Electronic Control System (TEC).

#### 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 Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

## SPECIFICATIONS

### MILITARY

MIL-STD-130	Identification and Marking of U.S. Military Property.
MIL-STD-810	Environmental Test Methods and Engineering Guidelines.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Tank-Automotive Command, ATTN: AMSTA-GDS, Warren, MI 48397-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) or by letter.

AMSC N/A

FSC 2520

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

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

**DRAWINGS**

12380418	BFV Shift Tower Interface Control Drawing.
12389388	Shipping Hardware BFV Shift Tower Assembly.
12389491	Electronics Assembly.
12446242	Shift Tower Assembly (BFV).

(Copies of other Government documents, drawings, and publications required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 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/ASQC Z1.4-1993 Sampling Procedures and Tables for Inspection by Attributes

(Applications for copies should be addressed to the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.)

2.3 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. Unless otherwise specified (see 6.2), the contractor shall furnish shift tower assemblies which shall be subjected to first article inspection (see 4.4). First article samples, properly marked with identifying information, shall be representative of the unit to be furnished to the Government. All subsequent shift tower assemblies delivered to the Government shall conform to these samples in all of their pertinent physical and performance attributes.

3.2 Materials, design and construction. The design and construction of the shift tower assembly shall be in accordance with 12446242 and all data assembled thereunder. When installed in a vehicle the shift tower assembly will allow the driver to start the engine and select the transmission mode of operation. The shift tower assembly will also provide mechanical linkage for retaining the parking brake in the on position along with an interlock which will inhibit range selector movement to the pivot mode while the parking brake mechanism is in the engaged position.

3.2.1 Weight. The shift tower assembly shall not exceed 10 pounds (lb).

3.2.2 Interface. The shift tower assembly dimensions and features shall conform to 12380418.

3.2.3 Interchangeability. Each shift tower assembly shall be physically and functionally interchangeable with any other shift tower assembly accepted in accordance with this specification without selection.

#### 3.3 Performance.

3.3.1 Starter switch. When the range selector lever is in the Neutral (default) position the starter switch shall be in the open mode, resistance shall be greater than 10 Megohms. When the shift lever is moved over to the Start position the switch shall have less than 1 ohm electrical resistance.

#### 3.3.2 Parking brake.

3.3.2.1 Holding force. When the parking brake is set in the Set position it shall hold a minimum force of 50 pounds (lbs) applied to the service brake connecting pin in the X (see 6.4.1) axis in the release direction of travel.

3.3.2.2 Range lockout. When the parking brake is in the Set position, it shall prevent movement of the range selector into Reverse, Drive, and Low and impede the movement of the selector into Pivot.

3.3.2.3 Parking brake lockout. When the range selector is in Pivot, Reverse, Forward or Low, the parking brake application shall be inhibited.

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3.3.3 Lever forces.

3.3.3.1 Range selector. The range selector shall be actuated with forces between 8 lbs and 20 lbs force from Start to Pivot modes. The range selector shall return to the Neutral position when released from either the Start or Pivot positions without externally applied forces. Forces required to move the range selector from Reverse to Low and back shall not exceed 1 lb force.

3.3.3.2 Parking brake. Forces required to actuate the parking brake shall not exceed 10 lbs force in the lateral direction with not more than 6 ft-lbs required to rotate the brake selector knob.

3.3.4 Lever travels.

3.3.4.1 Parking brake motion. The parking brake lever shall demonstrate a minimum travel of 1.5 inches at the service brake connecting pin when the parking brake lever is moved from the On to Set positions.

3.3.4.2 Slave lever motion. Actuation of the range selector from Start to Pivot shall yield a Slave Lever motion of not less than 0.60 inches in the Z direction (see 6.4.1), while activation from Reverse to Low shall produce a minimum of 62 degrees of motion at the Slave Lever.

3.4 Environmental conditions. Unless otherwise specified, the shift tower assembly shall meet the requirements of 3.3 and show no evidence of deformation or damage after exposure to the environmental conditions specified in the following paragraphs.

3.4.1 Operating temperature.

- a. High temperature shall be in accordance with MIL-STD-810, method 501.2, Procedure II at 160 degrees Fahrenheit (°F).
- b. Low temperature shall be in accordance with MIL-STD-810, method 502.2, Procedure II at -65°F.

3.4.2 Relative humidity. Relative humidity shall be in accordance with MIL-STD-810, Method 507.2, Procedure III for 10 cycles.

3.4.3 Vibration. Vibration shall be in accordance with MIL-STD-810, Method 514.3, category 8, using figures 1-3 herein, for a period of not less than 4 hours each in three mutually perpendicular axis.

3.4.4 Steam and water-jet cleaning. The shift tower assembly shall be capable of withstanding steam and water-jet cleaning without damage to any of its components or functions.

3.5 Nameplates and product markings. Nameplates, product markings, serial and lot number markings, and all other identifying markings required for the shift tower assembly shall be in accordance with MIL-STD-130.

3.6 Workmanship. Workmanship shall be of a quality which assures a product free from cracked, broken, loose or dented parts or components. Also there shall be no burrs, sharp edges, or other defects which may affect serviceability or performance.

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4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor is responsible for the performance of all inspection requirements (examination and test) 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 performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform or witness any of the inspection 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 shall 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 comply with all the requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

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

- a. First article inspection (see 4.4).
- b. Quality conformance inspection (QCI) (see 4.5).
  - 1. Examination (see 4.5.1).
  - 2. Test (see 4.5.2).

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

- a. Temperature:  $77 \pm 18^{\circ}\text{F}$ .
- b. Relative humidity: uncontrolled room ambient.
- c. Atmospheric pressure: site pressure.

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4.4 First article inspection. Unless otherwise specified (see 6.2), the Government shall select one shift tower assembly produced under the production contract for first article inspection. First article samples shall be inspected as specified in table I. Approval of the first article sample by the Government shall not relieve the contractor of his obligation to supply shift tower assemblies that are fully representative of those inspected as a first article sample. Any changes or deviation of the production units from the first article sample shall be subject to the approval of the contracting officer.

4.4.1 First article inspection failures. 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 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. The Government will not accept products until first article inspection is completed to the satisfaction of the Government. Any retrofit of unconditionally accepted shift tower assemblies required by the procuring activity due to the incidents or failures as specified herein shall be accomplished by the supplier as a change to the acquisition contract or document.

4.4.1.1 Teardown and inspection. At the conclusion of first article testing the shift tower assembly and its major components shall be disassembled and inspected by the supplier in the presence, if so directed, of the procuring activity representative. Disassembly will be accomplished to the extent required for inspection and repair of major subassemblies or components.

4.4.1.2 Correction and assembly. If there is evidence of a test induced defect on the shift tower assembly or its components requiring correction, such corrections shall be made by the supplier while the shift tower assembly is in its disassembled state. The supplier shall report all such activity to the procuring activity. The corrected shift tower assembly shall be reassembled and shall meet the QCI test requirements specified in table I.

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TABLE I. Classification of inspections.

Title	Requirement	Inspection	First Article	QCI	
				Examination	Test
Materials Design & Construction	3.2.1 thru 3.2.2	4.6.1	X		
Starter Switch	3.3.1	4.6.3.2.1	X		X
Parking Brake					
Holding Force	3.3.2.1	4.6.3.2.2.1	X		X
Range Lockout	3.3.2.2	4.6.3.2.2.2	X		X
Parking Brake Lockout	3.3.2.3	4.6.3.2.2.3	X		X
Lever Forces					
Range Selector	3.3.3.1	4.6.3.2.3.1	X		
Parking Brake	3.3.3.2	4.6.3.2.3.2	X		
Lever Travel					
Parking Brake Motion	3.3.4.1	4.6.3.2.4.1	X		X
Slave Lever Motion	3.3.4.2	4.6.3.2.4.2	X		X
Environmental					
Operating Temp	3.4.1	4.6.4.1	X		
Relative Humidity	3.4.2	4.6.4.2	X		
Vibration	3.4.3	4.6.4.3	X		
Steam & Water-Jet Cleaning	3.4.4	4.6.4.4	X		
Nameplates & Product Markings	3.5	4.6.4.5	X	X	
Workmanship	3.6	4.6.4.6	X	X	

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4.5 QCI. QCI shall consist of the following examination and test.

4.5.1 Examination. Each piece of each lot shall be subject to examination, visual and Standard Inspection Equipment (SIE) in accordance with table 1.

4.5.1.1 QCI examination failure. Any failure of the selected sample by either visual or SIE examination shall constitute a failure of the item. The rejected item may be repaired or corrected and resubmitted for inspection.

4.5.2 Test. All shift tower assemblies shall be subjected to the QCI tests as specified by Table 1. Sampling is permitted per ANSI/ASQC Z1.4-1993, General Inspection Level II, Acceptable Quality Level (AQL) 1.0%, provided historical evidence of process control and acceptance is shown by the contractor and approved by the procurement agency. Historical evidence is defined as an acceptance rate of 100% over 200 pieces of continuous production.

4.5.2.1 QCI test failure. Failure of a shift tower assembly to pass the QCI test shall be cause for the Government to refuse acceptance of the product. Any shift tower assembly containing one or more defects either shall be corrected and re-examined, or retested and resubmitted without defects for Government acceptance. Resubmitted shift tower assemblies shall be kept separate from new shift tower assemblies, and shall be clearly identified as resubmitted shift tower assemblies.

4.6 Methods of inspection.

4.6.1 Materials, design and construction. Unless otherwise specified herein, conformance to 3.2.1 through 3.2.2 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, specification, 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. Failure to comply with the requirements of 3.2.1 and 3.2.2 shall be cause for the Government to refuse acceptance of the item. Any rejected item may be repaired or corrected and resubmitted for inspection.

4.6.3 Performance test.

4.6.3.1 Test equipment configuration and conditions.

4.6.3.1.1 Installation. The shift tower assembly shall be installed on an appropriate mounting fixture so as to allow the required measurements without interfering with test equipment or shift tower motion.

4.6.3.1.2 Instrumentation. Instrumentation shall be provided to make the required measurements herein. All standard measuring equipment shall be calibrated at regular intervals to industry standards, traceable to standards of the National Bureau of Standards. Records of such calibrations shall be made available to the Government upon request.

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4.6.3.2 Test procedures.

4.6.3.2.1 Starter switch. Conformance to 3.3.1 shall be demonstrated initially with the range selector in the Neutral position, and measuring the resistance across starter switch pins A to C and D to F. Next, actuate and hold the range selector in the Start position and measure the resistance across starter switch pins A to C and D to F.

4.6.3.2.2 Parking brake.

4.6.3.2.2.1 Holding force. Conformance to 3.3.2.1 shall be demonstrated by applying the parking brake and securing it in the Set position. A force of 50 lbs shall then be applied along the axis of the brake shaft; the shaft shall not slip more than one tooth of the pawl along the ratchet bar.

4.6.3.2.2.2 Range lockout. Conformance with 3.3.2.2 shall be demonstrated by applying and setting the parking brake. A force of 24 lbs shall be applied to the range select lever through the center of the shift knob in the Neutral to Pivot direction; the range selector shall not enter the Low to Reverse gate in the shift tower.

4.6.3.2.2.3 Parking brake lockout. Conformance to 3.3.2.3 shall be demonstrated by moving the range selector to the forward position. A force not exceeding 24 lbs shall be applied to the parking brake from the Stowed position toward the On/Set position. Movement of the parking brake to the Set position shall constitute a failure.

4.6.3.2.3 Lever forces.

4.6.3.2.3.1 Range selector. Conformance to 3.3.3.1 shall be demonstrated by applying a force perpendicular to the range select lever in the lateral direction. The force required to move the range selector to the Start position and back through Neutral to the Pivot position shall not exceed the force specified by 3.3.3.1. With range selector in the low range hold position the force required to move the selector lever from Low to Reverse and back as applied through the center of the shift selector knob shall not exceed that specified in 3.3.3.1 for the back to front movement. (Note that provisions must be made to prevent lateral side loading while measuring the actuation forces between Reverse and Low.) When the lever is released while in the Start and Pivot positions it shall return to Neutral without application of external forces.

4.6.3.2.3.2 Parking brake. Conformance to 3.3.3.2 shall be demonstrated by measuring the force required perpendicular to the shaft in the direction of travel through the center of the knob required to move the shift selector from the On position into the Set position. Maximum forces measured shall not exceed those specified by 3.3.3.2. Deactivation torque shall not exceed that specified by 3.3.3.2 as determined by measuring the torque required to rotate the parking brake knob from the Set position such that it may be moved to the Release position.

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4.6.3.2.4 Lever travel.

4.6.3.2.4.1 Slave lever motion. Compliance with 3.3.4.1 shall be demonstrated by measuring the displacement of the service brake lever as the parking brake is moved from the Stowed to Set position. Linear displacement of the service brake connecting pin shall meet the minimum requirements of 3.3.4.1.

4.6.3.2.4.2 Range selector motion. Initial position of the slave lever shall be determined with the range selector against the hardstop (see 6.3.3) in the Pivot position. Actuation of the range select lever to the hardstop in the Start position shall yield a slave lever motion of not less than that specified in 3.3.4.2. Note that the starter switch may have to be moved out of position to achieve the minimum required travel. The range selector shall then be moved to the hardstop at the Reverse position and the slave lever position noted. Movement of the range selector to the Low hardstop shall produce a slave lever displacement in accordance with 3.3.4.2.

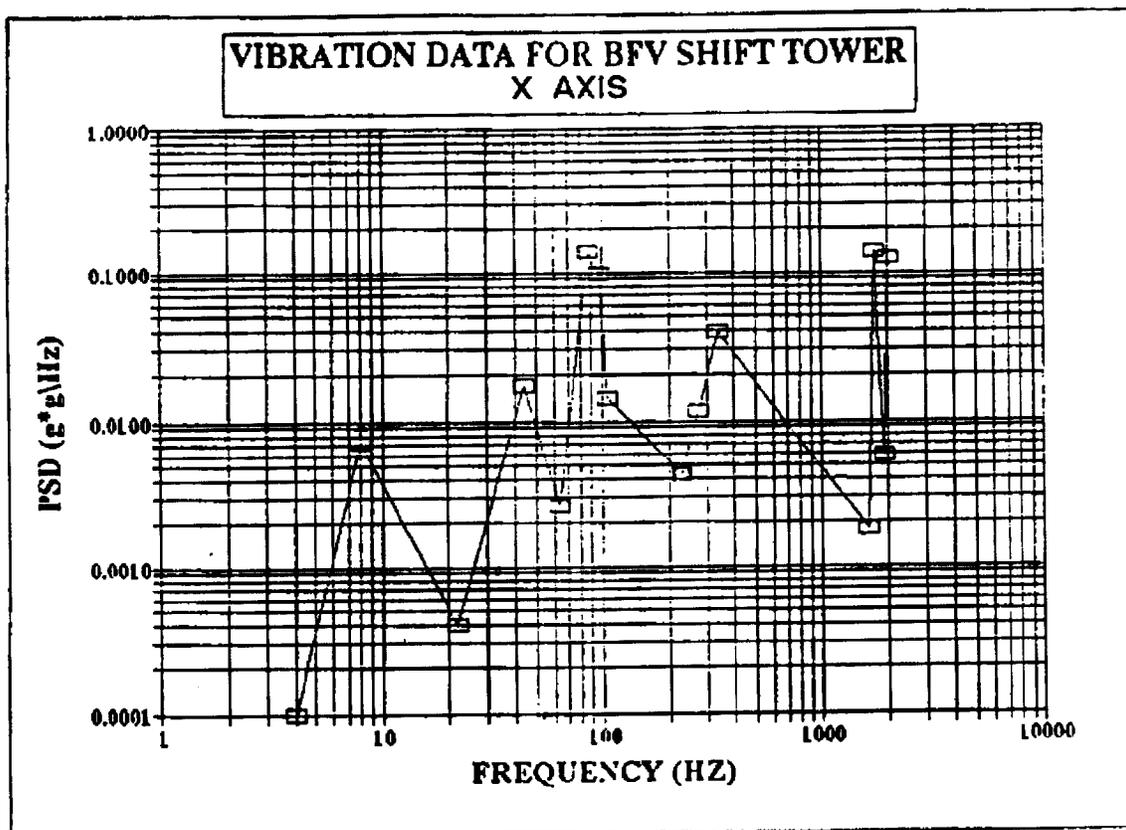
4.6.4 Environmental testing. Inspection, measurement, and operating procedures for the shift tower assembly shall be in accordance with MIL-STD-810 unless otherwise specified. Upon completion of all environmental tests, the shift tower assembly shall meet the requirements specified in 3.3. The following procedure shall be performed as a shift tower operational checkout when specified during environmental testing.

- a. Verify free motion of the shift lever over its full range of travel.
- b. Verify continuity of the starter switch when the shift lever is placed in the Start position, and discontinuity when placed in Neutral.

4.6.4.1 Operating temperature. The shift tower assembly shall be tested in accordance with MIL-STD-810, Method 501.2, using paragraph II-3.2 with a constant high temperature of 160°F in step 7; and Method 502.2, using paragraph II-3.2 with a low temperature of -65°F in Step 1. The shift tower assembly shall be checked out before, during and after, exposure to high and low temperature test in accordance with 4.6.4 herein.

4.6.4.2 Relative humidity. The shift tower assembly shall be tested in accordance with MIL-STD-810, Method 507.2, Procedure III for 10 cycles. Operational check-out of the shift tower assembly shall be conducted prior to, and following humidity testing in accordance with 4.6.4 herein.

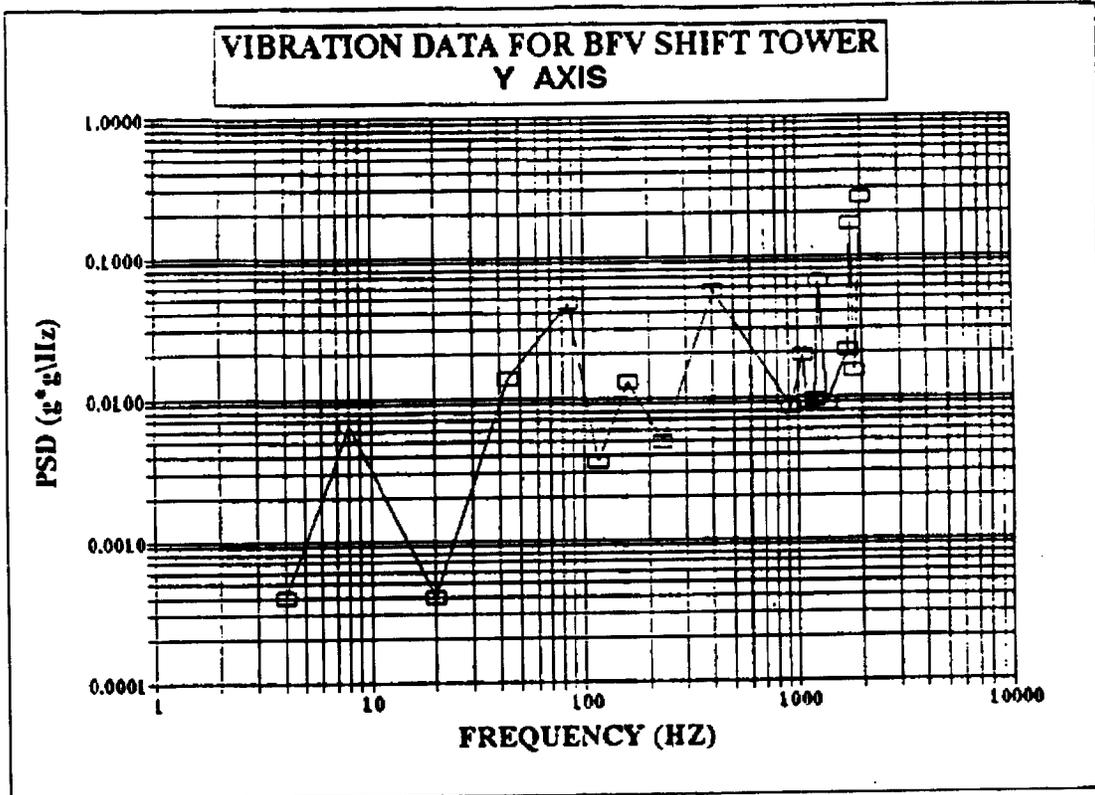
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PSD (g²/Hz)	FREQ (HZ)
0.0001	4
0.0072	8
0.0004	22
0.0173	44
0.0026	64
0.1402	86
0.099	96
0.0144	106
0.0043	230
0.0116	276
0.0388	336
0.0018	1634
0.1411	1740
0.0059	1922
0.1242	2000

FIGURE 1. X axis vibration curve.

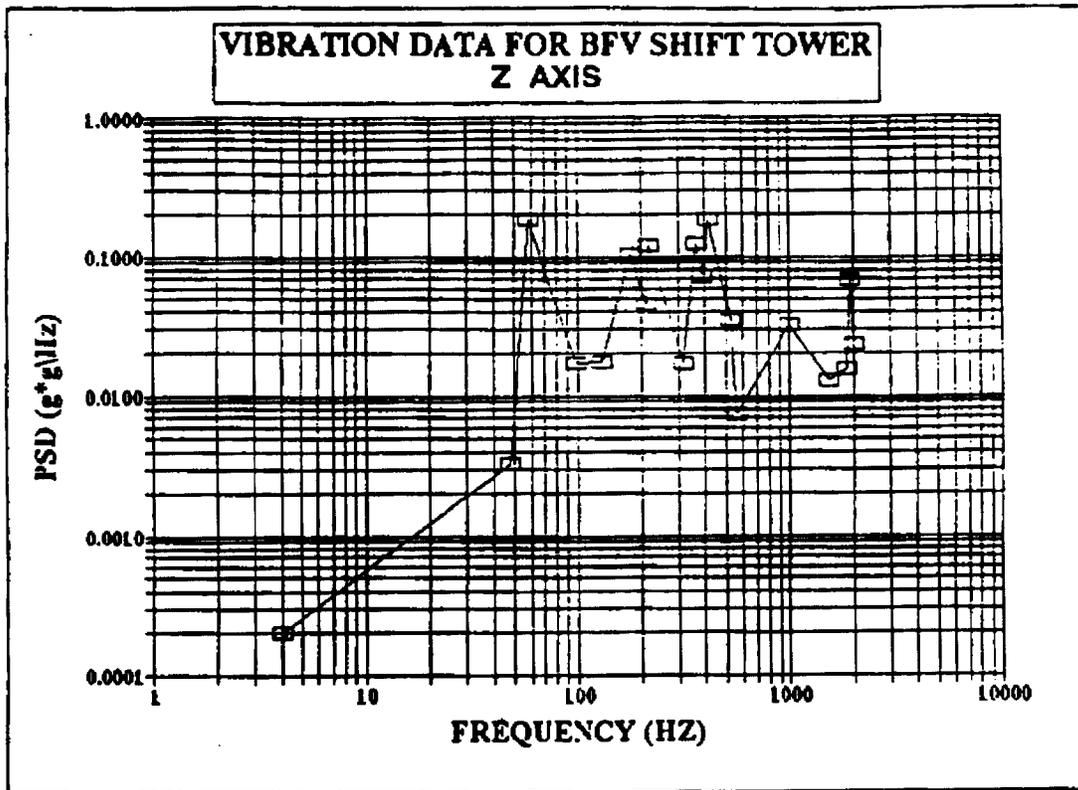
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PSD (g²/Hz)	FREQ (HZ)
0.0004	4
0.0065	8
0.0004	20
0.0137	44
0.0469	84
0.0036	116
0.013	160
0.0049	232
0.0557	402
0.0085	928
0.0195	1046
0.009	1092
0.0094	1188
0.0653	1250
0.0089	1370
0.0211	1720
0.164	1784
0.0148	1848
0.2552	2000

FIGURE 2. Y axis vibration curve.

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Z-AXIS PSD	FREQ (HZ)
0.0002	4
0.0033	48
0.1881	58
0.017	98
0.0174	130
0.1051	176
0.0458	210
0.1201	218
0.017	316
0.1222	368
0.0726	392
0.1827	414
0.0349	532
0.0074	564
0.0321	992
0.0128	1526
0.0155	1854
0.0686	1936
0.0236	2000

FIGURE 3. Z axis vibration curve.

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4.6.4.3 Vibration. The shift tower assembly shall be tested in accordance with MIL-STD-810, Method 514.3, Category 8. Vibration test levels shall be in accordance with figures 1 through 3 herein for a minimum duration of 4 hours in each axis. The shift tower assembly shall be fixtured to the vibration generator in a manner which utilizes its mounting provisions and simulates mass and structural characteristics of the Electronics Assembly (EA) (12389491) as approved by the procuring activity. Operational check-out of the shift tower assembly shall be conducted prior to, and following vibration testing in accordance with 4.6.4 herein.

4.6.4.4 Steam and water-jet cleaning. The shift tower assembly shall be steam cleaned utilizing a steam generator which shall produce a steam output pressure of 85 to 95 pounds per square inch (ppsi) at a flow rate of 70 to 90 gallons per hour (gph) at a temperature of 300 to 350°F. The unit under test shall be cleaned by sweeping the water-jet perpendicular to the unit surface at a distance of 7 to 12 inches (in.) and a rate of 1 square foot per minute until all surfaces have been exposed. Following steam cleaning the unit shall be water-jet washed by applying the spray at a distance of 4 to 5 feet (ft) and moved at a rate of 1 square foot per minute until all surfaces are exposed. Water to the nozzle shall be supplied at a pressure of 80 to 90 ppsi at a flow rate of 300 gph. The temperature of the water shall be normal cold-tap conditions. Upon completion of the cleaning the shift tower assembly shall be visually inspected for damage or missing parts. Operational checkout shall be conducted in accordance with 4.6.4 herein.

4.6.4.5 Nameplates and product markings. To determine compliance to 3.6 the shift tower assembly shall be visually inspected prior to packaging for shipment.

4.6.4.6 Workmanship. To determine compliance with paragraph 3.7 the shift tower assembly, along with its relevant inspection data shall be visually inspected or otherwise certified.

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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).

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6. NOTES

6.1 Intended use. The shift tower assembly is intended for use in the Bradley Fighting Vehicle System.

6.2 Ordering information. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. If first article inspection is not required (see 3.1).
- c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.1.2).
- d. If marking shall be other than specified (see 3.4).
- e. If responsibility for inspection shall be other than as specified (see 4.1.2).
- f. If responsibility for inspection equipment shall be other than as specified (see 4.1.2).
- g. Selection of applicable level and packaging requirement (see 5.1).

6.3 First article. When first article inspection is required, the contracting officer shall provide specific guidance to officers whether the item(s) may be preproduction sample, a first production piece sample or a standard production item from the contractors current inventory and the number of items to be tested in accordance with 3.1 herein. The contracting officer shall also include specific instruction in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first article sample(s). Invitations for bids should also provide that the Government reserves the right to waive the requirements for samples for first article inspection to those bidders offering a product which has been previously acquired to be 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. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.4 Definitions.

6.4.1 Shift tower orientation. Axis of the shift tower assembly shall be defined as follows: X axis shall be parallel to the range selector motion from reverse to low range hold; the Y axis shall be parallel to the range selector motion from pivot to start and the Z axis shall be perpendicular to the X and Y axis.

6.4.2 Component definitions. Reference to components within the shift tower assembly may be found on 12380418.

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6.4.3 Hardstop. A hardstop shall be defined as the point where the lever contacts a fixed point on the shift tower assembly limiting further travel.

6.5 Subject term (key word) listings.

Bradley Fighting Vehicle System  
Shift tower assembly  
Transmission Electronic Control System

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