

INCH-POUND

MIL-DTL-62099D(AT)

11 September 1998

SUPERSEDING

MIL-PRF-62099C(AT)

27 May 1996

DETAIL SPECIFICATION

TRANSMISSION, HYDRAULIC: MODIFIED AUTOMATIC TX-100-1

This specification is approved for use by the U.S. Army Tank-automotive and Armaments 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 one type of Modified Commercial Hydraulic Transmission assembly for use in military vehicles.

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 requirement 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/BLUE, 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 2520

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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

DEPARTMENT OF DEFENSE

- MIL-PRF-2104 - Lubricating Oil, Internal-Combustion Engine, Combat/Tactical Service.
- MIL-L-21260 - Lubricating Oil, Internal-Combustion Engine, Preservative and Break-In.
- MIL-L-46167 - Lubricating Oil, Internal-Combustion Engine, Arctic.

STANDARDS

DEPARTMENT OF DEFENSE

- MIL-STD-130 - Identification Marking of U.S. Military Property.

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

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

DRAWING

- 23014434 - Transmission.

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

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2.3 Non-Government publication. 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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings for Iron and Steel Products (AASHTO M111) (DoD Adopted).

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

GENERAL MOTORS CORP. (GM)

GM 9540P - Accelerated Corrosion Test.

(Application for copies should be addressed to General Motors Corp., c/o Global Engineering, 15 Inverness Way, Englewood, CO 80112.)

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

3. REQUIREMENTS

3.1 Materials. Materials shall be as specified herein and in referenced drawings, specifications, and standards and shall be free from all defects and imperfections that might affect the serviceability and function of the finished product (see 4.2.3).

3.1.1 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.

3.2 Construction. The transmission construction and assembly shall be in accordance with Drawing 23014434 (see 4.2.3).

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3.3 Operating requirements. Each assemble shall provide the following functional, operational, and performance capabilities (see 4.3)

3.3.1 Oil. Oil conforming to Grade 1 of MIL-L-21260, or equivalent shall be used during each transmission evaluation sequence. After the transmission is installed in its intended vehicle, oil conforming to MIL-L-46167, or equivalent shall be used when the transmission is operated in ambient temperature below 0 degrees Fahrenheit (°F). Oil conforming to grade 10 of MIL-PRF-2104, or equivalent shall be used when the transmission is operated in ambient temperature above 0°F (see 4.2.3).

3.3.1.1 Temperature range. The transmission converter out oil temperature shall not exceed 300°F during each transmission evaluation sequence and production runs.

3.3.2 Warm-up. During the warm-up period the transmission shall show no evidence of mechanical malfunction and shall maintain an oil sump temperature of between 160 and 200°F (see 4.3.1).

3.3.3 Functional pressure and flow requirements. With the transmission operating as indicated in table I, the transmission shall meet the functional pressure and flow requirements indicated therein (see 4.3.2).

TABLE I. Functional pressure and flow requirements.

Item	Reverse operation	Forward operation
Throttle valve (TV) lever position	Full on	Full on
Range selector lever position	Rev	1-3
Input speed, revolutions per minute (rpm)	2180 - 2220	2980 - 3020
Output torque, pound-feet (lb-ft)	No Load	No Load
Main oil pressure, pounds per square inch (psi)	275 to 340	
Lockup clutch oil pressure, psi	0	120 to 150
Cooler "out" oil pressure, psi		10 to 30

3.3.4 Automatic range upshift at detent position (TV). The automatic upshifts shall occur as specified in table II with the TV lever at the detent position and the range selector lever in the selected range. Lockup clutch pressure shall drop momentarily during the shift and rise again when shift is completed (see 4.3.3).

TABLE II. Automatic range upshift.

Item	Input speed, rpm	
	Min.	Max.
Range selector lever 1-3 position		
1-2 shift	3400	3600
2-3 shift	3400	3600

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3.3.5 Closed TV stop. With the TV fully closed, the TV lever shall be between 30.5 and 31.5 degrees from the detent position (see 4.3.4).

3.3.6 Automatic range upshifts input speed limits (through detent). The transmission shall not automatically upshift at input speeds less than 3700 rpm with the TV lever at full-on position and with the range selector in 1-3 position (see 4.3.5).

3.3.7 Drive range automatic downshift. The transmission shall produce an automatic 2-1 downshift between 775 and 985 rpm output speed (see 4.3.6).

3.3.8 Drive range converter stall capacity. With the output shaft stalled by the dynamometer and with the range selector lever in the 1-3 range position and with TV lever in the full-on position, the converter input stall speed and output torque shall conform to the requirements of table III. Cooler oil flow shall be 7.5 gallons per minute (gal/min) (see 4.3.7).

TABLE III. Converter stall capacity.

Item	Min.	Max.
Input speed, rpm	2000	2350
Input torque, lb-ft	240	260
Output torque, lb-ft	2500	

3.3.9 Shift inhibitor allowance. The shift inhibitor shall control the downshift as indicated in table IV when the selector lever is manually shifted from the 3-2 position to the 1-2 position and from the 1-2 position to the 1 position (see 4.3.8).

TABLE IV. Shift inhibitor allowances.

Item	Input speed, rpm	
	Min.	Max.
3-2 Downshift	2000	2350
2-1 Downshift	2000	2350

3.4 Support and ownership requirements. The assembly shall possess the following life cycle ownership characteristics (see 4.4).

3.4.1 Reliability. The transmission shall require no repair or maintenance, other than oil and oil filter changes and oil additions, during 5000 miles of normal vehicle operation (see 4.4.1).

3.4.2 Leakage. During any evaluation sequence or at completion of all evaluations, transmission leakage shall be limited to weep or seep (see 4.4.2 and 6.3).

3.4.3 Submersion. The transmission, pressurized internally with 3 to 7 psi air, shall show no evidence of leakage when immersed in a water bath (see 4.4.3).

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3.4.4 Exterior surface treatment. Unless otherwise specified in the applicable drawings, all exposed exterior surfaces of the transmission and its components shall be painted in accordance with the manufacturer's standard practice (see 4.1.1). All external component materials shall have corrosion resistance equal to or exceeding that provided by hot-dip galvanized 1020 steel, with coating thickness in accordance with ASTM A123 (or minimum coating thickness of 0.75 mil on pre-galvanized sheet 0.063 in. or less), with zinc phosphate pre-treatment. A proposed alternate design shall be compared to a galvanized sample (as described above) using the Accelerated Corrosion Test GM 9540P Method B 120 cycles, or until prior failure of one of the items with defects such as extensive corrosion at scribe or significant penetration of base material.

3.4.5 Identification marking. All parts requiring identification shall be marked in accordance with MIL-STD-130, or equivalent (see 4.1.1).

4. VERIFICATION

4.1 Inspection Requirements. Inspection requirement consist of a conformance inspection which shall include the examination of 4.1.1 and the tests of 4.1.2.

4.1.1 Examinations. To determine conformance to 3.2, 3.3, 3.4.2, 3.4.4 and 3.4.5 all transmissions (100%) shall be examined for the defects listed.

TABLE V. Classification defects.

Category	Defects	Method of examination
<u>Major:</u>		
101	Dimensions not as specified, affecting interchangeability of major components (see 3.2).	Visual/SIE <u>1/</u>
102	Control levers and valves malfunction (see 3.3).	Functional/Visual
103	Installation of hydraulic lines and fittings improper (see 3.2).	Functional/Visual
104	Dirt or foreign matter plugging oil filter lines or screens (see 3.4).	Functional/Visual
105	Marking improper or not legible (see 3.4.5).	Visual
106	Scratched, chipped, pitted, or burned (see 3.4.4).	Visual
107	Paint not as specified (see 3.4.4).	Visual
108	Leak or drip (weep or seep permissible) (see 3.4.2).	Visual

1/ SIE = Standard Inspection Equipment.

4.1.2 Tests. All transmissions (100%) shall be subjected to all of the tests in table VI except for the reliability test which shall be applied only to those transmissions installed in vehicles selected for testing in accordance with the provisions of the specification covering the vehicle.

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TABLE VI. Classification of inspection.

Title	Requirement	Test
Warm-up	3.3.2	4.3.1
Functional pressure and flow requirements	3.3.3	4.3.2
Automatic shift	3.3.4	4.3.3
Closed TV stop	3.3.5	4.3.4
Automatic range upshift, full-on TV lever position	3.3.6	4.3.5
Drive range load	3.3.7	4.3.6
Drive range converter stall capacity	3.3.8	4.3.7
Shift inhibitor allowance	3.3.9	4.3.8.1 & 4.3.8.2
Reliability	3.4.1	4.4.1
Leakage	3.4.2	4.4.2
Submersion	3.4.3	4.4.3

4.2 Verification methods. The types of verification methods included in this section are visual, inspection, measurement, sample tests full scale demonstration test, or equivalent tests, simulation modeling, engineering evaluation, component properties analysis, and similarity to previously-approved or previously-qualified designs.

4.2.1 Verification alternatives. The manufacturer may propose alternative test methods, techniques, or equipment including the application of statistical process control, tool control, or cost-effective sampling procedures, to verify performance. See the contractor for alternatives that replace verifications required by this specification.

4.2.2 Test conditions. The transmission shall be installed on an absorption dynamometer test stand with provisions for connecting the drive cover studs to an input power supply, linkage controls, and external hydraulic system. The engine used for input power supply shall be the same type as used in vehicle installation or a suitable equivalent power source. Separate linkage controls shall be provided for the engine throttle, transmission TV lever, and range selector shift lever. The external hydraulic circuit, which includes all oil lines, oil filter, and flowmeter, shall have a pressure drop between the transmission to oil cooler “outlet” connection point and the oil cooler to transmission “inlet” connection point that is in accordance with figure 1. Tests shall be made at ambient room temperatures and oil level shall be in accordance with 4.2.2.1.

4.2.2.1 Transmission oil level. The design oil level shall be determined using one of the following options:

- a. Option I. When testing with the sump oil pan installed, fill the transmission with approximately twenty (20) quarts of oil. The oil level shall be at the “Full” mark on the dipstick, as the installation drawing (see 2.2.2) directs, while running in neutral range at 1500 rpm input speed, with output shaft stalled, and with the oil at

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operating temperature of 160 to 200°F. Adjust the level if necessary by adding or removing oil.

- b. Option II. When testing with the sump pan removed, the bottom of the transmission normally enclosed by the sump oil pan shall be submerged in an oil reservoir to a level approximately one inch below the sump pan splitline. The temperature of the oil in the reservoir shall be maintained in the range of 160 to 200°F.

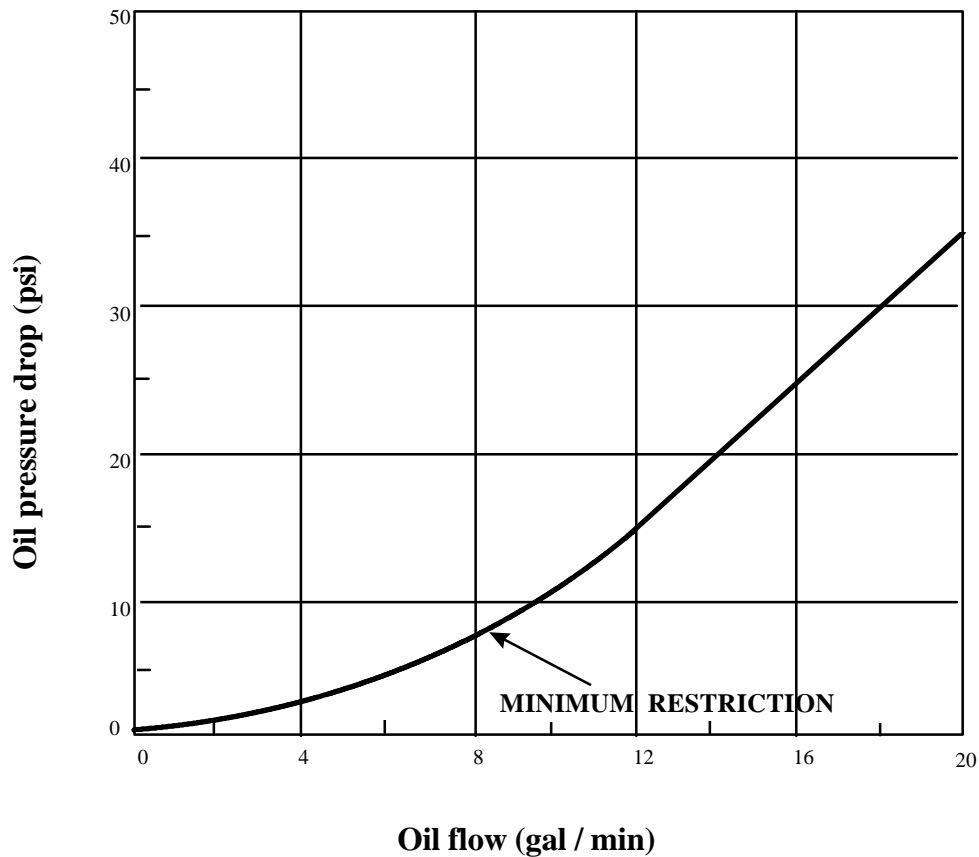


FIGURE 1. External Hydraulic system oil pressure drop.

4.2.3 Materials, design and construction. Conformance to 3.1 and 3.2 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 drawing, specification, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certification, industry standards, test reports, and rating data.

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4.3 Operating requirements verification.

4.3.1 Warm-up check. To determine conformance to 3.3.2, with the transmission filled with lubricant (see 4.2.2.1), the following test shall be performed:

- a. Place the range selector lever in the reverse range gear shift position with the transmission TV lever in the full-on position and the output shaft stalled.
- b. Increase input speed to 1000 ± 50 rpm and run at this speed until oil pressures stabilize.
- c. Release the output load on dynamometer, increase the input speed to 2200 ± 20 rpm, and run until all air is evacuated from the converter cooler circuit and sump oil temperatures are stabilized.
- d. Note reverse function (output rotation opposite input rotation).

4.3.2 Functional pressure and flow test. To determine conformance to 3.3.3, the following test shall be performed:

- a. Place the range selector shift lever in the reverse position with the TV lever in the “full-on” position and no dynamometer load on the output shaft.
- b. Increase the input speed to 2200 rpm.
- c. Determine main oil pressure.
- d. Reduce input speed to 1000 rpm.
- e. Place the range selector shift lever in the “1-3” range position and the TV lever in a “full-on” position with no dynamometer load on the output shaft.
- f. Increase the input speed to 3000 ± 20 rpm.
- g. Determine the lockup clutch apply pressure, cooler out oil pressure, and cooler oil flow.

4.3.3 Automatic shift test. To determine conformance to 3.3.4, the following test shall be performed:

- a. Place the range selector shift lever in the “1-3” range position and the TV lever in a “partial-on” position.
- b. Increase the input speed as required to obtain the automatic “1-2” and “2-3” range upshifts.
- c. By adjustment of the TV lever during “2-3” and “3-2” cycle shifts establish the TV lever position that produces a “2-3” range automatic upshift. This position is defined to be the “at detent” position for the TV lever.
- d. Place a light dynamometer load on the output shaft with the TV lever at the “at detent” position.
- e. With the range shift selector lever in the proper range position and with full engine throttle, adjust the output load to obtain all automatic shift points.
- f. Determine the input speed at which each automatic upshift occurs.

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4.3.4 TV lever closed-stop adjustment check. To determine conformance to 3.3.5, at completion of the automatic shift test, the input power supply shall be stopped. From the TV lever position established for the “at detent” position, the TV adjustment screw and nut shall be positioned and locked.

4.3.5 “Full-On” TV lever position - automatic range upshift tests. To determine conformance to 3.3.6, the following test shall be performed:

- a. Place the range selector lever in the 1-3 position and the TV lever in the “full-on” position with no dynamometer load on the output shaft.
- b. Increase the input speed.
- c. By adjustment of the TV lever and output load, allow the transmission to upshift “1-2” and “2-3”.
- d. Determine that shifts do not occur before specified minimum input speeds.

4.3.6 Drive range load test. To determine conformance to 3.3.7, the following test shall be performed:

- a. Place the TV lever in the full-on position.
- b. Increase the output shaft load to produce a “3-2” and “2-1” automatic range downshift.
- c. Determine the output speed at which the automatic “2-1” downshift occurs.

4.3.7 Drive range converter stall test. To determine conformance to 3.3.8, the following test shall be performed:

- a. Stall the output shaft with the dynamometer.
- b. Place the range selector shift lever in the “1-3” range position and the TV lever in the “full-on” position.
- c. Increase the input speed until input torque is within the limits of 240 to 260 lb-ft.
- d. Determine the input speed and output torque in accordance with table III.

4.3.8 Shift inhibitor test.

4.3.8.1 “3-2” shift inhibitor test. To determine conformance to 3.3.9, the following test shall be performed:

- a. With the transmission in “1-3” position and no TV, disconnect transmission output shaft from absorption dynamometer and adjust the engine throttle to obtain approximately 3000 rpm input speed. Check that lockup clutch is engaged.

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- b. Manually shift to “1-2” position and slowly decrease input speed to produce a “3-2” automatic range downshift.
- c. Determine the input speed at which the automatic downshift occurs in accordance with table IV.

4.3.8.2 “2-1” shift inhibitor test. To determine conformance to 3.3.9, the following test shall be performed:

- a. With the transmission in “1-2” position and no TV, disconnect transmission output shaft from absorption dynamometer and adjust the engine throttle to obtain approximately 3000 rpm input speed.
- b. Manually shift to “1” position and slowly decrease input speed to produce a “2-1” automatic range downshift.
- c. Determine the input speed at which the automatic downshift occurs, in accordance with table IV.

4.4 Ownership and support requirements verification.

4.4.1 Reliability. To determine conformance to 3.4.1 the transmission shall be installed in the selected vehicle (see 4.1.2) and operated.

4.4.2 Leak check. To determine conformance to 3.4.2, visually inspect transmission at various points during test operation and thoroughly at the end of test operation for indications of oil leaks.

4.4.3 Submersion test. To determine conformance to 3.4.3, when tested in accordance with option II of 4.2.2.1, one transmission from every ten produced (with sump pan installed) shall be further tested by plugging all holes, pressurizing internally with 3-7 psi air and immersing unit in water bath for visual inspection for leaks. No leaks are permissible. A continuous stream of air bubbles, regardless of size, shall be considered a leak.

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.

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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 transmission covered by this specification is military unique. The transmission is intended for production use, as spares, or as replacements in military combat and tactical vehicles (initially for the M113 family of tracked vehicles). Because of the specific design, military use, and physical performance, this transmission is considered military unique.

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. Packaging requirements (see 5.1).

6.3 Definitions. The following definitions are established as a guide in determining conformance with the leakage requirements of this specification.

- a. Weep - Any evidence of fluid beyond a seal or splitline.
- b. Seep - Any evidence of fluid beyond a seal or splitline that does not result in the formation of a droplet.
- c. Leak - Any evidence of fluid beyond a seal or splitline that results in the formation of a droplet.
- d. Drip - Any evidence of fluid beyond a seal or splitline where droplets form and fall.

6.4 Subject term (key word) listing.

Converter, drive range
Inhibitor, shift
Lever, throttle valve

6.5 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.

Custodian:
Army - AT

Preparing Activity:
Army - AT

(Project 2520-0018)

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, 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-DTL-62099D(AT)	2. DOCUMENT DATE (YYMMDD) 980911
3. DOCUMENT TITLE TRANSMISSION, HYDRAULIC: MODIFIED AUTOMATIC TX-100-1			
4. NATURE OF CHANGE (<i>Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.</i>)			
5. REASON FOR RECOMMENDATION			
6. SUBMITTER			
a. NAME (<i>Last, First, Middle Initial</i>)		b. ORGANIZATION	
c. ADDRESS (<i>Include Zip Code</i>)		d. TELEPHONE (<i>Include Area Code</i>) (1) Commercial (2) AUTOVON (<i>If applicable</i>)	7. DATE SUBMITTED (YYMMDD)
8. PREPARING ACTIVITY			
a. NAME		b. TELEPHONE (<i>Include Area Code</i>) (1) Commercial (810) 574-8745 (2) AUTOVON 786-8745	
c. ADDRESS (<i>Include Zip Code</i>) 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 Telephone (703) 756-2340 AUTOVON 289-2340	