

METRIC

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SUPERSEDING

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PERFORMANCE SPECIFICATION

STEER UNIT, TRACKED VEHICLE, CLUTCH BRAKE AND GEARED STEER

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

1. SCOPE

1.1 Scope. The steer unit covered by this specification is intended for use as a steer unit for the Armored Combat Earthmover M9 ACE. The steer unit is a two-speed, double-output gearbox, manually controlled for manipulating track laying vehicles. Includes a bevel gear set, clutch brake and geared steering systems, and full vehicle brakes.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to 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 2530

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2.2 Government documents.

2.2.1 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 (see 6.2).

DRAWINGS

ARMY

13215E6600 - Steer Unit.

(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.)

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.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.2.

3.2 Materials. Materials used shall be in accordance with the manufacturer's materials specifications for steer unit. The materials shall be capable of meeting all the operational and environmental requirements specified herein. Recovered materials shall be used to the maximum extent practicable (see 4.6.1).

3.2.1 Operating fluid. Unless otherwise specified (see 6.2), the operating fluid used in the steer units shall be a grade 10. The unit shall be filled to the operating level indicated on the dipstick (see 4.6.2).

3.3 Construction. Steer units shall be fabricated and assembled in accordance with Drawing 13215E6600 (see 4.6.2).

3.3.1 Interchangeability of parts. Component parts and assemblies of each steer unit shall be so constructed that any part(s), except assemblies requiring individual select fitting of components, may be installed in a like steer unit without modification (see 4.6.2).

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3.3.2 Weight. The dry weight of the steer unit shall be 590 ± 18 kilograms (kg) nominal (see 4.6.2).

3.4 Performance requirements. Steer unit assemblies shall meet the performance requirements of 3.4.1 through 3.6 when subjected to the performance tests of 4.6.3.1 through 4.6.3.10.

3.4.1 Functioning ability. All steer unit shift, steer, and brake positions shall function properly as specified herein without excessive noise, drag, vibration or other indications of malfunction (see 4.6.3.1 through 4.6.3.10).

3.4.2 External leakage. External leakage from the steer unit shall not have any evidence of fluid beyond a seal or joint that results in the formation of a droplet (see 4.6.3.1 through 4.6.3.10).

3.4.3 Lube regulator. The relationship between the input flow rate in liters per minute (L/min) at lube port L versus the oil pressure in kilopascals (kPa) at lube port L shall be as specified in table I (see 4.6.3.2).

TABLE I. Lube regulator pressure versus flow.

Item	Input flow into lube port L L/min	Pressure at lube port L L/min
A	** 27 Max allowed	* 35 ± 7
B	** 46 Max allowed	* 138 ± 7
C	* 53 ± 2	** 206 ± 34
D	* 76 ± 2	Pressure of test item D not to exceed actual pressure reading of test item C by more than 35 kPa

NOTE: * Predetermined value to be applied in test.
** Required test results.

3.4.4 Lube oil system. The pressure at each of the six lube test ports (see figures 3A and 3B) shall be within 41 kPa of the pressure at lube port L for each case specified for each of the following:

- At 0 revolutions per minute (rpm) input speed: per 3.4.3 and 4.6.3.2.
- At low rpm input speed: per 3.4.7, 4.6.3.3.b.3, and 4.6.3.4.b.
- At high rpm input speed: per 3.4.12, tables IV & V, and 4.6.3.7.

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- d. At 750 rpm reverse, counterclockwise (CCW), input speed: per 3.4.18.3, tables IV and V, and 4.6.3.7.

3.4.5 Lube pump high pressure output. The steer unit shall produce a minimum of 552 kPa pressure to the high speed and low speed clutches at a maximum output shaft speed of 300 rpm (see 4.6.3.3 and 4.6.3.4).

3.4.6 Auxiliary regulator. The auxiliary regulator shall not allow clutch pressure to exceed 862 kPa (see 4.6.3.3 and 4.6.3.4).

3.4.7 Lube pressure at low rpm. The pressure at lube at port L shall not be less than that specified below (see 4.6.3.3.b.3 and 4.6.3.4.b).

- a. In geared steer: 138 kPa minimum.
- b. In clutch brake: 35 kPa minimum.

3.4.8 Auxiliary regulator pilot leakage and main check valve leakage. The combined internal leakage past the auxiliary regulator pilot section and the main check valve shall not exceed 3.8 L/min (see 4.6.3.3.b.4 and 4.6.3.4.b).

3.4.9 Lube pump low pressure output. The steer unit lube pump shall produce the lube pressures specified in table II (see 4.6.3.5).

TABLE II. Lube pump low pressure output.

Steer unit Input shaft Speed (rpm)	Pressure at lube port L kPa	
	Geared steer	Clutch brake
500 ± 20	21 minimum	-----
1000 ± 40	-----	7 minimum
1300 ± 50	206 ±34	14 minimum

3.4.10 Clutch engagement. Output shaft speeds shall be as specified in table III (see 4.6.3.6).

3.4.11 Clutch pressures versus steer lever positions. The relationships between clutch pressures and steer lever positions shall be as specified in table IV for geared steer operations, and as specified in table V for clutch brake operations (see 4.6.3.7).

3.4.12 Lube pressures versus steer lever positions. The pressure at lube port L shall not be less than that specified in table IV for geared steer operations, or that specified in table V for clutch brake operations (see 4.6.3.7).

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TABLE III. Clutch engagement.

Shift lever position	Steer lever position	Input speed 200 ± 20 rpm, CW <u>1</u> / only port M vented to steer unit sump		Input speed 200 ± 20 rpm, CW only 1380 ± 35 kPa applied to port M	
		LH output speed rpm	RH output speed rpm	LH output speed rpm	RH output speed rpm
Geared Steer	0 Steer	* REQT 1	* REQT 1	-	-
	Full RH Steer	* REQT 1	* REQT 2	-	-
	Full LH Steer	* REQT 2	* REQT 1	-	-
Clutch Brake	0 Steer	* REQT 2	* REQT 2	-	-
	Full RH Steer	-	-	* REQT 2	0 rpm
	Full LH Steer	-	-	0 rpm	* REQT 2
Test Paragraph		4.6.3.6.1		4.6.3.6.2	
* Requirements:					
* Reqt 1: The actual measured output rpm must equal the actual measured input rpm divided by the geared steer gear ratio of 1.304. (Example: 200 ÷ 1.304 = 153)					
* Reqt 2: The actual measured output rpm must equal the actual measured input rpm divided by the clutch brake gear ratio of 1.926. (Example: 200 ÷ 1.926 = 104)					

1/ CW = clockwise

LH = left hand

RH = right hand

3.4.13 Internal leakage at control valves and clutches. The input flow required at control port M to maintain 1380 ± 35 kPa at control port M shall not exceed 11.4 L/min at any steer lever position listed in tables IV or V (see 4.6.3.7).

3.4.14 No load input torque. The input torque required to maintain the following input speeds, with no load at the output shafts, shall not exceed that specified in tables IV or V (see 4.6.3.7):

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- a. In geared steer at 2500 rpm.
- b. In clutch brake at 1800 rpm.

TABLE IV. Clutch pressures, input torques & lube pressures in geared steer.

	Steer lever position (degrees)		Clutch pressures (at input speeds of 2500 rpm CW & 750 rpm CCW) kPa max kPa min						No load Input torque N.m maximum (at 2500 rpm CW & 750 rpm CCW input speeds)	Lube pressure at lube port L kPa minimum	
			LH clutches			RH clutches				at 2500 rpm CW input speed	at 750 rpm CCW (reverse) input speed
	min	max	High speed	Low speed	Brake	High speed	Low speed	Brake			
Zero Steer	0	0	1410 1340	<2	<2	1410 1340	<2	<2	102	170	135
Left Steer	3	4	1410 1340	<2	<2	1410 1340	<2	<2	---	---	---
	4	6	<2	205 70	<2	1410 1340	<2	<2	88	170	135
	13	17	<2	310 170	<2	1410 1340	<2	<2	---	135	100
	Full 33	LH 38	<2	1410 1340	<2	1410 1340	<2	<2	88	135	100
	3	4	1410 1340	<2	<2	1410 1340	<2	<2	---	---	---
Right Steer	4	6	1410 1340	<2	<2	<2	205 70	<2	88	170	135
	13	17	1410 1340	<2	<2	<2	310 170	<2	---	135	100
	Full 33	RH 38	1410 1340	<2	<2	<2	1410 1340	<2	88	135	100
	Test conditions: A) 1380 ± 35 kPa applied to control port M B) 56 to 76 L/min applied lube port L										

3.4.15 Brakes. The brake lever application torques specified below shall be sufficient to prevent input shaft rotation, when 1220 Newton-meter (N.m) input torque is applied (see 4.6.3.8):

- a. 203 N.m maximum in geared steer.
- b. 244 N.m maximum in clutch brake.

3.4.16 Output performance, high torque and high power. When the six combinations of input torque and speed listed in table VI are applied to the steer unit input shaft, the output torques and speeds shall be as specified in table VI (see 4.6.3.9).

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TABLE V. Clutch pressures, input torques & lube pressures in clutch brake.

	Steer lever position (degrees)		Clutch pressures (at input speeds of 1800 rpm CW & 750 rpm CCW) kPa max kPa min						No load Input torque N.m maximum (at 1800 rpm CW & 750 rpm CCW input speeds)	Lube pressure at lube port L kPa minimum	
			LH clutches			RH clutches				at 1800 rpm CW input speed	at 750 rpm CCW (reverse) input speed
			High speed	Low speed	Brake	High speed	Low speed	Brake			
min	max										
Zero Steer	0	0	<2	1410 1340	<2	<2	1410 1340	<2	88	65	30
Left Steer	3	4	<2	1410 1340	<2	<2	1410 1340	<2	---	---	---
	4	6	<2	<2	205 70	<2	1410 1340	<2	102	135	100
	13	17	<2	<2	310 170	<2	1410 1340	<2	176	100	65
	Full 33	LH 38	<2	<2	1410 1340	<2	1410 1340	<2	176	30	20
Right Steer	3	4	<2	1410 1340	<2	<2	1410 1340	<2	---	---	---
	4	6	<2	1410 1340	<2	<2	<2	205 70	102	135	100
	13	17	<2	1410 1340	<2	<2	<2	310 170	176	100	65
	Full 33	RH 38	<2	1410 1340	<2	<2	<2	1410 1340	176	30	20
Test conditions: A) 1380 ± 35 kPa applied to control port M B) 56 to 76 L/min applied lube port L											

3.4.17 Output performance, high speed and high power. When the six combinations of input torque and speed listed in table VII are applied to the steer unit input shaft, the output torques and speeds shall be as specified in table VII (see 4.6.3.10).

TABLE VI. High torque and high power.

		Apply input			Minimum output torque N.m		Output speed maximum rpm minimum rpm	
		Input torque N.m ± 135	Input speed (rpm±10) CW & CCW (reverse) rotation	Input hp (ref)				
					LH output shaft	RH output shaft	LH output shaft	RH output shaft
Both outputs equally loaded	Geared Steer	7050	170	170	3920	3920	140 120	140 120
	Clutch Brake	4880	365	250	3880	3880	200 180	200 180

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TABLE VI. High torque and high power - Continued.

		Apply input			Minimum output torque N.m		Output speed	
		Input torque N.m ± 135	Input speed (rpm ± 10)	Input hp (ref)			maximum rpm	minimum rpm
			CW & CCW (reverse) rotation		LH output shaft	RH output shaft	LH output shaft	RH output shaft
Total load applied to LH output	Geared Steer	4750	375	250	5220		300 275	300 275
	Clutch Brake	3250	440	200	5090		245 220	245 220
Total load applied to RH output	Geared Steer	4750	375	250		5220	300 275	300 275
	Clutch Brake	3250	440	200		5090	245 220	245 220

TABLE VII. High speed and high power.

		Apply input			Minimum output torque N.m		Output speed	
		Input torque N.m ± 20	Input Speed (rpm ± 50)	Input hp (ref)			maximum rpm	minimum rpm
			CW rotation		LH output shaft	RH output shaft	LH output shaft	RH output shaft
Both outputs equally loaded	Geared Steer	475	3900	260	240	240	3035 2950	3035 2950
	Clutch Brake	665	1750	165	525	525	940 880	940 880
Total load applied to LH output	Geared Steer	475	3900	260	440		3035 2950	3035 2950
	Clutch Brake	665	1750	165	1050		940 880	940 880
Total load applied to RH output	Geared Steer	475	3900	260		475	3035 2950	3035 2950
	Clutch Brake	665	1750	165		1050	940 880	940 880

3.4.18 Reverse operation. The steer unit shall meet the following requirements when the input shaft is rotated in the reverse direction (CCW rotation as seen when looking at the end of the shaft).

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3.4.18.1 Clutch engagement (reverse rotation). Output shaft speeds shall be as specified in table III (see 4.6.3.6).

3.4.18.2 Clutch pressures versus steer lever positions (reverse rotation). The relationship between clutch pressures and steer lever positions shall be as specified in table IV for geared steer operations, and as specified in table V for clutch brake operations (see 4.6.3.7).

3.4.18.3 Lube pressures versus steer lever positions (reverse rotation). The pressure at lube port L shall not be less than that specified in table IV for geared steer operations, or that specified in table V for clutch brake operations (see 4.6.3.7).

3.4.18.4 No load input torque (reverse rotation). The input torque required to maintain 750 rpm CCW (reverse) input shaft speed, with no load at the output shafts, shall not exceed that specified in table IV for geared steer operations, or that specified in table V for clutch brake operations (see 4.6.3.7).

3.4.18.5 Reverse output performance at high torque and high power. When the six combinations of input torque and speed listed in table VI are applied to the steer unit input shaft in the CCW (reverse) direction of rotation, the output torques and speeds shall be as specified in table VI (see 4.6.3.9).

3.5 Nameplate. The steer unit shall have a name plate marked with the National Stock Number (NSN) and the manufacturer's name and part number (see 4.6.2).

3.6 Painting. Unless otherwise specified, steer units shall be cleaned, treated, and painted in accordance with Drawing 13215E6600 (see 4.6.2).

3.7 Workmanship. Workmanship shall be of a quality to assure that steer units and components are free from defects of a workmanship nature (see 4.6.2).

4. VERIFICATION

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

- a. First article inspection (see 4.2).
- b. Conformance inspection (see 4.3).

4.2 First article inspection. First article inspection shall be performed on two steer units from the first ten produced when a first article sample is required (see 6.2). This inspection shall include the examination of 4.4 and the tests of 4.6.3.1 through 4.6.3.9 (see table VIII).

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4.3 Conformance inspection. Conformance inspection shall include the examination of 4.4 and the tests of 4.6.3.1 through 4.6.3.9 (see table VIII).

4.3.1 Sampling for examination. Unless otherwise specified (see 6.2), the sampling plan specified herein shall be used. Samples for examination shall be selected in accordance with table IX.

4.3.2 Acceptance tests (100 percent). Each steer unit shall be subjected to the conformance tests specified in table VIII.

4.4 Examination. Each steer unit shall be examined for compliance with the requirements specified in 3.3.1, 3.3.2, and 3.5 through 3.7. Any redesign or modification of the contractor's standard product to comply with specified requirements, or any necessary redesign or modification following failure to meet the specified requirements shall receive particular attention for adequacy and suitability. This element of inspection shall encompass all visual examinations and dimensional measurements. Noncompliance with any specified requirements or presence of one or more defects preventing or lessening maximum efficiency shall constitute cause for rejection.

4.5 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in paragraphs 4.5.1 through 4.5.4.3.

4.5.1 Test oil. Test oil, grade 10 (see 6.2) shall be used for all testing except low temperature testing.

4.5.2 Test oil temperature. Except as otherwise specified, the temperature of the test oil shall be maintained at 66 degrees Celsius (°C) to 93°C.

4.5.3 Test equipment. The following test equipment will be required for performance of the tests specified herein.

4.5.3.1 Test fixture. A test fixture, to mount the steer unit that will also act as an anchor to counteract the output torque, shall be performed.

4.5.3.2 Power source. A powertrain to drive the steer unit input shaft at speeds up to 3900 rpm in the CW direction and 750 rpm in the CCW direction, input torque up to 7000 N.m in both directions, and up to 250 input horsepower in both directions shall be used (see figure 1).

4.5.3.3 Dynamometers. A dynamometer coupled to each steer unit output shaft is to be capable of absorbing an input torque of 6200 N.m at a speed of 300 rpm, and other torque and speed combinations listed in tables VI and VII.

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4.5.3.4 Dynamometer cooling system. A system such as a cold water circuit to cool the dynamometers shall be provided.

4.5.3.5 Dynamometer control system. A system to control the input torque to the dynamometers, and thus control the input torque to the steer unit shall be provided.

4.5.3.6 Dynamometer mounting stands. Stands to mount the dynamometers that will also act as anchors to counteract the input torque shall be provided.

4.5.3.7 Hydraulic power source. A hydraulic power source capable of 2100 kPa pressure at 76 L/min flow, and a hydraulic circuit setup similar to that shown in figure 2 shall be provided.

4.5.3.8 Hydraulic oil temperature control. Means to heat and to cool the oil so that oil temperature can be maintained within the limits specified in 4.5.2 shall be provided. A relief valve can also be used for heating, and an air-oil heat exchanger for cooling.

4.5.3.9 Instrumentation. Gages and meters to measure the items listed below shall be used. For locations, see figures 1, 2 and 3.

- a. Pressure gages at lube port L and the six lube pressure ports to measure 0 to 210 kPa.
- b. Pressure gages at main control port M and the six clutch pressure ports to measure 0 to 1520 kPa.
- c. Flow meter at lube port L to measure 0 to 76 L/min flow into L.
- d. Flow meter at main control port M to measure 0 to 23 L/min flow into M.
- e. Torque meters to measure torque at the steer unit input shaft from 0 to 7000 N.m, and at each output shaft from 0 to 6200 N.m.
- f. Tachometers to measure speed of the steer unit input shaft from 0 to 3900 rpm, and speed of the steer unit output shafts from 0 to 3100 rpm.
- g. A temperature probe and readout to indicate the temperature of the oil in the steer unit sump from 0 to 104°C.
- h. A scale or other means of measuring movement of the steer control lever from 0° to 38° LH and RH steer, with an accuracy of ± 0.5 degree.

4.5.4 Preparation for testing. The following procedures shall be accomplished prior to the starting of tests.

4.5.4.1 Fill with oil. Fill the steer unit sump and hydraulic circuit with the proper oil, and fill to the proper oil level designated on the steer unit dipstick.

4.5.4.2 Heat oil. Warm the oil in the steer unit sump and hydraulic circuit to the specified temperature (see 4.5.2).

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4.5.4.3 Adjust brakes. Adjust each brake lever as follows:

- a. Turn each brake lever clockwise until the lever can no longer be rotated when applying medium effort with a 254 millimeter (mm) adjustable wrench.
- b. Back each lever off 10 \pm 0.25 complete 360° turn.

TABLE VIII. Classification of inspections.

Title	Requirement	Inspection	First article	Conformance	
				Examination	Test
Materials and construction	3.2 thru 3.3	4.6.1	X		
Defects	3.3.1, 3.3.2, 3.5 thru 3.7	4.6.2	X	X	
Preparation for testing		4.5.4			
Functioning ability, high speed	3.4.1	4.6.3.1	X		X
Functioning ability	3.4.1	4.6.3.2 thru 4.6.3.10	X	X	
External leakage	3.4.2	4.6.3.1 thru 4.6.3.10	X	X	
Lube regulator	3.4.3	4.6.3.2	X	X	
Lube oil system	3.4.4	4.6.3.2 thru 4.6.3.3.b.3 4.6.3.4.b thru 4.6.3.7	X	X	
Lube pump high pressure output	3.4.5	4.6.3.3 and 4.6.3.4	X	X	
Auxiliary regulator	3.4.6	4.6.3.3 and 4.6.3.4	X	X	
Lube pressure at low rpm	3.4.7	4.6.3.3.b.3 and 4.6.3.4.b	X	X	
Aux REG & check valve LKG	3.4.8	4.6.3.3.b.4 and 4.6.3.4.b	X	X	
Lube pump low pressure output	3.4.9	4.6.3.5	X	X	
Clutch engagement	3.4.10	4.6.3.6	X	X	
Clutch pressure vs steer position	3.4.11	4.6.3.7	X	X	
Lube pressure vs steer position	3.4.12	4.6.3.7	X	X	

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TABLE VIII. Classification of inspections - Continued.

Title	Requirement	Inspection	First article	Conformance	
				Examination	Test
Internal leakage	3.4.13	4.6.3.7	X	X	
No load input torque	3.4.14	4.6.3.7	X	X	
Brakes	3.4.15	4.6.3.8	X	X	
Output performance high torque and power	3.4.16	4.6.3.9	X	X	
Output performance high speed and power	3.4.17	4.6.3.10	X		X
Reverse operation					
Clutch engagement	3.4.18.1	4.6.3.6	X	X	
Clutch pressure vs steer position	3.4.18.2	4.6.3.7	X	X	
Lube pressure vs steer position	3.4.18.3	4.6.3.7	X	X	
No load input torque	3.4.18.4	4.6.3.7	X	X	
Output performance high torque and power	3.4.18.5	4.6.3.9			X

TABLE IX. Sampling plan for conformance.

Conformance sampling plan		
Inspection lot size	Sample size	
	Examination	
	Major	Minor
2 to 8	*	5
9 to 15	13	5
16 to 25	13	5
26 to 50	13	5
51 to 90	13	7
91 to 150	13	11
151 to 280	20	13
281 to 500	29	16
501 to 1200	34	19
1201 to 3200	42	23
3201 to 10 000	50	29
10 001 to 35 000	60	35
35 001 to 150 000	74	40
150 001 to 500 000	90	40
500 001 and over	102	40

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TABLE X. Classification of defects.

Category	Defect	Method of examination
<u>Major:</u>		
101	Dimensions affecting interchangeability, not within tolerance (see 3.3.1).	Visual and SIE <u>1/</u>
102	Weight: Not as specified (see 3.3.2).	Weigh scale
103	Workmanship: Not as specified (see 3.7).	Visual
<u>Minor:</u>		
201	Dimensions not affecting interchangeability, not within tolerance (see 3.3.1).	Visual and SIE
202	Nameplates, not as specified (see 3.5).	Visual
203	Painting, not as specified, poor coverage (see 3.6).	Visual

1/ SIE = Standard Inspection Equipment.

4.6 Methods of inspection.

4.6.1 Materials and construction. Conformance to 3.2 thru 3.3 shall be determined by inspection of contractor records providing proof or certification that design, construction, processing, and materials conform to requirements. Applicable records shall include drawings, specifications, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data.

4.6.2 Defects. Conformance to 3.3.1, 3.3.2 and 3.5 through 3.7, shall be determined by examination of the defects listed in table X. Examination shall be visual, tactile, or by measurement with standard inspection equipment.

4.6.3 Performance tests. The following test procedures, or equivalent procedures acceptable to the Government, shall be applied to determine conformance to requirements of 3.4. Prior to performing the following tests, preparation for testing paragraph 4.5.4 shall have been accomplished to provide a proper setup.

4.6.3.1 Functional check. To determine initial conformance to 3.4.1 and 3.4.2:

- a. Apply 56 to 76 L/min flow into lube port L.
- b. Apply 1380 ± 35 kPa to control port M and hold that pressure.
- c. Gradually increase the steer unit input shaft speed in CW direction of rotation to 3900 rpm in the geared steer mode and to 1800 rpm in the clutch brake mode.
CAUTION!! DO NOT SHIFT FROM GEARED STEER TO CLUTCH BRAKE OR VICE VERSA AT HIGH SHAFT SPEEDS.

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- d. Operate the steer control lever through the full steering range at various input shaft speeds in both geared steer and clutch brake.
- e. Repeat c and d above except in reverse counter clockwise (CCW) direction of rotation with input speed increasing to only 750 rpm.

4.6.3.2 Lube regulator. To determine conformance to 3.4.3 and table I, and to 3.4.4.a:

- a. Vent control port M to steer unit sump, place selector in geared steer mode, and leave steer control lever at 0 steer position.
- b. With 0 rpm to steer unit, apply flow into lube port L. Slowly increase the flow rate until pressure at lube port L is per test item A of table I, then hold that pressure and record the flow rate. Also record the pressure at each of the six lube pressure ports for conformance to 3.4.4.a.
- c. Repeat b for test item B of table I.
- d. Increase the flow rate until it is per test item C of table I, then hold that flow rate and record the pressure at lube port L and the six lube pressure ports.
- e. Repeat d for test item D of table I.
- f. Repeat a thru e above, except with selector in the clutch brake mode.

4.6.3.3 Lube pump high pressure output and auxiliary regulator in geared steer mode. To determine conformance to 3.4.4.b, 3.4.5, 3.4.6, 3.4.7 and 3.4.8 in geared steer mode:

- a. Vent control port M to steer unit sump, apply 56 to 76 L/min flow into lube port L, place selector in geared steer mode, and leave steer control lever at 0 steer position.
- b. Slowly increase the input shaft speed and record the following:
 1. For conformance to 3.4.5, record the minimum clockwise (CW) output speed required to produce 552 kPa at the high speed clutches.
 2. For conformance to 3.4.6, record the high speed clutch pressures when input speed is increased to 2500 ± 50 rpm.
 3. For conformance to 3.4.7 and 3.4.4.b, record the pressure at lube port L and the six lube pressure ports at 200 ± 20 , and 800 ± 50 rpm input speed.
 4. For conformance to 3.4.8, disconnect the port M hose from the sump and measure flow (leakage) out port M at 800 ± 50 rpm input speed.

4.6.3.4 Lube pump high pressure output and auxiliary regulator in clutch brake mode. To determine conformance to 3.4.4.b, 3.4.5, 3.4.6, 3.4.7, and 3.4.8 in clutch brake mode, repeat the procedures of 4.6.3.3 except as follows:

- a. In part a, place the selector in the clutch brake mode instead of the geared steer mode.

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- b. In paragraph 1 of part b, record the minimum output speed required to produce 552 kPa at the low speed clutches, instead of at the high speed clutches.
- c. In paragraph 2 of part b, record the low speed clutch pressure at 1800 \pm 50 rpm instead of the high speed clutch pressure at 2500 \pm 50 rpm.

4.6.3.5 Lube pump low pressure output. To determine conformance to 3.4.9 and table II:

- a. Apply 1380 \pm 35 kPa to control port M and hold that pressure.
- b. Close valve A (Fig 2) at lube port L (do not apply flow to lube port L).
- c. Leave steer control lever at 0 steer position.
- d. Record the pressure at lube port L at the input speeds and conditions specified in table II.

4.6.3.6 Clutch engagement. To determine conformance to 3.4.10, 3.4.18 and table III, apply the procedures of 4.6.3.6.1 and 4.6.3.6.2.4.6.3.6.1 Clutch engagement with control port M vented:

- a. Apply 56 to 76 L/min flow into lube port L.
- b. Apply 200 \pm 20 rpm, CW, to the input shaft.
- c. Measure the output shaft speeds at the steer lever positions and other conditions as listed in table III.

4.6.3.6.2 Clutch engagement with pressure applied to control port M.

- a. Apply 56 to 76 L/min flow into lube port L.
- b. Apply 1380 \pm 35 kPa to control port M and hold that pressure.
- c. Apply 200 \pm 20 rpm, CCW (reverse), to the input shaft.
- d. Measure the output shaft speeds at the steer lever positions and other conditions as listed in table III.

4.6.3.7 Clutch pressures, lube pressures, internal leakage, and input torque. To determine conformance to 3.4.11, 3.4.12, 3.4.13, 3.4.14, 3.4.4.c, 3.4.4.d, 3.4.18.2, 3.4.18.3 and 3.4.18.4:

- a. Apply 56 to 76 L/min flow into lube port L.
- b. Apply 1380 \pm 35 kPa to control port M and hold that pressure.
- c. At the forward (CW) input speeds and at the reverse (CCW) input speed listed in table XI, in both the geared steer and clutch brake modes, record the data items indicated in table XI at each steer lever position indicated in tables IV and V.

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4.6.3.8 Brakes. To determine conformance to 3.4.15:

- a. Apply 56 to 76 L/min flow into lube port L.
- b. Apply 1380 ± 35 kPa to control port M and hold that pressure.

TABLE XI. Data required in tests of 4.6.3.7.

		Data to be measured and recorded				
	Input Shaft Speed (rpm)	Pressure at each of the 6 clutch test ports	Pressure at lube port L	Pressure at each of the 6 lube test ports	Flow reqd at port M	No load input torque
Geared Steer	0					
	2500 ± 50 CW	3.4.11 and table IV	3.4.12 and table IV	3.4.4.c	3.4.13	3.4.14 and table IV
	750 ± 50 CCW (reverse)	3.4.18.2 and table IV	3.4.18.3 and table IV	3.4.4.d		3.4.18.4 and table IV
Clutch Brake	0					
	1800 ± 50 CW	3.4.11 and table V	3.4.12 and table V	3.4.4.c	3.4.13	3.4.14 and table V
	750 ± 50 CCW (reverse)	3.4.18.2 and table V	3.4.18.3 and table V	3.4.4.d		3.4.18.4 and table V

4.6.3.9 Output performance, high torque and high power. To determine conformance to 3.4.16 and 3.4.18.5.

- a. Apply 56 to 76 L/min flow into lube port L.
- b. Apply 1380 ± 35 kPa to control port M and hold that pressure.
- c. Couple each output shaft to a dynamometer.
- d. Place control into the geared steer mode or clutch brake mode as specified in table VI.
- e. With steer control lever in zero steer position, slowly increase power to the input shaft in the CW direction of rotation while using the dynamometers to load the output shaft(s). Increase power until the input torque and input speed conform to one of the six test conditions of table VI. Measure output torques and speeds for conformance to table VI. Repeat the above procedures for each of the other five test conditions of table VI. For the four test conditions of table VI that require total load applied to only one output, use only one of the two dynamometers to apply load, disconnect the other dynamometer.
- f. Repeat above steps for CCW (reverse) direction of rotation.

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4.6.3.10 Output performance, high speed and high power. To determine conformance to 3.4.17, apply the procedures of 4.6.3.9 except apply input torque and speed per table VII. Measure output torques and speeds for conformance to table VII.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This specifications covers a steer unit, capable of performing steering and braking functions, for the Armored Combat Earthmover (M9 ACE).

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Type, number, and date of this specification.
- b. Title, number, and revision letter of the applicable engineering drawing (see 2.2.1).
- c. If first article inspection is required (see 3.1).
- d. If operating fluid and test oil are other than as specified (see 3.2.1 and 4.5.1).
- e. If sampling plan for conformance inspection is other than as specified (see 4.3.1).
- f. Packaging requirements (see 5.1).

6.3 Supplementary engineering data. Engineering data is listed below:

Weight	590 kg (approximate)
Rated input torque	7600 N.m
Rated input speed	4300 rpm [Input speed is approximately 3900 rpm with M9 at 48 kilometer per hours (km/h)]
Rated input power	265 horsepower (hp)
Gear ratios (input/output)	Geared steer: 1.304:1 Clutch brake: 1.926:1

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6.3.1 Steer unit shaft rotation directions. With the M9 moving forward with no turning, the steer unit shafts rotate as follows (as seen when looking at ends of shafts):

- a. Input shaft - CW
- * b. LH output shaft - CW
- * c. RH output shaft - CCW

* The final drive assemblies in the M9 reverse the direction of rotation between the steer unit and the track drive sprockets.

6.4 Subject term (key word) listing.

Auxiliary regulator
Control valves
Dynamometer
M9 ACE
Rotation
Shaft

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.

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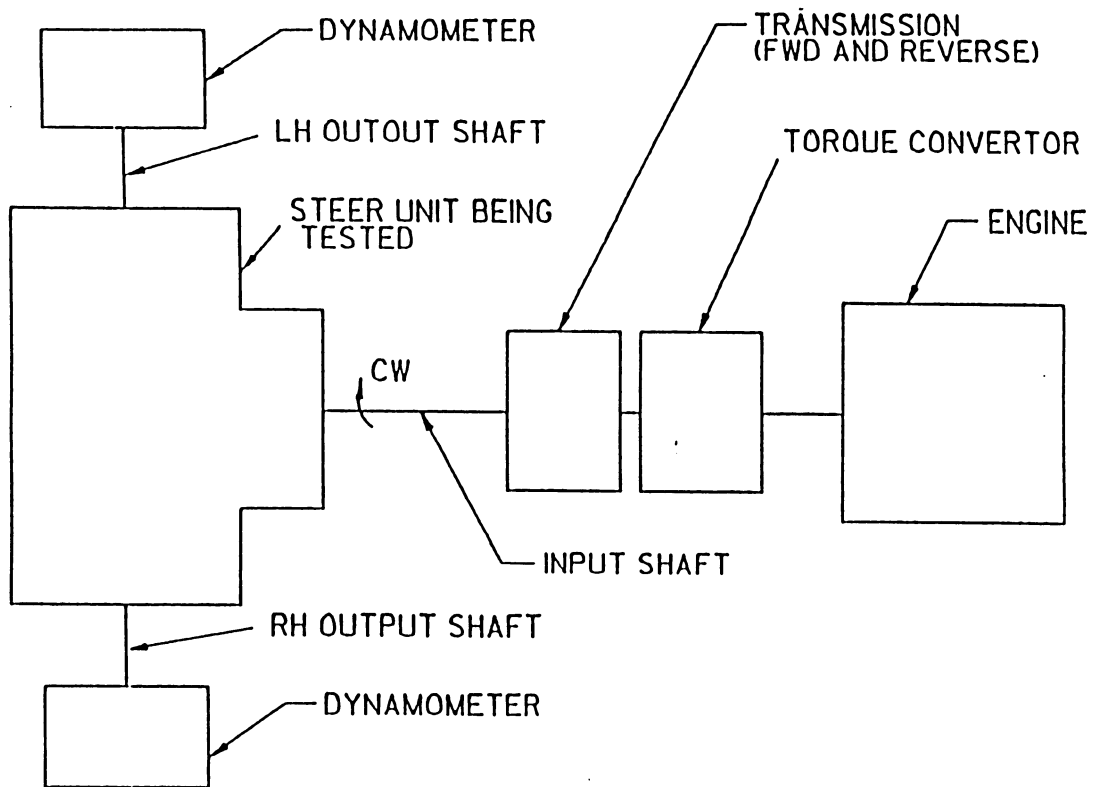
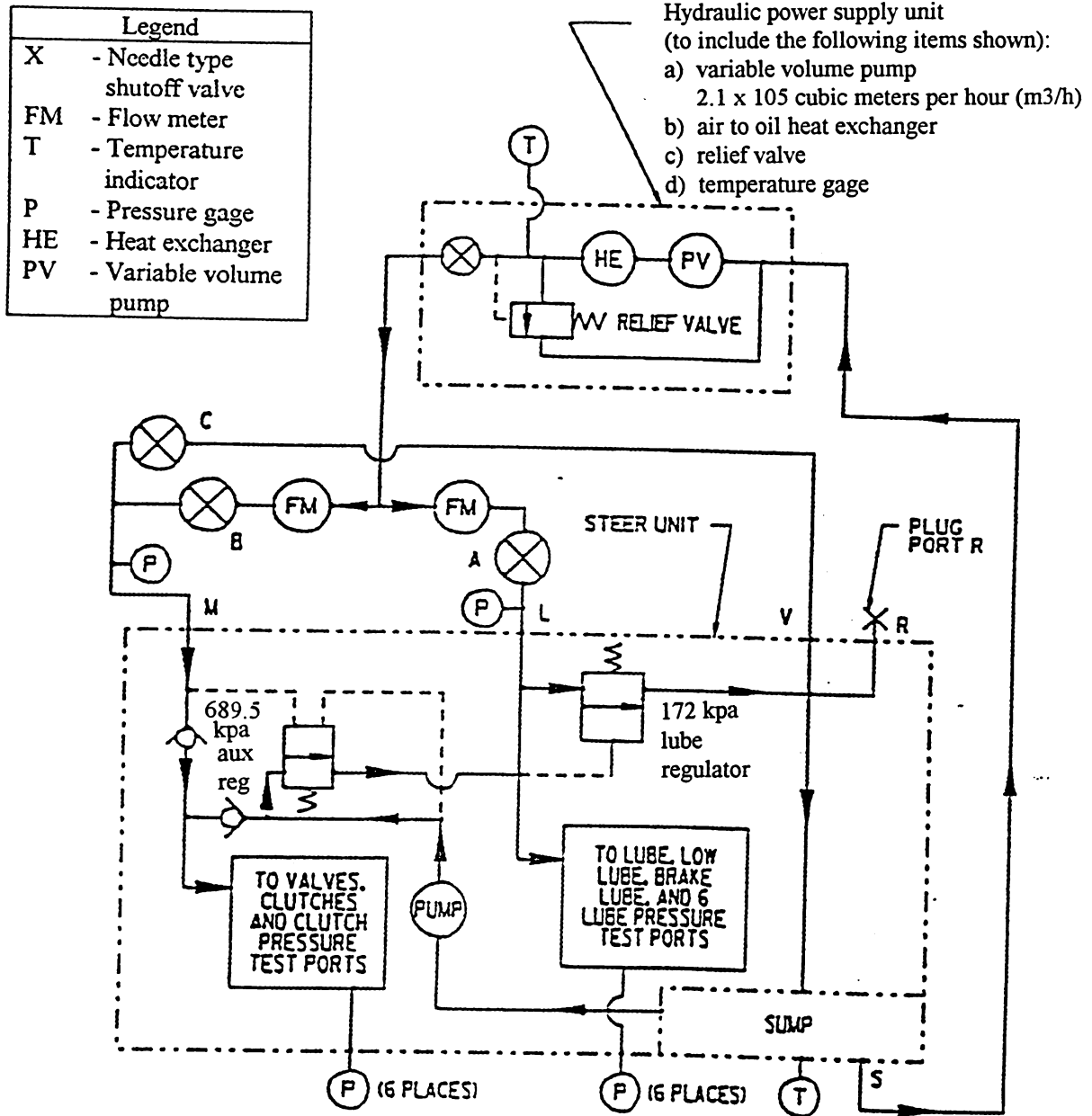


FIGURE 1. Example of driveline for steer unit tests.

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NOTES:

1. To obtain $1.577 \times 10^5 \text{ m}^3/\text{h}$ flow into port L at same time as supplying 1380 kPa to port M, close valve A as required to develop 1380 kPa pressure drop across valve A at $1.577 \text{ m}^3/\text{h}$ flow.
2. To vent port M, close valve B and open valve C.

FIGURE 2. Example of hydraulic schematic for steer unit tests.

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PORT LEGEND	
PORT	
1	MAIN CONTROL PRESSURE PORT M
2	LUBE OIL INLET PORT (L)
3	LH BRAKE CLUTCH PRESSURE
4	RH BRAKE CLUTCH PRESSURE
5	LH HI CLUTCH PRESSURE
6	RH HI CLUTCH PRESSURE
7	LH HI CLUTCH PRESSURE
8	RH HI CLUTCH PRESSURE
9	LH RH LUBE PRESSURE
10	LH RH LOW LUBE PRESSURE
11	LH RH BRAKE LUBE PRESSURE
12	BREATHER PORT
13	RETURN PORT (R)

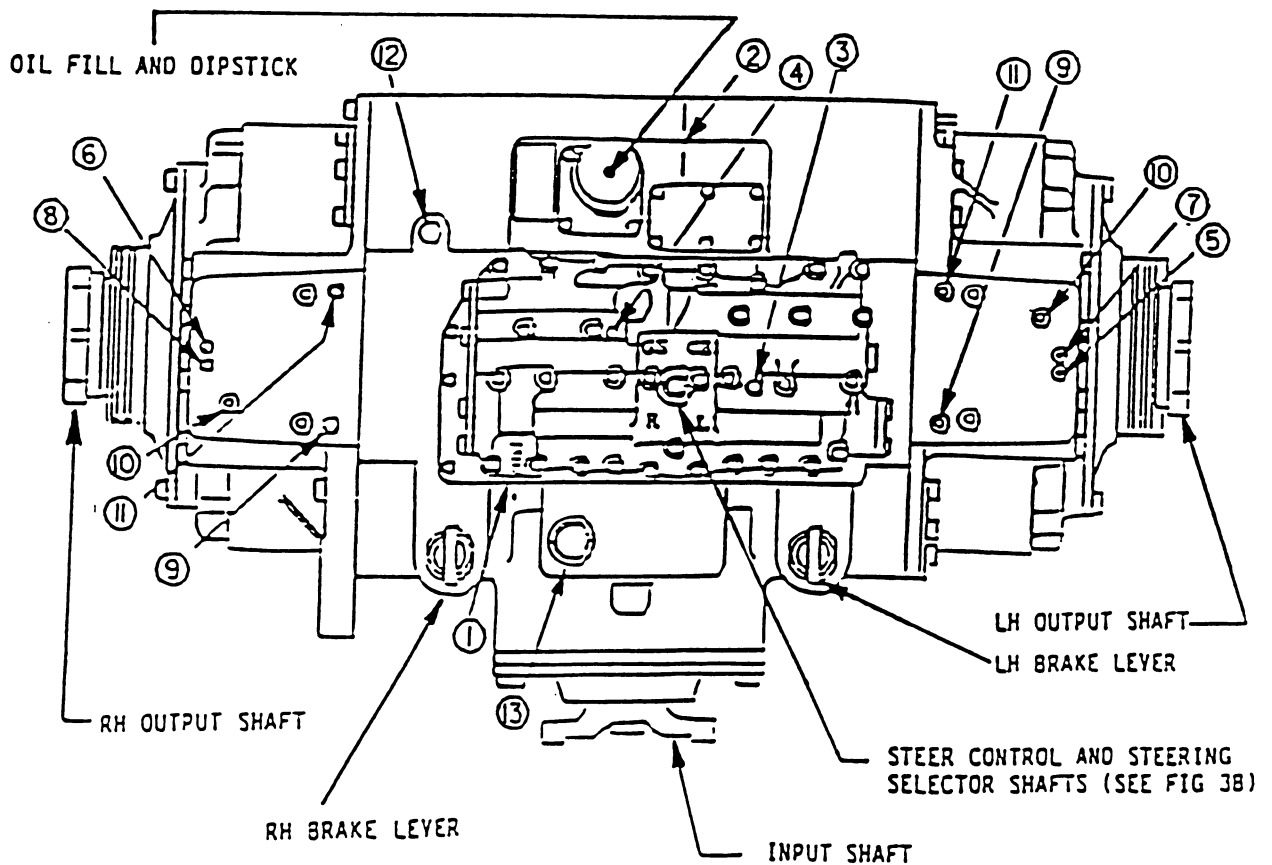


FIGURE 3A. Top view of steer unit (see figure 3B for front view).

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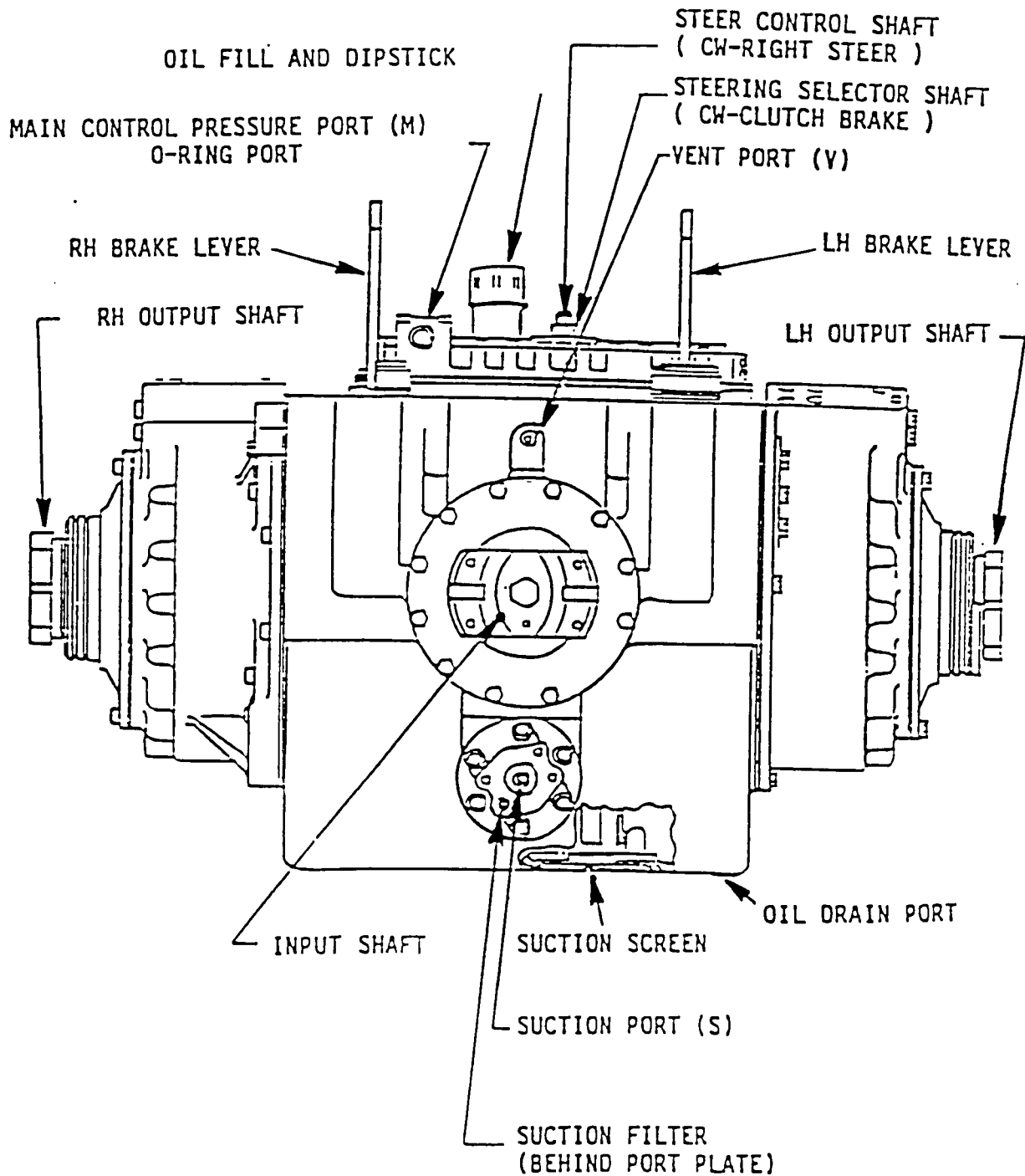


FIGURE 3B. Front view of steer unit (see figure 3A for top view).

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1. DOCUMENT NUMBER
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2. DOCUMENT DATE (YYMMDD)
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3. DOCUMENT TITLE STEER UNIT, TRACKED VEHICLE, CLUTCH BRAKE AND GEARED STEER

4. NATURE OF CHANGE *Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

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