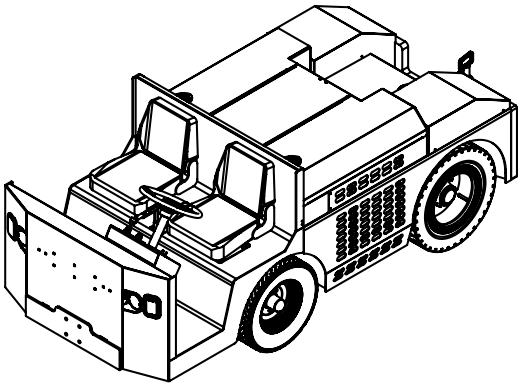
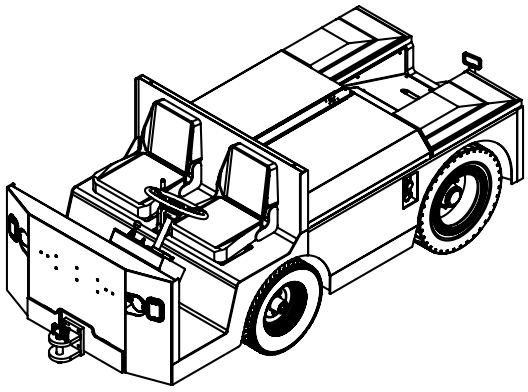
TOW TRACTOR
MODEL M40E/M40D

OPERATION, MAINTENANCE AND PARTS MANUAL



Model 40D
Diesel



Model 40E
Electric

NMC-WOLLARD, Inc.
2021 Truax Blvd.
Eau Claire, WI 54702
715-835-3151
Fax 715-835-6625
nmc-wollard.com
General Email nmc-wollard@nmc-wollard.com

INTRODUCTION

Congratulations on the purchase of your new Tow Tractor from NMC-Wollard, Inc. With its optional equipment this is the simplest, most flexible system on the market today. With proper operation and preventative maintenance it will last for years.

⚠ This SAFETY ALERT SYMBOL indicates important safety messages in the manual. When you see this symbol, be alert to the possibility of PERSONAL INJURY and carefully read the message that follows.

⚠WARNING Never operate without all covers, shields and guards in place. Body, hair or clothing can become entangled in exposed, moving parts and can cause serious injury or death.
Some covers and guards have been removed for illustrative/photographic purposes only in this manual.

The Warranty appears in the front of this book. The order number and serial number are recorded on the cover. These numbers should be recorded on the Registration and Inspection Certificate for your reference and for proper identification of your machine by NMC-Wollard, Inc.

For information on ordering repair parts, refer to the Repair Parts chapter at the back of this book.
For convenience, it is recommended to copy the serial number and other important information from the data plate affixed to this unit onto page14. This data is used to properly identify this unit by the manufacturer when ordering repair parts or obtaining technical support

You are urged to study this manual and follow the instructions carefully. Your efforts will be repaid in better operation and service as well as a savings in time and repair expense. Failure to read and understand the machine or the system could lead to serious injury. If you do not understand the instructions in this manual contact the manufacturer.

This supercedes all previous published instructions.

When reading this manual, if a figure or paragraph *outside* the current section is referred to, it will be identified by Chapter-Section-Figure Number or Chapter-Section-Paragraph.
Example:
Figure 2-2-4.....Chapter 2-Section 2-Figure 4
2-2-1.4.....Chapter 2-Section 2-Paragraph 1.4
If figures or paragraphs from the current section are referred, the chapter and section may not be referenced.

This manual is available in pdf format on CD-ROM.

Keep a copy of your NMC-Wollard, Inc. manuals on your computer or CD-ROM! You will be able to view and print pages and search for words or numbers. CD-ROM manuals include a linked table of contents. Mouse click on a table of contents entry to display the page containing that item.

For availability and pricing, contact NMC-Wollard, Inc. customer service at:
Phone (715) 835-3151
Fax (715) 835-6625
Email custserv@nmc-wollard.com

Purpose of this Manual
This manual is meant to provide the information necessary to operate, maintain, and repair the tow tractor, model number M40E/M40D, manufactured by NMC-Wollard, Inc., Eau Claire, WI 54702, phone 715-835-3151.

Arrangement of this Manual
This manual is divided into five Chapters. The introduction contains general information for familiarization with the manual. Chapter 1, General Information & Operating Instructions, contains general safety information, descriptions of the baggage tractor and its components or systems, operating instructions and specifications. Chapter 2, Maintenance, contains a periodic/preventive maintenance schedule and routine maintenance procedures. Chapter 3 contains information for major repair or overhaul. Chapter 4 is the Illustrated Parts Breakdown (IPB). The IPB shows all parts and part numbers necessary for support of the tractor. The IPB can be used for requisitioning and identifying parts. Chapter 5 contains OEM manuals or data for major assemblies used on the tractor.

1 YEAR LIMITED WARRANTY

NMC-Wollard, Inc

NMC-Wollard, Inc. warrants to the original owner that all components of the equipment are free from defects in material and workmanship under normal use and service for 12 months or 1,000 hours, whichever comes first, from the date of shipment.

This warranty provides for NMC-Wollard, Inc. equipment components that fail because of defects in material or workmanship during the warranty period, without charge to the owner for parts or labor. The owner must provide prompt notice of the defect and allow a reasonable time for replacement or repair.

This warranty applies only to parts manufactured by NMC-Wollard, Inc. Components installed on NMC-Wollard, Inc. equipment but not manufactured by NMC-Wollard, Inc. shall be covered under the original manufacturer's warranty. NMC-Wollard, Inc. will assist in administering all such warranties, with the exception of tires, battery, and other expendable parts, for which the owner will be required to deal directly with the original manufacturer for warranty service. Neither tune-ups, normal maintenance and repair or replacement of expendable parts (such as oil, lubricants, belts, filters, tires, battery, etc.) are covered by this warranty.

This warranty does not cover damage resulting from carelessness or neglect; accidents, fire, or other casualties; improper repair, operation, transportation, or storage; or failure to provide necessary or appropriate maintenance. This warranty does not cover deterioration or failure caused by chemicals, falling objects, dirt and sand, or excessive heat or moisture. The NMC-Wollard, Inc. equipment must be maintained according to the instructions provided with it or this warranty may be considered void. Warranted components must be replaced with parts manufactured or approved by NMC-Wollard, Inc. Warranty determination will be made after NMC-Wollard, Inc. inspects the failed part.

NMC-Wollard, Inc. is not liable for damage or injury resulting from improper installation, use, abuse, inability to use or misapplication of NMC-Wollard, Inc. equipment, nor is NMC-Wollard, Inc. liable for damage resulting from equipment repaired or modified by persons not authorized by NMC-Wollard, Inc. NMC-Wollard, Inc. does not warrant any part or product to meet local, municipal, state, provincial, or national laws or regulations.

This Limited Warranty is in lieu of all other warranties, whether express, implied, or statutory. No other express warranty is given or authorized by NMC-Wollard, Inc. NMC-Wollard, Inc. expressly disclaims any implied warranty of merchantability or fitness for a particular purpose or otherwise. NMC-Wollard, Inc. shall not be liable for loss of use of equipment, loss of time, loss of business, or for any other incidental, or consequential damages. No authorized NMC-Wollard, Inc. representative has the right to change or modify this warranty in any respect.

This warranty is non-transferable.

TO OBTAIN WARRANTY SERVICE

Warranty can be obtained by contacting NMC-Wollard, Inc., 2021 Truax Blvd., Eau Claire, WI. 54703, (Phone 715 835-3151) (Fax 715 835-6625)

What should you do when you receive a new unit?

Check that you have received all the equipment ordered. Check inside the product manual for engine warranties. Some OEM manufacturers supply a registration card that must be filled out and returned immediately to initiate the warranty. If a survey card or delivery checklist is enclosed from NMC-Wollard, Inc. please return it.

What should you do when you discover a possible warranty problem?

Call NMC-Wollard, Inc. (715-835-3151). We will require the serial number, number of hours on the unit, and a description of the problem. You will be given a warranty authorization number and assistance in troubleshooting.

IMPORTANT!
Clear and immediate communication with the factory is the key to obtaining a satisfactory and timely resolution of your warranty problem.

Every warranty situation is different and so there are no hard rules. We will work with your maintenance personnel and service managers to equitably resolve all claims.

What should you do after warranty problem has been resolved?

Complete and return the warranty claim form within 10 days. Place the assigned warranty authorization number we gave you when you first called us with the problem on your claim.

Return defective parts immediately. Your claim cannot be processed until all defective parts have been returned to NMC-Wollard, Inc. Identify returned parts with the assigned warranty authorization number.

What should you use for labor rate and labor time?

Labor rate are reviewed annually, if you do not have an established rate, call NMC-Wollard, Inc. We do not publish a rate book; instead, we have accumulated average times for repairs. We will authorize repair time once we have approved the repair. If unforeseen circumstances cause a significantly greater repair time than originally approved, please contact us before submitting your claim.

TABLE OF CONTENTS

REVISION RECORD

Rev No.	Issue Date	Date Inserted	Initial
0	11/1/14	11/1/14	NMC-Wollard
1	12/15/14	12/15/14	NMC-Wollard
2	1/5/15	1/5/15	NMC-Wollard
3	3/18/15	3/18/15	NMC-Wollard

REVISION HIGHLIGHTS

TO: HOLDERS OF NMC-Wollard, Inc. OPERATION AND MAINTENANCE MANUAL number 51460, M40E/M40D Tow Tractor.

Pages that have been revised are outlined below, together with highlights of the revision. Please delete the affected pages and enter Revision No.and date to the Revision Record page.

REVISION NO. 0 DATED 11/01/14

Chapter/Section And Page No.	**Description of Changes**	**Effectivity**
All	Preliminary manual	all

REVISION NO. 1 DATED 12/15/14

Chapter/Section And Page No.	**Description of Changes**	**Effectivity**
Intro/6, 7, 8, 10-13	Updated TOC, Rev, Rev Highlights	all
4/TOC/1	Updated	all
4/2/1-4	Page Eff. Updated	all
4/3/1, 2	Part Index Updated	all
4/4/2-50	Added numerous parts and page flow affected	all
5/1-98	Added Chapter 5	all

REVISION NO. 2 DATED 1/5/15

Chapter/Section And Page No.	**Description of Changes**	**Effectivity**
Intro/ 7, 8, 10-11	Updated Rev, Rev Highlights, Page Eff.	all
1/TOC	Updated	all
1/1/1-4	Added safety signs for Model D, page flow affected	all
1/3/4	Updated Model D instrument panel call outs	all
1/4/2	Updated Model D instrument panel listings	all
4/TOC	Updated	all
4/3/1-3	Updated numerical parts list	all
4/4/22,23	Updated Model D instrument panel part numbers	all
4/4/28,29	Added Model D decal group	all

REVISION NO. 3 DATED 3/18/15		
Chapter/Section And Page No.	**Description of Changes**	**Effectivity**
Intro/ 7, 9, 10-12,14,15	Updated Rev, Rev Highlights, Page Eff. ,Configuration	all
1/1/4	Deleted 1018145, 45417 signs	all
1/3/7,1/4/1	Added switch under seat in list item 2, T4i was T4	all
2/1/3,4,9,12,13,15	Change brake fluid spec. to Kendall, removed 18 psi note, revised fig 5, revised fig 7, revised fig 9, revised chart on page 15	all
4/TOC/1	Updated	all
4/Parts Index	Updated	all
4/4/4,6,7,10,11,16, 17,18,26,27,30,31 ,44,43,45,46	Revised illustrations and page flow	all

PAGE EFFECTIVITY

Chapter/Section	Page	Date	Chapter/Section	Page	Date
Cover	1	11/01/14	2-1	5	11/01/14
Introduction	2	11/01/14	2-1	6	11/01/14
Introduction	3	11/01/14	2-1	7	11/01/14
Limited Warranty	4	11/01/14	2-1	8	11/01/14
Limited Warranty	5	11/01/14	2-1	9	03/18/15
Table of Contents	6	11/01/14	2-1	10	11/01/14
Revision Record	7	03/01/15	2-1	11	11/01/14
Revision Highlights	8	01/05/15	2-1	12	03/18/15
Revision Highlights	9	03/18/15	2-1	13	03/18/15
Page Effectivity	10	03/18/15	2-1	14	11/01/14
Page Effectivity	11	03/18/15	2-1	15	03/18/15
Page Effectivity	12	03/18/15	2-1	16	11/01/14
Page Effectivity	13	12/15/14	2-1	17	11/01/14
Configuration	14	03/18/15	2-1	18	11/01/14
Configuration	15	03/18/15	2-1	19	11/01/14
Effectivity	16	11/01/14	2-1	20	11/01/14
1-TOC	1	01/05/15	2-1	21	11/01/14
1-TOC	2	01/05/15	2-1	22	11/01/14
1-1	1	01/05/15	2-1	23	11/01/14
1-1	2	01/05/15	2-1	24	11/01/14
1-1	3	01/05/15	2-2	1	11/01/14
1-1	4	01/05/15	2-2	2	03/18/15
1-1	5	11/01/14	2-2	3	03/18/15
1-1	6	11/01/14	2-2	4	03/18/15
1-1	7	11/01/14	2-2	5	03/18/15
1-1	8	11/01/14	2-2	6	03/18/15
1-2	1	11/01/14	2-3	1	11/01/14
1-2	2	11/01/14	2-3	2	11/01/14
1-2	3	11/01/14	2-3	3	11/01/14
1-2	4	11/01/14	2-3	4	11/01/14
1-2	5	11/01/14	2-4	1	11/01/14
1-2	6	11/01/14	2-4	2	11/01/14
1-3	1	11/01/14	3-TOC	1	11/01/14
1-3	2	11/01/14	3-TOC	2	11/01/14
1-3	3	11/01/14	3-1	1	11/01/14
1-3	4	01/05/15	3-1	2	11/01/14
1-3	5	11/01/14	4-TOC	1	03/18/15
1-3	6	11/01/14	4-TOC	2	11/01/14
1-3	7	03/18/15	4-1	1	03/18/15
1-3	8	11/01/14	4-1	2	03/18/15
1-4	1	03/18/15	4-2	1	12/15/14
1-4	2	01/05/15	4-2	2	12/15/14
1-4	3	11/01/14	4-2	3	12/15/14
1-4	4	11/01/14	4-2	4	12/15/14
1-5	1	11/01/14	4-3	1	01/15/15
1-5	2	11/01/14	4-3	2	01/15/15
1-6	1	11/01/14	4-3	3	01/15/15
1-6	2	11/01/14	4-3	4	11/01/14
2-TOC	1	03/18/15	4-4	1	11/01/14
2-TOC	2	11/01/14	4-4	2	12/15/14
2-1	1	11/01/14	4-4	3	12/15/14
2-1	2	11/01/14	4-4	4	03/18/15
2-1	3	03/18/15	4-4	5	12/15/14
2-1	4	03/18/15	4-4	6	03/18/15

Chapter/Section	Page	Date
4-4	7	03/18/15
4-4	8	12/15/14
4-4	9	12/15/14
4-4	10	03/18/15
4-4	11	03/18/15
4-4	12	12/15/14
4-4	13	12/15/14
4-4	14	12/15/14
4-4	15	12/15/14
4-4	16	03/18/15
4-4	17	03/18/15
4-4	18	03/18/15
4-4	19	12/15/14
4-4	20	12/15/14
4-4	21	12/15/14
4-4	22	01/05/14
4-4	23	01/05/14
4-4	24	12/15/14
4-4	25	12/15/14
4-4	26	03/18/15
4-4	27	03/18/15
4-4	28	01/05/14
4-4	29	01/05/14
4-4	30	03/18/15
4-4	31	03/18/15
4-4	32	12/15/14
4-4	33	12/15/14
4-4	34	12/15/14
4-4	35	12/15/14
4-4	36	12/15/14
4-4	37	12/15/14
4-4	38	12/15/14
4-4	39	12/15/14
4-4	40	12/15/14
4-4	41	12/15/14
4-4	42	12/15/14
4-4	43	03/18/15
4-4	44	03/18/15
4-4	45	03/18/15
4-4	46	03/18/15
5-TOC	1	12/15/14
5-TOC	2	12/15/14
5-1	3	12/15/14
5-1	4	12/15/14
5-1	5	12/15/14
5-1	6	12/15/14
5-1	7	12/15/14
5-1	8	12/15/14
5-1	9	12/15/14
5-1	10	12/15/14
5-1	11	12/15/14
5-1	12	12/15/14
5-1	13	12/15/14
5-1	14	12/15/14
5-1	15	12/15/14
5-1	16	12/15/14
5-1	17	12/15/14
5-1	18	12/15/14
5-1	19	12/15/14
5-1	20	12/15/14
5-1	21	12/15/14
5-1	22	12/15/14
5-1	23	12/15/14
5-1	24	12/15/14
5-1	25	12/15/14
5-1	26	12/15/14
5-1	27	12/15/14
5-1	28	12/15/14
5-1	29	12/15/14
5-1	30	12/15/14
5-1	31	12/15/14
5-1	32	12/15/14
5-1	33	12/15/14
5-1	34	12/15/14
5-1	35	12/15/14
5-1	36	12/15/14
5-1	37	12/15/14
5-1	38	12/15/14
5-1	39	12/15/14
5-1	40	12/15/14
5-1	41	12/15/14
5-1	42	12/15/14
5-1	43	12/15/14
5-1	44	12/15/14
5-1	45	12/15/14
5-1	46	12/15/14
5-1	47	12/15/14
5-1	48	12/15/14
5-1	49	12/15/14
5-1	50	12/15/14
5-1	51	12/15/14
5-1	52	12/15/14
5-1	53	12/15/14
5-1	54	12/15/14
5-1	55	12/15/14
5-1	56	12/15/14
5-1	57	12/15/14
5-1	58	12/15/14
5-1	59	12/15/14
5-1	60	12/15/14
5-1	61	12/15/14
5-1	62	12/15/14
5-1	63	12/15/14
5-1	64	12/15/14
5-1	65	12/15/14
5-1	66	12/15/14
5-1	67	12/15/14

Chapter/Section	Page	Date	Chapter/Section	Page	Date
5-1	68	12/15/14			
5-1	69	12/15/14			
5-1	70	12/15/14			
5-1	71	12/15/14			
5-1	72	12/15/14			
5-1	73	12/15/14			
5-1	74	12/15/14			
5-1	75	12/15/14			
5-1	76	12/15/14			
5-1	77	12/15/14			
5-1	78	12/15/14			
5-1	79	12/15/14			
5-1	80	12/15/14			
5-1	81	12/15/14			
5-1	82	12/15/14			
5-1	83	12/15/14			
5-1	84	12/15/14			
5-1	85	12/15/14			
5-1	86	12/15/14			
5-1	87	12/15/14			
5-1	88	12/15/14			
5-1	89	12/15/14			
5-1	90	12/15/14			
5-1	91	12/15/14			
5-1	92	12/15/14			
5-1	93	12/15/14			
5-1	94	12/15/14			
5-1	95	12/15/14			
5-1	96	12/15/14			
5-1	97	12/15/14			
5-1	98	12/15/14			

Chapter/Section	Page	Date	Chapter/Section	Page	Date

This Page Intentionally Blank

CONFIGURATION

The NMC-Wollard, Inc. sales order number for this unit is _____

The serial number placard for this unit is located on the inside firewall. For your convenience, record the serial number (or range of numbers for multiple orders) below.

Serial Number(s)

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Both the sales order and serial numbers are required for proper identification by NMC-Wollard, Inc. whenever you call for service parts or other technical support.

The unit shipped with this operator's manual was equipped with the items indicated on the following available options listing.

☐ 51514 LED Turn Signal Lights

This Page Intentionally Blank

EFFECTIVITY CODE

This manual is effective on units having the following serial numbers:

Effectivity Code	Serial Numbers
A	14-C-4025+

CHAPTER 1 GENERAL INFORMATION AND OPERATING INSTRUCTIONS

1. PRODUCT SAFETY

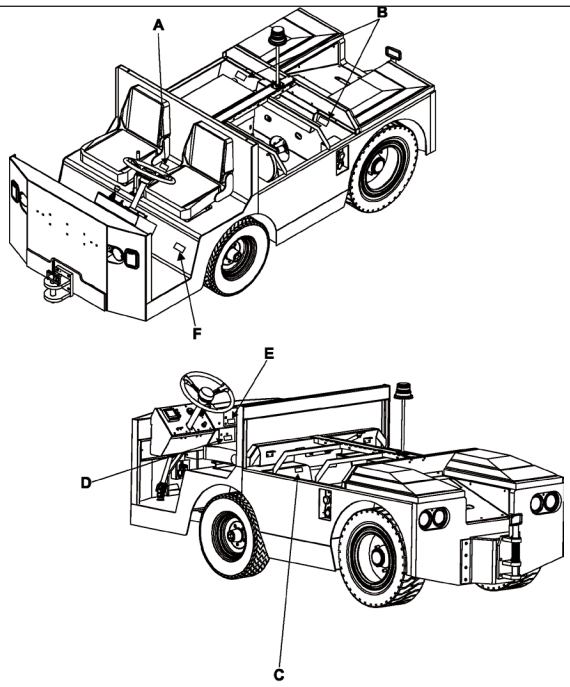
A brief description of signal words that may be used in this manual:

⚠ DANGER Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠WARNING Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠CAUTION Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE! Used to address practices not related to personal injury.

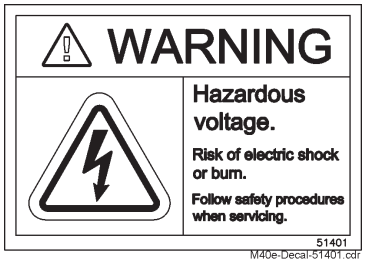


SAFETY SIGN LOCATIONS MODEL E

⚠CAUTION For your protection, read all safety signs on the machine and in this manual. Replace any missing or illegible signs by ordering the part numbers shown on the safety sign page.

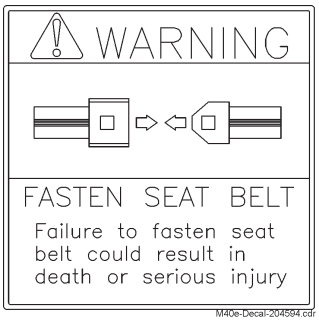
1.1 SAFETY SIGNS MODEL E

DECAL A.
PART NO. 51393



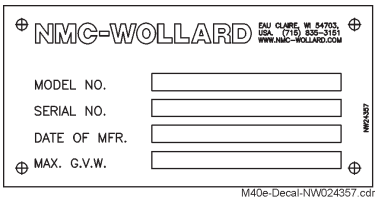
DECAL B .
PART NO. 51401

DECAL C .
PART NO. 51402

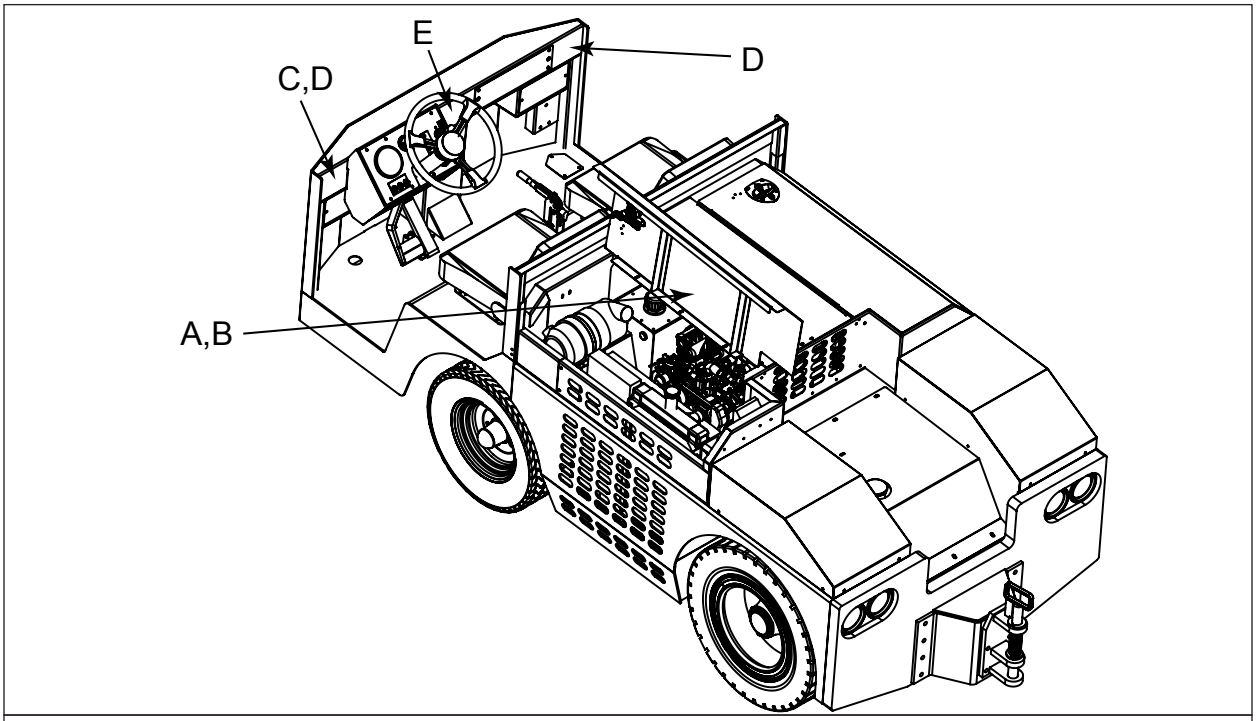


DECAL D.
PART NO. 204594

DECAL E.
PART NO. 305732



DECAL F.
PART NO. 024357

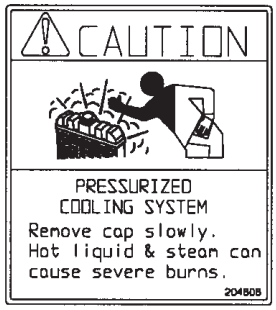


SAFETY SIGN LOCATIONS MODEL D

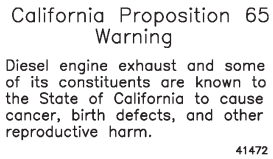
⚠CAUTION For your protection, read all safety signs on the machine and in this manual. Replace any missing or illegible signs by ordering the part numbers shown on the safety sign page.

1.2 SAFETY SIGNS MODEL D

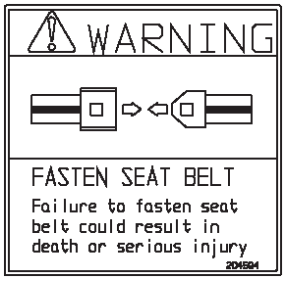
DECAL A .
PART NO. 204604



DECAL B .
PART NO. 204606



DECAL C .
PART NO. 41472



DECAL D .
PART NO. 204594

DECAL E.
PART NO. 305732

1.2.1 Safety Sign Care

- Keep safety signs clean and legible at all times.
- Replace safety signs that are missing or have become illegible.
- Replaced parts that displayed a safety sign should also display the current sign.
- Safety Signs are available from your dealer.

1.2.2 How To Install Safety Signs

- Be sure that the installation area is clean and dry.
- Remove the smallest portion of the split backing paper.
- Align the sign over the specified area and carefully press the small portion with the exposed adhesive backing in place.
- Remove second backing and press remaining sign in place

1.3 GENERAL SAFETY PRECATIONS

All personnel who will handle, install, use or service this machine are required to read and understand the recommended practices and safety precautions in this manual. If there is a question that can not be answered satisfactorily by a supervisor, contact the Customer Service Department at NMC-Wollard, Inc.

There are inherent hazards associated with the operation and servicing of this machine. For your protection please read and understand the following precautions before operating or servicing this machine.

⚠ DANGER

- Never approach overhead power lines or cables with any part of your machine. Contact with or getting close to any power lines or cables can result in electrocution.
- Fuel vapors create fire and explosion hazards. Do not allow any open flame, smoking materials or other potential ignition sources near fuel or the fuel system.

⚠WARNING

- Never operate without all covers, shields and guards in place. Body, hair or clothing can become entangled in exposed, moving parts and can cause serious injury or death.
- Keep hands, loose clothing, long hair and loose jewelry away from moving parts. You may become entangled in moving parts that can cause serious injury or death.
- Perform lockout/tagout procedures before adjusting, lubricating, cleaning or otherwise servicing. Failure to do so could result in unexpected startup and could cause serious injury or death.
- Use seat belts, approved headgear, eye protection and other protective equipment as required by federal, state, local or employer regulations.
- Do not operate or service this machine while under the influence of any drugs or alcohol.

- Do not indulge in stunt driving or other reckless operation.
- Limit travel speed. Ground conditions, congestion, slope, location of personnel and other factors increase risk of collision or injury to personnel.
- Operator must be present while this machine is in use.
- California Proposition 65 Warning: Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.
- To minimize risk of serious injury or death, follow these hydraulic servicing precautions:
    - Follow all necessary lockout/tagout procedures.
    - Hydraulic systems have residual, stored pressure. Relieve all pressure from the hydraulic system before servicing.
    - Allow fluid to cool before working on system.
    - Hydraulic fluid escaping under pressure can have sufficient force to enter eyes and penetrate skin. If fluid gets in eyes or skin, flush with large quantities of water and seek medical attention.
    - Wear eye protection when servicing hydraulic components or systems.
    - Keep all hoses and connections in good serviceable condition. Check before start-up and periodically during operation.
    - Do not investigate for leaks with hands. Use a large piece of cardboard.

• To minimize risk of fire or explosion, follow these battery servicing safety precautions:

    - Sulfuric battery acid is poisonous. Avoid breathing battery fumes.
    - Battery acid is strong enough to burn skin and cause blindness if splashed into the eyes. Protect eyes and skin from contact. In the event of contact with battery acid, immediately rinse in large amounts of water. Obtain medical care if the eyes are burned.
    - Battery gas can explode. Keep sparks and flame away from battery.
    - Never check battery charge by placing a metal object across the batteryposts. A spark will occur and cause possible explosion. Use a voltmeter or hydrometer.
- To avoid falls and injury, stand only on areas constructed with a skid resistant surface. Keep these surfaces in serviceable condition.
- Never make any alterations or modifications to this equipment including disabling safety devices or interlocks.

⚠ CAUTION

- Before starting repairs which do not require battery power, always turn off the key switch, then disconnect the battery connector from the battery to prevent accidental short circuit.
- Be certain area is clear of people and other equipment before starting operation.
- Keep machine clear of foreign objects and clean of grease/oil and other lubricants.

Failure to heed could result in serious personal injury or death.

In addition to these general safety precautions you will find specific safety messages embedded in the Operating and Maintenance Chapters of this manual.
Please review them for your protection.

1.4 MODEL E- AC POWERED SYSTEM SAFETY

⚠ DANGER Electric vehicles can be dangerous. All testing, fault-finding and adjustment should be carried out by competent personnel. The drive wheels should be off the floor and free to rotate during the following procedures.

The controller contains a triple fail-safe system to give a high level of safety. If the diagnostic LED is not illuminated or flashes, the safety circuit may have tripped and the truck may not drive.

To ensure continued safety of the controller system, the fail-safe circuit should be checked whenever the truck is serviced. The period between checks should not exceed 3 months.

THE BATTERY MUST BE DISCONNECTED BEFORE REPLACING OR ATTEMPTING ANY REPAIRS OF THE CONTROLS.

Before working on the controls disconnect the battery and connect the B+ and B controller terminals via a 10 ohm 25 watt resistor to discharge the internal capacitors.

Never connect the controller to a battery with its vent caps removed as an arc may occur due to the controller’s internal capacitance when it is first connected.

FAIL-SAFE CHECK:

- Ensure the drive wheels are CLEAR OF THE FLOOR AND FREE TO ROTATE.

- Switch on, select seat switch, release brake, select direction and FS1, the wheels should rotate and the diagnostic LED should give a steady illumination.

- Switch off, disconnect battery and connect the A and B- terminals together with, at least,10mm2 cable. Ensure that no other fault that would allow drive is present.

- Reconnect battery; switch on key with direction in neutral. The LED should stay off. Select a direction and check that the direction contactors do not close and the wheels do not rotate. IF THE TRUCK DRIVES, THE CONTROLLER IS FAULTY AND MUST BE REPLACED.

- Switch off at key and remove the A/B- connection. Switch on at key, reselect the power-up sequence and check that the LED illuminates and the truck wheels rotate.

Blow out magnets are fitted to contactors to ensure that no magnetic particles can accumulate in the contact gaps and cause malfunction. Ensure that contactors are wired with the correct polarity to their power terminals as indicated by the + sign on the top moulding.

The controller must NOT be used with permanently connected on board chargers or damage to the system may result.

2. EQUIPMENT DESCRIPTION

2.1 INTENDED USE

The NMC-Wollard, Inc. Tow Tractor, M40E/M40D, is a tractor designed for towing baggage, light cargo and small to medium aircrafts. Towing couplers may be attached to the front and/or rear of the tractor. Its drawbar pull capacity is 4,000 lbs.

2.2 MODEL E & D-MAIN CHASSIS

The chassis is a welded-steel structure containing the operator's station, power pack and drive train, stabilizers, and independent hydraulic system. Steering is powered by the independent electric or hydraulic system depending on model. The drive train is a conventional rear-wheel drive design, having either and elecric motor or hydrostatic drive (depending on model), drive shaft, and differential. The alternator/battery electrical system powers all electrical requirements on the diesel model. Heavy duty, precision aligned 1-piece welded structure. Main frame plates and side panels are heavy duty steel with structural rear bumper. All frame and body surfaces are shot blasted, primed and painted with weather resistant paint. Standard bolts are SAE grade 5, zinc-phosphate coated to resist corrosion.

2.3 MODEL E-ELECTRIC POWER UNIT

This modular unit contains a 88.8 V Lithium Polymer battery to power the AC motor which is drive shaft connected to a conventional automotive type rear differential axle. It also powers a AC motor driven hydraulic gear pump in the hydraulic power pack. The electrical controller assembly is also mounted in the power unit module.

2.4 MODEL D- DIESEL POWER UNIT

Four cylinder turbo charged diesel engine drives a hydrostatic transmission system that connects to a dive shaft running to a conventional automotive type rear differential axle.

2.5 MODEL D-HYDRAULIC SYSTEM

The hydraulic system powers vehicle steering and powers the rear dive wheels via a hydrostatic pump and motor The system consists of the motor driven hydraulic gear pump, oil reservoir, control valves, oil filter, hydraulic work cylinder (steering); check, flow control valves and associated plumbing, fittings and hoses. The functional units are explained on the following pages.

NOTICE! Use only MOBIL DTE-13 or equivalent in operating temperatures of +20°F to +120°F (-7°C to +50°C). Use Mobil Aero HFA or equivalent (MIL-H-5606A) in operating temperatures of -25°F to +50°F (-32°C to +10°C). Do not use hydraulic oils of different specifications. They may not be compatible and could result in damage to the hydraulic system components.

2.6 MODEL D-HYDRAULIC OIL RESERVOIR

The hydraulic oil reservoir is behind the operator's station. Working oil capacity is 8.5 U.S. gallons (32 liters). The reservoir is fitted with a magnetic drain plug, sight gauge, and a vented filler/strainer located on the cover.

Two 100-mesh removable strainers are installed in the suction line between the reservoir and the pumps. A 10-micron filter unit, with a replaceable element and a shutoff valve, is located in the return line.

2.7 MODEL D-HYDROSTATIC DRIVE

The hydrostatic pump is driven by the diesel motor. The motor drives the rear wheels through a drive shaft and rear axle.

2.8 MODEL D & E-POWER STEERING SYSTEM

Model D steering gear is powered by a gimbal-mounted, double-acting hydraulic cylinder mounted on the front axle. The control unit is actuated directly by the steering wheel to control flow of hydraulic power to the steering cylinder.

Turning the steering wheel actuates the rotary valve in the power steering unit. As the valve opens, hydraulic oil travels into a metering motor within the power steering unit, then out from the motor, through the valve, and out to the retract side of the steering cylinder. Return oil from the extend side flows through the valve to the reservoir. Oil flowing through the metering motor causes it to turn, and as it turns, it moves a feedback linkage that returns the rotary valve to center and locks the steering cylinder in position. The metering motor therefore ensures that the steering cylinder is precisely controlled by the command received from the steering wheel.

In the event of a power failure, steering can be done manually by spinning the steering wheel. In this case, steering wheel movement turns the metering motor.

Model E uses an electric power-assisted front-wheel steering gear operating through a mechanical linkage (drag link, pitman arm and single tie rod). The tie rod is attached to knuckles on the front axle. The front axle assembly is spring-mounted. The steering gear is a recirculating ballnut type.

directly through the feedback linkage. The motor is then used as a pump to force oil into the cylinder, while drawing oil into the suction side (through check valve) from the return line.

2.9 MODEL D- ELECTRICAL SYSTEM

See schematics in 2-2

All electrical power is supplied by the AC battery. This includes control and monitoring, vehicle lighting, and accessory equipment.

2.10 MODEL D & E- INSTRUMENT PANEL ASSEMBLY

The instrument panel, located at the operator's station, contains all necessary controls, electrical system monitoring, and lighting systems.

Fuses for the control circuits are located in the battery compartment behind the passenger seat. All fuses are labeled as to circuit and current rating. The complete panel can be unplugged and removed for service or replacement.

2.11 MODEL E-BATTERY RECHARGING

A receptacle is provided with electrical interlock preventing operation during recharge from an external charger by others.

2.12 MODEL D & E-BRAKE SYSTEM

The standard brake system is a non-powered, dual circuit system using standard automotive components. The front wheels have disc brakes and the rear have wet disk brakes. A pressure differential metering valve balances the pressures between the front and rear brake systems to assure safe, effective braking. This valve also monitors pressures in both systems and signals system malfunctions via the "Brake Fault" light on the instrument panel.

2.12.1 Model D & E-Service Brake

The brake pedal is located on the floor, to the right of the steering column. The front service brakes are disc. The rear, are "wet" disk type, fully enclosed and oil cooled. They will withstand repetitive use without excessive fading, provide short stopping distances, and are spark free.

Dual brake system serves front and rear wheels independently. In the event of an engine failure, hydraulic accumulators store enough energy for several applications of the brake.

2.12.2 Model D & E-Parking Brake

Model D- The electrically applied parking brake is automatically applied when the shift lever is moved to netural and released when the lever is moved off of netural.

Model E- The parking brake is located on the transmission between the seats. The park brake is manually applied and released. An indicator light on the dash will come on when the parking brake is applied. Release the parking brake before shifting from neutral. If the shift selector is moved from neutral while the parking brake is applied, the accelerator will not respond.

2.12.3 Model D & E-Brake System Monitoring

The pressure differential/metering valve on the split brake system contains a switch that closes and illuminates the “Brake Fault” light if there is any pressure unbalance in the brake system. The “Brake Fault” indicator is self-testing.

2.13 MODEL D & E-LIGHTS, HORNS, AND OTHER ACCESSORIES

Headlights and rear lights are controlled by a switch on the instrument panel. Two head lights are on the front of the tractor. The stop/tail lights and rear backup lights are in the rear body. The backup lights can also be used as work lights (there is a separate switch for this purpose).

Back work lights are controled by a switch on the instrument panel.

Optional turn signal lights are controlled by a lever-operated switch on the steering column and a flasher.

The horn is controlled by a center-mounted button on the steering wheel.

2.14 MODEL D & E- AXLES

Front axle is steerable.
Rear axle is planetary, double reduction, heavy-duty bearing mounted differential assembly. The second reduction planetary gears set in wheel hubs multiply torque and reduce drive line stress. Rear and front axles are leaf spring mounted to the tractror frame.

Both front and rear axles are conventional automotive type, with disc brakes on the front and wet disc brakes on the rear. The rear axle incorporated a parking brake and has a limited slip differential to provide improved traction in wet, ice, and snow conditions.

This Page Intentionally Blank

3. OPERATION

⚠WARNING Read and understand this manual before operating this machine. Failure to follow the safety instructions could result in serious injury or death.

⚠WARNING Use seat belts, approved headgear, eye protection and other protective equipment as required by federal, state, local or employer regulations.

⚠WARNING For Model E always set the parking brake when parking the machine.

⚠WARNING To prevent serious injury, all riders must ride in a passenger seat with the safety belt fastened.

⚠WARNING Never allow any person on this machine while in motion, including positioning, operating, or adjusting

⚠CAUTION This unit has restricted visibility on the right-hand side and rear.

- Before moving unit, walk around and ensure that there are no obstructions in the desired direction of movement.
- Be extra cautious when driving in reverse or making right turns. The operator position is forward of the front wheels. Be sure to compensate for this by steering late.

⚠CAUTION Be extremely alert during hazardous operating conditions. Operating conditions can change as work progresses and as weather changes.

3.1 MODEL E-EXTERNAL CHARGING

A receptacle for connecting to a external AC charger is located inside the rear, left fender. Opening the receptacle cover opens a circuit preventing operation while a charger is connected.

The digital display on the control panel indicates percent of battery charge. When charging, your charger will shutoff when the battery is fully charged, and the display will show 100% when the power switch is turned ON.
Whenever the battery level drops to 20%, plan to discontinue operation and recharge the battery.

The battery can be charged at any convenient time. Maximum length of charge from fully discharged state is 8 hours.

1. Park vehicle at charging station, place direction control lever in neutral and set handbrake. Switch power off.
2. Connect battery charger and operate in accordance with charger manufacturer's instructions.

3.2 MODEL D & E-OPERATOR'S STATION AND CONTROLS

Operator station controls are conventional in design, clearly labeled, and conveniently grouped at the operator station. Functional and operational interlocks are provided for operator safety and protection of the vehicle to permit long, trouble-free service. General instructions for operation of the unit are given in this section, see figure 1 and 2.

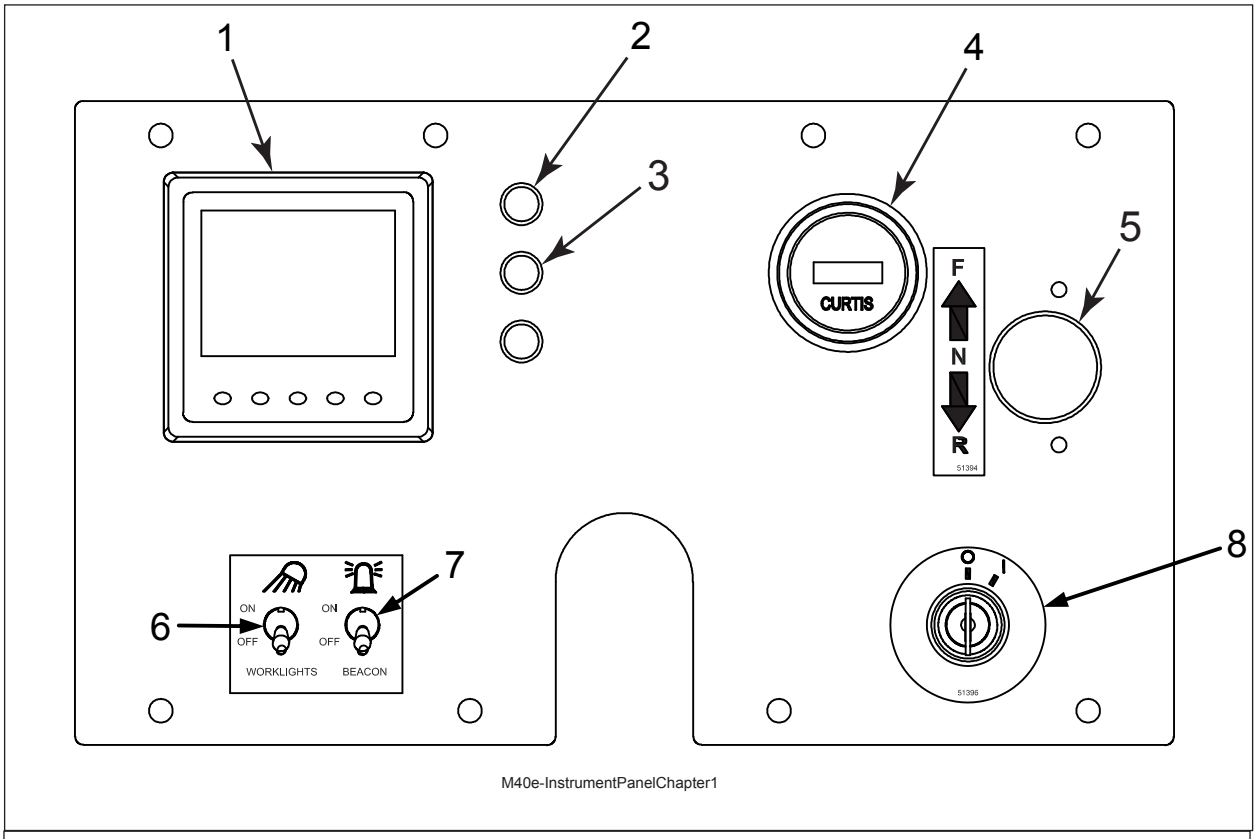


FIGURE 1. MODEL E-INSTRUMENT PANEL

3.2.1 Model E-Instrument Panel

All driver instruments are conveniently located on the instrument panel (see Figure 1).

1. Electronic display – shows remaining battery life.
2. Parking Brake Applied Indicator
3. Brake System Failure Indicator – “brake failure” light operates if either the front or rear brake systems lose pressure.
4. Hour Meter – registers how many hours the motor has operated. It is sealed and can record 99999.9 hours before it returns to zero.
5. Shifter
6. Work Light Switch – toggle switch controls the rear work lights.
7. Beacon Switch – toggle switch controls the beacon.
8. Ignition Switch - a rotary type with OFF, RUN and START positions.

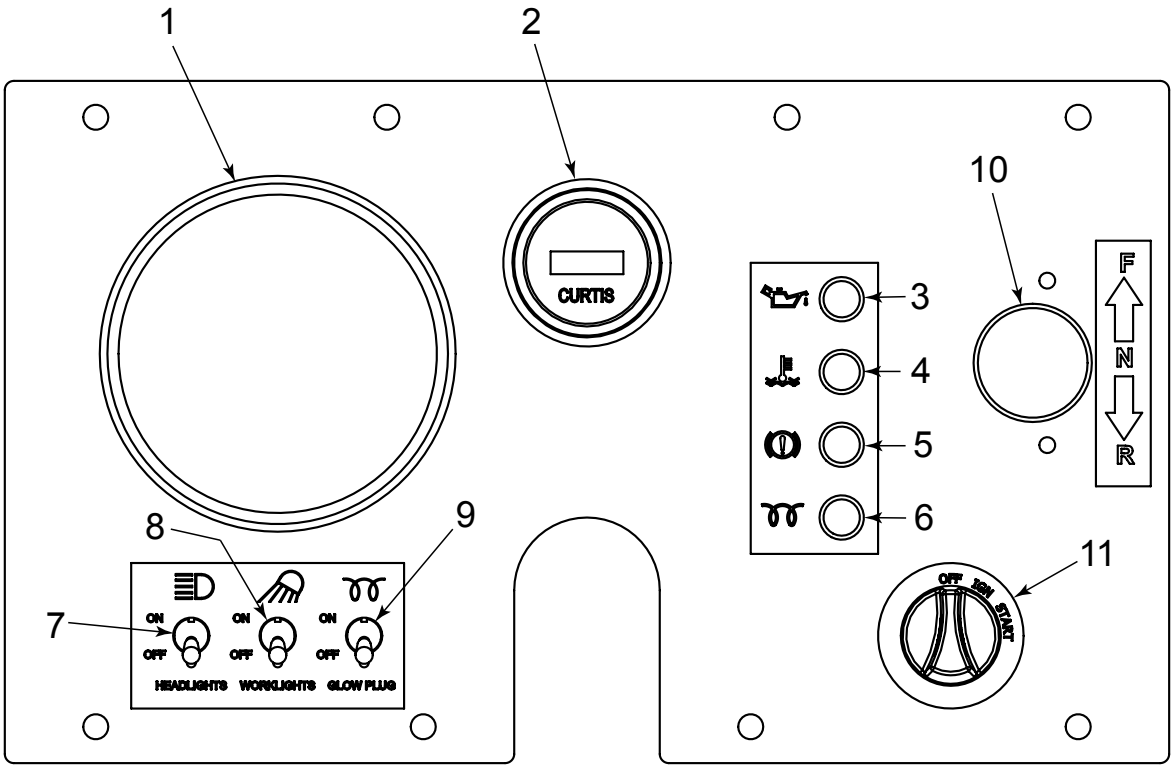


FIGURE 2. MODEL D-INSTRUMENT PANEL

3.2.2 Model D-Instrument Panel

All driver instruments are conveniently located on the instrument panel (see Figure 2).

1. Gauge-Fuel, Engine Temp., Engine Oil Press., Battery Volts
2. Hour Meter – registers how many hours the motor has operated. It is sealed and can record 99999.9 hours before it returns to zero.
3. Indicator- Low engine oil pressure
4. Indicator- High engine water temperature
5. Indicator-Brake System Failure Indicator – “brake failure” light operates if either the front or rear brake systems lose pressure.
6. Indicator- Engine pre-heat glow plugs on
7. Switch-Head Lights on/off
8. Switch-Rear Work Lights on/off.
9. Switch-Preheat Glow Plugs on/off
10. Shifter- Foward-Netural-Reverse
11. Switch-Ignition - a rotary type with OFF, RUN and START positions.

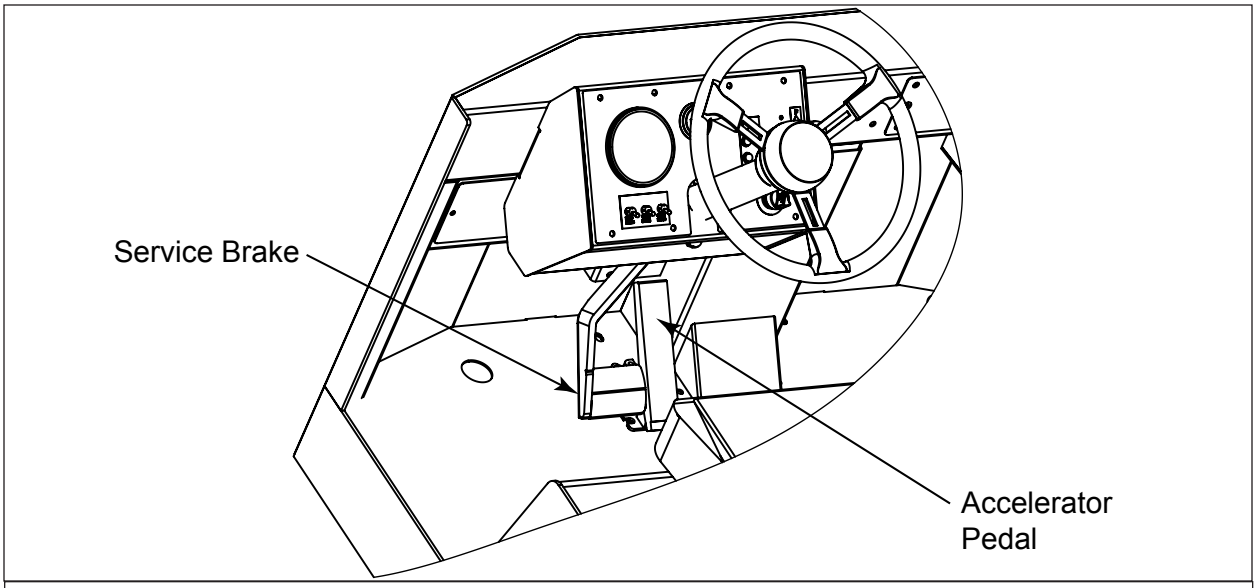


FIGURE 3. MODEL D & E-OPERATOR CONTROLS

3.2.3 Model D & E & E-Operator Controls

1. The accelerator pedal is to the right of the brake pedal and is an electronic sending unit type.
2. The service brake pedal is to the left of the accelerator pedal. In the event of a motor failure, braking is still by application of the service brake pedal. Hydraulic brakes are power boosted so will be harder to apply with loss of power. If necessary, additional emergency braking can be obtained by application of the park brake.
3. Park brake (between the front seats) is applied by pulling up on the parking brake lever. Push the lever down to release.

3.2.4 Model D & E-Seats

The operator and passenger Seats are adjustable for fore and aft, vertical (by adjusting front and rear of seat together), backrest inclination (by adjusting front and rear of seat independently).

3.2.5 Model D & E-Pre Operation Checklist

1. Always perform a thorough visual examination for any damage or missing items that may have occurred since the last operation that could cause the tractor not to be ground worthy or safe to operate. Report damage to the proper authorities so that repairs can be made.
2. Check for signs of fluid leakage under the parked machine. If found, identify the fluid and report to the proper authorities so that repairs can be made.
3. Check the brake fluid level.
4. Check the energy level and ensure you have an adequate supply for the anticipated operation.
5. Check wheels and tires for damage and proper inflation pressure, see 2-1-1.13
6. Check that the (optional) fire extinguisher is securely attached and the charge gauge indicates in the green range.
7. With the ignition on, check operation of lights and horn.
8. With the park brake applied, start the motor. Check for any malfunction indicators.

3.3 MODEL D & E-DRIVING THE TRACTOR

⚠WARNING To prevent serious injury, all riders must ride in a passenger seat with the safety belt fastened.

⚠CAUTION Always check local ordinances before driving a vehicle on public roads or streets. Comply with all regulations and obey all traffic signs to prevent an accident.

⚠CAUTION Be extremely alert during hazardous operating conditions. Operating conditions can change as work progresses and as weather changes.

⚠CAUTION Always approach turns slowly and carefully. When approaching blind corners or steering around obstructions, reduce speed and proceed cautiously.

1. Turn on the lights required for your operation.
2. Before operating the tractor, be sure to have your seat belt fastened. A safety

switch is located under the drivers seat. If the driver gets off or leans off the seat, the driver must be re-seated within 2 seconds or the unit will stop. To re-start the unit, shift to netural and then back into drive.

3. Passenger is also required to fasten seat belt.
4. With the motor (Model D) at idle speed, press on the brake pedal; release the parking brake (and trailer brake if in tow).
5. Pull up on the shift release ring below the shift knob. Position the shift lever in the direction of desired travel.
6. Safety issues should be considered when selecting travel speed. Some trial and error may be advised.
7. Release the foot brake and press the accelerator pedal slowly and evenly.
8. When towing, allow tractor to decelerate by releasing accelerator pedal before applying foot brake.
9. When driving or towing, avoid the tendency to oversteer and turn too sharply. Allow enough clearance for the towed load.
10. To stop the vehicle, remove your foot from the accelerator and smoothly place moderate pressure on the brake to bring the vehicle to a stop.
11. With the tractor completely stopped, place the shift lever in the neutral detent. For Model E pull up on the parking brake handle to apply the parking brake.
12. ***NOTICE!***: The parking brake is designed to hold the tractor after it has come to a complete stop. It is not to be used to stop the vehicle except for emergency stopping described in 3-5.

3.4 MODEL D & E-SHUTTING DOWN THE TRACTOR

1. Bring tractor to a safe and complete stop. Place gear shift lever in neutral (N).
2. Apply the parking brake for Model E. Model D automatically applies the parking brake when shiftes to netural.
3. Turn off all lights.
4. Turn off ignition switch.

⚠WARNING Be sure that the shift control lever is secure in the neutral detent and the parking brake is applied (Model E) to prevent unintended movement that could result in serious injury or death.

3.5 MODEL D & E-EMERGENCY STOPPING

1. Be prepared for emergency situations such as brake failure, by driving defensively and being aware of options. Options will be dependent on the situation.
2. The best defense against emergencies created by equipment failure is adhering to the periodical maintenance schedule and performing regular equipment inspections.

3. In the event of brake failure:
- Pump the brakes to build brake pressure
- Apply the parking brake
- Turn off power switch if loss of power steering and power brakes will not cause additional problems

3.6 MODEL D & E-TOWING THE TRACTOR

Tow the tractor with the rear end picked up or with the drive shaft disconnected. Failure to do so will damage the tractor drive components.

3.7 MODEL D-ENGINE PERFORMANCE

To get the best performance and the longest life from your engine, you must ensure that maintenance operations are done as indicated in Chapter 2. If the engine works in a very dusty environment or other adverse conditions, maintenance will have to be done more frequently. Replace filter elements and lubricating oil regularly to remove corrosive materials and compounds. Ensure that adjustments and repairs are done by persons who have had the correct training. The left and right sides of the engine are as when seated in the operator's seat. Read the "Safety Precautions" in section 1 of this chapter.

BREAK-IN

Gradual new-engine break-in is not recommended because prolonged operation at light loads during the early life of the engine can cause excessive carbon build-up. As soon as the engine is put into service and coolant temperature has reached at least 140F, you can apply maximum load to the engine.
Do not operate the engine at high speeds without a load and do not overload the engine.

ADJUSTING ENGINE SPEED

Do not change the idle or maximum speed settings because this can damage the engine or transmission. Adjust speed only to the manufacturer's specifications. Engine warranty can be affected if the seals on the fuel injection pump (diesel) are broken during the warranty period by a person not approved by Northwestern Motor Co.

ALTITUDE (diesel)

If the engine is to run at an altitude above 2,000 ft., fuel delivery can be adjusted to reduce fuel consumption and smoke. NMC-Wollard, Inc. can advise as to fuel reduction necessary if details of engine application and ambient conditions are given. Changes to settings of the fuel injection pump must be made by authorized personnel.

4. SPECIFICATIONS AND CAPABILITIES

4.1 TOW TRACTOR

Type of Vehicle:
Front Wheel Drive, Front Wheel Steer, Model 40 Towing Tractor

4.2 MODEL D & E-DIMENSIONS

Length, exluding hitch..... 124” (3,142)
Width ..... 56” (1,422)
Height to top of steering wheel ..... 53” (1,340)
Height to top of cab (optional) ..... 76” (1,930)
Wheelbase..... 60” (1,532)
Ground clearance ..... 5.9” (149.9)
Turning radius (outside)..... 135”
Track width (centerline) Front ..... 43.3”
Track width (centerline) Rear..... 42.1”
Tire size (front)..... 175R13, 8 ply pneumatic
Tire size (rear) ..... 28x9-15, 12 ply pneumatic

4.3 MODEL D & E-WEIGHTS AND PERFORMANCE

GVW ..... 6,600 lbs
Front weight..... 1,600 lbs
Rear weight ..... 5,000 lbs
Battery weight (per module)-e ..... 153 lbs
Towing weight ..... 55,000 lbs
Maximum drawbar pull ..... 4,000 lbs
Gradeability 26%
Maximum governed speed-e ..... 15.2 mph

4.4 MODEL E-DRIVE SYSTEM

Battery type ..... Lithium polymer
Voltage..... 88.8 V
Capacity (per module) ..... 75 AH
Power (peak) ..... 60 HP
Power (continuous)..... 30 HP
Torque (peak) ..... 350 ft-lbs.
Motor controller..... Curtis
Motor ..... AC induction
Rear drive axle ..... Comer 080 with 19.7:1 reduction

4.5 MODEL D-DRIVE SYSTEM

Engine ..... 4-cylinder turbo charged Diesel
Make..... V2403 Kubota Tier 4i
Horsepower ..... 48.9 @2700 RPM
Transmission ..... Hydrostatic
Rear drive axle ..... Comer 080 with 15.6:1 reduction

4.6 MODEL D & E-BRAKE SYSTEM

Service.....Hydraulic
Front .....Disc
Rear Wet ..... disc
Park .....Drum
Proportional electronic regenerative-e

4.7 MODEL D & E-STEERING SYSTEM

Power Steering.....
Manual, 6 turns lock-to-lock
Steer axle (front)..... Brierton
Steering column .....Fixed position

4.8 MODEL D & E-SUSPENSION

Rear.....Leaf spring
Front .....Leaf spring

4.9 MODEL D & E-CHASSIS

Frame .....Steel plate
Assembly.....Welded

4.10 MODEL E-INSTRUMENTATION

Electronic display (weatherproof) sensor communication system CAN bus J1949 protocol
Battery life .....Integral to display
Diagnostic faults .....Integral to display
Hour meter .....LCD gauge
Hand brake engaged..... LED panel light
Battery charger status ..... LED panel light
Low brake pressure..... LED panel light

4.11 MODEL D-INSTRUMENTATION

Gages .....Fuel Level, Volts, Engine Temp, Oil Press.
Hour meter ..... digital
Brake system failure..... LED panel light
High engine temperature..... LED panel light
Low engine oil pressure ..... LED panel light
Glow Plug on ..... LED panel light

4.12 MODEL D & E-LIGHTING PACKAGE

Headlights-LED
Tail lights-LED
Brake lights-LED
Reverse/Work light-LED

4.13 MODEL E-CHARGING SYSTEM

Onboard SAE J1772 compliant 3kW charger.
SAE J1772 compliant 120/240VC charge station

4.14 SAFETY FEATURES:

Model E-Tractor drive automatically disabled while charging.
Adjustable driver's seat with seat belts
Easy access to controller and battery
Rear hitch visible from seat
Back-up alarm
E-stop switch at rear left side of tractor
Horn with center of steering wheel actuator
Model E-Drive disabled, inching enabled when operator leaves seat

4.15 AVAILABLE OPTIONS

Rear pintel hitch
Rear E-hitch-mechanical
Front E-hitch-mechanical
Passenger seat with seat belts
Bolt-on front & rear rubber bumpers
Side mirrors
Beacon
Turn signal lights-LED
Inching switch at rear left side of tractor-e
Second lithium polymer battery-e
Third lithium polymer battery-e
Upgrade to 6kW onboard SAE J1772 compliant charger-e
Stop switch at rear right side of tractor-e
Inching switches at both front corners of tractor-e
Cab (detachable)
Hydraulic assist steering with Orbitrol controlled hydraulic cylinder
Fire Extinguisher

NOTE: * Gross vehicle weight may vary by ±5% and is dependent on optional equipment installed.

5. SHIPPING

NOTICE! Tie down points are for tie down only, not for lifting.

1. Review transportation plate for pertinent shipping data.
2. Securely tie the tractor down using the tie down eyes provided.

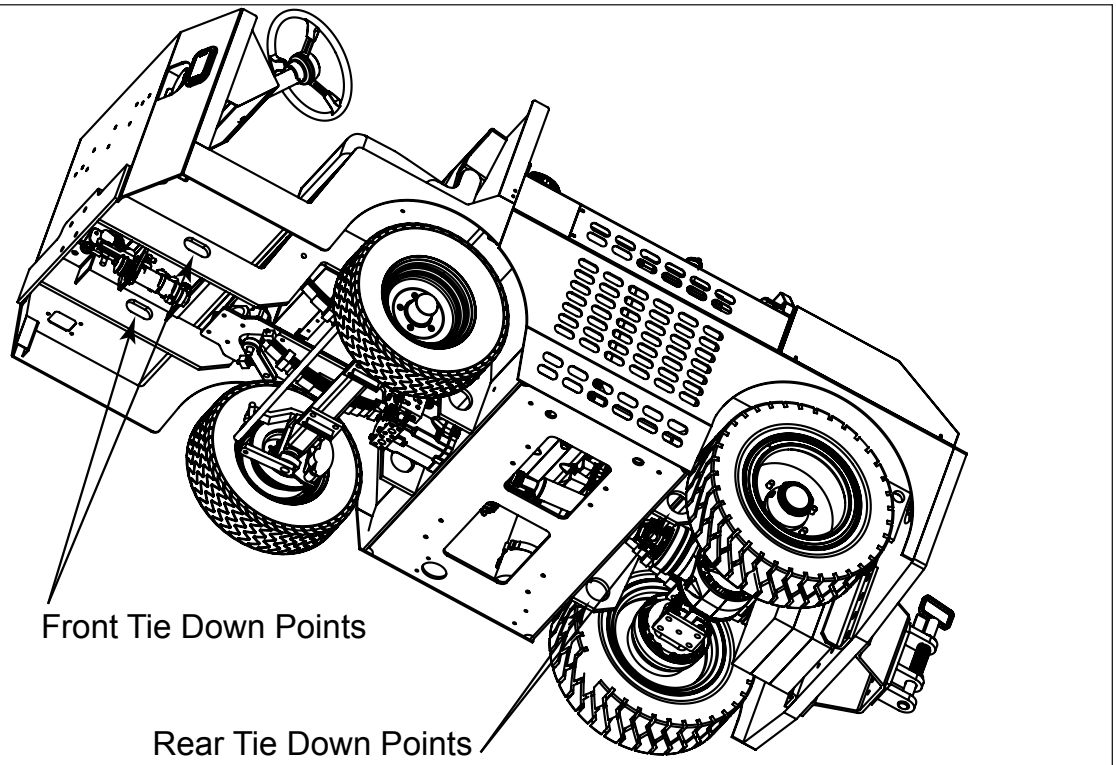


FIGURE 4 . MODEL D & E-TIE DOWN POINTS

This Page Intentionally Blank

6. STORAGE

6.1 SHORT TERM STORAGE (UP TO 1 MONTH)

The unit may be stored under cover with the wheels blocked for a period not to exceed one month. No special precautions are required.

6.2 LONG TERM STORAGE (LONGER THAN ONE MONTH)

Common sense should be applied to preparing the vehicle for storage. No special instructions are necessary except for those provided below:

Hydraulic System

1. Drain and clean hydraulic tank.
2. Refill tank with clean, new oil.
3. Run complete system through several cycles to flush new oil into all lines, cylinders and pumps.

Brake System

Special storage precautions are not required; however, to prevent rusting of brakes and water absorption by the brake fluid, the following procedures may be followed:

1. Drain master cylinder reservoir and refill with clean brake fluid to DOT-5 specification.

NOTE! DOT-5 is a moisture-repellant fluid.

2. Bleed each wheel brake until all original fluid is expelled.
3. Refill reservoir with DOT-5 fluid.
4. Coat all wheel discs and drums with a protective film of grease.

IMPORTANT: Wheel brake liners must be changed after this operation.

Hydraulic Cylinders

All cylinders should be stored with rods fully retracted. If this is not possible, apply a light coat of automotive grease to all exposed cylinder rod surfaces. Wrap rods securely with heavy-duty plastic sheeting.

Battery

The battery should be removed and kept on a trickle charge in an appropriate storage area.

Axles

Drain oil and remove access cover from rear axle. Clean inside of differential with a lint-free rag; replace and refill with clean, new oil. Run the axle for 2-5 minutes to make sure that oil is evenly distributed. Lubricate wheel bearings on both axles.

Tires

Support the vehicle on blocks to take the weight off the tires.

Chassis

Thoroughly clean all structural elements and paint or coat with protective grease, all exposed bare metal. Lubricate all rotating and sliding elements.

CHAPTER 2 MAINTENANCE

This Page Intentionally Blank

1. SERVICING

⚠WARNING Perform lockout/tagout procedures before adjusting, lubricating, cleaning or otherwise servicing. Failure to do so could result in unexpected startup and could result in injury or death.

⚠WARNING Disconnect battery before performing service to prevent accidental startup.

⚠CAUTION Keep maintenance area clean and dry. Oily and wet spots are slippery, greasy rags are a fire hazard, and wet spots are dangerous around electrical equipment.

1.1 PREVENTATIVE MAINTENANCE AND PERIODIC INSPECTION

⚠WARNING Follow the recommended maintenance program to prevent unsafe operation or accidents.

The following is a guide for conducting periodic inspections on the tractor to ensure long service life. The frequencies shown are for the unit operating in average U.S. climate. If the unit is operated in adverse climatic conditions, such as salt spray and extreme cold or dusty environments, adjust the inspection schedules to a more realistic frequency.

Servicing the tractor requires little more attention than other conventional vehicles of its type. All work should be performed in accordance with authorized standard shop practices.

1.2 BOLT TIGHTENING DATA

The following data is excerpted from SAE Report J1701, March, 1999. The complete report is available from SAE at www.sae.org. It contains detailed information about variables for torquemanagement to achieve correct fastener joint tightening. This is an advisory guide and responsibility for its application lies with the user. Individual application discretion is recommended.

INCH TIGHTENING TORQUE, FT-LB						
Bolt Size	Grade 2 Dry	Grade2 Lubed	Grade 5 Dry	Grade 5 Lubed	Grade 8 Dry	Grade 8 Lubed
0.250-28	7	5	10	8	14	11
0.250-20	6	5	9	7	12	9
0.3125-24	13	10	20	15	28	21
0.3125-18	12	9	18	14	25	19
0.375-24	23	17	35	27	50	38
0.375-16	20	15	31	24	44	33
0.4375-20	36	27	56	42	78	59
0.4375-14	32	24	50	38	70	53
0.500-20	55	42	85	64	120	90
0.500-13	49	37	76	32	107	80
0.5625-18	78	59	121	91	171	128
0.5625-12	70	53	109	82	154	115
0.625-18	110	82	170	127	240	180
0.625-11	97	73	150	113	212	159
0.750-16	192	144	297	223	420	315
0.750-10	172	129	269	201	376	282
1.000-12	--	--	704	528	995	746
1.000-8	--	--	644	483	909	681

METRIC TIGHTENING TORQUE N-m						
Bolt Size	Class 8.8 Dry	Class 8.8 Lubed	Class 9.8 Dry	Class9.8 Lubed	Class 10.9 Dry	Class 10.9 Lubed
8.0 x 1.25	26.40	19.80	28.50	21.40	36.50	27.30
10.0 x 1.50	52.20	39.20	56.60	42.40	72.20	54.20
12.0 x 1.75	91.00	68.00	99.00	74.00	126.00	94.00
14.0 x 2.00	145.00	109.00	157.00	118.00	200.00	150.00
16.0 x 2.00	226.00	170.00	245.00	184.00	313.00	235.00
20.0 x 2.50	441.00	331.00	478.00	358.00	610.00	458.00
24.0 x 3.00	762.00	572.00	826.00	620.00	1055.00	791.00
30.0 x 3.50	1515.00	1136.00	1641.00	1231.00	2095.00	1572.00
36.0 x 4.00	2647.00	1985.00	2868.00	2151.00	3662.00	2746.00

37° TUBE FITTINGS & PIPE FITTINGS						
Dash #	37° Swivel Nut	37° JIC Flats from Finger Tight	O-Ring Lock Nut Ft-Lbs.	Pipe Dia. Inch)	NPT Ft. Lbs.	NPT Turns from Finger Tight
-04	10	2	8	1/4	25	2 1/2
-06	20	1 1/4	13	3/8	40	2 1/2
-08	40	1	21	1/2	54	2 1/2
-10	60	1	33	--	--	2 1/2
-12	80	1	48	3/4	78	2 1/2
-16	110	1	63	1	112	2 1/2
-20	130	1	--	1 1/4	154	2 1/2
-24	160	1	--	1 1/2	211	2 1/2
-32	250	1	--	2	300	2 1/2

Torque Conversion: Ft-Lbs = 0.7376xN-m N-m = 1.356xFt-Lbs

NOTE: Do not use these values if a different torque value is given for a specific procedure.

1.3 FLUIDS, CAPACITIES, AMBIENT TEMP. RANGES

The tow tractor can be operated over a wide range of ambient temperatures if the fluid recommendations and use of special equipment procedures described in the following sections are used.

MODEL D-ENGINE REQUIREMENTS			
Item	**Ambient Temp.**	**Specification**	**Capacity**
Engine Coolant (Kubota)	All	50/50 ethylene glycol antifreeze/water mixture ASTM4985 GM6038M specs.	
Engine Fuel (Kubota)	All	Refer to Kubota engne manual	18.0 gal [68 L]
Engine Oil (Kubota)	All	API CF or higher, SAE 10W-30	10 qts [9.5 L]

MODEL D & E-HYDRAULIC REQUIREMENTS			
Item	**Ambient temp**	**Specification**	**Capacity**
Hydrostatic/ hydraulic	All	MOBILE DTE-13 see 1-2-2	

MODEL D & E-AXLE REQUIREMENTS			
Item	**Ambient temp**	**Specification**	**Capacity**
Rear Axle	All	SAE 80W-90 Gearlube (differential and hubs) add 4 oz. of friction modifier (Ford#C8AZ19546A)	8.3 qts [7.9 L]

MODEL D & E-BRAKE REQUIREMENTS			
Item	**Ambient temp**	**Specification**	**Capacity**
Master Cylinder	All	Kendall Hyken® Glacial Blu Hydraulic Fluid or equal	0.5 qt. [0.5 L]

1.4 PERIODIC INSPECTION AND SERVICE

LUBRICATION AND MAINTENANCE SERVICE INTERVAL CHART							
Item	**Daily**	**50 hrs**	**250 hrs**	**500 hrs**	**1000 hrs**	**2000 hrs**	**Fig./Par.**
Check Engine Oil & Coolant Level	●						
Check Air Cleaner Dust Valve		●					
Air Filter		●			◆		
Pre-Operation Inspection		●					
Hydraulic Oil Level and Filter (in tank)		●					
Inspect Engine, Hydraulic system, mechanical drive train.		●					
Check wheel lug nut torque and tighten as required.	After 8 hours	●					
Inspect Wheels for dented rims and replace as required.		●					
Inspect Tires for cuts, bulges, or excessive wear. Replace as required. Check Pressure and inflate as required.		●					

- ● = Check and Replenish
- ◆ = Replace
- ■ = Consult Manufacturer or Certified Dealer

LUBRICATION AND MAINTENANCE SERVICE INTERVAL CHART							
Item	**Daily**	**50 hrs**	**250 hrs**	**500 hrs**	**1000 hrs**	**2000 hrs**	**Fig./Par.**
Fan and Alternator Belt	●					◆	
Check for Proper Park Brake Adjustment	●						
Fuel Filter				◆			
Battery (check electrolyte level)			●	●			
Change Engine Oil and Replace Filter (every 250 hours)		◆ initial	◆	◆			
Axles, oil			● ◆ initial		◆		
Clean Crankcase Vent Tube				●			
Check Air Intake Hoses, Connections & System		●					
Check Coolant Level	●						
Coolant Solution Analysis-Add SCAs as needed				●		◆	
Hydraulic Oil and Filter (on Suction line)				◆			
Check and Adjust Engine Valve Clearance						■	

● = Check and Replenish
◆ = Replace
■ = Consult Manufacturer or Certified Dealer

1.5 MODEL D-FUEL

The quality of the fuel and lubricants used in an engine affect its service life. For best performance and long service, use only fresh, clean, and uncontaminated grades. Obtain your fuel, lubricating oils and greases, hydraulic system fluids, and engine coolant from a reputable supplier. Never mix fuel, oils, coolant, or other such fluids of different specifications from different manufacturers.

1.5.1 Fuel Specifications

See Kubota engine manual

NOTICE! Always use the correct diesel fuel grade according to weather and altitude. Using warm weather fuel during cold weather will make the engine hard to start. Using cold weather fuel during warm weather may cause the engine to run erratically.

1.5.2 Filling The Fuel Tank

Fill the tank at the end of each day's operation to prevent condensation damage and moisture contamination.

IMPORTANT: The fuel tank should be vented through the filler cap. If a new filler cap is required, replace it with a vented cap.

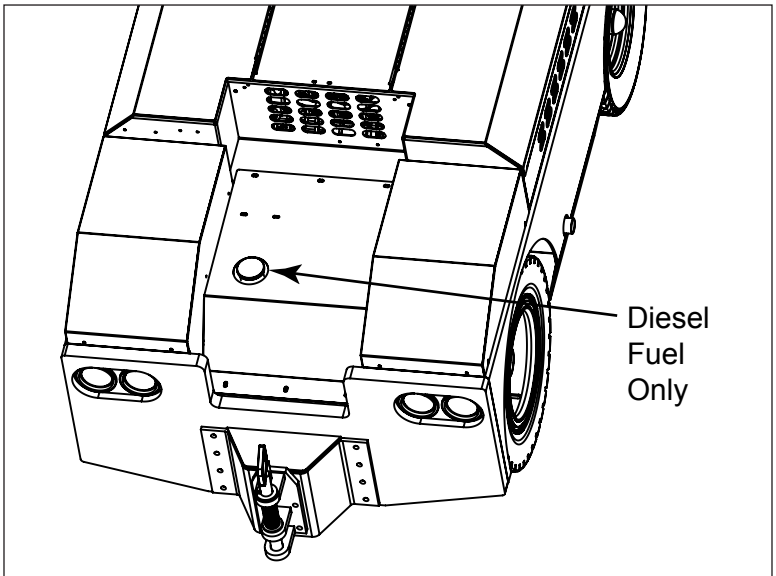


FIGURE 1. FUEL CAP

1.6 MODEL D-BREAK-IN SERVICE

During the first 50 hours of operation:

- To prolong engine life, idle engine for a few minutes at 800-1200 RPM for a few minutes to circulate warm oil, then increase speed to half throttle until engine water reaches 100F.
- Operate engine long enough to bring oil and coolant temperature to normal operating temperature.
- Avoid prolonged periods of idling or sustained maximum load operation.
- Monitor oil pressure and coolant temperature at the gauges.

After the first hour and after the first 8 hours of operation:

- Tighten wheel lug nuts, see 1.13

After first 50 hours of operation:

- Change engine oil and filter.
- Change in-line filter between reservoir and hydraulic pump, refill reservoir with new, filtered fluid.

After first 150 hours of operation:

- Change in-line filter between reservoir and hydraulic pump, refill reservoir with new, filtered fluid.
- OBSERVE SERVICE INTERVALS
- Use the engine hour meter to keep track of when preventive maintenance is required.

After first 250 hours of operation or monthly, whichever occurs first:

- Tighten wheel lug nuts, see 1.13

NOTICE! Recommended service intervals are for normal operating conditions. Service MORE OFTEN if machine is operating under sandy, dusty, or wet conditions.

Neglecting maintenance can result in failures or permanent damage to loader components and may void the warranty. For detailed engine instructions, refer to the Engine Manufacturer's Manual.

1.7 MODEL D-DAILY MAINTENANCE

Engine Oil

- Check the oil level.
- Check that the oil filler breather cap is clean.

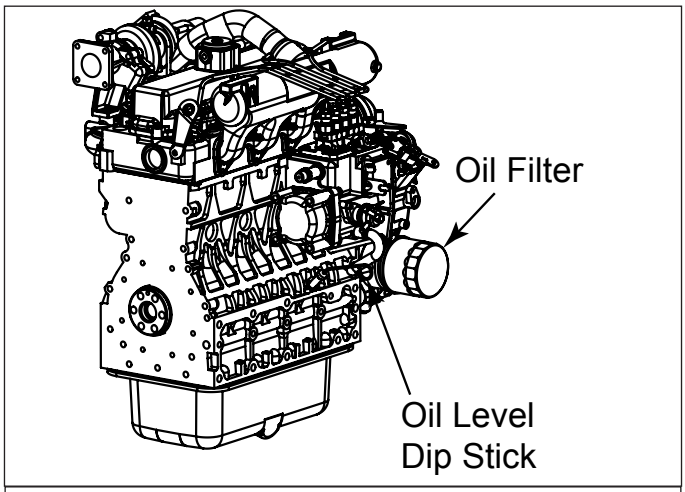


FIGURE 2. OIL FILTER & OIL LEVEL

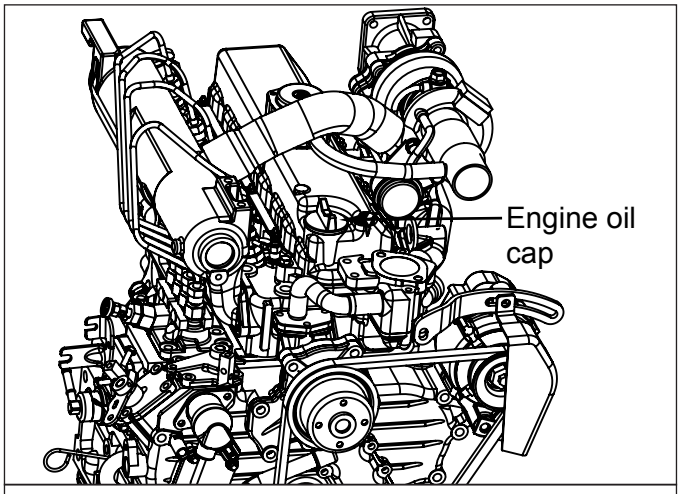


FIGURE 3. ENGINE OIL FILL CAP

1.8 MODEL D-COOLANT LEVEL

After the engine has cooled, remove the radiator cap and check that the coolant reaches the supply port.

Check the level in the coolant recovery tank. Coolant should always be above the **NORMAL** level.

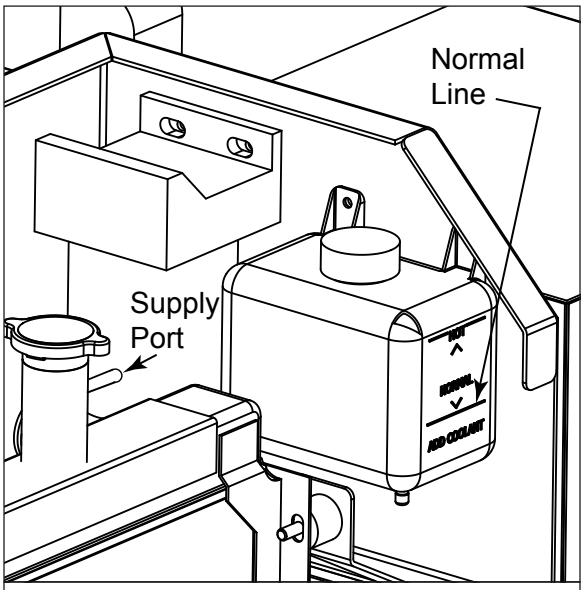


FIGURE 4. ENG. COOLANT LEVEL

1.9 MODEL D-AIR CLEANER

1. Every 250 hours, remove the filter element, and blow clean with compressed air directed from the inner surface of the element.
2. Every 500 Hours replace both the filter element.

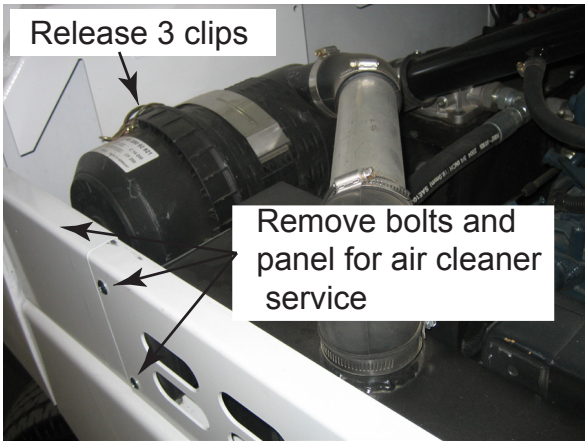


FIGURE 5. ENG. AIR FILTER

1.10 MODEL D-FAN AND ALTERNATOR BELT

Adjust the belt tension by loosening the alternator bolts and prying between the engine and alternator to tighten the belt. Proper belt tension is achieved when the middle of the belt between the crank shaft and alternator can be deflected 0.25-0.375 in. [7-9]mm.

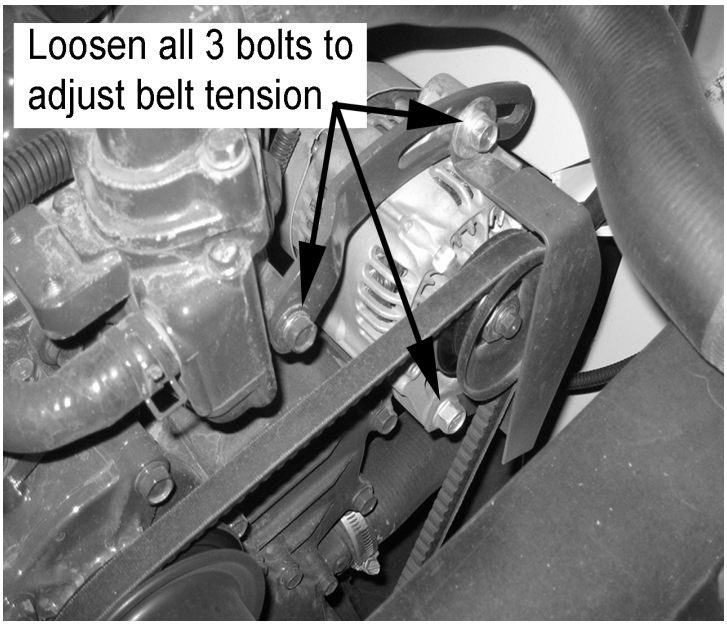


FIGURE 6. ENGINE. ALTERNATOR BELT

1.11 MODEL D-HYDRAULIC SYSTEM

1.11.1 Hydraulic Fluid Recommendations

A reputable supplier can help you make the best selection of hydraulic fluid for use in the hydrostatic drive and hydraulic cylinders. See 1-2-2.4

NOTICE! When adding oil to the hydraulic system, always pass oil through a 10-micron filter.

Hydraulic Fluid

- Check the hydraulic fluid level. The hydraulic tank has a sight gauge on the front of the tank. The oil level should fill the gauge.
- Check the hydraulic filter (in tank). Over 18 PSI indicates filter should be changed.
- Check all fittings for leaks.

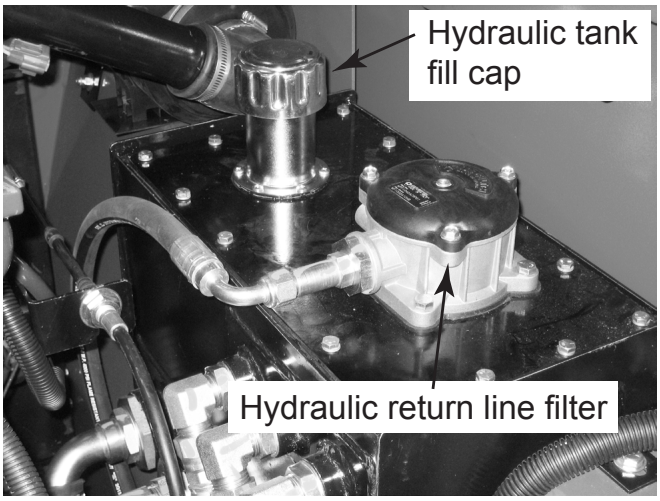


FIGURE 7. HYD. TANK FILTER AND CAP

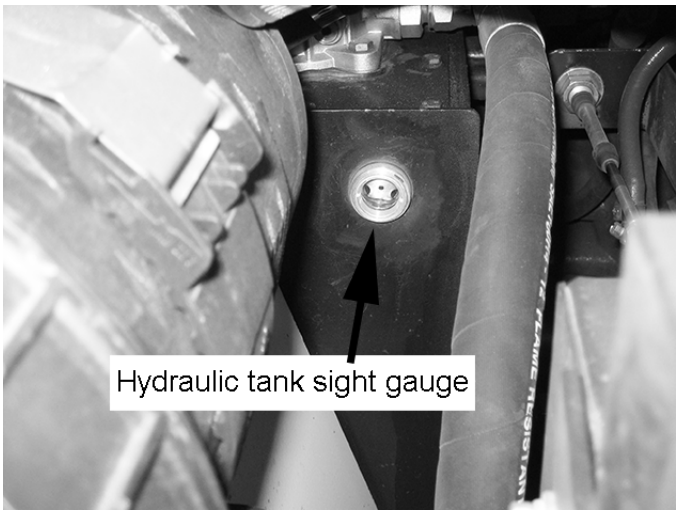


FIGURE 8. HYD. TANK SIGHT GAUGE

1.11.2 Hydraulic Filters

Replacing hydraulic in tank return filter:
This filter is located in the hydraulic tank. See figure 7.

1. Turn off engine and remove key.
2. Allow oil to cool down before removing filter.
3. Clean the top of hydraulic tank and filter head and filter mount thoroughly. Allowing dirt in hydraulic system will cause damage to the system.
4. Loosen and remove the four nuts on the top of filter head.

Replacing hydraulic in-tank filter strainer:
This filter is located in the hydraulic tank. See figure 9.

1. Turn off engine and remove key.
2. Allow oil to cool down.
3. Clean outside of tank thoroughly. Allowing dirt in hydraulic system will cause damage to the system.
4. Drain tank
5. Remove hose and unscrew strainer
6. Apply a thin layer of hydraulic oil to new strainer seal and screw back into tank and tighten.
7. Install hose and fill tank.
8. Start engine and check for leaks.
9. Check hydraulic tank level; add oil if necessary.

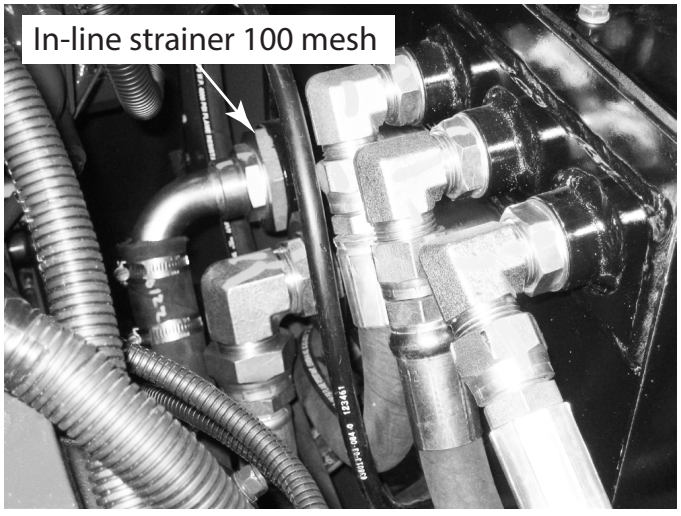


FIGURE 9. HYD. IN-TANK STRAINER

1.12 MODEL D & E- AXLE MAINTENANCE

1. Check the oil level every 250 hrs at the oil level check plug.
2. Drain and change the oil every 500 hrs.
3. See 1.3 for specification and capacity.

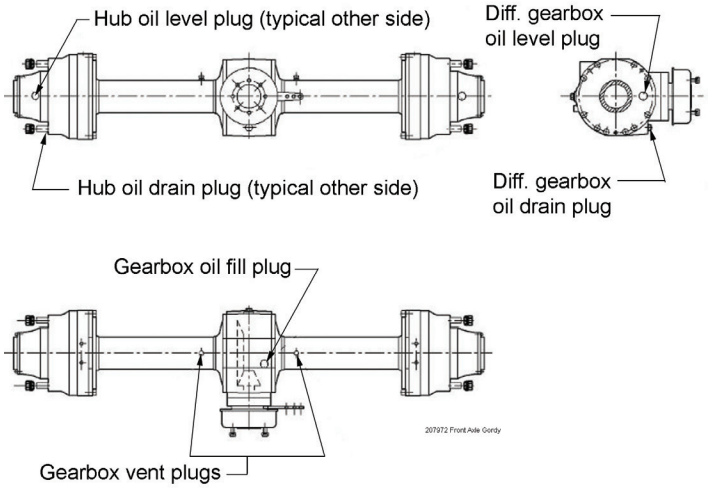


FIGURE 10. REAR AXLE OIL FILL AND LEVEL PLUGS

1.13 MODEL D & E- WHEEL LUG NUT TORQUE & INFLATION PRESS.

FIGURE 11. REAR AXLE WHEEL HUB & LUG NUTS

⚠ CAUTION After initially mounting wheel and tire assembly, recheck lug nut torque after the first hour of operation and after the first 8 hours of operation. After this, check monthly or every 250 hours, whichever comes first. Do not lube wheel studs as it will result in inaccurate tightening torque. Failure to follow these procedures could result in wheel mounting failure and loss of vehicle control.

Which tire	Stud Size	Tightening Torque(dry)	Tire Inflation Pressure
Front	1/2-20	100 ft-lbs	50 PSI
Rear	M18x1.5	200 ft-lbs	110 PSI

1.14 MODEL D & E-GENERAL LUBRICATION

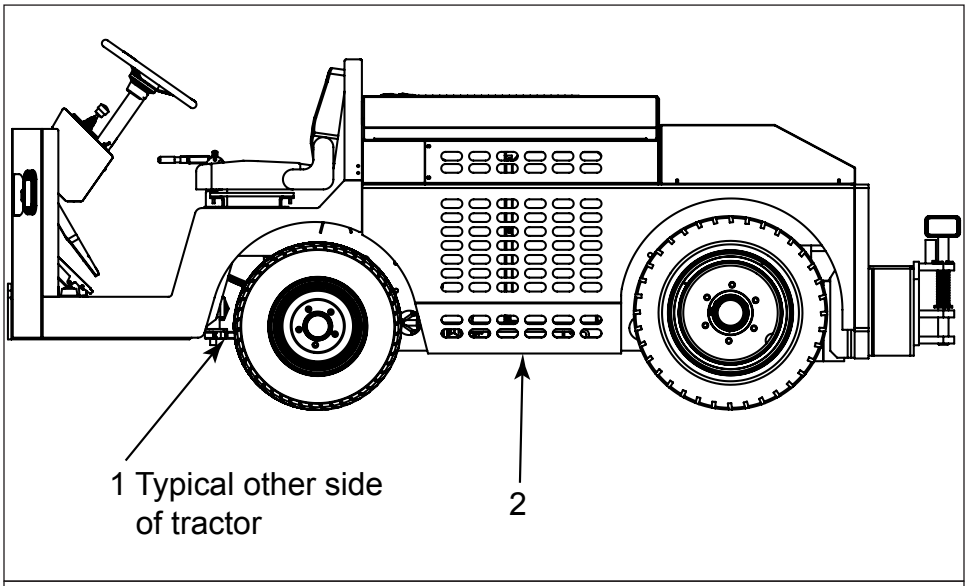


FIGURE 12. GREASE POINTS

1.14.1 Lubricate

Grease all front axle king pins, tie rod ends, drive shaft U-joint and slip joint.

No	Item	Specification & Quantity	Frequency
1	Pivot pins and rod ends	Lithium NLG1 #2EP. Purge old grease.	100 hrs
2	Drive Shaft, U-joint and slip joint	Lithium NLG1 #2EP. 3 pumps.	50 hrs.

This Page Intentionally Blank

1.15 MODEL D-BATTERY CARE, INSPECTION AND MAINTENANCE

The battery is located under the access panel on the right side of the engine compartment.

Battery acid can cause severe corrosive burns. Always wear eye protection and proper safety equipment.

To minimize risk of fire or explosion, follow these battery servicing safety precautions:

- Sulfuric battery acid is poisonous. Avoid breathing battery fumes.
- Battery acid is strong enough to burn skin and cause blindness if splashed into the eyes. Protect eyes and skin from contact. In the event of contact with battery acid, immediately rinse in large amounts of water. Obtain medical care if the eyes are burned.
- Battery gas can explode. Keep sparks and flame away from battery.
- Never check battery charge by placing a metal object across the battery posts. A spark will occur and cause possible explosion. Use a voltmeter or hydrometer.

1.15.1 Battery General Maintenance

- Keep the top of battery clean and dry.
- Keep electrolyte level above plates.
- Add distilled water only. Avoid overfilling.
- Keep metal objects off the top of the battery.
- During charging, keep engine compartment open for increased ventilation.
- During charging, keep flame and sparks away from the battery. The flame may ignite battery gases.
- Keep battery caps in place at all times. Exceptions: adding water, charging, or taking hydrometer readings.
- Keep battery electrolyte away from eyes, skin, clothing, or any materials it might damage.
- Keep battery in charged condition at all times.
- Wear eye protection and rubber gloves while working around battery.

FIGURE 13. BATTERY

1. Check battery cables for corrosion, damage, or loose connections to the battery terminals.
2. Use a baking soda and water solution to clean the battery top and terminals. Never let solution enter battery. Use battery terminal post cleaner to clean up battery. After cleaning the battery, rinse and dry top of battery, apply a thin coat of grease to cable ends.
3. When tractor is going to sit for an extended period of time, the battery should be disconnected.

1.15.2 Checking Battery Charge

Checking the specific gravity of the electrolyte in the battery is a good method for determining approximate state of charge and condition.

To test specific gravity, use a good-quality hydrometer.

If the electrolyte level is too low to draw a sufficient amount into the hydrometer, add water and either charge battery or run engine for 30 minutes or so to thoroughly mix electrolyte.

If the battery was just charged, crank the engine for several seconds to reduce the “surface charge.”

Draw electrolyte into hydrometer, then squirt it back several times to bring float to electrolyte temperature. Draw in enough to suspend float, and allow bubbles to rise to surface before taking your reading. Hold hydrometer at eye level and take reading.

Correct reading by subtracting .004 for each 10F BELOW 80F, and add .004 for each 10F ABOVE 80F

A Typical fully-charged battery should have a specific gravity (SG) of 1.280-1.260. A
50% charge is indicated by a SG of 1.180-1.170. A Typical discharged battery will have a SG of 1.080-1.070.

A difference of more than .025 between cells means the battery is starting to fail due to internal shorts, or normal deterioration.

If charging does not bring SG to a satisfactory level, replace the battery. See specifications table for original battery rating.

If a good battery repeatedly becomes discharged during normal operation, there may be a problem with the regulator or alternator.

1.15.3 Charging The Battery

⚠WARNING To minimize risk of fire or explosion when charging a battery:

- Keep sparks and flame away from battery to avoid battery gas explosion.
- If charging the battery while installed in the vehicle, disconnect the negative (black) battery cable and then the positive (red) cable before connecting the charger.

- With the charger unplugged and the switch OFF, connect the positive (red) charger cable to the positive (+) battery post figure 14 and then the negative (black) charger cable to engine block figure 15.

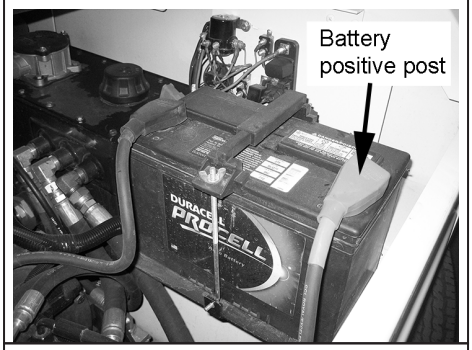


FIGURE 14. + POST ON BAT.

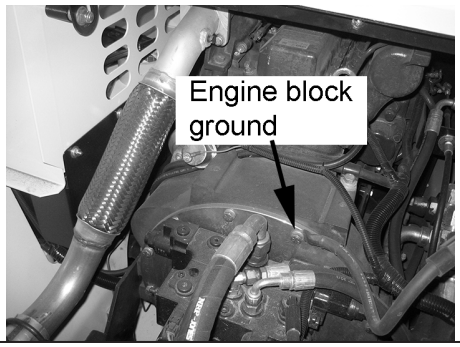


FIGURE 15. ENG. BLOCK GROUND

- Set the charger for the correct voltage and charging rate. Then plug the charger in and turn the switch ON.
-

When charging is completed, turn the charger OFF, unplug it and then disconnect negative and then positive cables. Reconnect the positive and then the negative battery cables.

Slow Charging

Slow charging passes a relatively small amount (5-7 amps) of current through a battery for a long period (14-16 hours or longer).
Slow charging is preferred to fast charging if time is available, but a sound battery will not be damaged by proper fast charging. Older batteries respond better to slow charging.
Before charging, clean and fill the battery to recommended level. If battery is to remain in the machine, remove cables to prevent damage to machine electronics.
Remove battery from charger when charged because over charging is harmful.
When installing the battery, be sure you connect the ground strap to the negative battery post.

Jump Starting The Tractor

⚠WARNING To minimize risk of fire/explosion when jump starting a vehicle:

- Keep sparks and flame away from battery to avoid battery gas explosion.
- Do not allow the booster and dead vehicles to touch. Set park brakes and turn both vehicle ignitions OFF.
- Connect one end of the positive (red) booster cable to the positive (+) battery post figure 14 and then the other end of this red cable to the positive + terminal of the booster vehicle battery.
- Connect end of the negative (black) booster cable to the negative (-) terminal of booster vehicle battery and the other end of this black cable to a unpainted bolt or bracket on dead vehicle (good ground) located as far as possible from the dead battery to minimize the possibility of igniting any hydrogen gas.
- Start the booster vehicle and let it idle for several minutes, then start the dead vehicle. If the vehicle fails to start in a normal manner, discontinue jump starting and service the vehicle for other problems.
- Once the dead vehicle is running, disconnect the booster cables in the reverse order they were installed.
- Never allow booster cable ends to touch while connected to a battery.

Cold weather reduces battery efficiency. For example, at 32F, battery capacity is reduced to 65%, and at 0F, capacity is reduced to 40%.

A 12-volt booster battery can be connected in parallel with battery on the loader to in cold weather starting.

Heavy duty jumper cables will supply significantly more current than inexpensive cables.

To jump start a machine, make sure the two vehicles are not touching each other.

Wear protective glasses, and do not lean over battery when making connections.

Loosen vent caps on battery.

In very cold weather, check for frozen electrolyte or no visible electrolyte. If either condition exists, warm the battery until it reaches a temperature of at least 40F before attaching booster. This will prevent battery rupture or explosion.

Charging vehicle should not be running.

Because a spark is caused when attaching the clamp, it is dangerous to make the connection at the discharged battery.

Start vehicle having the good battery, then crank starter of disabled vehicle. Do not over-crank.

Remove jumper cables in the reverse order.

A Sound Battery Is A Must

A worn out or badly sulfated battery will produce numerous problems that cannot be corrected until the battery is replaced.

Always check battery condition and connections before condemning other parts of the system. A fully charged battery is a must for conducting accurate systems tests.

1.16 MODEL D & E-PARKING BRAKE

1.16.1 Parking Brake Test

In high gear and full throttle, you should not be able to move the tractor. If it does, the brake needs adjustment or service.

1.16.2Model D-Adjusting The Brake Handle

The brake can be adjusted by turning the threaded rod between the actuator and drum brake lever on the rear axle,

1.16.3 Model E-Adjusting The Brake Handle

The brake can be adjusted by turning the end of the brake lever handle. Adjust the brake so that as you pull the handle you begin to feel resistance 1/3 of the way to handle full-up position.

1.17 MODEL E-FAULT CODES

The instrument panel display unit will display fault codes when system or operating errors are encountered. If the code begins with a “P” it is an operating procedure error, operating controls in the improper sequence, etc. Correcting the error will reset the system. If the code begins with a “F” it is a fault in the equipment requiring service or maintenance. Descriptions for these codes are listed in Chapter 5

1.18 MODEL E-ELECTRIC MOTOR MAINTENANCE

Refer to Manufacturers Recommendations and Procedures in Chapter 5, for bearings, brushes/commutator, insulation; inspections and repair.

2. TROUBLE SHOOTING

⚠WARNING Perform lockout/tagout procedures before adjusting, lubricating, cleaning or otherwise servicing. Failure to do so could result in unexpected startup and could cause serious injury or death.

⚠WARNING To minimize risk of serious injury or death, follow these hydraulic servicing precautions:

- Follow all necessary lockout/tagout procedures.
- Hydraulic systems have residual, stored pressure. Relieve all pressure from the hydraulic system before servicing.
- Allow fluid to cool before working on system.
- Hydraulic fluid escaping under pressure can have sufficient force to enter eyes and penetrate skin. If fluid gets in eyes or skin, flush with large quantities of water and seek medical attention.
- Wear eye protection when servicing hydraulic components or systems.
- Keep all hoses and connections in good serviceable condition. Check before start-up and periodically during operation.
- Do not investigate for leaks with hands. Use a large piece of cardboard.

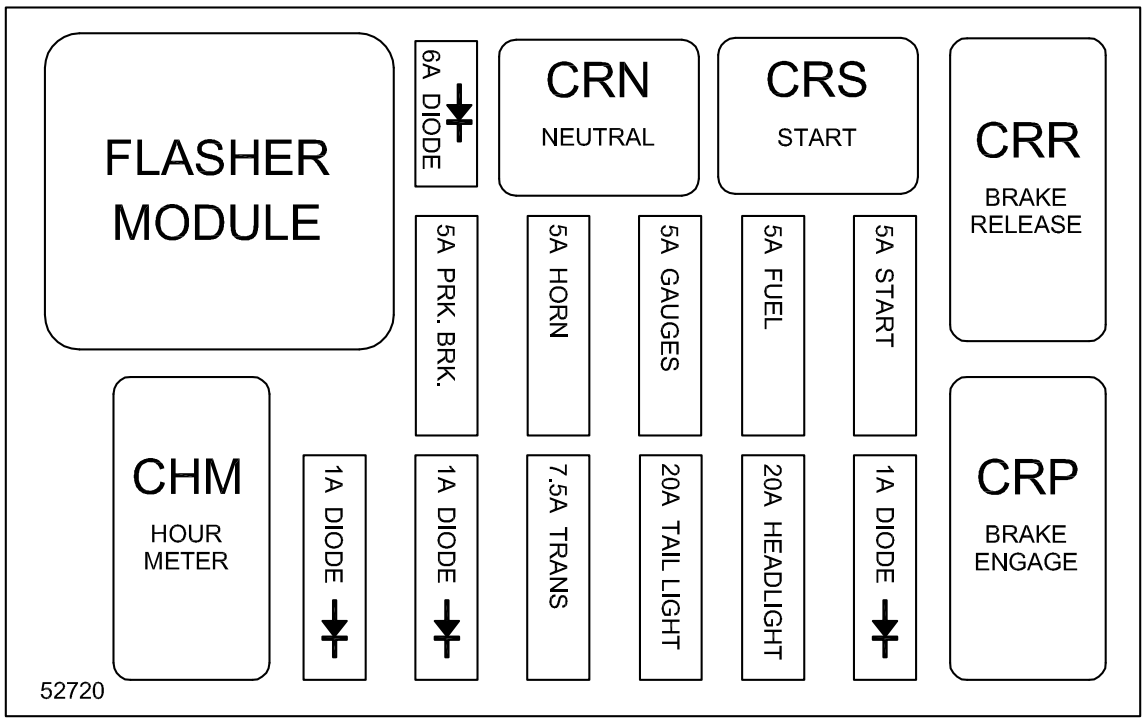


FIGURE 1. DECAL FUSES AND RELAYS M40D

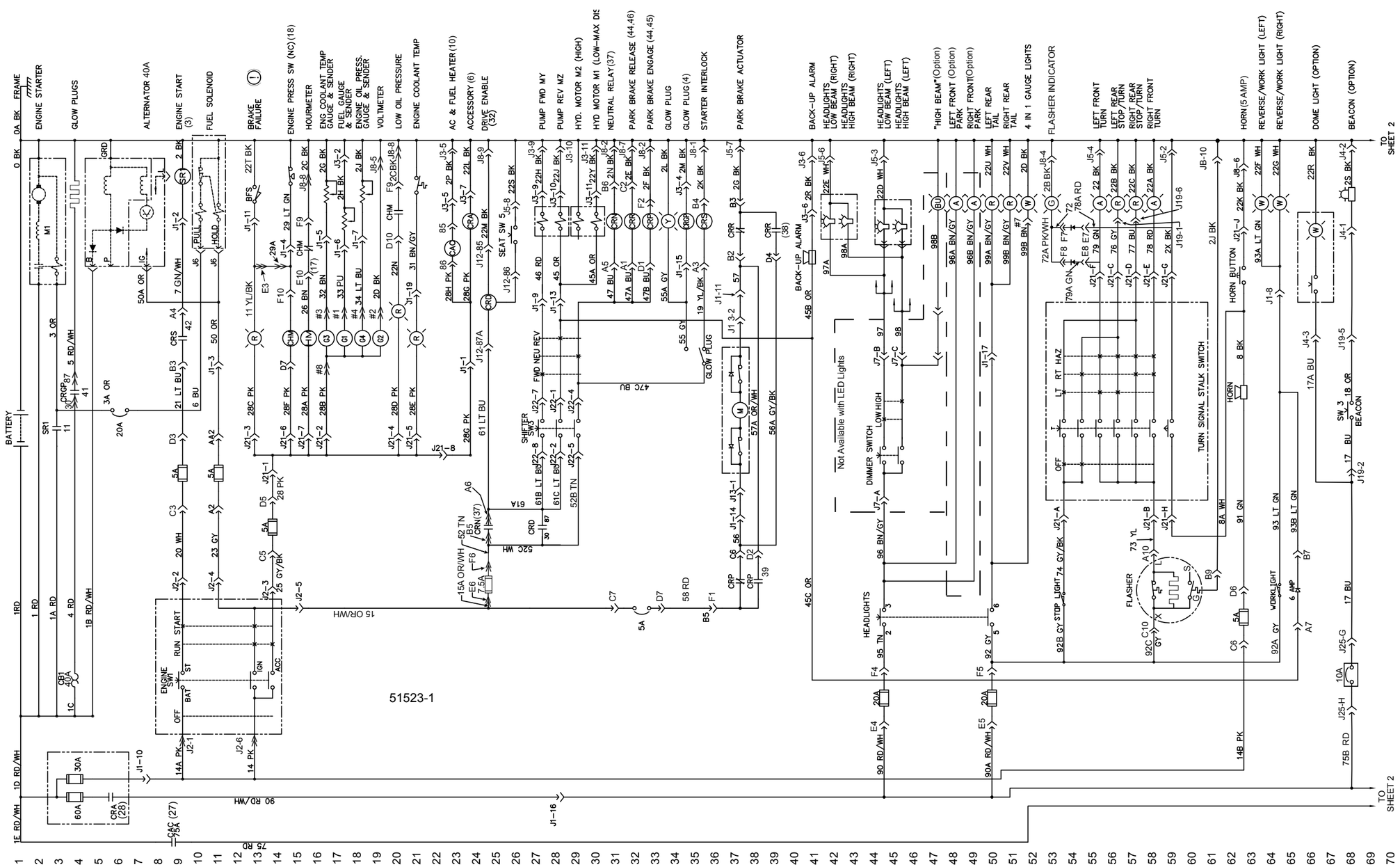


FIGURE 2. SCHEMATIC, WIRING , M40 (1 OF 2)

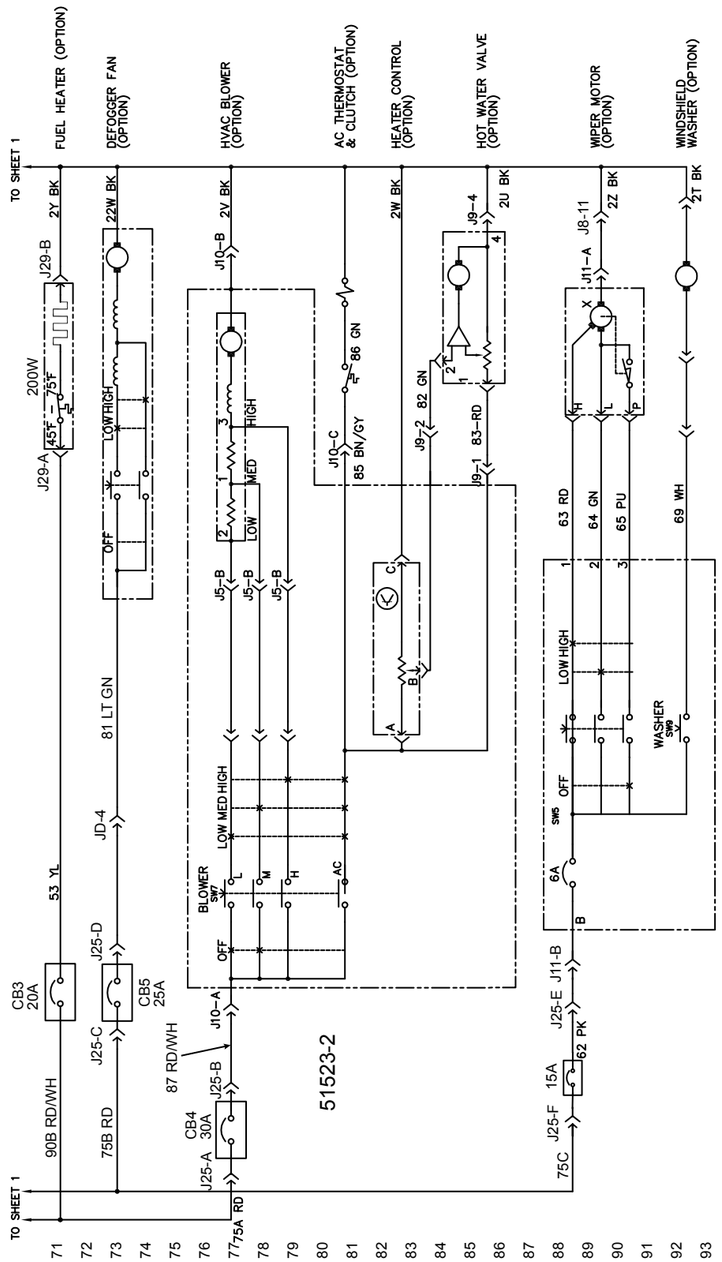


FIGURE 2. SCHEMATIC, WIRING, M40D (2 OF 2)

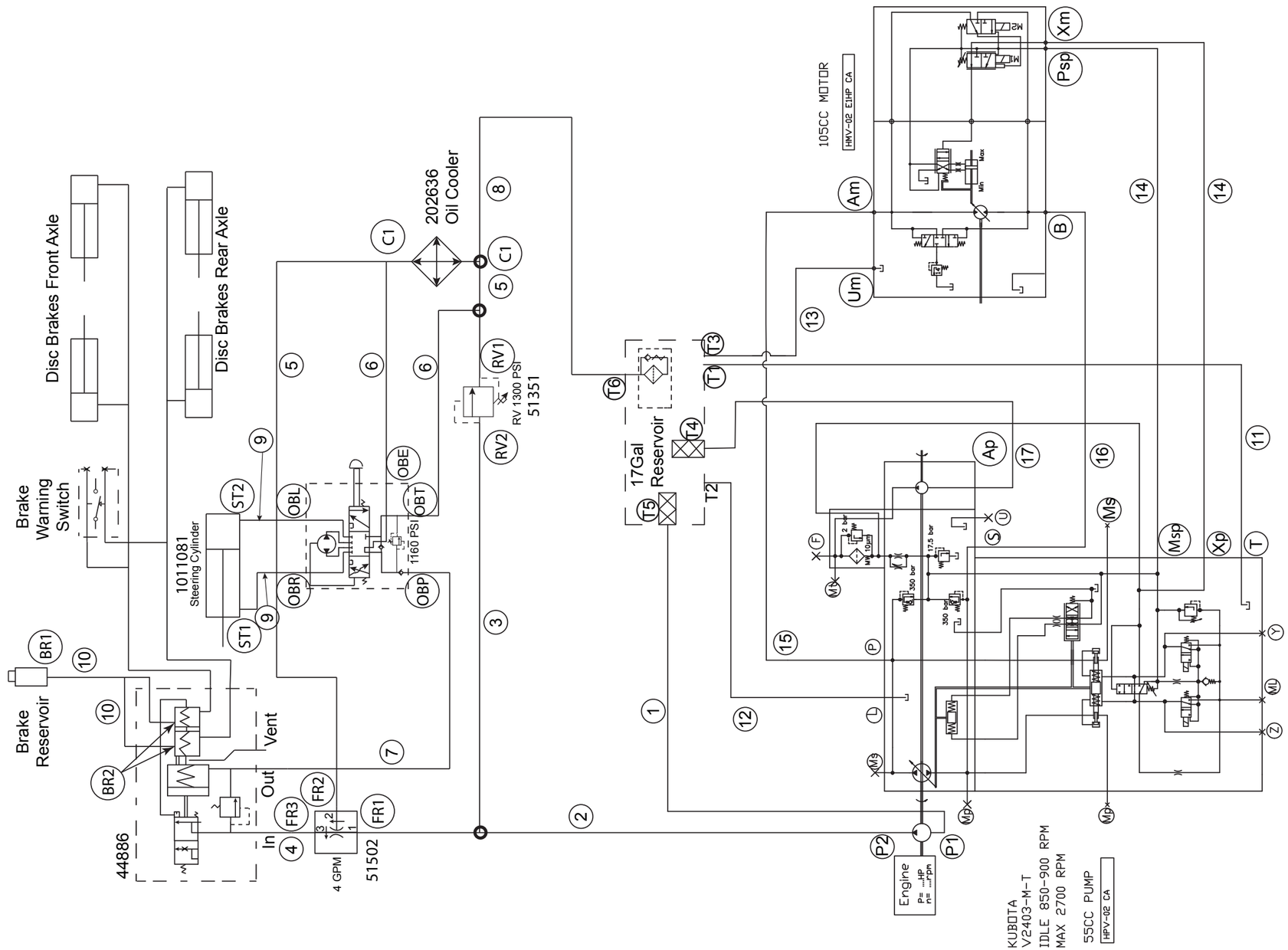


FIGURE 3. SCHEMATIC, HYDRAULIC, M40D

This Page Intentionally Blank

3. REMOVAL AND INSTALLATION

⚠WARNING Perform lockout/tagout procedures before adjusting, lubricating, cleaning or otherwise servicing. Failure to do so could result in unexpected startup and could cause serious injury or death.

3.1 GENERAL

Removal and installation of components and assemblies from the unit are generally not difficult and no special tools are required. Instructions given here are for those components and assemblies that may pose the greater challenge. All fastenings are standard SAE or metric. Some components will require suitable hoists or slings for removal and installation.

The following procedures are given only as a guide and do not in any way restrict technicians from developing their own procedures. No procedures are given where the type of work required is obvious. Assembly is normally done in reverse order of disassembly unless a special procedure is required.

⚠ DANGER To prevent the conveyor bed from falling on you, take the following precautions:
Store conveyor front on safety stand before removing any plumbing from the front cylinder or before performing any work under the bed. See figure 2-1-. Block the rear scissor before removing any plumbing from the rear cylinder or before performing any work under the bed.

3.2 MODELE--COMMISSION UNIT

On receipt of the unit, the following pre-operational checks and procedures should be followed:

1. Check specific gravity in all cells. This should read in the range of 1.225 - 1.300, and all cells should read approximately the same gravity to within + 0.010. If any of these conditions are not satisfactory, please contact NMC-Wollard, Inc. or the battery manufacturer's representative to determine what action should be taken.
2. Check water level. Add water (see NOTE) as required to bring water in all cells to level 1/8 inch above splash plate.

NOTICE! Never charge battery unless water level is at least 1/8 inch above splash plate.

3. After cells are fully charged and gassing (steps D thru G), complete the filling process by bringing level to not more than 3/8 inch below bottom of filler tubes. Water level should never be allowed to drop below perforated splash plate.

NOTICE! Distilled (or deionized) water must be used for maximum operating life and efficiency of the battery.

4. Wash the top of the battery with a mild baking soda solution (1 lb. per gallon water) to neutralize any acid film, then rinse all traces of solution with clear water.

NOTICE! Do not permit any solution to enter the battery cells i.e., ensure that all caps are securely closed.

5. Connect battery charger following charger manufacturer's instructions. The charger is supplied by the using organization, therefore, no attempt is made herein to give specific battery charging procedures.

NOTICE! The charging station chosen should be in a well ventilated location protected from all weather.

6. Set charger controls per manufacturer's instruction. Open vehicle charging receptacle door and plug charging lead into receptacle provided. Lock in place.
7. The charger will commence charging at an initially high amperage rate (in the 80-ampere range). As the battery approaches full charge, this will taper down to a lower finishing rate (approximately 20 amperes), and will continue at this rate until terminated by the timer. An equalizing charge (2-1 paragraph 1.A) will allow the charging to continue for a few extra hours to assure that all cells are fully charged.
8. On completion of charging, check specific gravity in all cells. Refer to battery manufacturer's recommendation. When manufacturer's standards are met, the battery is ready for service.

3.3 MODEL E-ELECTRIC POWER UNIT

3.3.1 Removal

1. Chock wheels. Turn power switch on.
2. Raise rear conveyor bed hydraulically to the maximum height.
3. Raise front of conveyor bed hydraulically so the bed is horizontal.
4. Turn off power switch.
5. Remove conveyor bed as described on page 19.
6. Disconnect two drive shaft U-bolts and remove drive shaft.
7. Disconnect shift lever cable and move clear of power unit frame. Mark for identification if necessary.
8. Disconnect throttle cable and move clear of power unit frame. Mark for identification if necessary.
9. Unplug wire harnesses. Disconnect and mark power cables for battery, hydraulic unit motor, and conveyor bed motor.
10. Use suitable sling to remove battery. (weight approx. 3300 lbs.)
11. Remove two bolts and nuts that secure power unit frame to vehicle chassis.

12. Connect a low profile sling or rigid frame to the four lifting points on power unit frame. Lift out power unit frame assembly from vehicle chassis with sling using a forklift truck or similar boom lifting device.

3.3.2 Installation

1. Connect a low profile sling or rigid frame to the four lifting points on the power unit frame.
2. CAREFULLY lift power unit frame assembly back into vehicle chassis with sling, using a forklift truck or similar boom lifting device.
3. Align the two power unit frame tie-down points with mating holes in vehicle chassis. Reinstall the two bolts and nuts that secure power unit frame to vehicle chassis, and tighten.
4. Replace battery.
5. Perform the previous steps 9-6, the reverse of installation.
6. Replace conveyor bed as described on page 19.
7. Connect battery. Check all fluid levels.
8. Turn power switch on and check for proper operation.

This Page Intentionally Blank

4. REPAIRS

⚠WARNING Perform lockout/tagout procedures before adjusting, lubricating, cleaning or otherwise servicing. Failure to do so could result in unexpected startup and could cause serious injury or death.

Repairs should consist of part replacement or replacement of the entire assembly. Repair of electrical and hydraulic components should be restricted to the procedures outlined in this section. Refer to Chapter 4 for parts identification and location.

⚠CAUTION Before repairing the electrical system, disconnect the battery connector to prevent possible injury due to electrical shock or accidental startup.

All structural repair is performed at the discretion of the user's maintenance shop and should follow prevailing practices for that shop. The instructions below are offered only to advise the user of NMC-Wollard Inc. recommended procedures.

Metal Cracks
Small cracks or fractures in non-critical areas may be stop-drilled, welded or patched. The user should also determine if the component is beyond economical repair and should be replaced.

Welding
Welding repair to major structural members, assemblies of subassemblies, which effect their structural integrity, should not be attempted without first contacting the engineering department at NMC-Wollard, Inc. for instructions.

4.1 AXLE BEARINGS, BRAKE ASSY, STEERING UNIT, DIFFERENTIAL

Refer to Chapter 5 and the illustrated parts breakdowns in Chapter 4.

This Page Intentionally Blank

CHAPTER 3 OVERHAUL/MAJOR REPAIR TABLE OF CONTENTS

This Page Intentionally Blank

1 GENERAL REPAIRS

⚠WARNING Perform lockout/tagout procedures before adjusting, lubricating, cleaning or otherwise servicing. Failure to do so could result in unexpected startup and could cause serious injury or death.

⚠WARNING To minimize risk of brake system failure and possible accident, when servicing brakes or brake system:

- Do not over tighten brake tube fittings. Over tightening may crack the fitting or damage the seat in the cylinder fitting.
- Compressed air used to service brake components must be oil-free or rubber parts may be damaged.
- Always replace brake lines that are questionable.
- Never allow brake system rubber parts to come in contact with gasoline, diesel fuel, or any type of cleaner other than an approved brake cleaner. Wash hands before handling brake components.
- Brake linings that contact oil or grease can become contaminated, lose braking friction and then must be discarded.

⚠WARNING This machine has stored hydraulic energy in an accumulator, even when power is off. Certain functions such as steering can start without warning and cause injury. Before servicing, discharge stored energy in the hydraulic accumulator as follows:

1. Switch Off Power
2. Disconnect Battery
3. Turn Steering Wheel Back And Forth Until Steering Becomes Very Hard.

⚠WARNING Disconnect battery before performing service to prevent accidental startup.

⚠CAUTION Using non-original replacement parts is not recommended. Their use may cause unit failure and/or affect vehicle safety.

1.1 LIMITED REPAIR ITEMS

Certain components, although not recommended for overhaul, are subject to limited repair procedures. Repairs consist mainly of removal and replacement of parts, the installation of seal kits, etc. Components not covered in the overhaul and repair sections in this manual are not considered reparable items and should be replaced when defective.

This Page Intentionally Blank

CHAPTER 4 REPAIR PARTS
TABLE OF CONTENTS

This Page Intentionally Blank

1. HOW TO USE THE REPAIR PARTS CHAPTER

To ORDER REPAIR PARTS, call NMC-Wollard, Inc. Customer Service at 1-715-835-3151. Be prepared to supply the model number and serial number of your machine. Inform the Customer Service Representative what page and figure number the part you require is on, along with the date that appears in the footer of the parts page. Then order the part number that is listed for the item you require. For your convenience, Visa and MasterCard are accepted for payment.

VENDOR PART NUMBER column lists the original manufacturers' part numbers of items purchased by NMC-Wollard, Inc.. Although these parts may be purchased from NMC-Wollard, Inc. by using the NMC-Wollard, Inc. part number, you may wish to purchase directly from the original manufacturer.

ABBREVIATIONS may be used in this manual as follows:
A/R - As Required
COMM - commercial item readily available from local sources
DPST - Double-Polesingle-Throw
HHCS - Hexhead Capscrew
ID - Inside Diameter
LH - Left-Hand
NS - Not Shown
OA - Over-All
OD - Outside Diameter
RH - Right-Hand
RHMS - Roundhead Machine Screw
SHCS - Socket Head Capscrew
SPDT - Single-Pole Double-Throw

NOMENCLATURE column contains the part description required for identification or procurement. If the part is an item purchased by NMC-Wollard, Inc. and has not been modified by NMC-Wollard, Inc., then following the description will be the vendor's federal supply (CAGE) code. If a vendor does not have a CAGE code, a number will be assigned by NMC-Wollard, Inc. with the prefix letter "V". Example: V1234. Where there is no vendor or CAGE code, NMC-Wollard, Inc. is the manufacturer.

EFF (Effectivity) column identifies by code the model or serial number/s on which a particular part is used. Absence of the code in the "EFF" column indicates that the part or assembly is used on all models with Ser #001 and on.

See the Introduction for Effectivity Code and Serial Numbers

This Page Intentionally Blank

2. LIST OF VENDORS

Cage Code	Vendor
NVC	Sam's Auto Supply (purchase locally)
NVC	White City Glass (purchase locally) NVC Breed Safety Restraint Systems
NVC	Breed Safety Restraint System
V00501	Metalastic/Canada, 11 Curity Avenue, Toronto, Canada, M4B 1X5
V00506	D&D Instruments, PO Box 64097. St. Paul, MN 55164-0097
V00507	Advanced Laser Machining LLC, 600 Cashman Drive, Chippewa Falls, WI 54729
V00511	Unlimited Services, Dept. No. 59431, Milwaukee, WI 53259-0431
V00512	Tech Products Corp., Dept. 0166, Columbus, OH 43265-0166
V00513	Certified Power Inc. Co., 95 West Deere Rd., Elkhorn, WI 53121
V00514	Northwest Filter, 7844 12th Avenue South, Minneapolis, MN 55420
V00517	Power Great Lakes, Inc., Dept 77-5626, Chicago, IL 60678-5626
V00523	Genuine Service & Machine, Inc., 2424 Pleasant Street, Eau Claire, WI 54701
V00524	Bearing Headquarters, 1814 Truax Blvd., Eau Claire, WI 54703
V00529	AA Electric, PO Box 325, Cedarburg, WI 53012-0325
V00531	Electronic Components, Dept. #149701, Detroit, MI 48267-1497
V00532	Batteries Plus, 3115 E. Hamilton Avenue, Eau Claire, WI 54701
V00539	Courtney Industrial Battery, 6522 N 40th St., Milwaukee, WI 53209
V00540	Ken Vance Motors, Inc., 5252 Hwy 93, Eau Claire, WI 54701
V00541	Markquart Chevrolet, PO Box 1528, Eau Claire, WI 54702
V00542	Maxima Technologies, Inc., PO Box 11579, Boston, MA 02211
V00543	Motion Industries, PO Box 1503, Eau Claire, WI 54702
V00544	Fiamm Technologies, Inc., 1550 Leeson Ave., Cadillac, MI 49601
V00545	Transtar Industries, 34 Offical Rd., Addison, IL 60101
V00546	Catco, 2785 Long Lake Rd., St. Paul, MN 55113
V00547	Engineered Cooling Systems, 201 W Carmel Dr., Carmel, IN 46032
V00548	OE Sales, 239 Old New Brunswick Rd., Piscataway, NJ 08854
V00549	Wells Mfg. Corp., PO Box 88832, Milwaukee, WI 53288
V00550	JW Speaker Corp., MB Unit #68-6171, Milwaukee, WI 53268-0489
V00551	Grey Products, N6673 State Hwy 25, Durand, WI 54736-4206
V00552	Acme Alternate Fuel Systems, PO Box 2168, Mankato, MN 56002
V00553	Springs, Inc., 522 SW 19th St., Forrest Lake, MN 55025
V00554	Safety Systems & Controls, 2400 Campell Rd., Houston, TX 77080
V00555	Frank W. Murphy Mfg., PO Box 470248, Tulsa, OK 74147-0248
V00556	Contiental Engineering, PO Box 68, Chaska, MN 55318
V00570	Motormite
00779	Tyco Electronics Corp., M/S 38-77, 2800 Fulling Mill Road, PO Box 3608, Harrisburg, PA 17105-3608, Middletown, PA 17057

01276	Aeroquip Corporation, 1225 West Main Street, Van Wert, OH 45891
03718	Cummins Great Lakes, 5555 S Kilpatrick, Chicago, IL 60629-5348
05WC5	Bosch Automotive Motor Systems, 101 1st Ave, Waltham, MA 02154
0AT39	Brierton Engineering, PO Box 217, Abilene, KS 67410
0BFU2	Tewco Inc., 9701 South 58 Street, Franklin, WI 53132
0GE52	Drive Line, Inc., 5290 Hiatus Rd., Fort Lauderdale, FL 33351
0J567	Indiana Heat Transfer, 500 W. Harrison St., Plymouth, IN 46563
0NYT6	Interdynamics Inc., 80 39th St., Brooklyn, NY 11232
0NZJ1	Engineered Components, Inc., PO Box 360, 546 Old York Rd., Three Bridges, NJ 08887
0X0P8	Superior Unlimited, PO Box 3888, Bristol, TN 37625
12204	Daimler Chrysler, 26311 Lawrence Ave., Center Line, MI 48015
12662	Peterson Mfg. – Grndvw, PO Box410032, Kansas City, MO 64141-0032
13445	Cole-Hersee Co., 20 Old Colony Ave., Boston, MA 02127
14894	Allied Automotive, 1094 Bendix Dr., Jackson TN 38301
16476	Datcon Instruments Co., PO Box 128, East Petersburg, PA 17520-0128
1CW22	Hella Inc., 210 Kelley Dr., Peach Tree, GA 30269
1DF85	Genuine Parts Co., DBA Napa Auto Parts, 1317 S 700 W, PO Box 26068, Salt Lake City, UT 84126
1FDW0	Force America, 501 East Cliff Rd. 100, Burnsville, MN 55337
1FQX3	Newark Electronics, 1611 West County Road B, Roseville, MN 55112
1HS72	Chicago Power Systems, Inc., 1533 Lathem St., Batavia, IL 60510
1W654	Terminal Supply Co., PO Box 1253, Troy, MI 48099
20984	Arrow Safety Device Company, Route 113, Georgetown, DE 19947-9524
24161	Gates Rubber Co., 999 South Broadway, Denver, CO 80217
24617	General Motors Corp., 3044 W Grand Blvd., Detroit, MI 48202-3091
26377	Ford Motor Company, General Parts Div., PO Box 412, Ypsilanti, MI 48197-0412
2Y580	Dominion Automotive Ind., 19308 70th Ave S., Kent, WA 98032
39569	Northern Power Products, PO Box 21348, Eagan, MN 55121-0348
3E157	Rockwell Standard Axle Co., 500 Commerce Rd, Richmond VA 23224-5414
3E525	Wilton Corp., RRI PO Box K, Winchester, TN 37398-9801
3U016	Diesel Service Co., PO Box E-1414, Minneapolis, MN 55480
41625	Incom Intl. Inc., Morse Controls Div., 21 Clinton St., Hudson OH 44236-2802
44185	NMC-WOLLARD, Inc., 2021 Truax Blvd., Eau Claire, WI 54703
49234	Protectoseal Co., 225 West Foster Avenue, Bensenville, IL 60106
52793	Saginaw Products Corp., 68 Willamson St., Saginaw MI 48601-3246

53867	Robert Bosch Corporation, 2800 South 25th Avenue, Broadview, IL 60153-4532
56118	Sparton Corp., 2400 W Ganson, Jackson, MI 49202-3772
56289	Sprague Electric Co., World Hqs., 678 Main St., Sanford ME 04073
57013	Preco Inc., 415 North Maple Grove, Boise, ID 83704
58051	Quadrastat Controls Corp., 3860 S Capital Avenue, City of Industry, CA 91748
58961	Waytek Inc., PO Box 690, Chanhassen, MN 55317
62465	Electronic Controls Co., 11080 Executive Dr., PO Box 7246, Boise, ID 83707
63477	Cooper Industries, Inc., Wagner Brake Div., 3700 Forrest Park Blvd., St., Louis, MO 63018
64386	Buckhorn Rubber Co., 5151 Industrial Dr., Hannibal, MO 63401-0998
65439	Advanced Technology Corp., 101 N. Eagle St., Geneva, OH 44041
68505	Prestolite Electric, Inc., 2100 Commonwealth Blvd. Suite 300, Ann Arbor,MI 48105
68ZA5	Comer Industries, 12730 Virkler Dr, Charlotte, NC 28273
69633	Meritor HVS LLC, ASP Div., 7975 Dixie Hwy, Florence, KY 41042
6H839	Zenith Spring Co., 3116 W Michigan St., Duluth MN 55806-1744
6K866	Keystone Cable Corp., 7600 Chrysler Dr., Detroit, MI 48211-1974
6N512	Inland Diesel Inc., PO Box 68-9633, Milwaukee WI 53268-9633
6Z742	Pokorny Sales, 20 Tierney Rd., Lake Hopatcong, NJ 07849
72447	Dana Corporation, Universal Joint Division, 6201 Trust Drive, Holland, OH 43528
73342	Allison Transmission Division, General Motors Corp., 4700 West 10th St., Indianapolis, IN 46222-3277
75175	Concord Instruments Corp., KD Lamp Company, 1910 Elm St., Cincinnati, OH 45210-2451
75958	Borg-Warner Automotive Transmission & Engine Components Corp., 6700 18-1/2 Mile Rd., Sterling Heights, MI 48314-3206 (OBSOLETE)
77060	General Motors, Packard Electric Div., 408 Dana St. NE, P.O. Box 431, Warren, OH 44486
77326	Pollak Joseph Corp., 195 Freeport St., Dorchester, MA 02122-2827
78505	Electronic Industries Inc., PO Box 266, 19 E Irving Ave., Oshkosh, WI 54902-0266
79470	Weatherhead Div., Dana Corp., 6615 Brotherhood Way, Ft. Wayne, IN 46825
7J132	Machine Service, Inc., 1000 Ashwaubenon St., PO Box 10265, Green Bay, WI 54307-0265
7J925	Endries Fastners & Supply Inc., PO Box 69, Hwy 10W, Brillion, WI 54110
8S377	Fuel Systems, 12730 Robin Lane, Brookfield, WI 53005

92867	Orschlein Brake Lever Mfg. Co., 1177 North Morley, Moberly, MO 65270-2736
94222	Southco Inc., 210 N Brinton Lake Rd., Concordville, PA 19331
96151	(Char-Lynn) Eaton Corp., Fluid Power Operations, 15151 Hwy. 5 Eden Prairie, MI 55344

3. NUMERICAL PART NUMBER LIST

This Page Intentionally Blank

This Page Intentionally Blank

4. ILLUSTRATED REPAIR PARTS

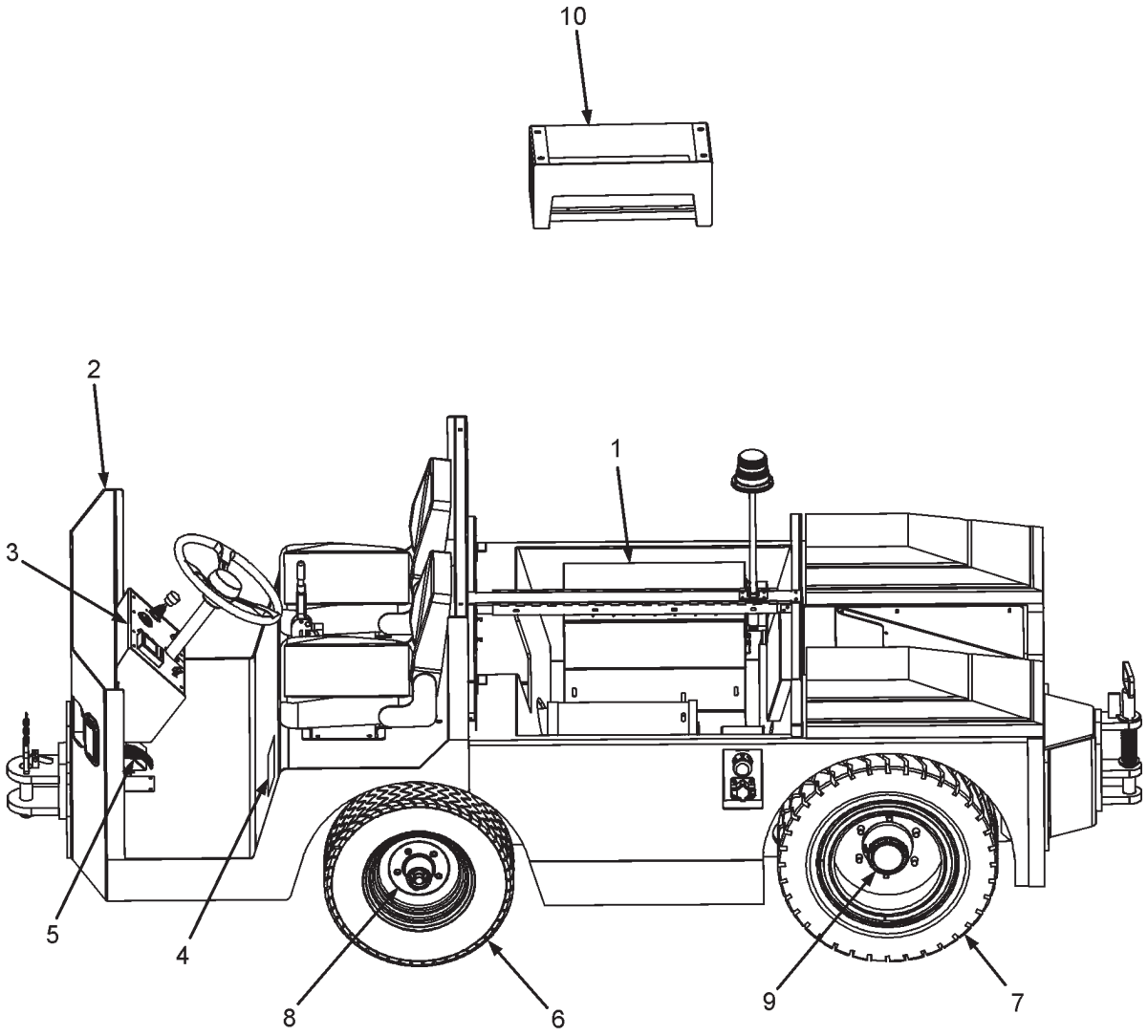


FIGURE 1.
MAIN ASSEMBLY MODEL E

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
1-			Main Assembly		Ref
1			Power Package, Electric		Ref
2	51025		Frame Assembly (See Figure 2)		Ref
3	51150		Instrument Panel		Ref
4	51403		Decal Assembly		Ref
5			Pedal Assembly, Brake (See Figure 9)		Ref
6	NW026802		Tires, Front		Ref
7	51022		Tires, Rear		Ref
8	51024		Axle, Front		Ref
9	51069		Axle, Rear		Ref
10	51062		Battery, Pedestal Assembly (See Figure 4)		Ref

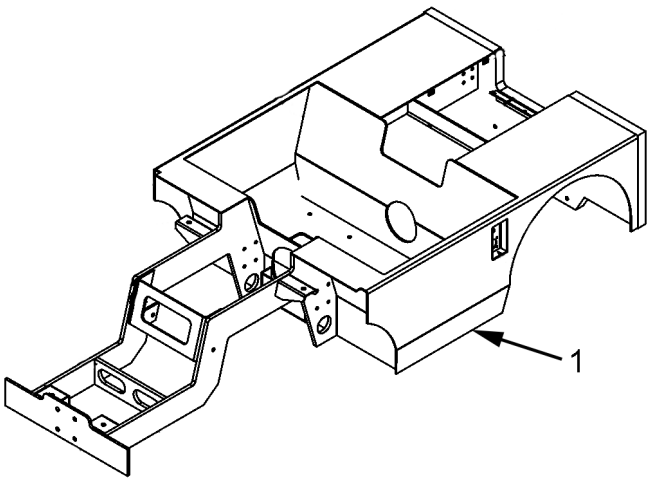


FIGURE 2.
FRAME ASSEMBLY, MODEL E

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
2-	51025		Model E-Frame Weldmnt		1

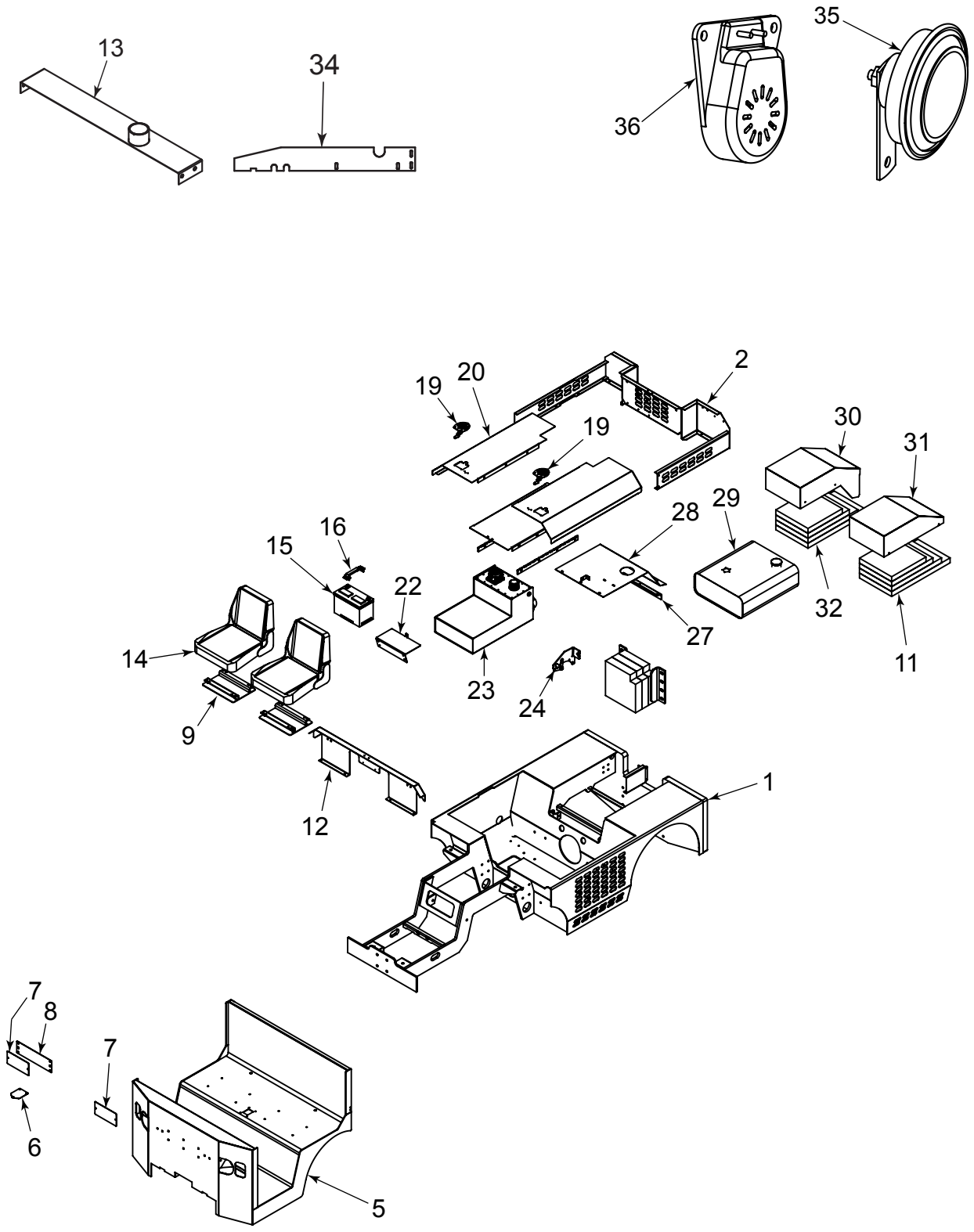
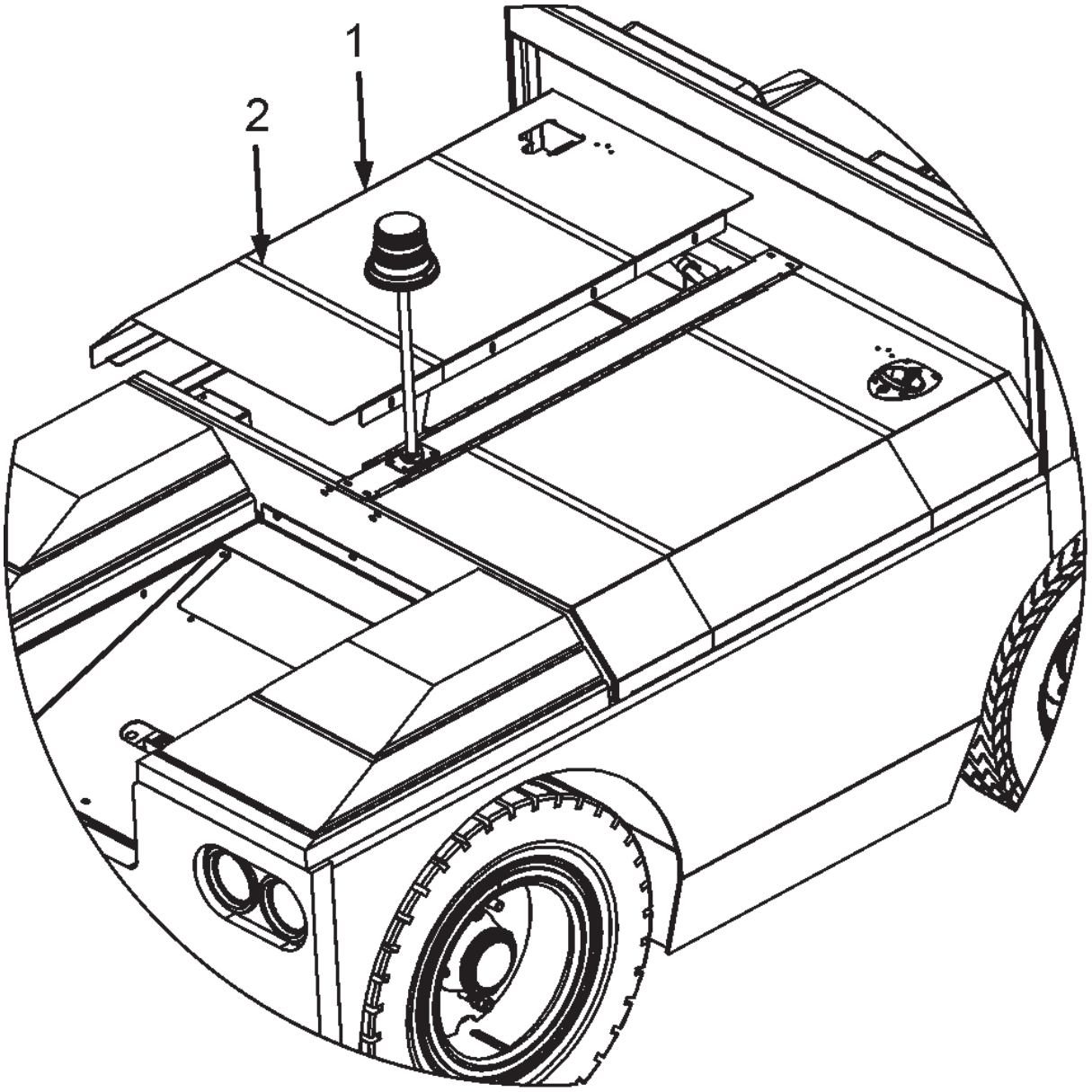


FIGURE 3.
MAIN ASSEMBLY MODEL D

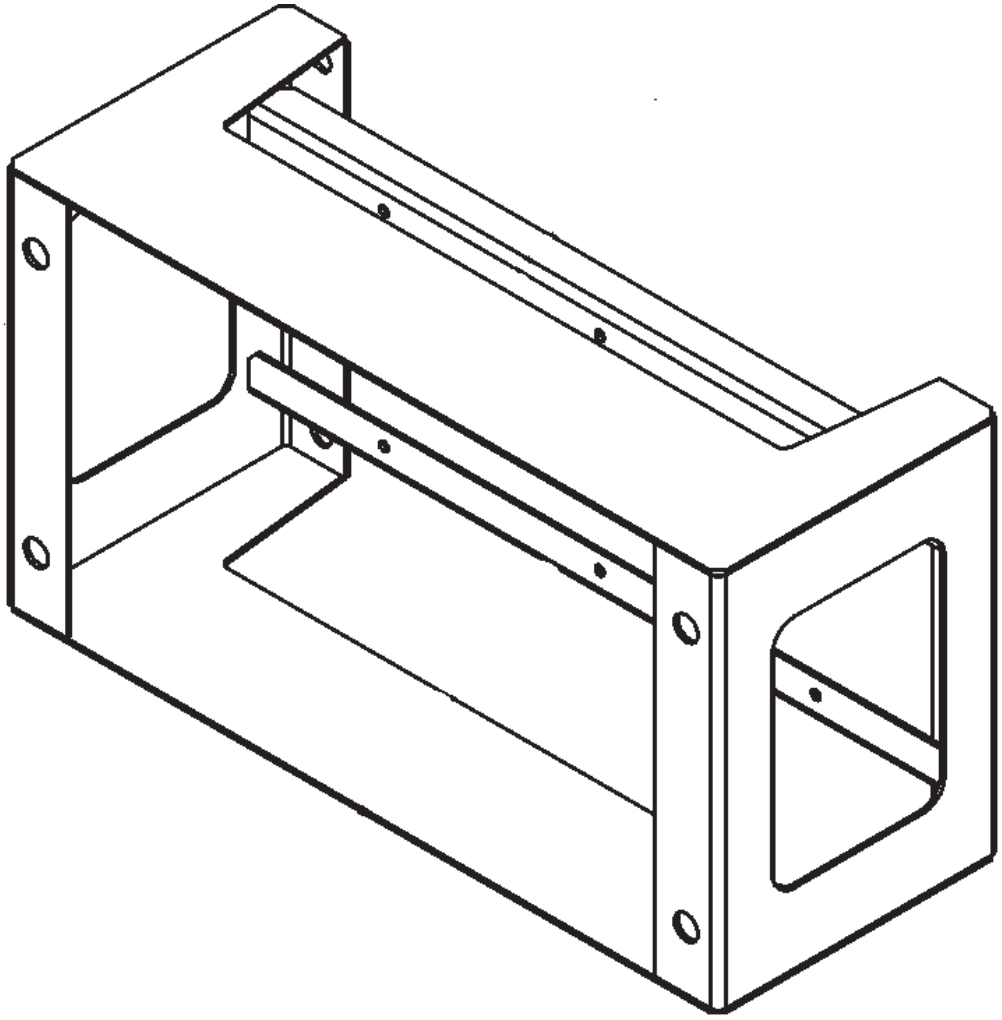
Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
3-			Main Assembly, Model D		Ref
1	51470		Frame Weldment		1
5	51130		*N* Cab Weldmnt, Lower		1
6	51314		Cover, Pedal		2
7	51404		Cover, Light		2
8	51313		Cover, Dash		1
9	51177		Mnt Wldmnt, Seat		2
11	52492		Weight LH		1
12	51494		Cab, Hood Latch Angle		1
13	52613		Air Dam Weldmnt		1
14	47704		Seat, Semi Suspen W/Hip Guards		2
	1.0106		Belt, Seat		2
15	2.3268		Battery, 12V,627FCCA		1
16	48531		Hold Down Kit, Battery		1
17	51500		Brace Center, Hood		1
19	208181		T-Handle Locking		2
20	51496		Hood, RH		1
21	51497		Hood, LH		1
22	NW029866		Tray, Battery,6005-D		1
23	51490		Tank, Hydraulic		1
24	51451		Park Brake Mnt Assy		1
25	51243		Hood, Hinge		2
26	51532		Cover, Fuel Tank		1
27	51047		Mount, Shield, rear		1
29	51480		Tank, Fuel, 18 Gallons		1
30	52499		Cover, Weight, RH		1
31	52504		Cover, Weight, LH		1
32	52498		Weight RH		1
33	51429		Weigh, Rear Assy		1
34	52585		Air Dam, Side		2
35	2.3000		Horn, 12V, 2-Wire		1
36	NW024637		Alarm, Backup, SAE J944		1
NS	51245		Spring, Gas		2
NS	51246		Brkt, Spring, Gas		2
NS	51067		Mount, hood Latch		2
NS	51083		Cab, Hood Latch Angle		1
NS	NW034592		Cable, Shift, 84”		1
NS	304608		Ball Joint, QD, 1/4-28		1
NS	SW1H1247		Rod End, 1/4-28, Fem		1
NS	203228		Plate, Hood Pivot		2
NS	1.8426		Ftg, Brk, 03FI-03FI		2
NS	49070		Cable, Battery, Negative 19”		1
NS	209586		Cable, Battery, Positive 48”		1



M40e-Hood.cdr

FIGURE 4.
HOOD MODEL E

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
4-	51238		Hood, RH		Ref
	51241		Hood, LH		Ref
1	51239		Hood, Right		1
	51242		Hood, Left		1
2	51240		Cover, Hoood Brace		2
NS	51243		Hood Hinge		36"
NS	51362		Support, Hood, Frame, Side		6"
NS	51363		Support, Hood, Frame, Bottom		13.75"



M40e-BatteryPedestal.cdr

FIGURE 5.
BATTERY PEDESTAL MODEL E

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
5-	51062		Weldmnt, Battery Pedestal		Ref

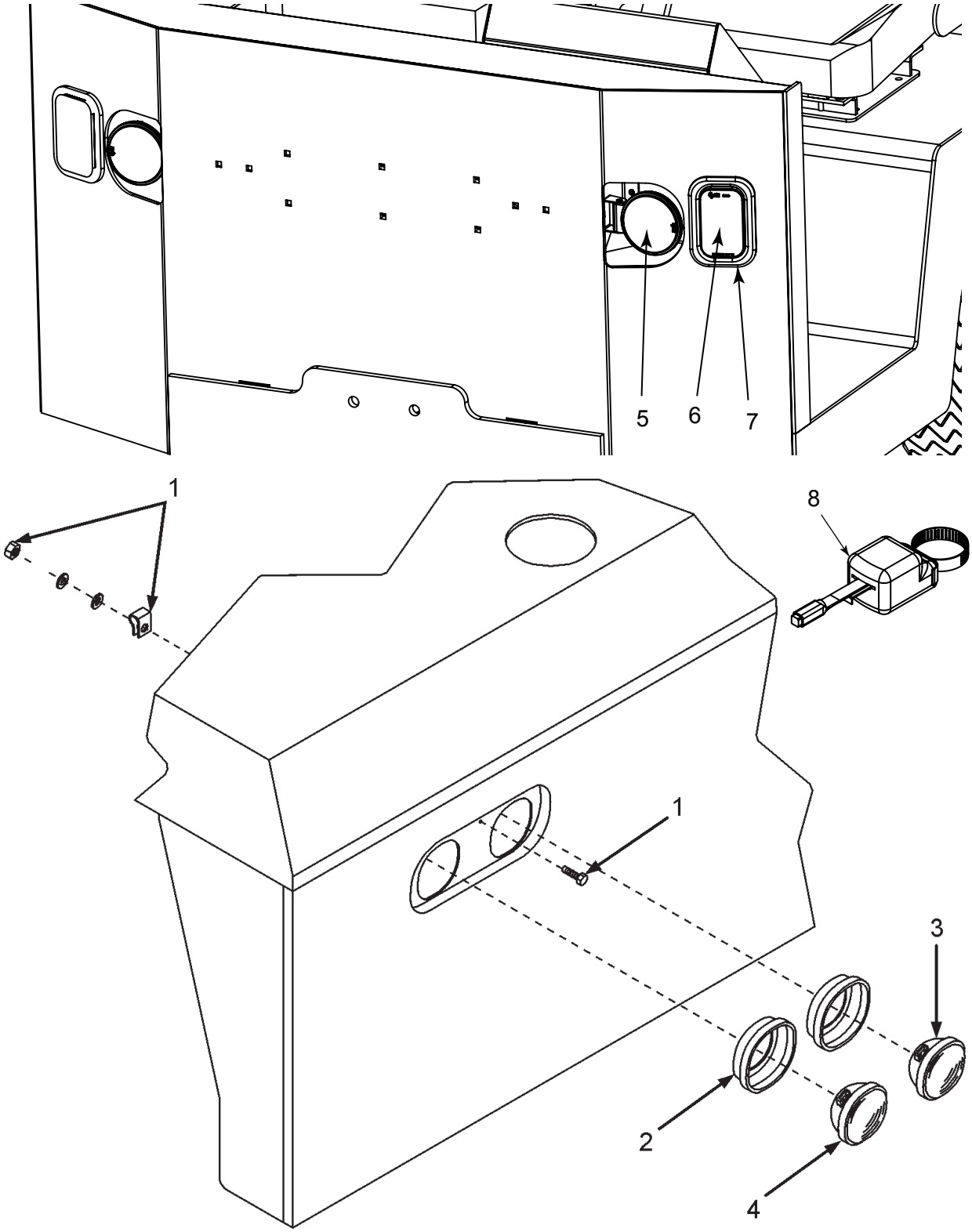


FIGURE 6.
LIGHTS, MODEL D & E

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
6-	51516		Grp, M40 Lights, HD / Tail, Bu,Std		**Ref**
1	NW034546		THMS, 1/4-20 X 0.75		4
	Comm		Clip Insulated		2
	Comm		Flat Washer, 1/4		2
	Comm		Lock Washer, 1/4		2
	Comm		Hex Nut, 1/4-20		2
2	NW035843	91740	Grommet, Light, Tail-Back-Up (KD) 4		4
3	NW035842		Light, Back-Up, 4” Round, Incand, 12V		2
4	NW035844		Light, Stop/Tail, Red Sealed		2
NS	2.3608		Light, Trapezoid, Rubber Mnt, Inc		2

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
6-	51515		Grp, M40, Lights, HD / Tail / BU, LED		Ref
2	NW035843	91740	Grommet, Light, Tail-Back-Up (KD) 4		4
3	51227		Light, Backup, 4” Round, LED		2
4	45817		Light, Stop / Tail, Red, LED		2
5	309488		Light, Head, 4.4 DIA. LED, W/ Bracket		2

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
6-	51514		Turn Signals, Incand		Ref
6	51173		Light, Turn/Park 3 x 5 LED (Optional)		2
	51172		Light, Turn/Park, Rec, Series 45		2
7	51174		Grommet		2
8	47735		Turn Signal Assy, 8 Wire, Sealed		1
NS	F101567		Flasher, Turn / Park Rec, Series 45		1

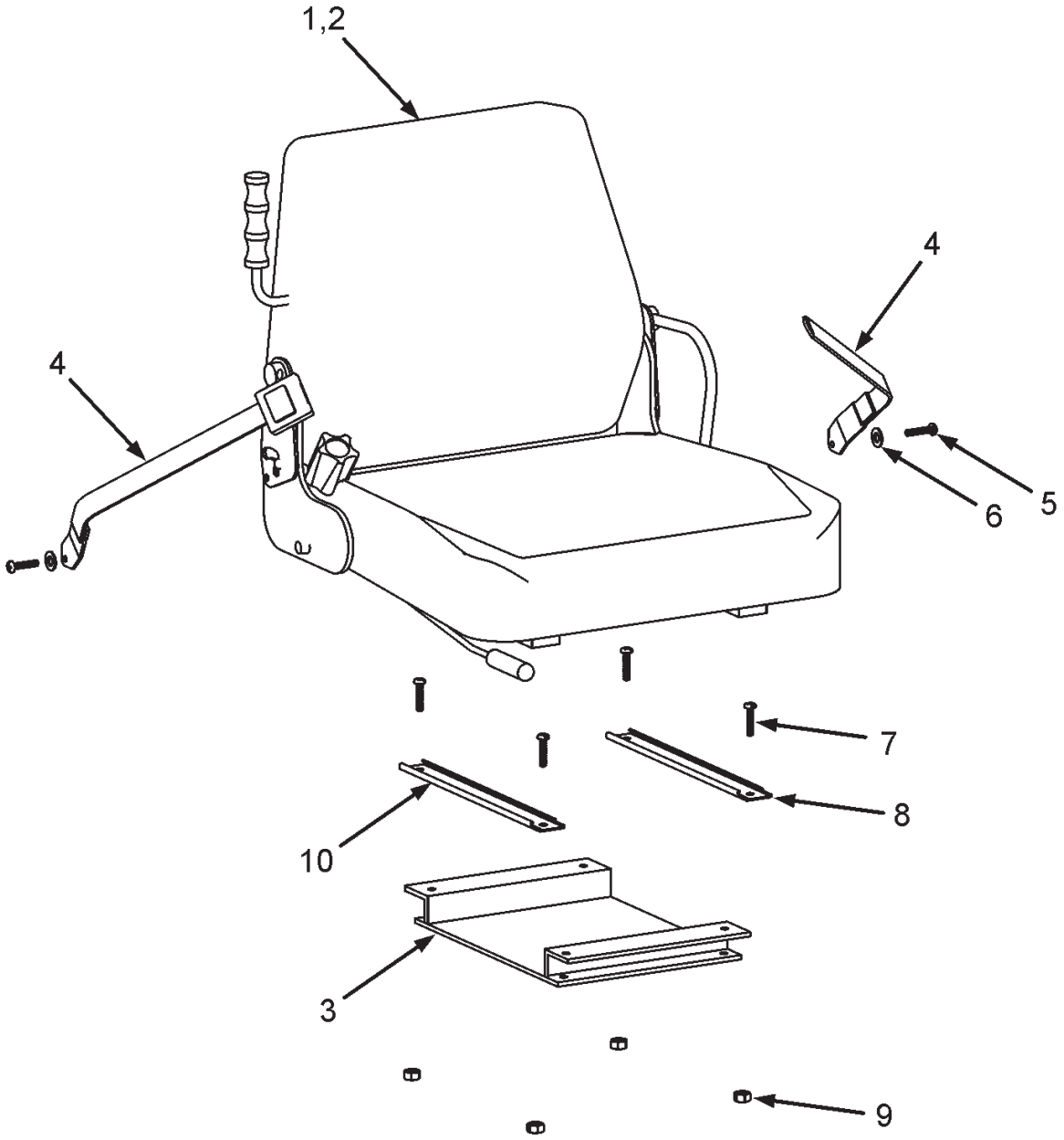


FIGURE 7.
SEAT ASSEMBLY MODEL D & E

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
7-			Seat Assy. Model D & E		Ref
1	47704		Seat, Semi Suspen W/Hip Guards		1
2					
3	51177		Mnt Wldmnt, Seat		2
4	1.0106		Belt, Seat		2
5			HHCS		2
6			Washer		2
7			HHCS		4
8			Rail, Seat, LH		1
9			Nut, Plain, Hex		4
10			Rail, Seat, RH		1

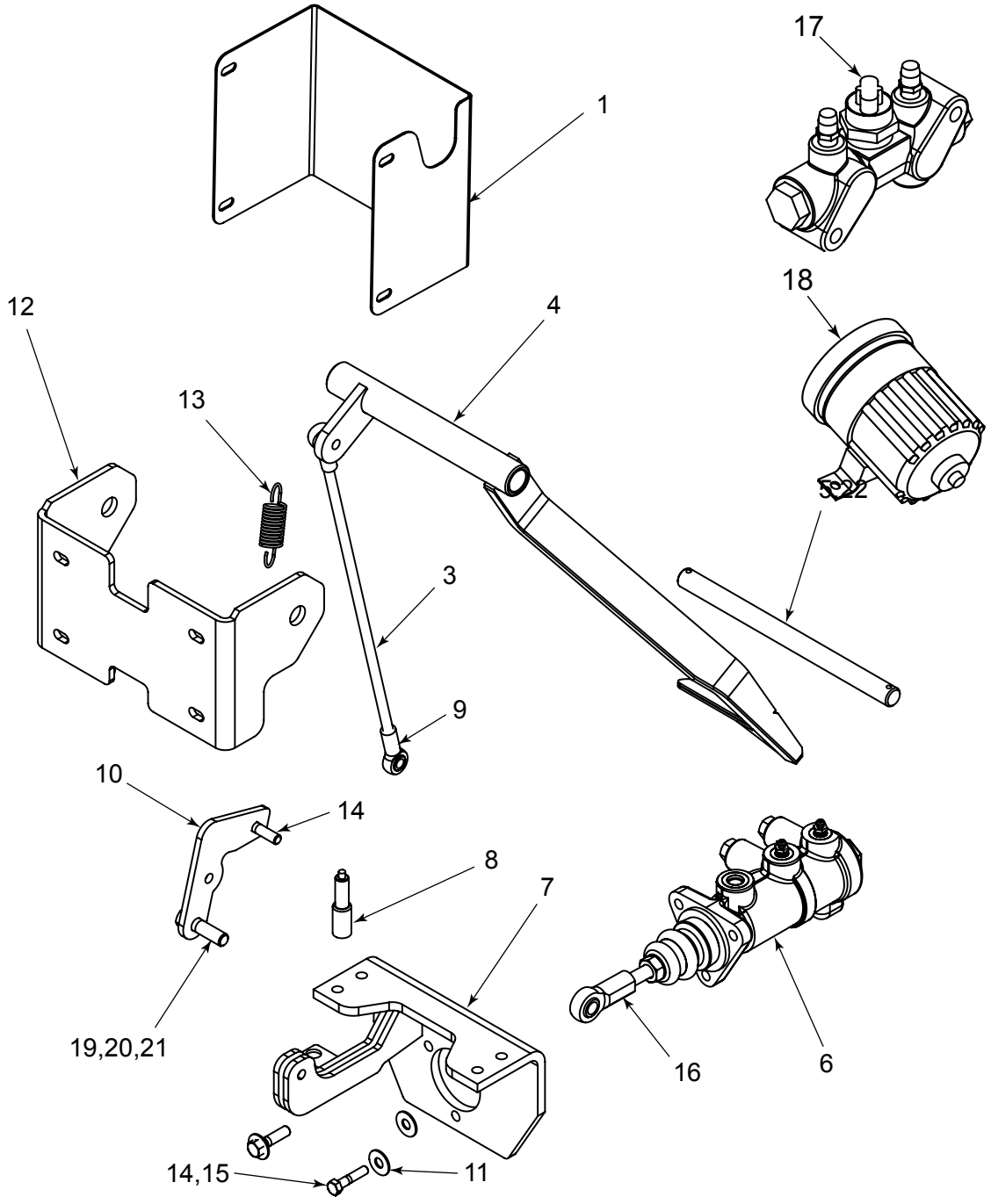


FIGURE 8.
BRAKE SYSTEM, MODEL D & E (1 OF 2)

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
8-	51300		Brake, System Model D & E		Ref
1	51324		Cover, Center Cab		1
3	416502		Rod, Cut, 4165, 15.38		1
4	51299		Pedal, Wldmnt, Brake		1
5	51303		Shaft, Brake Pivot		1
6	44886		Booster, Brk, W / Master		1
7	52692		Mnt Brake Lever		1
8	2.0739		Switch, Stoplight, Plunger Type		1
9	300314		Rod End		2
10	51655		Bellcrank, Brakes		1
11	F009669		FW, 3/8 Std, Zc		9
12	51307		Mnt, Wldmnt Brake Pedal		1
13	F104435		Spring, Extension, 0.85 OD x 2.75		1
14	F101448		HHCS 3/8-16 x 1.5, Grd 5		9
15	9413534		Nut, Hex 3/8-16, Nylock		3
16	NW033861		Ron End, 1/2-20 Fem 140		1
17	45089		Valve, Brake Warn Mineral Oil		1
18	47399		Reservoir, Hyd, 14.5 CI,06MJ		1
19	F018701		HHCS, 1/2-13 1.75		1
20	F100064		FW, 1/2 SAE, Zc		1
21	F013500		Nut, Hex, 1/2-13 Nylock		1
22	F003141		Pin, Cotter, 1/8 x 1 1/2		2
NS	204614		FW, 3/4 SAE, Hardened		2
NS	42790		Ftg, Hyd, 14MM-04MJ90		1
NS	NW036184		Ftg, Hyd, 04MJ-04M90		1
NS	48821		Ftg, Hyd, M18MB-06MT90		2
NS	F101295		Ftg, Hyd, 06MJ-10MB		2
NS	F101278		Ftg, 04MJ-06MB		1
NS	52647		Brkt, Reservoir		1
NS	1.8808		Ftg, Hyd, 06H-06FJX		2
NS	1.7348		Hose, Brk W/O Brkt		1
NS	1.7347		Hose, Brk W/O Brkt		1
NS	NW032343		Ftg, Brk, Tee, 04FI-04FI-04FI, Bkt		1
NS	NW015632		Brkt, Mntg, Brake Line		1
NS	1.7362		Washer, “C”		3
NS	NW030263		Ftg, Brk, 04MI-03FI		1
NS	F100728		Ftg, Brk, Tee, 03FI-03FI-03MI		1
NS	42794		Ftg, Hyd, 02FP-04FJX		2
NS	3.2793		Ftg, Brk, 02MP-03FI		2
NS	3.2254		Ftg, Hyd, 04MJ-04FJX90		2
NS	F101921		Line, Brake, Flex, #6, 24” OA		1

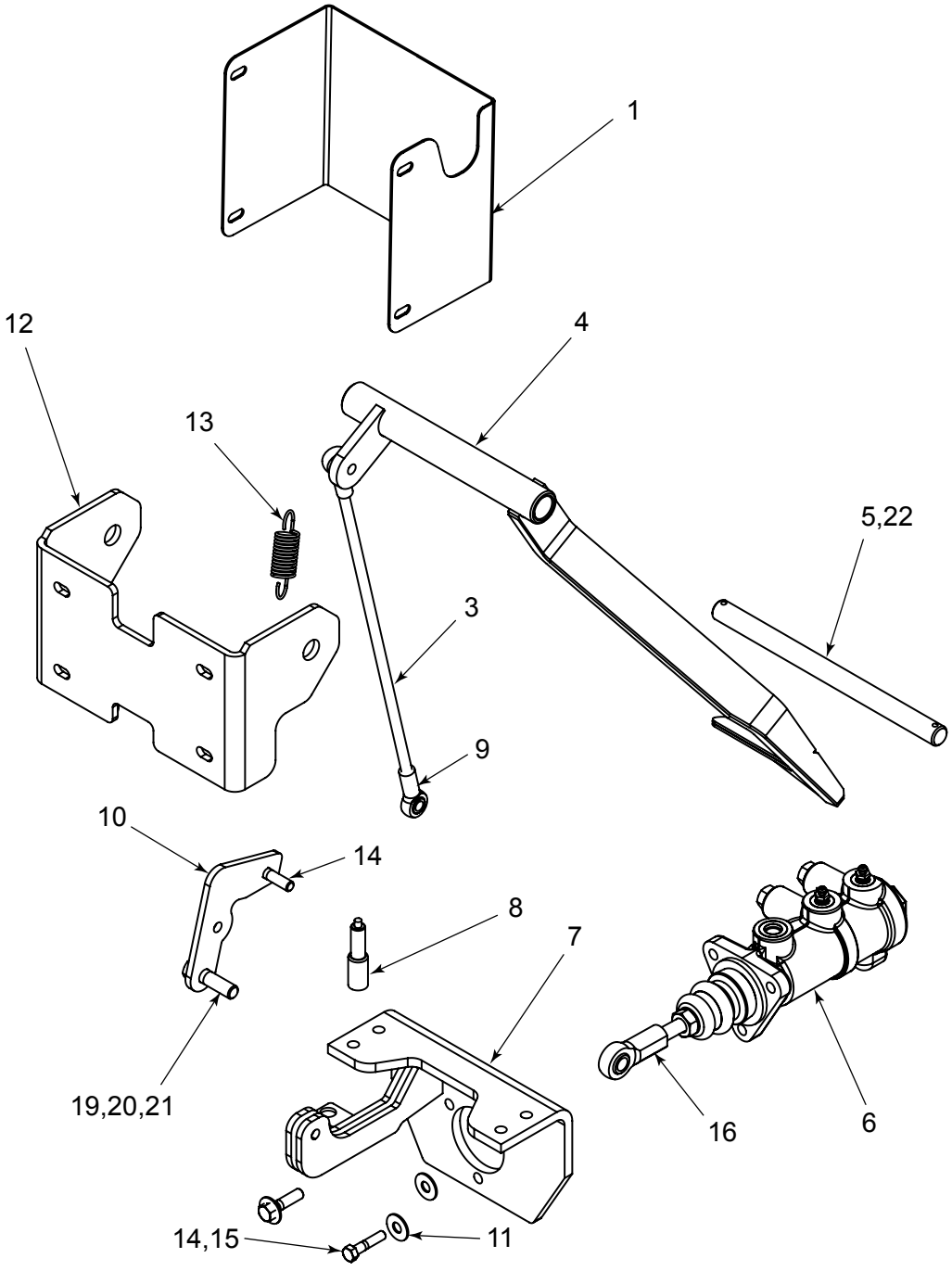


FIGURE 8.
BRAKE SYSTEM, MODEL D & E (2 OF 2)

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
8-	51300		Brake, System Model D & E		Ref
NS	51507		Line, Brake, RH, Rear Axle		1
NS	51508		Line, Brake, LH, Rear Axle		1
NS	51724		Line, Brake, LH, Front Axle		1
NS	51725		Line, Brake, RH, Front Axle		1
NS	51726		Line, Brk, Brk Warn to Rear		1
NS	52645		Line, Brake, MC / Brk Warn		1
NS	52648		Line, Brake, MC / Brk Warn		1
NS	52649		Line, Brake, Mid Chassis to Pr Vlv		1
NS	52650		Line, Brake, Brk Warn To Frt		1
NS	52651		Line, Brake, Pr Vlv To Rear Axle		1
NS	52652		Line, brake, Brk Warn To Rear		1
NS	51379		Valve, Brk, Pressure Limit		1

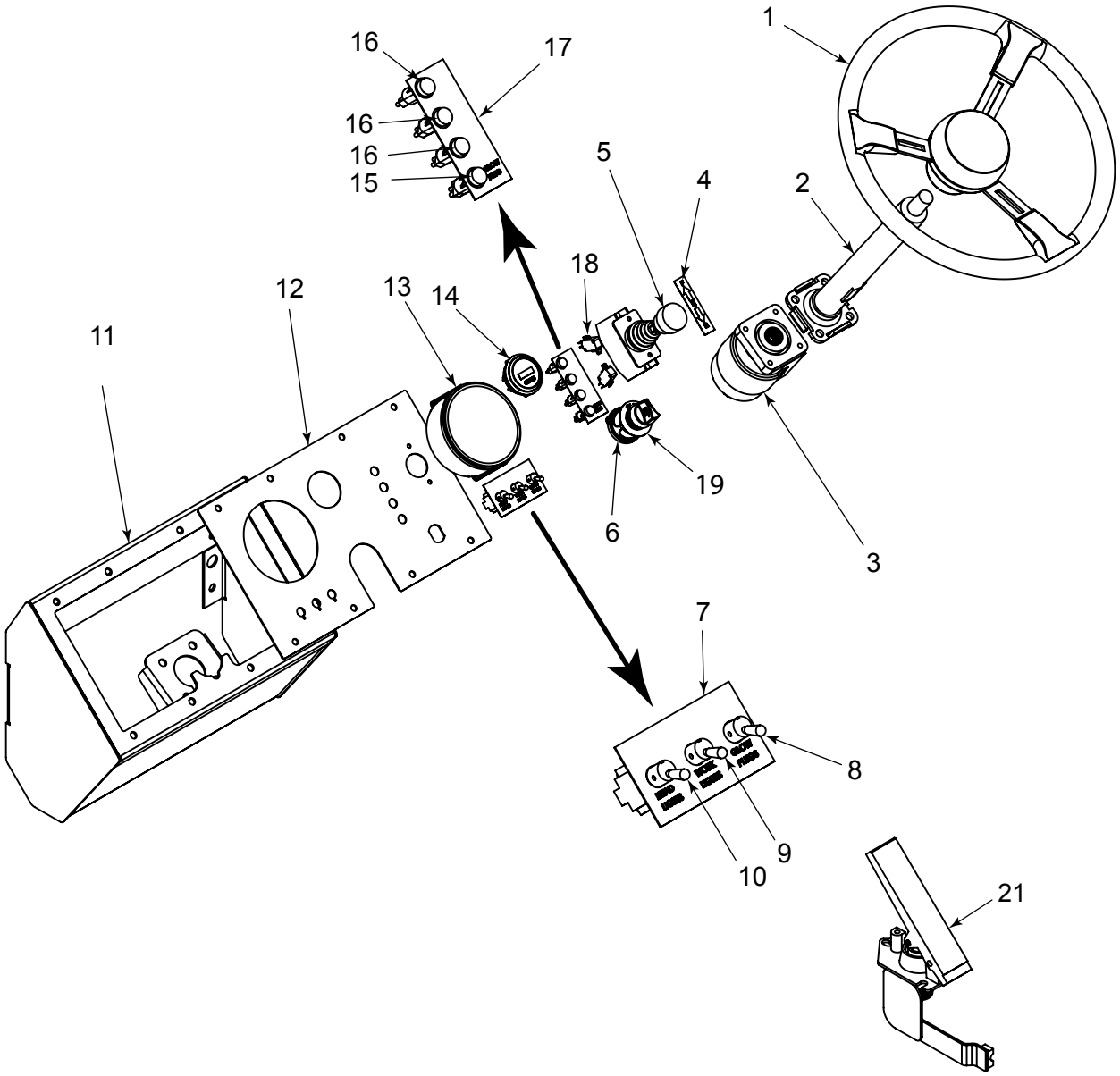
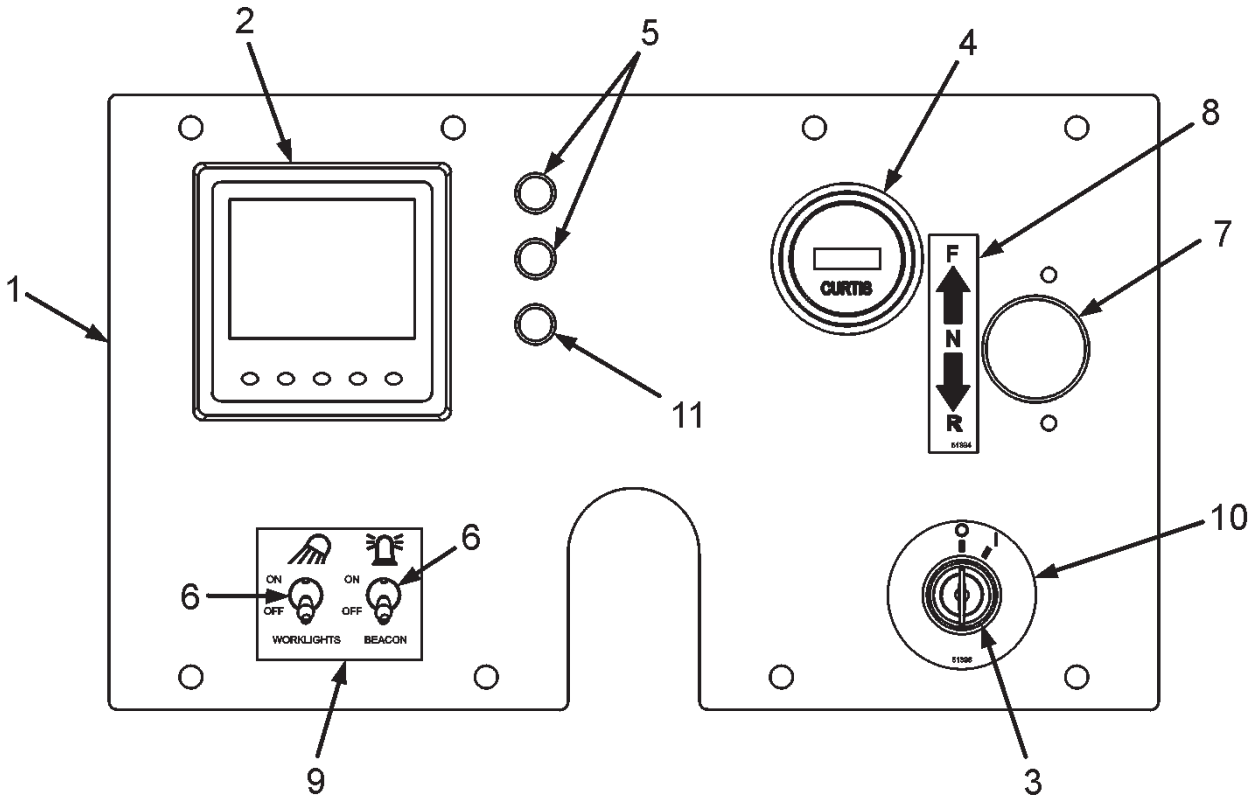


FIGURE 9.
INSTRUMENT PANEL, MODEL D

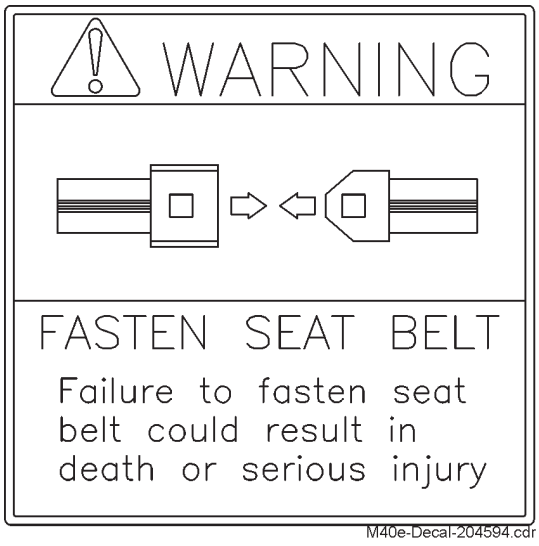
Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
9-			Instrument Panel, Model D		Ref
1	NW036491		Wheel, Steer, 16"		1
2	45082		Column. Steer		1
3	47514		Steering Unit		1
4	202723		Button, Horn		1
5	51089		Joystick Control		1
6	209755		Switch, Ign, Rotating, 3 Pos, Plst		1
7	52658		Decal, 3-Switch, M40D		1
8	2.3014		Switch, Toggle, SPNO		1
9	38865		Switch, Toggle, SP3T		1
10	2.1991		Switch, Toggle, SPNO, Momentary		1
11	51505		Housing, Wldmnt, Instrument, LH		1
12	52566		Panel, Instrument		1
13	208167		Gauge, 4-1, Fuel, Temp, Oil, Volts		1
14	1.8317		Gauge, Hourmeter, SOL, ST, 9-60VDC		1
15	309424		Light, Pilot, LED, 12V, Amber		1
16	309423		Light, Pilot, LED, 12V, Red		3
17	52657		Decal, Light, 4-LED, M40D		1
18					2
19	NW030247		Placard, Ign Switch, Al, Adhesive		1
21	50747		Pedal, Accel, Cable		1
NS	150526		Nut, Hex 13/16-20 (Holds Steering Wheel to Column)		1
NS	90413		Ftg, Hyd, 08MJ-08MB		2
NS	2.0021		Block, Terminal		4
NS	2.0022		End, Terminal		1
NS	2.3319		Capacitor, 2000MFD, 15V		1
NS	309440		Resistor, 680 Ohm		1
NS	51526		Capacitor 2000MFD, 16V		



M40e-InstrumentPanel.cdr

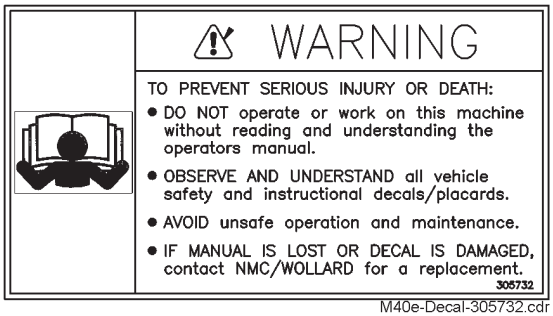
FIGURE 10.
INSTRUMENT PANEL, MODEL 40E

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
10-	51185		Instrument Panel Assy		Ref
1	51310		Panel, Instrument		1
2			VCU - System Controller		1
3	51344		Switch, Keyed, 2 Pos, Off/On		1
4	1.8317		Gauge, Hourmeter, Sol ST, 9-60VDC		1
5	309423		Light, Pilot, LED, 12V, Red		2
6	38863		Switch, Toggle, SPST		2
7	51089		Joystick Control, Single Axis		1
8	51394		Decal, Directional Control		1
9	51395		Decal, Switch Plate, 2-Gang		1
10	51396		Decal, Ign Switch		1
11	309425		Light, Pilot, LED, 12V, Green		1
NS	51405		Boot, Switch, Tgl, Silicone, Gray		1

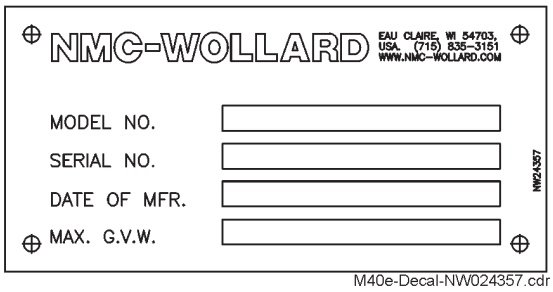


1

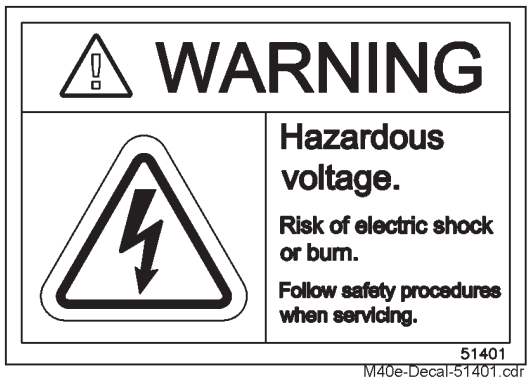
2



3



4



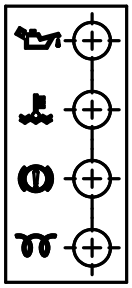
5

6

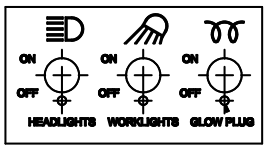
M40e-Placards&Decals.cdr

FIGURE 11.
SAFETY SIGNS AND PLACARDS MODEL E

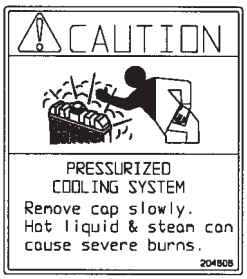
Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
11-	51403		Safety Signs and Placards Model E		Ref
1	204594		Sign, Warning, Seat Belt		1
2	51393		Sign, Warning, Park Brake		1
3	305732		Sign, Warning, Read Manual		1
4	NW024357		Plate, Serial No.		1
5	51401		Sign, Warning Electrical Hazard		3
6	51402		Decal, Use Mineral Oil		1



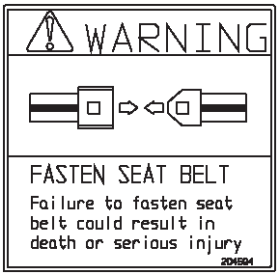
1



2



3

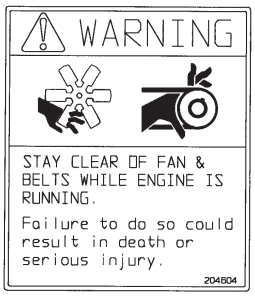


4

5

6

7

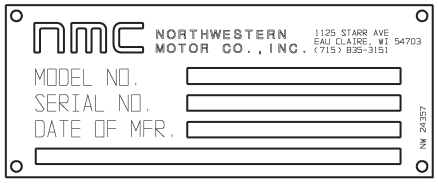


8

9

10

11



12

13

14

FIGURE 12.
SAFETY SIGNS AND PLACARDS MODEL D

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
12-	52582		Group, Decal, Model 40D		Ref
1	52657		Decal, Light, 4-LED, M40		1
2	52658		Decal, 3-Switch, M40D		1
3	204606		Decal, Caution, Cooling		2
4	204594		Decal, Warning Sealt Belt		1
5	41472		Decal, Warning, Calif. Diesel Emmission		1
6	204917		Decal, Made In The USA		2
7	SW14H1066		Decal, Arrow, Dipstick		1
8	204604		Decal, Warning Fan Belt		2
9	305732		Decal, Warning Read Manual		1
10	153768		Decal, Diesel Fuel Only		1
11	46341		Decal, Contact Info. Customer Srvice		1
12	NW024357		Plate, Serial Number		1
13	51464		Placard, EPA		1
14	SW10H2688		Decal, Hyd Oil		1

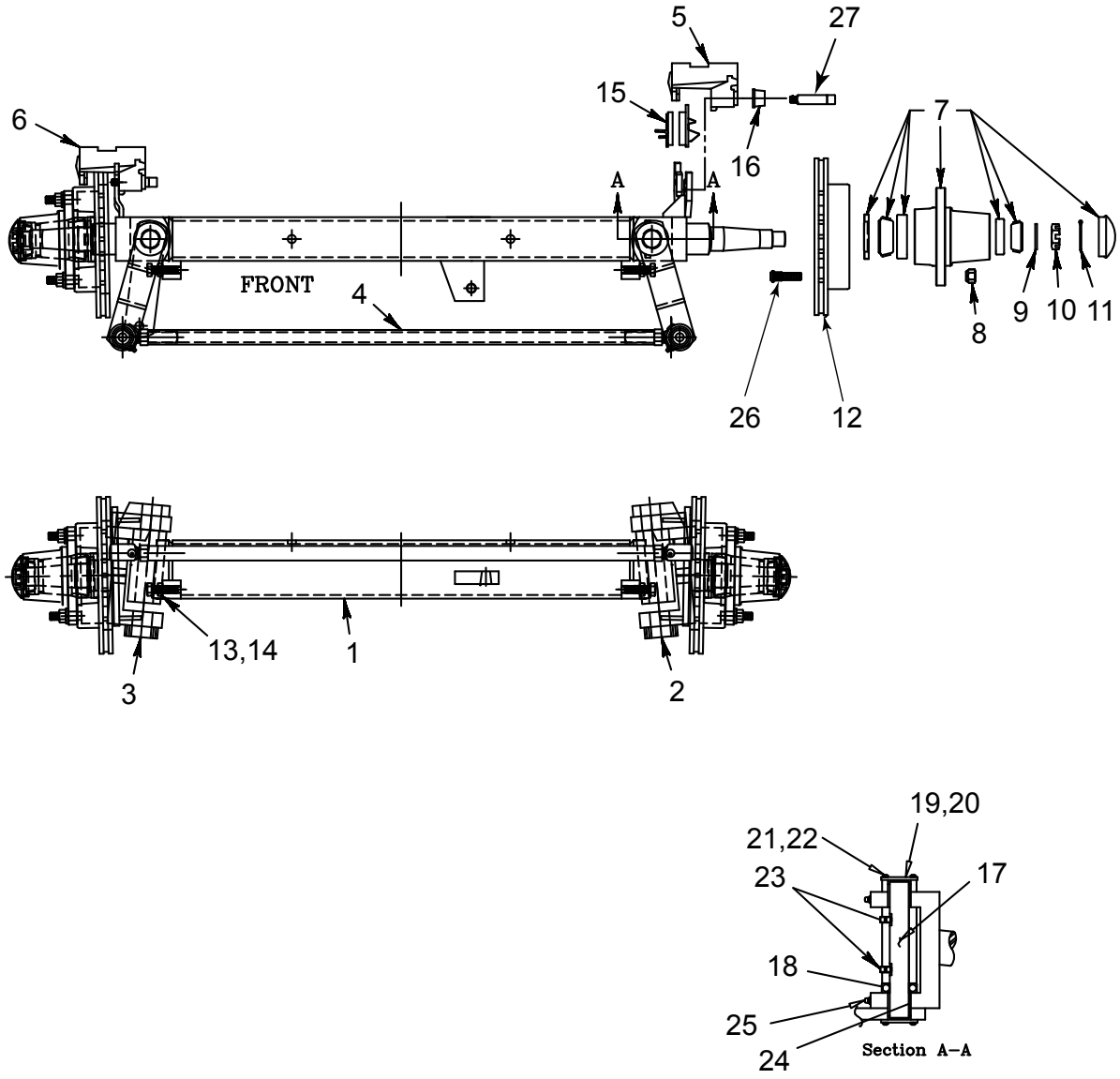


FIGURE 13.
AXLE ASSEMBLY, FRONT, BRIERTON, MODEL D & E

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
13-	51024		Axle Assy, Front		Ref
1		03-30941	Axle Weldmnt.		1
2		03-30943	R.H. Knuckle Weldmnt		1
3		03-30842	L.H. Knuckle Weldmnt		1
4		02-21083	Tir Rod Tube Assy.		1
5		06-63022	RH Brake Caliper		1
6		06-63023	LH Brake Caliper		1
7		02-20322	#623 Hub Assy		2
8	NW017242	06-13144	Nut, 1/2-20 UNF Tapered Hex		10
9		06-13108	Spindel Washer		2
10		06-62085	Spindel Nut, 1-14, 12-Slotted		2
11		32404160	Cotter Pin, 3/16 X 2-1/2		2
12		06-61459A	Rotor, 10.75Ø		2
13		321800090	Nut, 1/2-13 Hex Jam		2
14		320214160	Screw, 1/2-13 UNC X 2.50 LG HX HD		2
15		06-6266	Brake Pad Kit		2
16		06-62065	Rubber Mounting Pin Boot		4
17		06-62415	King Pin		2
18		06-60498	T126 Thrust Bearing		2
19		06-60547	King Pin Cap, Std		4
20		06-61376	King Pin Cap, Gasket		4
21		06-61080	Screw, #10-24 X 5/8 LG.		8
22		06-61081	Washer, #10 Lock		8
23		06-60811	3/8-16 Set Screw		8
24		06-61721	King Pin Bushing		4
25		3090406410	Grease Zerk		4
26	NW033807	06-61460A	Stud, 1/2-20 w/3/4 Knurl, 40-60		10
27		06-61460A	Caliper Mounting Screws		4
NS	1011081		Cyl, Steer, 2B 1.4s 1R		1
NS	NW034968		End Tie Rod, 3/4-16, RH		2

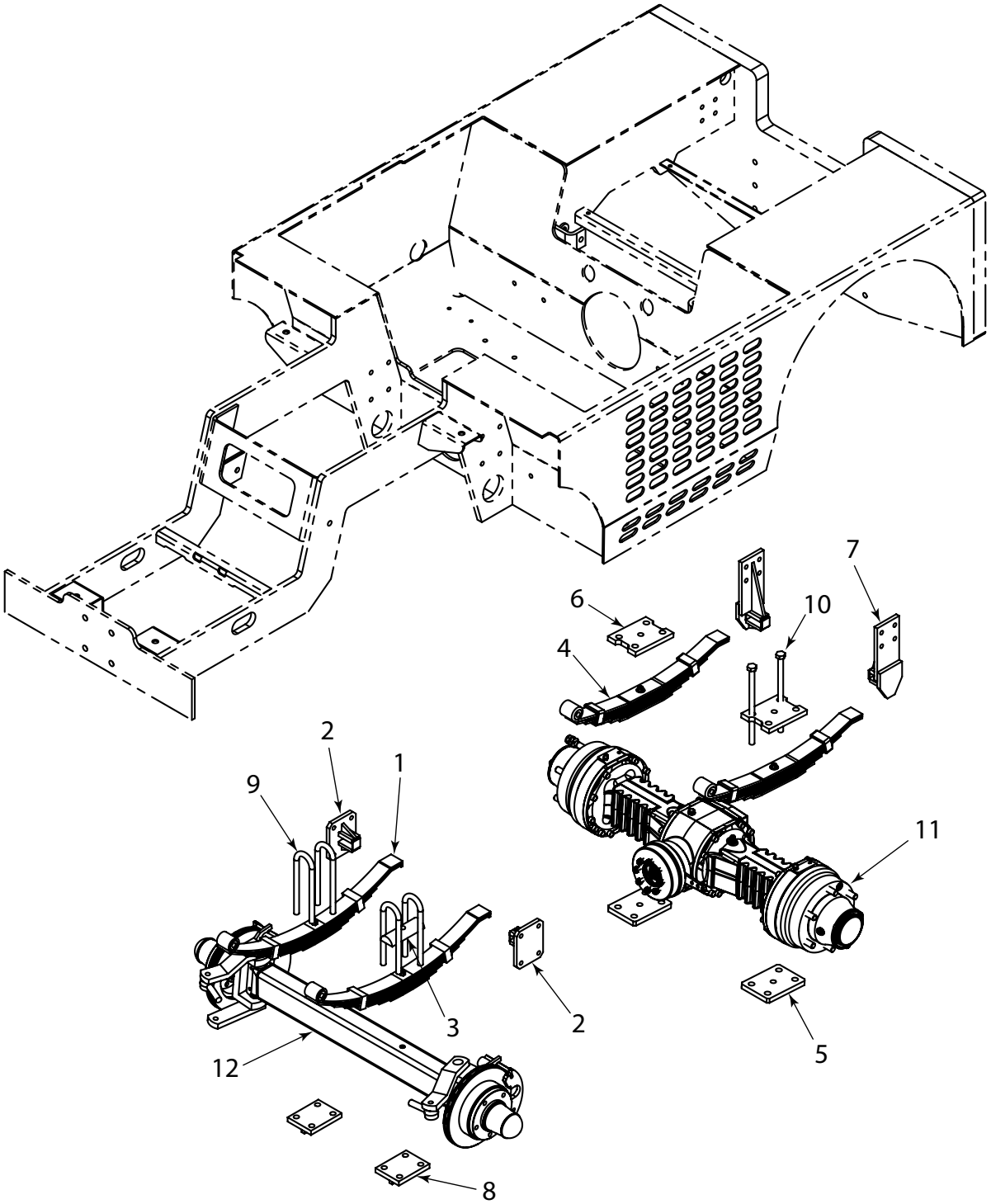


FIGURE 14.
SUSPENSION MODEL D

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
14-			Suspension, Model D		Ref
1	40036		Spring, Front		2
2	NW035667		Spring Mount		2
3	45696		Plate, Top		2
4	NW030070		Spring, Rear		2
5	51075		Plate, Rear Axle Spring		2
6	51074		Plate, Top		2
7	45570		Spring Mount		2
8	NW033675		Plate, Mount, Front Spring		2
9	12654.39		U-Bolt		4
10	51471		HHCS 5/8-11 x 11		8
11	51099		Axle, Assy, Rear		1
12	51024		Axle, Front		1

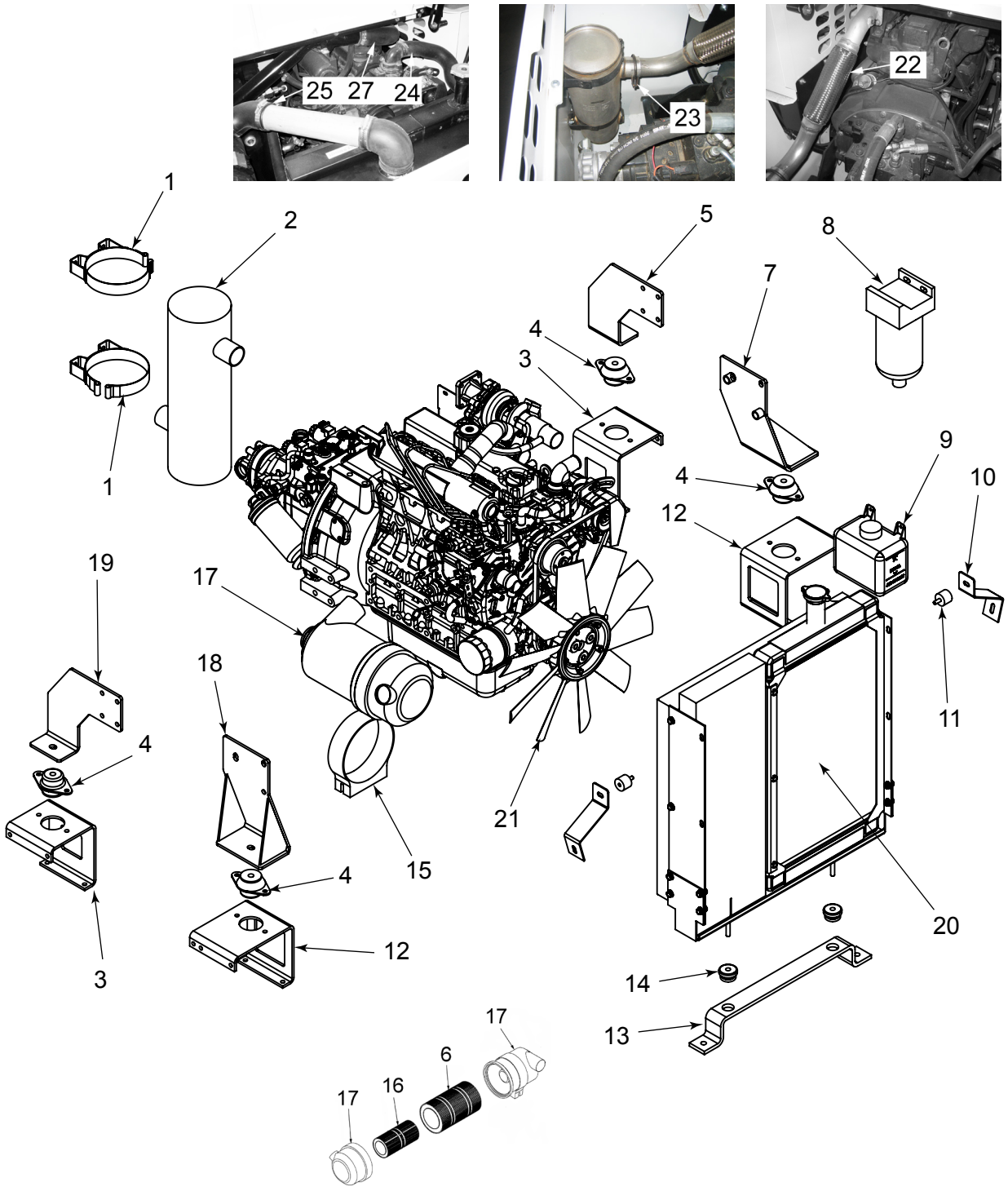


FIGURE 15.
COOLING, MOUNTING, INTAKE, EXHAUST-KUBOTA V2403

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
15-			Cooling, Mounting, Intake, Exhaust-Kubota V2403		Ref
1	51251		Mounting Band, Muffler		2
2	51249		Muffler		1
3	51478		Engine Mount, Base		2
4	37674		Isolator, Rubber, Engine		4
5	51533		Mount, Motor, Right		1
6	206410		Element, Primary, Air Cleaner		1
7	51535		Mount, Motor, Weldment, rear		1
8	37287		Fuel Filter W / Water Sep, heater		1
9	44544		Reservoir, Coolant, Overflow		1
10	51671		Support, Radiator, Upper		2
11	44298		Isolator, Rubber, Stud, Plt, 5/16		2
12	51479		Engine, Mount, Base, Front		1
13					
14	203566		Isolator, Rubber, Cntr, Bush, 3/8”		2
15	206260		Mnt, Air Cleaner, Mann		1
16	206411		Element, Safety, Air Cleaner		1
17	206259		Air Cleaner, Mann, 6”, Plastic		1
18	51536		Mount, Motor, Wldmnt, Front		1
19	51534		Mount, Motor, Left		1
20	51255		Radiator		1
21	51254		Fan, 20”		1
22	51719		Exhaust, Weldment		1
23	NW018217		Clamp, Muffler, 2.00”		1
24	1.8349		Hose, Radiator, Upper		1
25	NW036784		Ell, 2 1/4” ID, Rubber 45 Degree		2
26	206331		Ell, 60mm, Rubber, 90 Degree		1
27	50363		Hose, Air Intake		1
NS	205768		Reducer, Hose Insert 1.5 x 1.25		1
NS	51672		Hub, Lower, Fan		1
NS	51715		Universal Mount, Fan		1
NS	51720		Elbow, 90 Degree, Beaded Insert		1
NS	51721		Elbow, 90 Degree, Beaded Insert		1

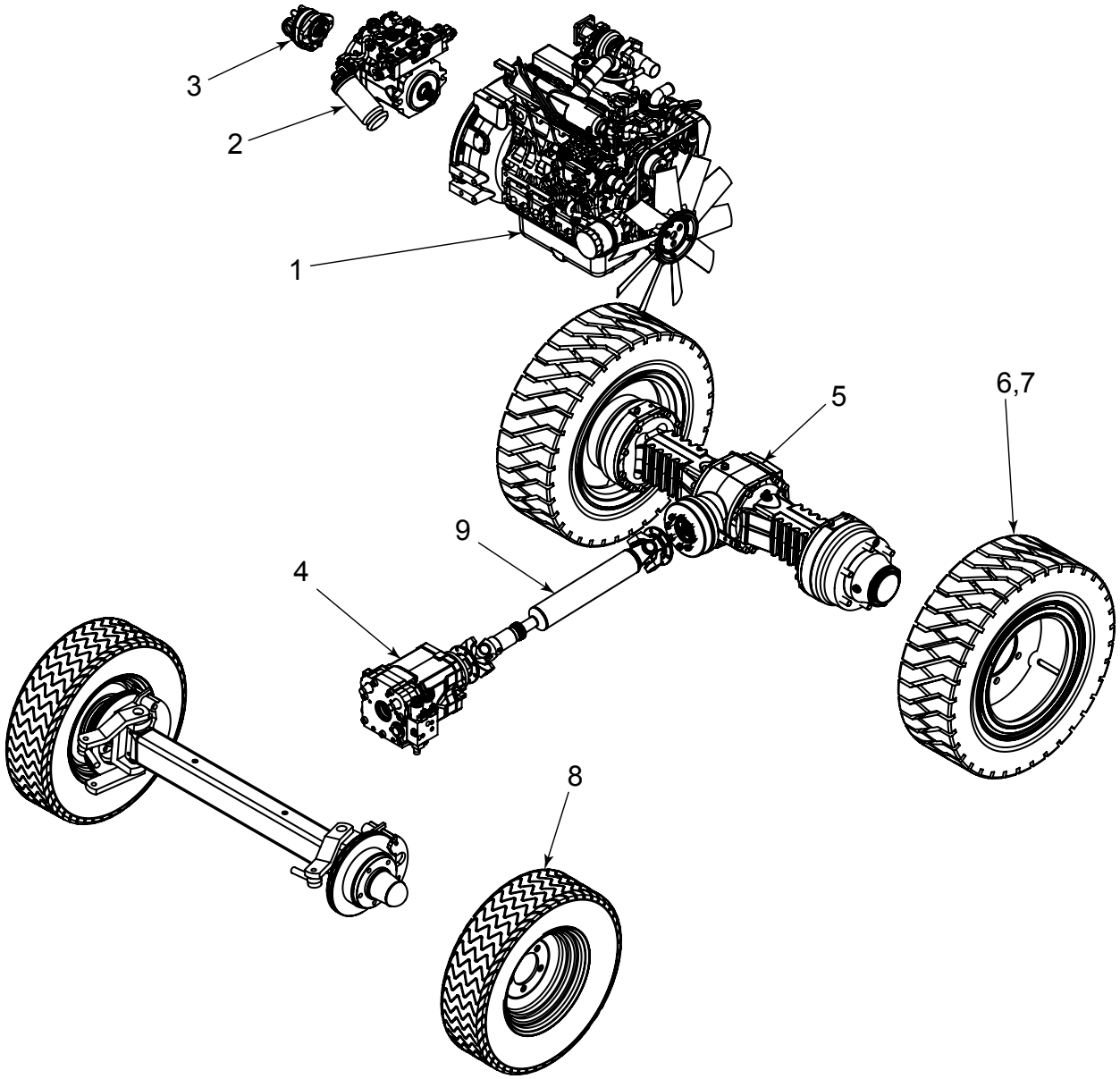
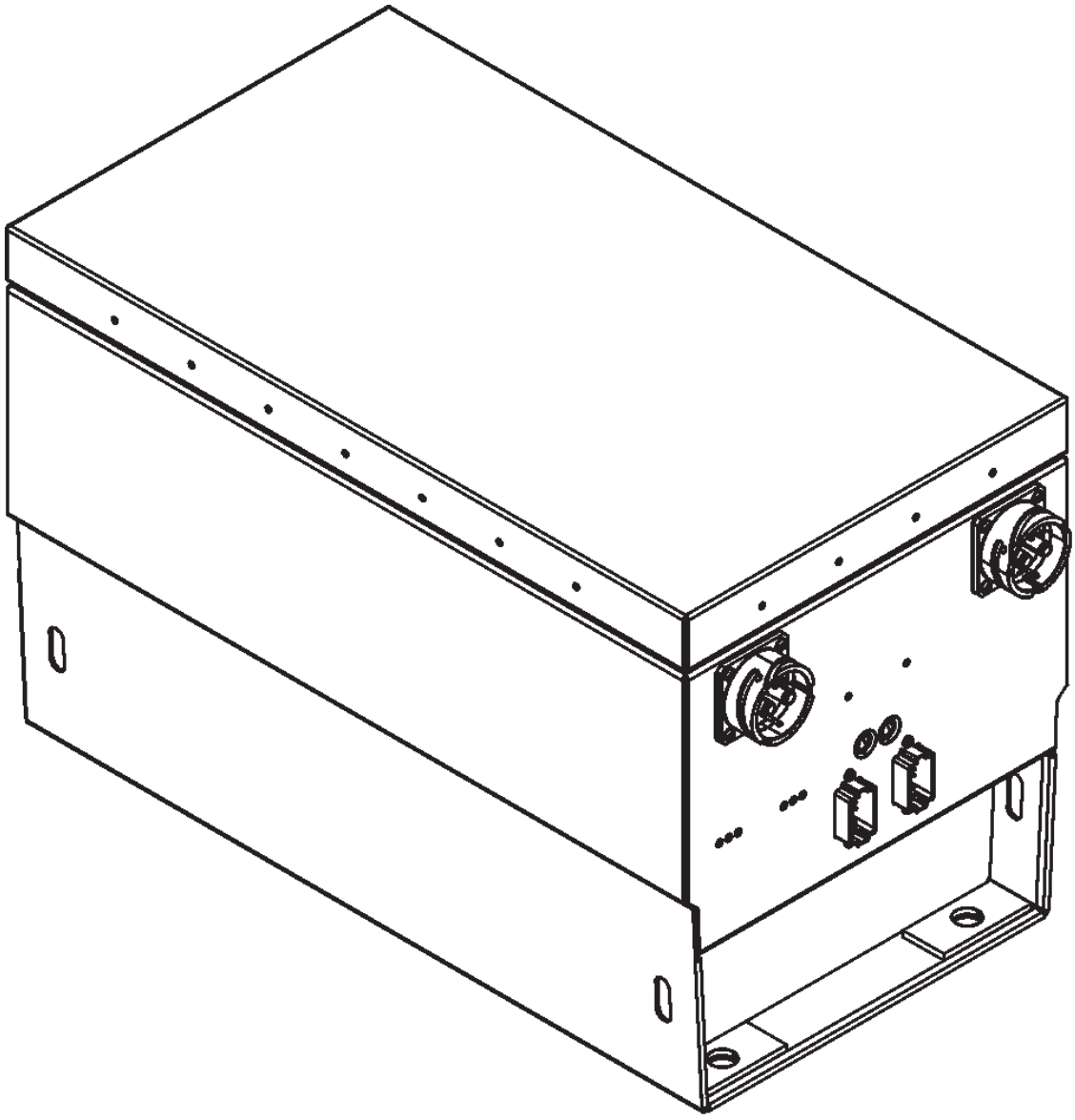


FIGURE 16.
DRIVE COMPONENTS MODEL D

Fig-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
16			Drive Components Model D		Ref
1	51248		Engine, Kubota, V2403		1
2	51252	HPV-55CC	Pump, Duraforce, 55CC		1
3	51350	26006-RZE	Pump, Gear, Eaton, 1.02 CID		1
4	51253	531AW00327A	Motor, Hydro, Duraforce, 105CC		
5	51099		Axle, Assembly, Comer (F08010141002A01)		1
6	51022		Tire, 28x9x15, 14 Ply		2
7	51088		Wheel Assy, 15x7, 3 Piece		2
8	NW026802		Wheel/Tire Assy, Front, 40/60 Air		2
9	51247		Driveshaft Assy		1
NS	51351		Relief, Diff Area		1
NS	47378-13		Engine Oil Filter		1
NS	47378-11		Fuel Filter		1
NS	47378-12		Fan Belt		1
NS	51353		Filter, Hydraulic Element		1



M40e-Battery.cdr

FIGURE 17.
BATTERY, MODEL 40E

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
17-	51071		Battery, Lithium Polymer		Ref

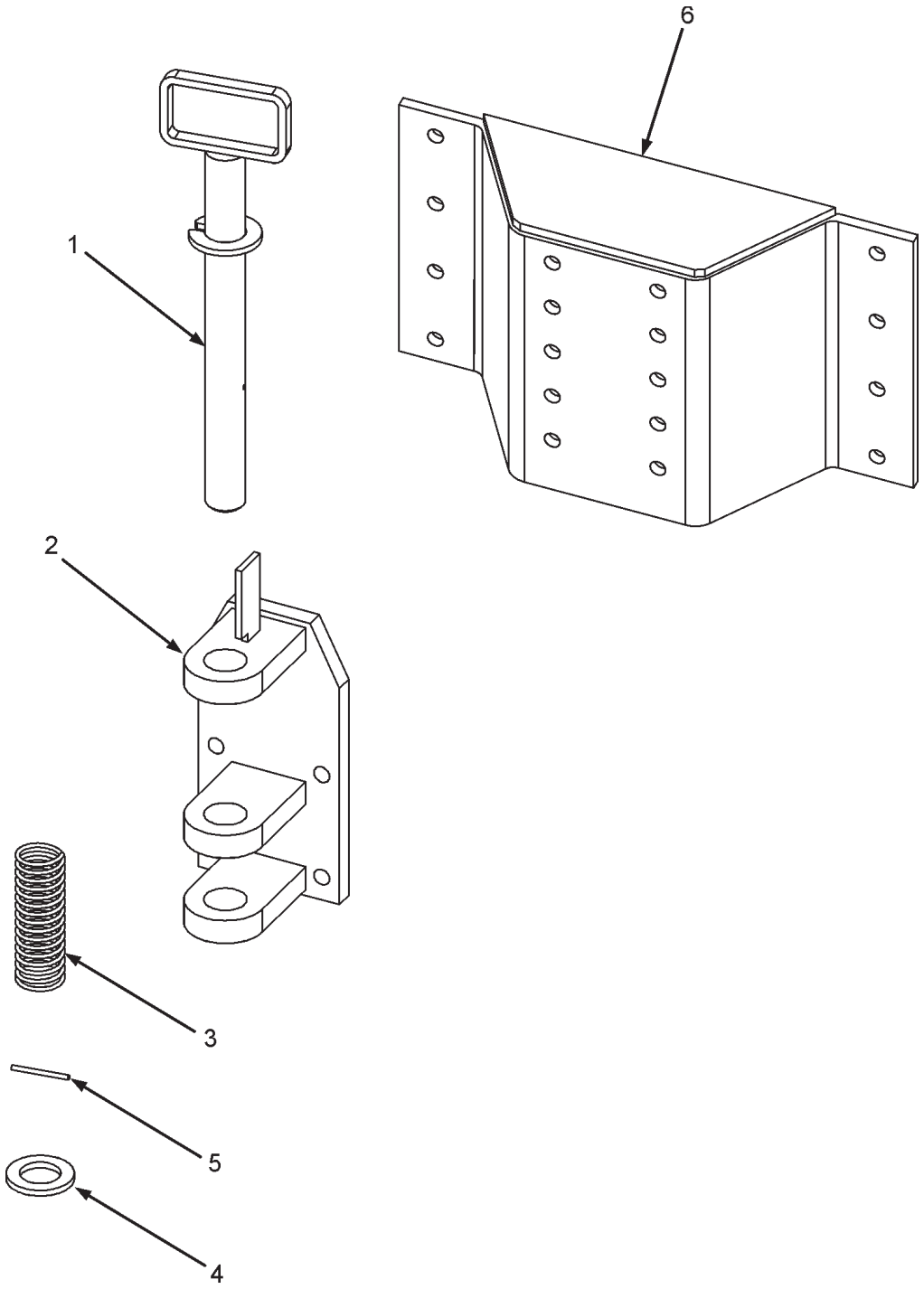


FIGURE 18.
HITCH, REAR

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
18-			Hitch, Rear		Ref
	39138		Hitch, Pin / Eye, Ssr Loaded, 1.50 OD		1
1	39140		Pin Wldmnt, 1.50		1
2	39139		Hitch Wldmnt, 1.5		1
3	39141		Spring, Comp, 1.56 X 5.56 X .125		1
4	39487		FW, 1.56 ID X 2.56 OD X .25		1
5	SWXRP202		Pin, Roll		1
6	51048		Hitch Extension Wldmnt		1

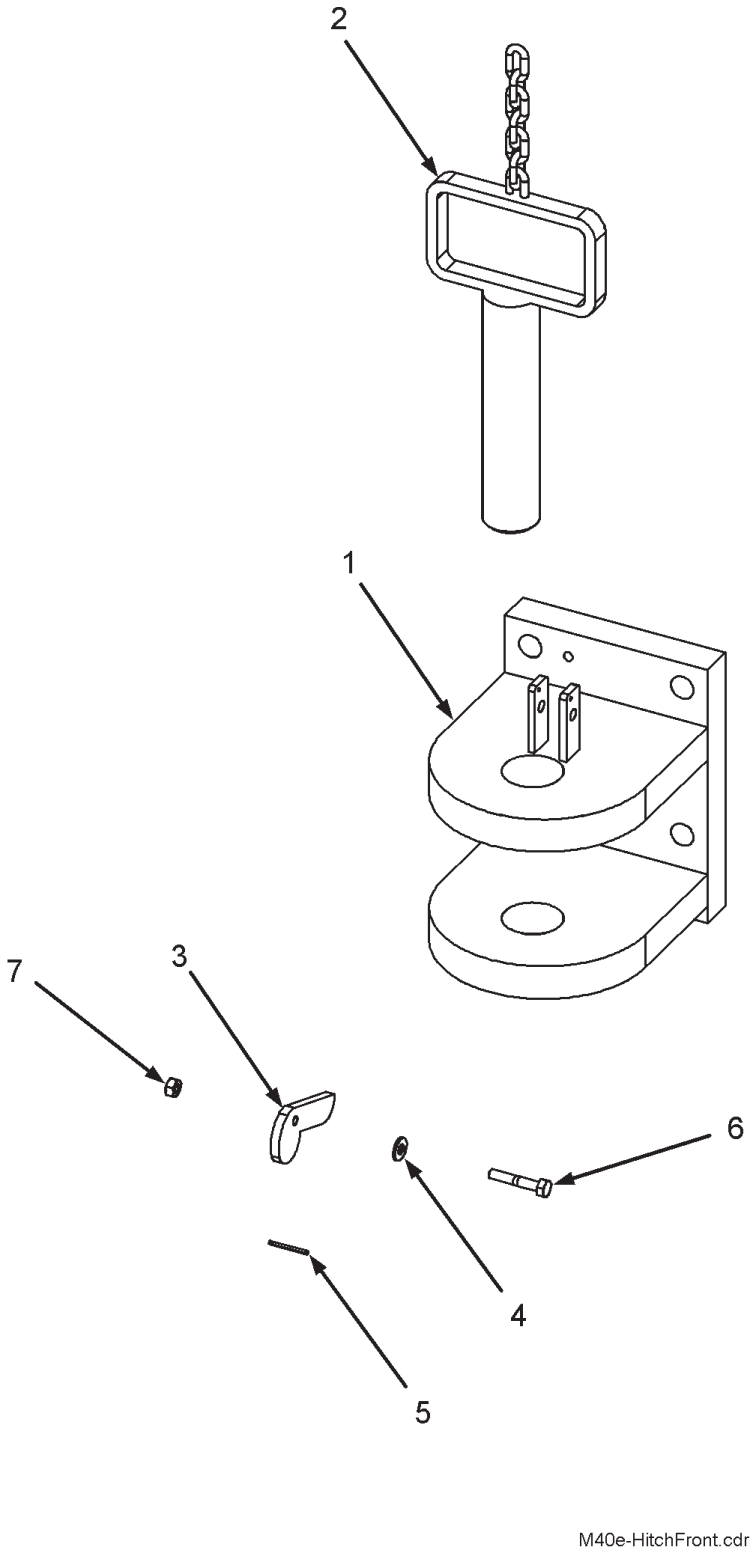


FIGURE 19.
HITCH, FRONT, W/RELEASE OPTION

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
19-			Hitch, Front, W / Release, Option		Ref
	38743		Coupler Assy, Pin / Eye, 1.5"		1
1	38744		Coupler Wldmnt, 1.5" Pin		1
2	38746		Pin Wldmnt, 1.50		1
3	NW034993		Lever Wldmnt, Safe-Catch,Pin / Eye		1
4	NW035901		Pin, Roll, 1/8 X 1		1
5	F0017264		HHCS, 1/4-20 X 1.00, GR5, ZC		1
6	F0009704		FW, 1/4 STD, ZC		1
7	F0009536		Nut, Hex, 1/4-20, Full, ZC		1

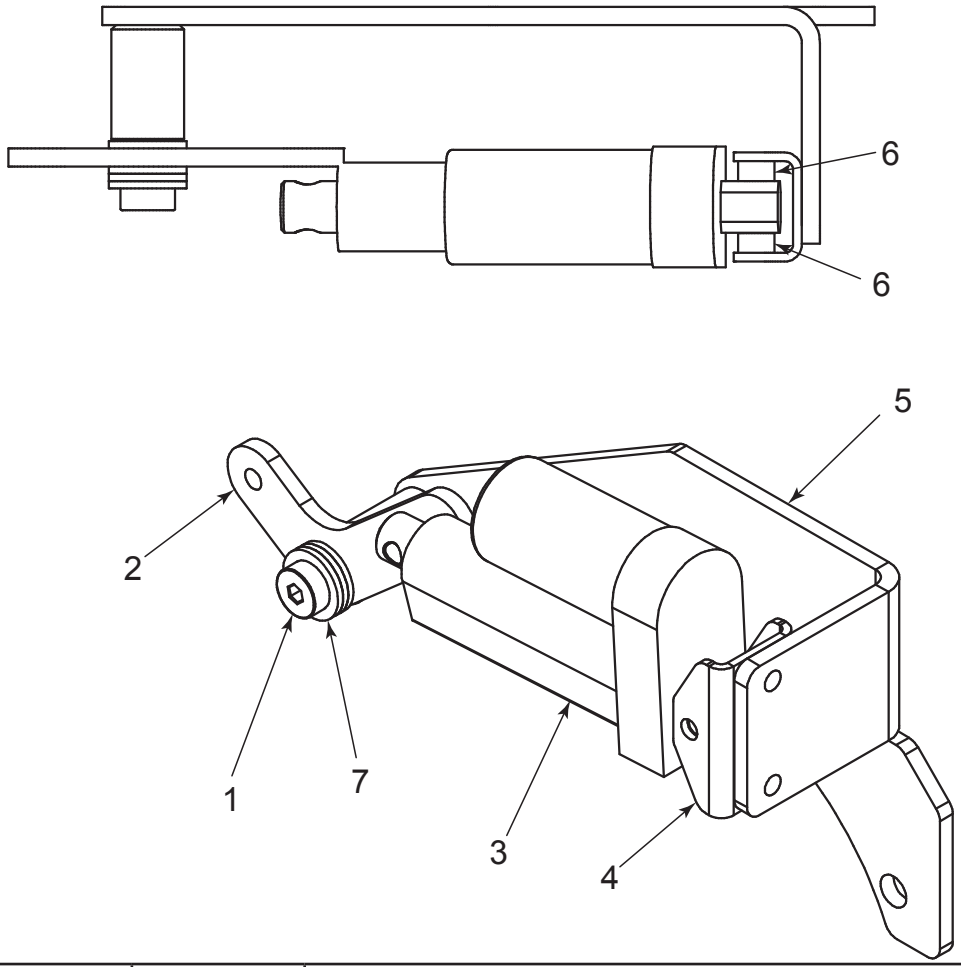


Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
10-	51451		Park Brake Mount Assy, Model D & E		Ref
1	3.2055		Bolt, SHLDR, 1/2 x 0.63		1
2	51453		Bellcrank, Park Brake		1
3	51638		Actuator, Brake, Electric		1
4	51722		Bracket, Brake, Electric		1
5	52614		Park Brake Actuator, Wldmnt		1
6	52615		Park Brake Actuator, Bushing		2
7	F100064		FW, 1/2 SAE, ZC		4

FIGURE 20.
PARK BRAKE MOUNT ASSY, MODEL D & E

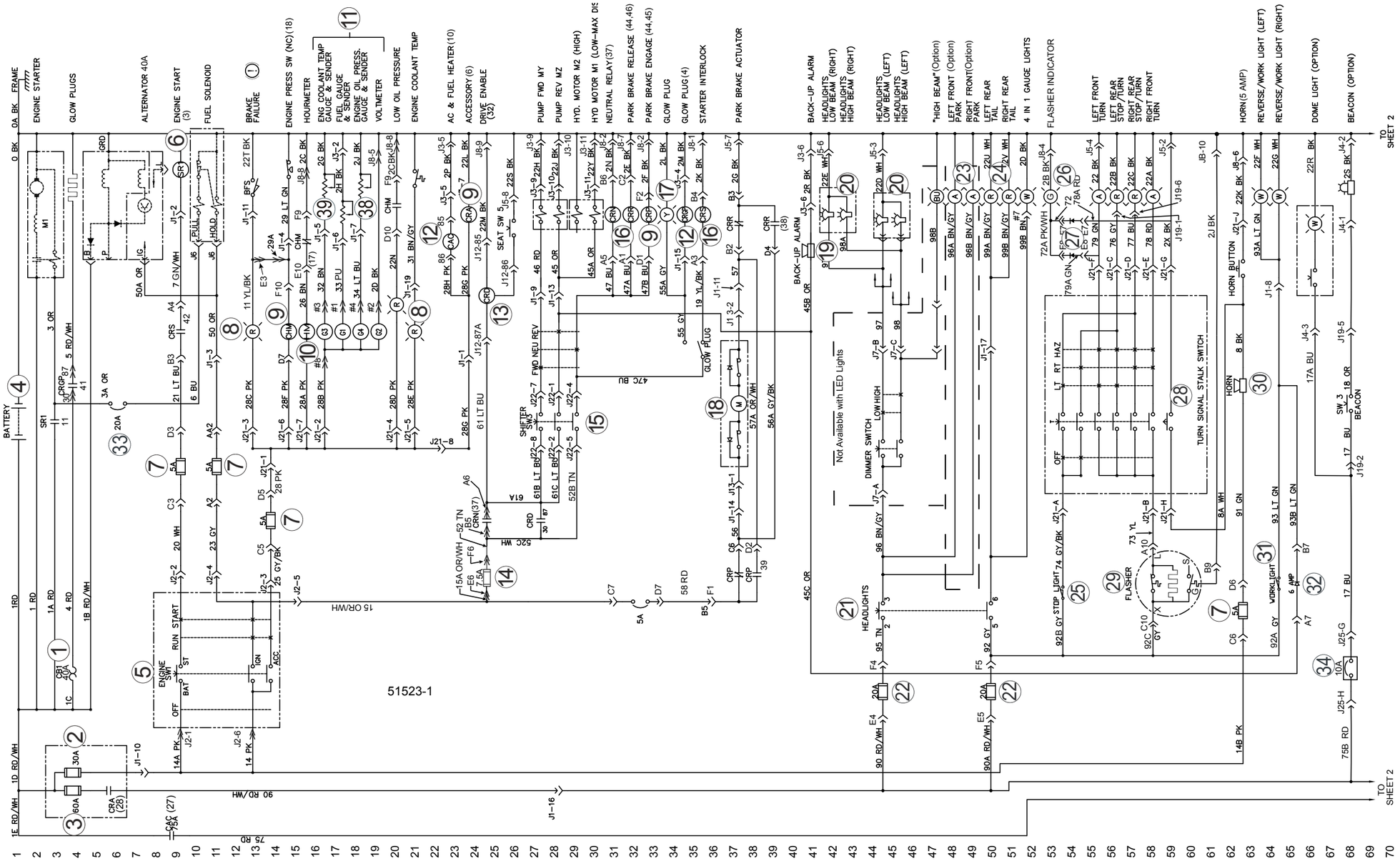


FIGURE 21.
ELECTRICAL ASSEMBLY MODEL D (1 OF 2)

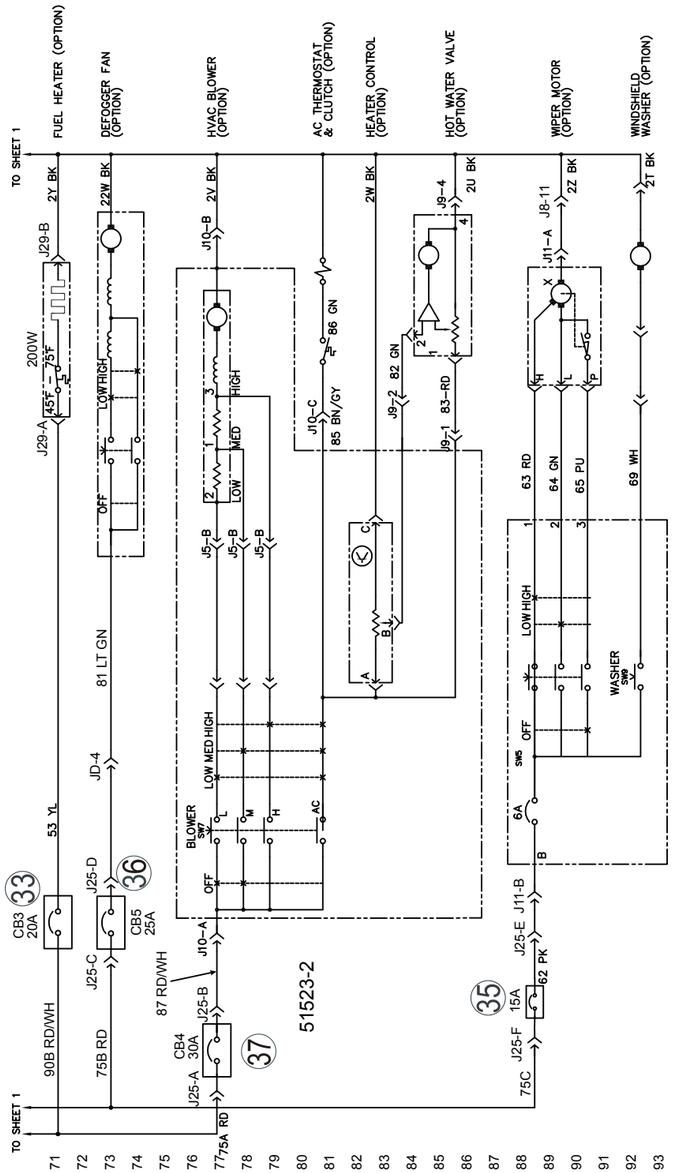


FIGURE 21.
ELECTRICAL ASSEMBLY MODEL D (2 OF 2)

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
21-	52568		Group, Electrical, M40D		Ref
1	2.0132		Breaker, Circuit 40A		1
2	49095		Fuse, 30A FMX		1
3	48915		Fuse, 60A FMX		1
4	2.3268		Battery		1
5	51826		Switch, Ignition		1
6	F102160		Relay, Starter, 12v		1
7	307215		Fuse, 5A/32V, ATM, Mini		4
8	310198		Light, Pilot, LED, 12v, Red		3
9	48144		Relay, Micro		3
10	41434		Gauge, Hourmeter		1
11	208167		Gauge-4-1		1
12	308475		Relay, 70A, 12v		1
13	52437		Relay, Time Delay 2 Seconds		1
14	51462		Fuse, 7.5A/32V,ATM		1
15	51089		Joystick Control		1
16	310171		Relay, 12v		2
17	310201		Light, Pilot, LED, 12v, Amber		1
18	51638		Actuator, Brake		1
19	NW024637		Alarm, Backup		1
20	309488		Light, Head,4.4Dia,		2
21	2.3014		Switch, Toggle, DPNO		1
22	307218		Fuse, 20A/32V ATM, Mini		2
23	51173		Light, Turn Park		2
24	45817		Light, Stop / Tail Red		2
25	2.0739		Switch, Stoplight, Plunger		1
26	310199		Light, Pilot, LED, 12v, Green		1
27	48154		Diode, 1A, ATM		3
28	47735		Turn Signal Assy		1
29	310175		Flasher, 12V		1
30	2.3000		Horn		1
31	2.3013		Switch, Toggle, SPNO		1
32	51527		Diode, 6A, ATM		1
33	2.0131		Breaker,Circuit, 20A		2
34	52006		Breaker, Circuit, 10A, Mini		1
35	52007		Breaker, Circuit, 15A, Mini		1
36	52009		Breaker, Circuit, 25A, Mini		1
37	52010		Breaker, Circuit, 30A, Mini		1
38	208310		Sender, Oil/Air Pressure 0-80 PSI		1
39	208311		Sender, Temp, 100-240		1

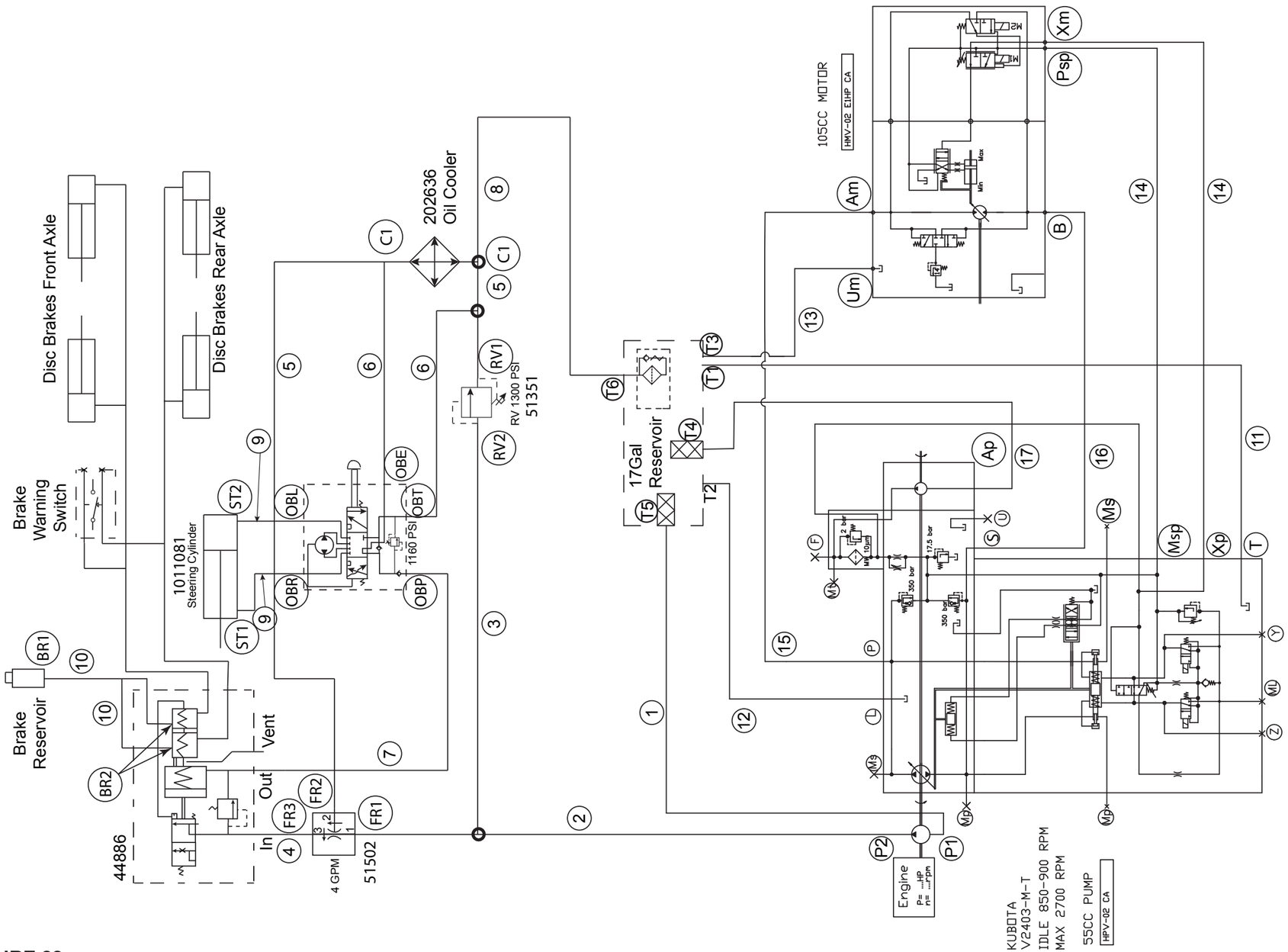


FIGURE 22.
HYDRAULIC ASSEMBLY MODEL D

Fig.-Item	NMC Wollard Part No.	Vendor Part No.	Nomenclature	Eff	Units Per Assy
-	52581		Group, Hydraulic, M40D		Ref
1	210122		Hose, Suction 1.25 x 34		1
2	207793.28		Hose, #8H x 28, St/St		1
3	202609		Hose, #8M x 11.5, St/St		1
4	8797.53		Hose, #8M x 79.5. St/90		1
5	8797.51		Hose, #8M x 53, St/90		2
6	48395.9		Hose, #6M x 130, #6 St/#8 St		2
7	208714		Hose, #6H x 49, #6St/#8St		1
8	8797.56		Hose, #8M x 22 St/90		1
9	208514		Hose, #6H x 96, St/St		2
10	9.2066		Hose, 0.37ID Low Press		72.5”
11	200609		Hose, #12L x 36, St/90		1
12	207036		Hose, #12L x 20, St/St		1
13	NW035956		Hose, #12L x 24, St/90		1
14	208709		Hose, #6H x 50, St/90		2
15	52842		Hose, #12H x 30, # 12FL90/#16 St		1
16	52841		Hose, #12H x 26, #12FL90/#16 St		1
17	52837		Hose, #16L x 36, #16St/#20 St		1
T,L,Um	52217		Ftg, Hyd,12MJ-22MM		3
X, Msp	52216		Ftg, Hyd, 06MJ-14MM		3
A	52803		Ftg,Hyd, 16MJ-27MM		1
P,S	206159		Kit, Flange, C62-12		2
Xm,Psp	52334		Ftg, Hyd, Ell, 06MJ-14MM		2
Am,B	50900		Ftg, Hyd, 16MJ-16FLH90		2
Am.B	206149		Kit, Flange, C62-16		2
T1,T2,T3	91938		Ftg, Hyd, 12MJ-12MB90		3
T5	51721		Elbow, 90 deg, Beaded Insert,20		1
T4	1012226		Ftg, Hyd, 20MJ-20MB90		1
T6	52821		Ftg, Hyd, 16MB-8FB		1
T6	NW033653		Ftg, Hyd, 8MJL-8MB		1
P1	51720		Elbow, 90 deg, Beaded Insert,16-20		1
P2 OUT	3.3304		Ftg, Hyd, 08-MJ-10MB90		3
RV1	90422		Ftg, Hyd, Tee, 08MJ-08MJ		1
RV2	F101324		Ftg, Hyd, 08MJ-08MB45		1
FR1,C1	202636		Ftg, Hyd, Tee 08MJ-10MB-08MJ		3
FR2, FR3	3.3304		Ftg, Hyd, 08MJ-10MB90		2
ST1,ST2	3.1572		Ftg, Hyd, 06MJ-06MP		2
OBL OBR OBT OBP OBE	3.2518		Ftg, Hyd, 06MJ-06MB		5
IN	3.2703		Ftg, Hyd, 08MJ-10MB		1
VENT	3.2461		Ftg, Hyd, Plug, 02MT,Skt		1
BR1	1.8808		Ftg,Hyd, 06H-06FJX		1
BR2	F104402		Ftg, Hyd, 06H-06FJX90		3

CHAPTER 5 MANUFACTURES INFORMATION TABLE OF CONTENTS

This Page Intentionally Blank

comer industries
axles

MAINTENANCE INSTRUCTIONS

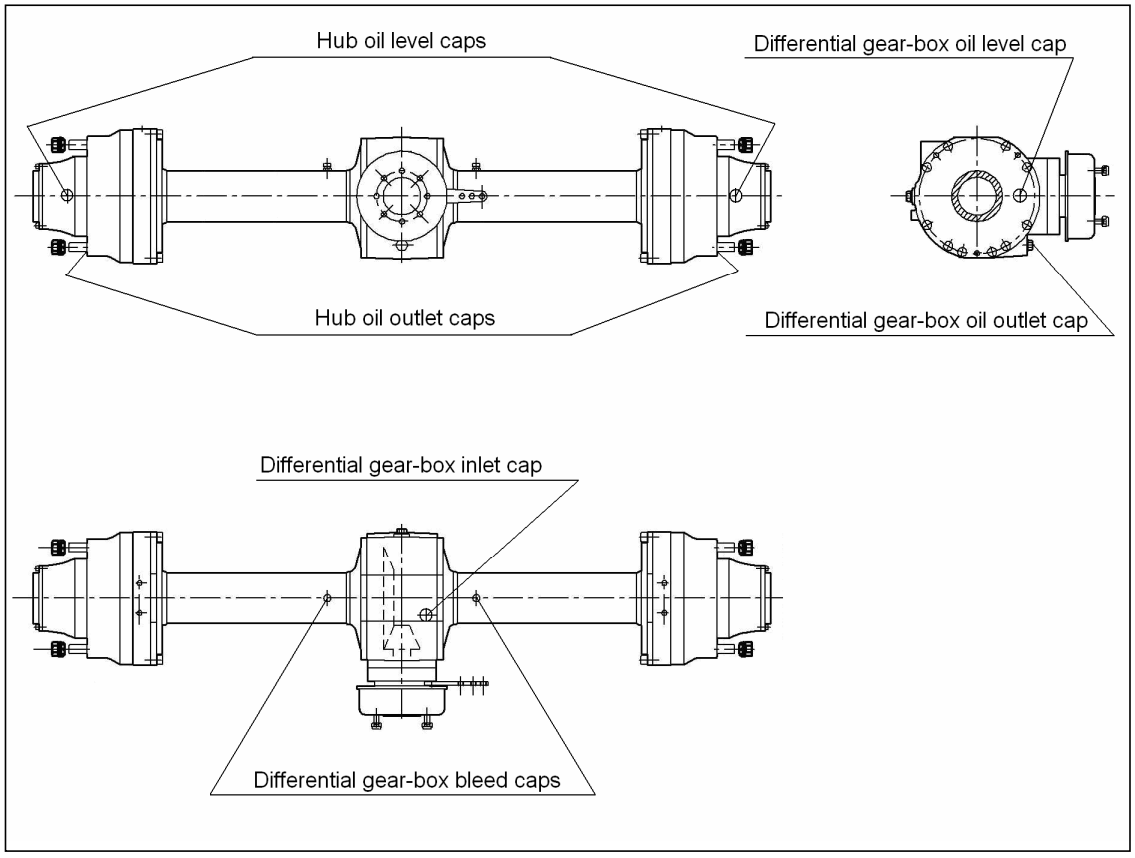
RIGID DRIVE AXLE

SERIES

Indumec 080

SMN 870585.B001

comer industries	*Drive axle series* ***080*** ***SMN 870585.B001***	Issue date: 04/07 Revision: 01 Issued by: POS Checked by: POS

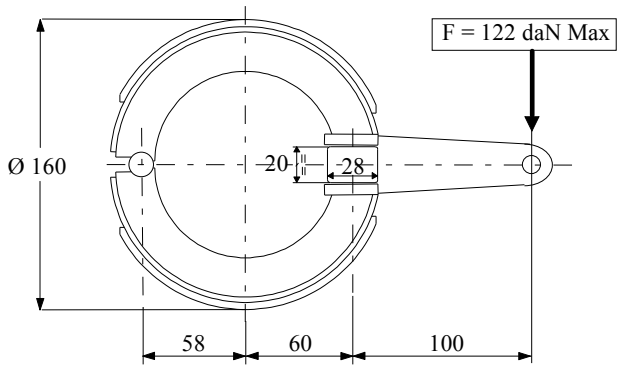


- For the lubrication of the differential axle use "AGIP ROTRA MP"-type oil. Pour approximately **7,9** lt into the axle through the diffential gear-box inlet port.

  In order to allow effective operation and better performance of the transmission members, completely replace the oil after the first 300 operating hours. Subsequently repeat replacement every 1000 hours.

comer industries	*Drive axle series* ***080*** ***SMN 870585.B001***	Issue date: 04/07 Revision: 01 Issued by: POS Checked by: POS

KNOTT 160x40 DRUM PARKING BRAKE



Brakeshoe dimension	= 160x40 mm
Brakeshoe thickness	= 4 mm
Total braking surface	= 128 cm^2
Max braking torque (with F = 122 daN)	= 70 daNm
Max braking moment at wheels (with total ratio 10.7294:1)	**= 751 daNm**

In order to allow use of oils of different manufacturers, the main features of the two recommended oil types are shown below.

AGIP ROTRA MP (Gear lubrication)

SAE rating		80W-90
Viscosity at 100 °C	mm^2/S	15
Viscosity at 40 °C	mm^2/S	144
Viscosity at -26 °C	cP	110,000
Viscosity index		104
Inflammability V.A.	°C	210
Creeping point	°C	-27
Density at 15° C	kg/l	0.900

51252 HYDROSTATIC PUMP SERVICE

Eaton® DuraForce™ General

Service Manual

Powering Business Worldwide

Torque Specifications for Eaton Metric Socket-Head Cap Screws

Table 1: Screws without Loctite

Note:

The torque specifications presented within this Service Bulletin are standard for the metric sockethead cap screws (S.H.C.S.) used on Eaton products. The standard torque specifications are to be disregarded ONLY when a different torque specification is called out for by a Eaton Spare Parts List, a Eaton Engineering Drawing, a Eaton Engineering Document, or by a Eaton Engineer.

		Torque (ft.lb)						
	Dimension	**4.6**	**4.8**	**5.8/22H/45H**	**6.8**	**8.8**	**10.9**	**12.9**
Standard Thread	M4	0.7	1.0	1.3	.5	2.0	2.8	3.4
	M5	1.5	2.0	2.5	3.0	4.1	5.9	7.0
	M6	2.7	3.5	4.4	5.2	7.0	9.6	11.8
	M8	6	8	10	13	17	24	29
	M10	13	17	21	25	34	47	57
	M12	22	30	37	44	59	81	100
	M14	35	46	58	69	92	133	159
	M16	54	74	90	108	144	203	243
	M20	107	140	177	213	284	398	479
	M24	184	243	302	365	487	686	811
	M30	376	498	620	738	996	1364	1659
	M36	649	863	1084	1298	1733	2434	2876
Fine Pitch Thread	M8 X 1	7	9	12	14	18	26	31
	M10 X 1	15	19	24	29	38	53	70
	M10 X 1.25	13	18	22	27	36	50	60
	M12 X 1.25	24	32	41	49	65	92	111
	M12 X 1.5	23	30	38	46	61	85	103
	M14 X 1.5	38	52	64	77	103	144	173
	M16 X 1.5	58	77	96	116	155	218	258
	M18 X 1.5	85	111	140	170	225	313	376
	M20 X 1.5	118	155	195	236	313	443	531
	M22 X 1.5	159	210	262	313	420	590	708
	M24 X 2	199	266	332	398	531	738	885
	M27 X 2	291	387	483	579	774	1106	1328
	M30 X 2	398	535	667	800	1069	1512	1844
	M36 X 3	686	922	1151	1379	1844	2581	3024

Torque Specifications for Eaton Metric Socket-Head Cap Screws

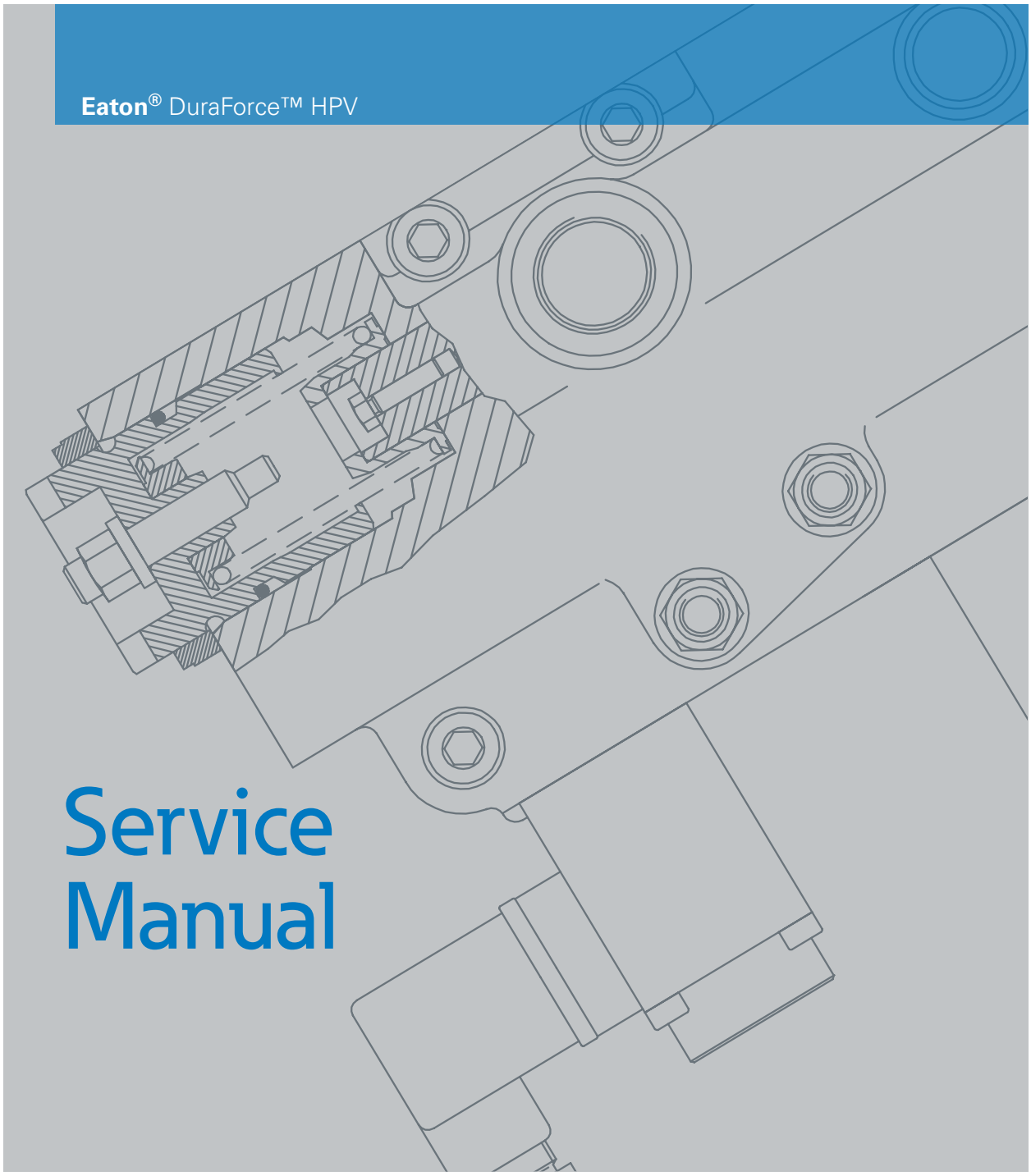
Table 2: Screws with Loctite

Note:

The torque specifications presented within this Service Bulletin are standard for the metric sockethead cap screws (S.H.C.S.) used on Eaton products. The standard torque specifications are to be disregarded ONLY when a different torque specification is called out for by a Eaton Spare Parts List, a Eaton Engineering Drawing, a Eaton Engineering Document, or by a Eaton Engineer.

		Torque (ft.lb)						
	Dimension	**4.6**	**4.8**	**5.8/22H/45H**	**6.8**	**8.8**	**10.9**	**12.9**
Standard Thread	M4	0.8	1.0	1.3	1.6	2.1	3.0	3.6
	M5	1.6	2.2	2.7	3.3	4.4	6.3	7.4
	M6	2.7	3.7	4.6	5.5	7.4	10.3	12.5
	M8	7	9	12	14	18	26	30
	M10	13	18	23	27	36	51	61
	M12	24	32	40	48	63	89	107
	M14	37	49	63	74	100	140	170
	M16	59	77	96	118	155	218	262
	M20	114	151	192	229	302	428	509
	M24	195	262	328	391	524	738	885
	M30	398	535	667	797	1069	1475	1770
	M36	723	959	1195	1438	1918	2729	3171
Fine Pitch Thread	M8 X 1	7	10	13	15	20	28	33
	M10 X 1	15	20	25	30	41	57	69
	M10 X	1.25	14	19	24	29	38	54 65
	M12 X 1.25	27	35	44	52	70	100	118
	M12 X 1.5	26	33	41	50	66	92	111
	M14 X 1.5	41	55	70	81	111	155	184
	M16 X 1.5	63	83	103	125	166	232	280
	M18 X 1.5	89	118	151	181	240	339	406
	M20 X 1.5	125	170	214	254	339	472	568
	M22 X 1.5	170	225	280	339	450	634	774
	M24 X 2	214	288	361	431	575	811	959
	M27 X 2	317	424	531	634	848	1180	1438
	M30 X 2	443	590	738	885	1180	1659	1991
	M36 X 3	767	1033	1291	1549	2065	2876	3393

Eaton® DuraForce™ HPV



Service Manual

Powering Business Worldwide

Table of Contents

Hydraulic Neutral Adjustment for HPV Pumps

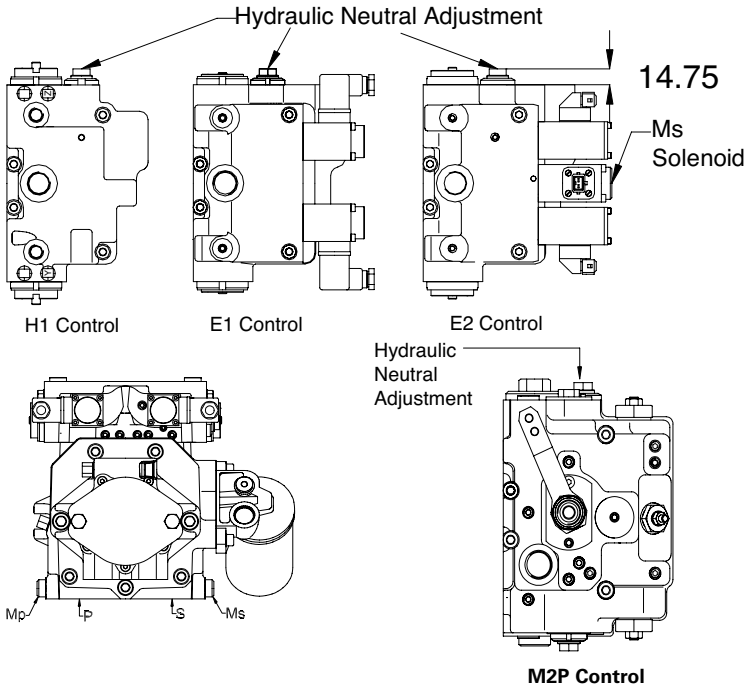
Set Up and Procedure

⚠ Note

This Service Bulletin is valid for HPV pumps controls, except the "M1" control. For HPV pumps with "M1" Control, refer to pages 9-10 for the hydraulic neutral adjustment instructions.

Tools / Equipment Required

- Two (2) 0-600 psi pressure gauges or transducers
- 16mm wrench (optional: adjustable wrench)
- Digital calipers (optional: depth micrometers)
- Hammer and punch



M2P Control

Adjustment Procedure:

1. Install the 0-600 psi pressure gauges into gauge ports "Mp" and "Ms" to measure work-port pressures "P" and "S".
2. Set the input speed to high idle.
3. With the pump in neutral, measure the pressure difference between work-ports "P" and "S".

Note: Pump in neutral means no control pressure or current supplied to the controls. For M2P controls, the lever must be in neutral position.

a. If the maximum pressure difference is 29 psi (2 bar) or less, then adjustment to the hydraulic neutral is NOT required, Remove all gauges from the pump.

b. If the maximum pressure difference is greater than 29 psi (2 bar), then go to step #4.

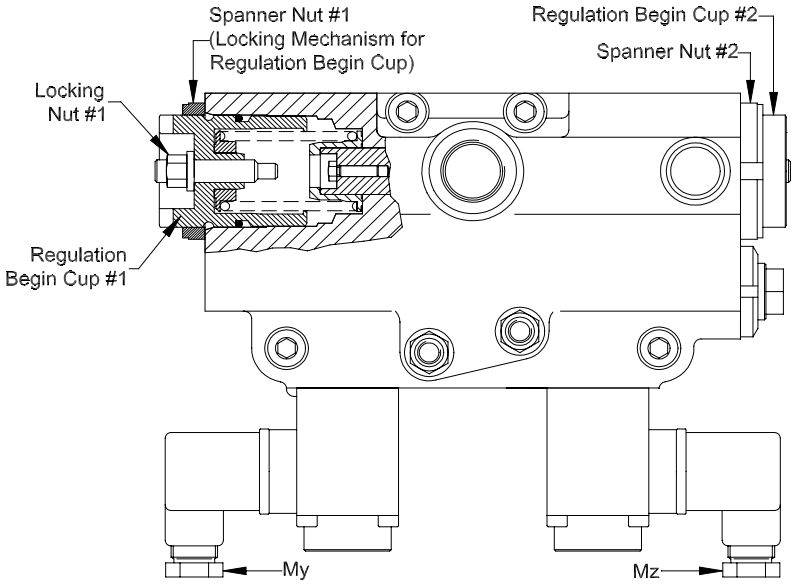
4. Loosen the Spanner Nut with the hammer and punch.
5. Using a 16mm wrench and the digital calipers, adjust the Hydraulic Neutral Adjustment to 14.75mm as illustrated in the sketch above.
6. Repeat steps #2 and #3. Continue to make small adjustments to the Hydraulic Neutral Adjustment until the pressure difference between work-ports "P" and "S" is less than 29 psi.
7. Secure the Hydraulic Neutral Adjustment by tightening the Spanner Nut once all settings are final. Remove all gauges from the pump.

Regulation Begin Adjustment for HPV With Electro-Hydraulic Remote Control

Set Up

Tools / Equipment Required

- Multi-meter (capable of reading 0 to 1000 mA)
- 0-6000 psi pressure gauge or transducer
- 13mm offset closed-end wrench
- Hammer and punch

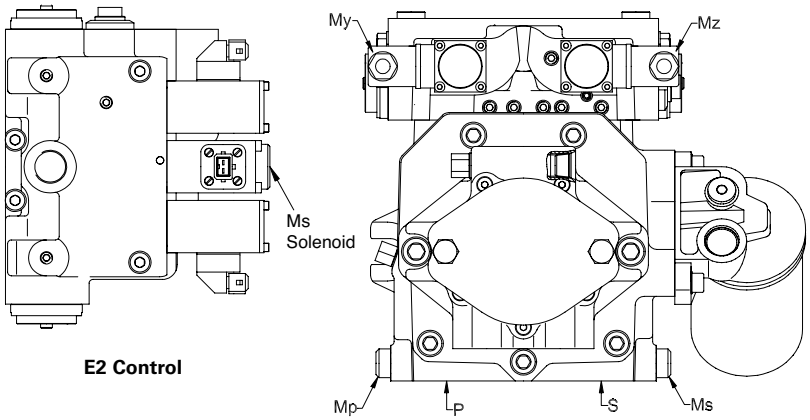


⚠ **Important**

AFTER adjusting the regulation begin, you must reset the pump maximum displacement setting. Follow the instructions on pages 7-8 to reset the pump maximum displacement.

⚠ **WARNING**

If performing this procedure on a vehicle, care must be taken. The pump will be put on stroke during this procedure, hence the vehicle must be safely elevated to allow the motor to free-wheel. If this is NOT possible, then the pump workports "P" and "S" must be short circuited to each other to avoid movement of the motor.



E2 Control

Regulation Begin Adjustment for HPV With Electro-Hydraulic Remote Control

Procedure for Right-Hand Rotation

⚠ **Note**

Prior to performing this procedure, verify that the hydraulic neutral on the pump is correctly adjusted.

Adjustment Procedure for Right-Hand Rotation (CW) Pump:

1. Connect the multi-meter to measure current at solenoid "My".
2. Install the 0-6000 psi gauge into gauge port "Mp".
3. Set the pump input speed to high idle.
4. For E2 controls, make sure that Ms Solenoid is energized.
   a. 1.82A (12VDC)
   b. 1.10A (24VDC)
5. While simultaneously monitoring the gauge and multi-meter, slowly energize solenoid "My". Note the current on the multi-meter when you first see pressure increase at port "Mp". This is the regulation begin setting for workport "P".
6. To Adjust the Regulation Begin Setting:
   a. Use the hammer and punch to loosen "Spanner Nut #2".
   b. Use the 13mm wrench on "Locking Nut #2" to adjust "Regulation Begin Cup #2". Turn it IN to increase the regulation begin setting or turn it OUT to decrease it.
   c. Use the hammer and punch to tighten "Spanner Nut #2".
   d. Repeat steps #3 through #5 to verify that the regulation begin setting is:

Control Range:	A (2-8bar)	B (4-10bar)	C(4-16bar)
Regulation Begin for 12 VDC:	350 mA	450 mA	450 mA
Regulation Begin for 24 VDC:	175 mA	225 mA	225 mA

7. Repeat steps #1 through #6 for solenoid "Mz" and gauge port "Ms" to adjust the regulation begin setting for workport "S".

Note: Adjustments should be made to "Regulation Begin Cup #1"

Regulation Begin Adjustment for HPV With Electro-Hydraulic Remote Control

Procedure for Left-Hand Rotation

⚠ **Note**

Prior to performing this procedure, verify that the hydraulic neutral on the pump is correctly adjusted.

Adjustment Procedure for Left-Hand Rotation (CCW) Pump:

1. Connect the multi-meter to measure current at solenoid "Mz".
2. Install the 0-6000 psi gauge into gauge port "Mp".
3. Set the pump input speed to high idle.
4. For E2 controls, make sure that Ms Solenoid is energized.
   a. 1.82A (12VDC)
   b. 1.10A (24VDC)
5. While simultaneously monitoring the gauge and multi-meter, slowly energize solenoid "Mz". Note the current on the multi-meter when you first see pressure increase at port "Mp". This is the regulation begin setting for workport "P".
6. To Adjust the Regulation Begin Setting:
   a. Use the hammer and punch to loosen "Spanner Nut #1".
   b. Use the 13mm wrench on "Locking Nut #1" to adjust "Regulation Begin Cup #1". Turn it IN to increase the regulation begin setting or turn it OUT to decrease it.
   c. Use the hammer and punch to tighten "Spanner Nut #1".
   d. Repeat steps #3 through #5 to verify that the regulation begin setting is:

Control Range:	A (2-8bar)	B (4-10bar)	C(4-16bar)
Regulation Begin for 12 VDC:	350 mA	450 mA	450 mA
Regulation Begin for 24 VDC:	175 mA	225 mA	225 mA

7. Repeat steps #1 through #6 for solenoid "My" and gauge port "Ms" to adjust the regulation begin setting for workport "S".

Note: Adjustments should be made to "Regulation Begin Cup #2".

Maximum Flow Adjustment Procedure for HPV Pumps with "H" or "E" Controls

Set Up

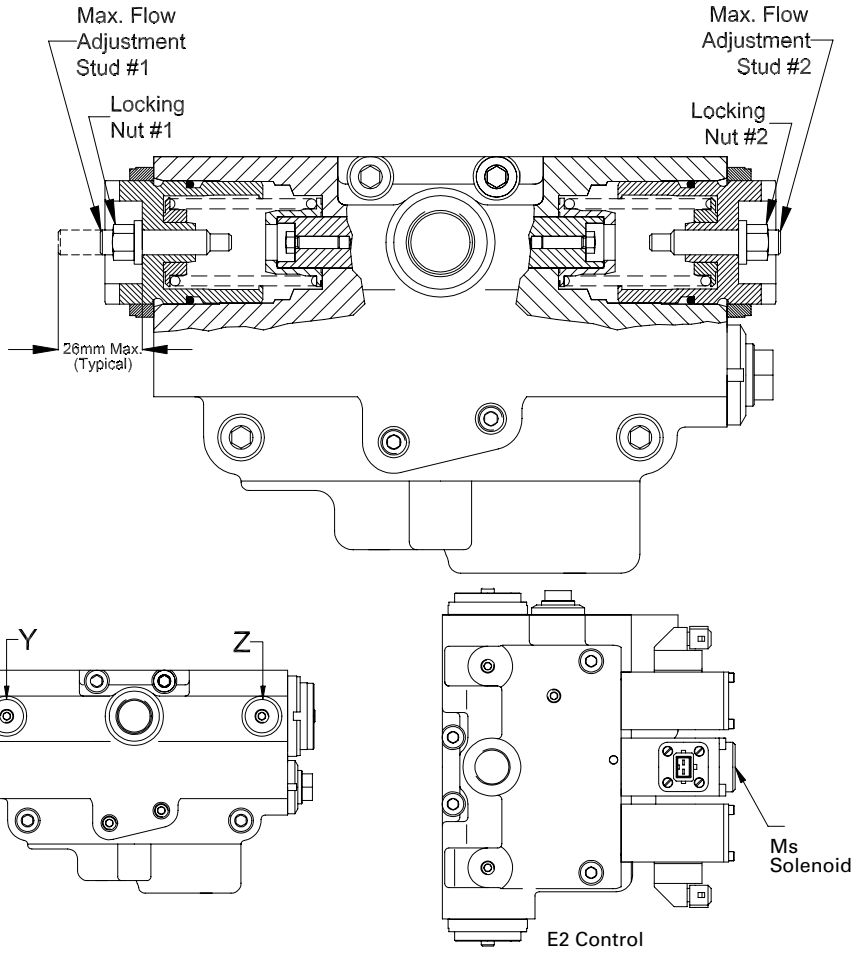
Tools / Equipment Required

- 0-600 psi pressure gauge or transducer (optional)
- 13mm offset closed-end wrench
- 4mm Allen wrench

⚠ Note

This Service Bulletin is valid for HPV pumps with either "H" (Hydraulic Remote) or "E" (Electro-Hydraulic Remote) Controls

The drawing below illustrates an "H1" Control, but the information is also valid for "H1P", "E1", "E1P, and "E2" Controls.



Maximum Flow Adjustment Procedure for HPV Pumps with "H" or "E" Controls

Adjustment Procedure

⚠ WARNING

If performing this procedure on a vehicle, care must be taken. The pump will be put on stroke during this procedure; hence the vehicle must be safely elevated to allow the motor to free-wheel. If this is NOT possible, then the pump work-ports "P" and "S" must be short circuited to each other. Install a properly sized flow-meter in the short circuit line between "P" and "S" to avoid movement of the motor.

1. (Optional) Install the 0-600 psi gauge into gauge port "Y".
2. Set the input speed to high idle.
3. For E2 Controls, make sure that Ms Solenoid is energized.
   a. 1.82A (12VDC)
   b. 1.10A (24VDC)
4. Supply full control pressure to port "Y" or full current to solenoid "My". (Optional) Confirm that the pressure at port "Y" is adequate to put the pump at full displacement.
5. Measure the rotational speed of the motor, the wheel, the gearbox, etc. and calculate if the pump is supplying enough flow. If using a short circuit line, measure the flow from the flow-meter.
6. To Adjust the Maximum Flow:
   a. Use the 13mm wrench to loosen "Locking Nut #2".
   b. Use the 4mm Allen wrench to turn "Max. Flow Adjustment Stud #2". Turn it IN to decrease the maximum flow or turn it OUT to increase it..

      ⚠ WARNING

      The flow adjustment stud is NOT mechanically restricted from being removed completely from the pump. Care should be taken when turning the flow adjustment stud OUT. DO NOT turn the adjustment stud OUT more than 26mm as illustrated on previous page.

   c. Once the desired maximum flow has been acquired, hold the flow adjustment stud stationary with the 4mm Allen wrench and tighten the locking nut with the 13mm wrench (the proper torque for the locking nut is 10 ft-lb [14 N-m].

7. (Optional) Install the 0-600 psi gauge into gauge port "Z".
8. Set the input speed to high idle.
9. For E2 Controls, Make sure that Ms Solenoid is energized.
   a. 1.82A (12VDC)
   b. 1.10A (24VDC)
10. Supply full control pressure to port "Z" or full current to solenoid "Mz". (Optional) Confirm that the pressure at port "Z" is adequate to put the pump at full displacement.
11. Measure the rotational speed of the motor, the wheel, the gearbox, etc. and calculate if the pump is supplying enough flow. If using the short circuit line, measure the flow from the flow-meter.
12. To Adjust the Maximum Flow:
    a. Use the 13mm wrench to loosen "Locking Nut #1".
    b. Use the 4mm Allen wrench to turn "Max. Flow Adjustment Stud #1". Turn it IN to decrease the maximum flow or turn it OUT to increase it.

⚠ WARNING

The flow adjustment stud is NOT mechanically restricted from being removed completely from the pump. Care should be taken when turning the flow adjustment stud OUT. DO NOT turn the adjustment stud OUT more than 26mm as illustrated on previous page.

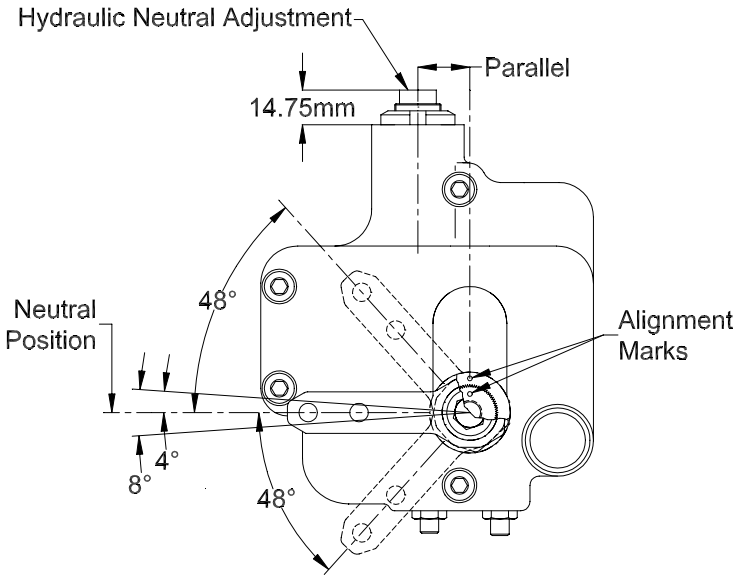
13. Once the desired maximum flow has been acquired, hold the flow adjustment stud stationary with the 4mm Allen wrench and tighten the locking nut with the 13mm wrench (the proper torque for the locking nut is 10 ft-lb [14 N-m]).

HPV Hydraulic Neutral Adjustment Procedure for M1 (Cam) Control

Set Up

Tools / Equipment Required

- Two (2) high pressure gauges or transducers (6000 psi)
- 16mm wrench (optional: adjustable wrench)
- Special pointing device provided by Eaton
- Digital calipers (optional: depth micrometers)
- Hammer and punch



⚠ **WARNING**

If performing this procedure on a vehicle, care must be taken. The pump will be put on stroke during this procedure; hence the vehicle must be safely elevated to allow the motor to free-wheel. If this is NOT possible, then clear all personnel from the machine to avoid injury when the machine moves.

Note:

The maximum displacement on this control must be set prior to using this Service Bulletin. Please follow all steps on page 38 before continuing with this Service Bulletin.

Note:

The following steps are ONLY to be carried out by those individuals trained on this particular procedure.

HPV Hydraulic Neutral Adjustment Procedure for M1 (Cam) Control

Procedure

Adjustment Procedure:

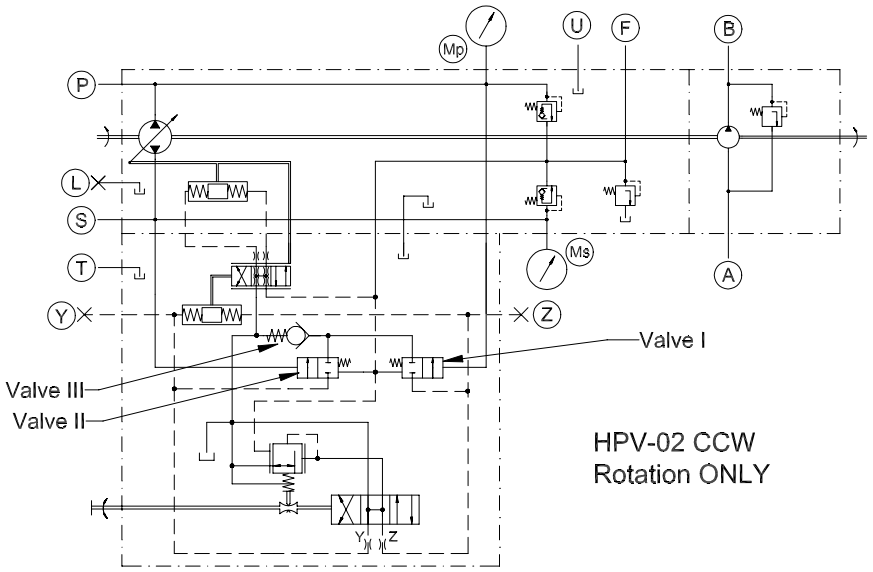
1. Install the two high pressure gauges to measure work-port pressure "P" and "S".
2. Orient the alignment marks so that they are parallel with the centerline of the hydraulic neutral adjustment as illustrated above.
3. Set the input speed to high idle.
4. Measure the pressure difference between work-ports "P" and "S".
   - If the maximum pressure difference is 29 psi (2 bar) or less, then adjustment to the hydraulic neutral is NOT required - Remove all gauges from the pump.
   - If the maximum pressure difference is greater than 29 psi (2 bar), then go to step #5.
5. Loosen the spanner nut on the Hydraulic Neutral Adjustment with the hammer and punch.
6. Using a 16mm wrench and the digital calipers, adjust the hydraulic neutral adjustment to 14.75mm as illustrated in the sketch above.
7. Install the special pointing device onto the cam lever.
8. With the pump aligned in neutral (as described in step #2), make a small mark on the pump control (either with a pen or a magic-marker) where the pointer of the pointing device is pointing.
9. Move the control lever in one direction until the pressure difference between the work-ports "P" and "S" is 580 psi (40 bar). Make a small mark where the pointer is.
10. Move the control lever in the opposite direction until the pressure difference is 580 psi (40 bar). Make a small mark where the pointer is.
11. The initial mark made in step #8 should be directly in the middle of the other two marks made in steps #9 and #10. If not, make a very small adjustment to the hydraulic neutral adjustment. Erase all previous marks and repeat steps #8 through #11 until the initial mark is directly in the middle of the other two marks.
12. Repeat steps #1 through #4 and verify that the maximum pressure difference between work-ports "P" and "S" is 29 psi (2 bar) or less. If not, confirm gauges (or transducers) are calibrated and functioning correctly. You may need to repeat the entire procedure to insure the hydraulic neutral is set correctly.
13. Secure the Hydraulic Neutral Adjustment by tightening the spanner nut. Remove all gauges from the pump.

HPV CCW (Left Hand) Rotation Pumps with "M2P" Control with Pressure Override (POR)

Set Up

⚠ Important

This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and M2P control.



Notes:

- Since the oil is being bled over the main relief valves during this procedure, monitor the oil temperature in the main loop to avoid over heating.
- Oil Temperature Limitations for Eaton Components: (-4)°F to 194°F (-20)°C to 90°C
- Changes to any pump setting, control supply pressure, or system hardware after the POR has been adjusted could alter the performance of the POR. It may be necessary to readjust the POR to compensate for any of these changes.
- Recommended Gauges:
  - (Qty 1) 7,500 psi Liquid-filled gauge
    (Qty 2 recommended for ease of testing)
  - (Qty 1) 0-200 psi △p-gauge or △p-transducer

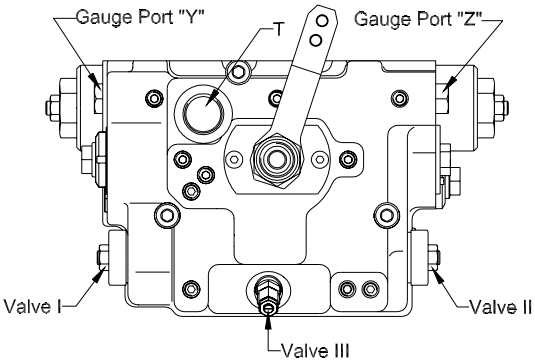
HPV CCW (Left Hand) Rotation Pumps with "M2P" Control with Pressure Override (POR)

Set Up

⚠ Important

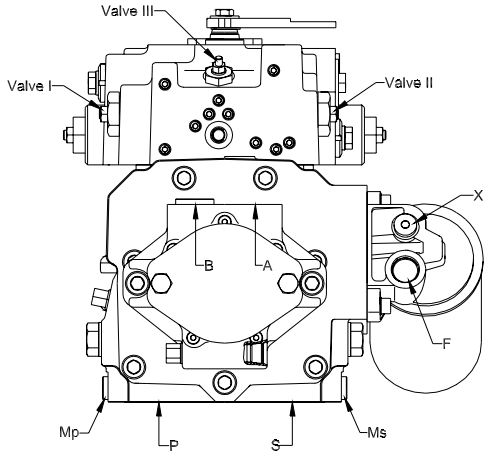
This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and M2P control.

Port Identification and Adjustment Locations:



For a CCW Rotation Pump:

	Turn Lever Clockwise	Turn Lever Counter-Clockwise
Control Pressure At Port	Z	Y
Pump Output Pressure at Port	P	S
Must Adjust	Valve I	Valve II



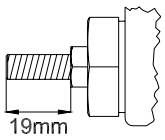
HPV CCW (Left Hand) Rotation Pumps with "M2P" Control with Pressure Override (POR)

Procedure

⚠ **Important**

This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and M2P control.

Pressure Override (POR) Adjustment:



1. POR Setup:

A. Measure and record the regulation begin pressures below.

"△Py-z" Regulation Begin:_____ psi…..(value "a")

"△Pz-y" Regulation Begin:_____ psi…..(value "b")

B. Turn OUT the adjustment screw for "Valve III" all the way (it is mechanically restricted from being removed completely).

C. Turn OUT the adjustment screw for "Valve I" and "Valve II" by 3-4 full turns.

⚠ **WARNING:** Care should be taken NOT to remove the adjustment screw in "Valve I" and "Valve II" completely. Do NOT turn OUT the adjustment screw more than 19mm as illustrated left.

D. Connect the 0-7500 psi liquid-filled gauges to work port gauge ports "Mp" and "Ms".

E. Connect the 0-200 psi △p-gauge/transducer to control gauge ports "Y" and "Z".

"Valve I" and "Valve II" Adjustments:

2. "Valve I" and "Valve II" Adjustments:

A. Close OFF or block both of the pump work ports "P" and "S".

B. Turn the control lever Counter-Clockwise (CCW) fully and hold it.

Note: System pressure will be unstable - This is an expected pump reaction.

C. While monitoring work port pressure "S", SLOWLY turn the adjustment screw for "Valve II" IN until the pressure just stabilizes.

Important: You must slowly turn the adjustment screw in ONLY until the pressure stabilizes and then stop. If you continue to turn the adjustment screw in, system pressure will continue to increase and an unnecessary amount of oil will be forced over the main relief valve, thus the operation of the POR will become less efficient.

D. Tighten the locking nut on "Valve II" and return the control lever to its neutral position.

E. Repeat steps "A" through "D" but turn the control lever Clockwise (CW) fully and monitor work port pressure "P" and adjust "Valve I".

HPV CCW (Left Hand) Rotation Pumps with "M2P" Control with Pressure Override (POR)

Procedure

⚠ **Important**

This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and M2P control.

"Valve III" Adjustment:

3. "Valve III" Adjustment:

A. Keep both of the pump work ports ("P" and "S") closed off or blocked.

B. Turn the control lever Counter-Clockwise (CCW) fully and hold it.

C. Slowly turn IN the adjustment screw for "Valve III" until control pressure "△Py-z" is 10 -15 psi higher than the "△Py-z" Regulation Begin pressure recorded above (value "a").

Record the "△Py-z" setting: _____ psid.....(value "e")

D. Tighten the locking nut on "Valve III" and return the control lever to its neutral position.

E. Turn the control lever Clockwise (CW) fully and hold it. Verify that the pressure is 10 - 15 psi higher than the "Pz-y" Regulation Begin pressure recorded above (value "b").

Record the "△Pz-y" setting: _____ psid.....(value "f")

Hint: If "Valve III" gets too hot, it will be difficult to adjust and/or get consistent results. Allow the pump to cool off if you encounter difficulty adjusting "Valve III".

Final Adjustment:

4. Final Adjustment:

A. IF the difference between (value "e") and (value "f") is 5 psi or less, then NO additional adjustments are required to the POR.

B. IF the difference between (value "e") and (value "f") is greater than 5 psi, then either "Valve I" or "Valve II" needs to be backed out. The side which has the higher value must be backed out until the difference between (value "e") and (value "f") is 5 psi or less.

C. Turn the control lever Counter-Clockwise (CCW) fully and verify that work port pressure "S" is stable and control pressure does NOT increase/decrease for ~10 seconds.

D. Turn the control lever Clockwise (CW) fully and verify that work port pressure "P" is stable and control pressure does NOT increase/decrease for ~10 seconds.

Note: If either one or both work port pressures are not stable, then repeat the POR adjustment process starting with step #1 above.

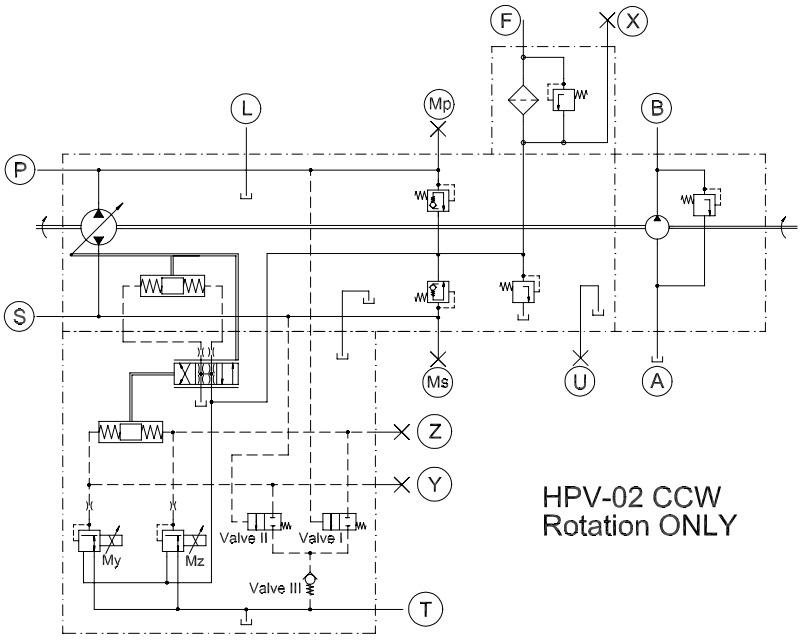
If the control pressure changes during steps "C" or "D" above, then "Valve I" and/or "Valve II" is not adjusted correctly. Repeat the POR adjustment process starting with step #1 above.

HPV CCW (Left-Hand) Rotation Pumps with E1P Control with Pressure Override (POR)

Set Up

⚠ Important

This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and E1P Control



Notes:

- Since the oil is being bled over the main relief valves during this procedure, monitor the oil temperature in the main loop to avoid over heating.
- Oil Temperature Limitations for Eaton Components: (-4)°F to 194°F (-20)°C to 90°C
- Changes to any pump setting, control supply pressure, or system hardware after the POR has been adjusted could alter the performance of the POR. It may be necessary to readjust the POR to compensate for any of these changes.
- Recommended Gauges:
  - (Qty 1) 7,500 psi Liquid-filled gauge
    (Qty 2 recommended for ease of testing)
  - (Qty 1) 0-200 psi △p-gauge or △p-transducer

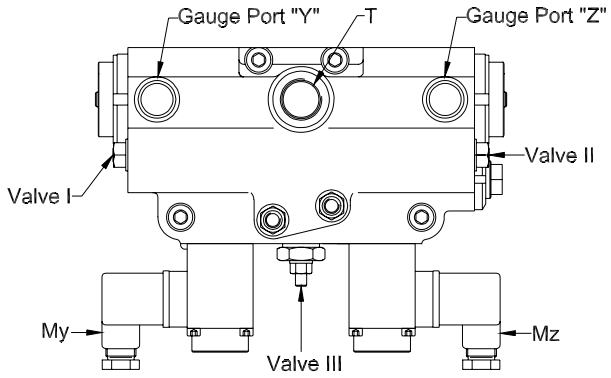
HPV CCW (Left-Hand) Rotation Pumps with E1P Control with Pressure Override (POR)

Set Up

⚠ Important

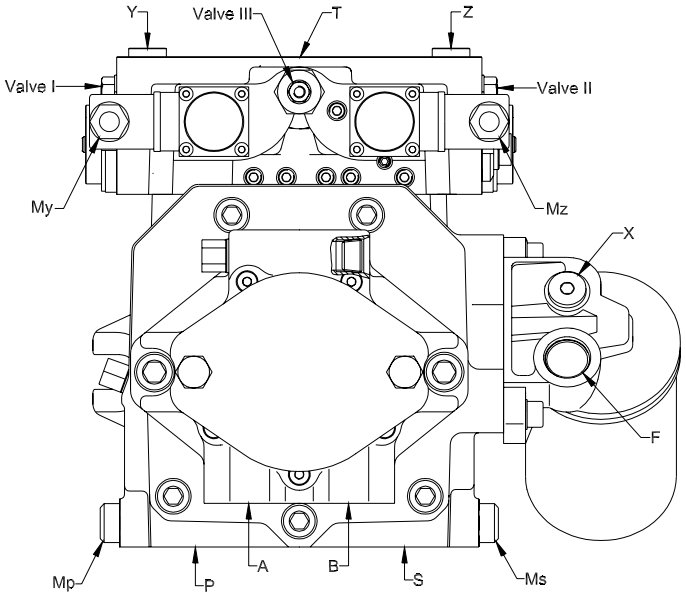
This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and E1P Control

Port Identification and Adjustment Locations:



For a CCW Rotation Pump:

	Energize Solenoid My	Energize Solenoid Mz
Control Pressure At Port	Y	Z
Pump Output Pressure at Port	S	P
Must Adjust	Valve II	Valve I



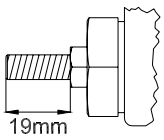
HPV CCW (Left-Hand) Rotation Pumps with E1P Control with Pressure Override (POR)

Procedure

⚠ **Important**

This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and E1P Control

Pressure Override (POR) Adjustment:



1. POR Setup:

A. Measure and record the regulation begin pressures below.

"△Py-z" Regulation Begin:_____ psi…..(value "a")

"△Pz-y" Regulation Begin:_____ psi…..(value "b")

B. Turn OUT the adjustment screw for "Valve III" all the way (it is mechanically restricted from being removed completely).

C. Turn OUT the adjustment screw for "Valve I" and "Valve II" by 3-4 full turns.

⚠ **WARNING:** Care should be taken NOT to remove the adjustment screw in "Valve I" and "Valve II" completely. Do NOT turn OUT the adjustment screw more than 19mm as illustrated left.

D. Connect the 0-7500 psi liquid-filled gauges to work port gauge ports "Mp" and "Ms".

E. Connect the 0-200 psi △p-gauge/transducer to control gauge ports "Y" and "Z".

"Valve I" and "Valve II" Adjustments:

2. "Valve I" and "Valve II" Adjustments:

A. Close OFF or block both of the pump work ports "P" and "S".

B. Energize solenoid "My" to its maximum value and hold it.

Note: System pressure will be unstable - This is an expected pump reaction.

C. While monitoring work port pressure "S", SLOWLY turn the adjustment screw for "Valve II" IN until the pressure just stabilizes.

Important: You must slowly turn the adjustment screw in ONLY until the pressure stabilizes and then stop. If you continue to turn the adjustment screw in, system pressure will continue to increase and an unnecessary amount of oil will be forced over the main relief valve, thus the operation of the POR will become less efficient.

D. Tighten the locking nut on "Valve II" and de-energize solenoid "My".

E. Repeat steps "A" through "D" for solenoid "Mz" while monitoring work port pressure "P" and adjusting "Valve I".

HPV CCW (Left-Hand) Rotation Pumps with E1P Control with Pressure Override (POR)

Procedure

⚠ **Important**

This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and E1P Control

"Valve III" Adjustment:

3. "Valve III" Adjustment:

A. Keep both of the pump work ports ("P" and "S") closed off or blocked.

B. Energize solenoid "My" to its maximum value and hold it.

C. Slowly turn IN the adjustment screw for "Valve III" until control pressure "△Py-z" is 10 -15 psi higher than the "△Py-z" Regulation Begin pressure recorded above (value "a").

Record the "△Py-z" setting: _____ psid…….(value "e")

D. Tighten the locking nut on "Valve III" and de-energize solenoid "My".

E. Energize solenoid "Mz" to its maximum value and hold it. Verify that the pressure is 10 -15 psi higher than the "△Pz-y" Regulation Begin pressure recorded above (value "b").

Record the "△Pz-y" setting: _____ psid…….(value "f")

Hint: If "Valve III" gets too hot, it will be difficult to adjust and/or get consistent results. Allow the pump to cool off if you encounter difficulty adjusting "Valve III".

Final Adjustment:

4. Final Adjustment:

A. IF the difference between (value "e") and (value "f") is 5 psi or less, then NO additional adjustments are required to the POR.

B. IF the difference between (value "e") and (value "f") is greater than 5 psi, then either "Valve I" or "Valve II" needs to be backed out. The side which has the higher value must be backed out until the difference between (value "e") and (value "f") is 5 psi or less.

C. Energize solenoid "My" to its maximum value and verify that work port pressure "S" is stable and control pressure does NOT increase/decrease for ~10 seconds.

D. Energize solenoid "Mz" to its maximum value and verify that work port pressure "P" is stable and control pressure does NOT increase/decrease for ~10 seconds.

Note: If either one or both work port pressures are not stable, then repeat the POR adjustment process starting with step #1 above.

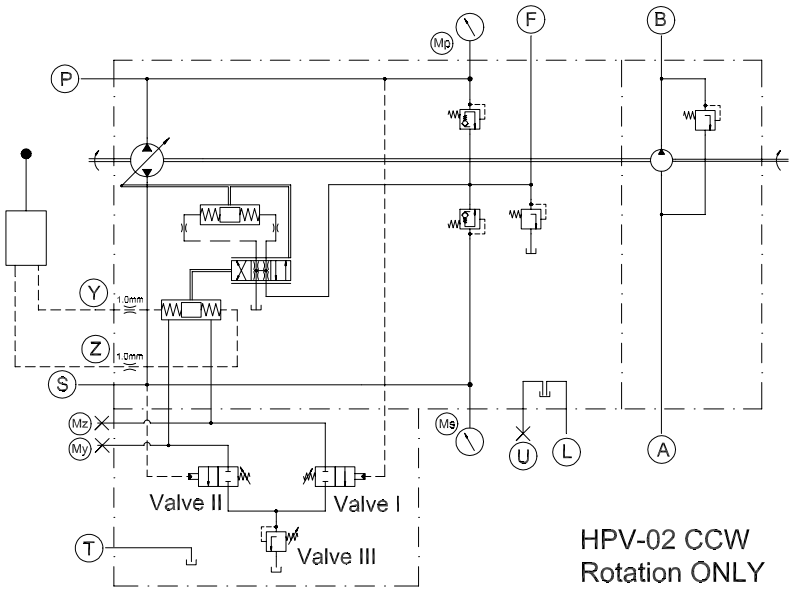
If the control pressure changes during steps "C" or "D" above, then "Valve I" and/or "Valve II" is not adjusted correctly. Repeat the POR adjustment process starting with step #1 above.

HPV CCW (Left Hand) Rotation Pumps with H1P Control with Pressure Override (POR)

Set Up

⚠ Important

This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and H1P Control



Notes:

- Since the oil is being bled over the main relief valves during this procedure, monitor the oil temperature in the main loop to avoid over heating.
- Oil Temperature Limitations for Eaton Components: (-4)°F to 194°F (-20)°C to 90°C
- Changes to any pump setting, control supply pressure, or system hardware after the POR has been adjusted could alter the performance of the POR. It may be necessary to readjust the POR to compensate for any of these changes.
- Recommended Gauges:
  - (Qty 1) 7,500 psi Liquid-filled gauge (Qty 2 recommended for ease of testing)
  - (Qty 1) 0-200 psi △p-gauge or △p-transducer

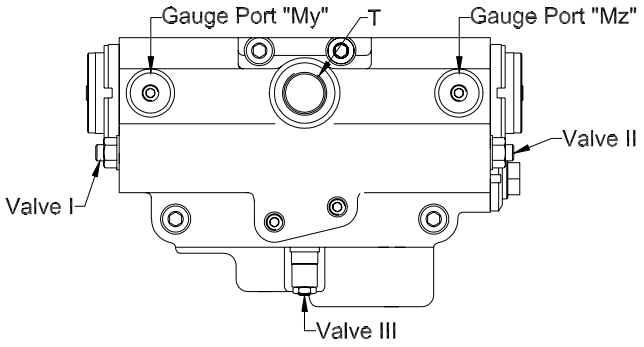
HPV CCW (Left Hand) Rotation Pumps with H1P Control with Pressure Override (POR)

Set Up

⚠ Important

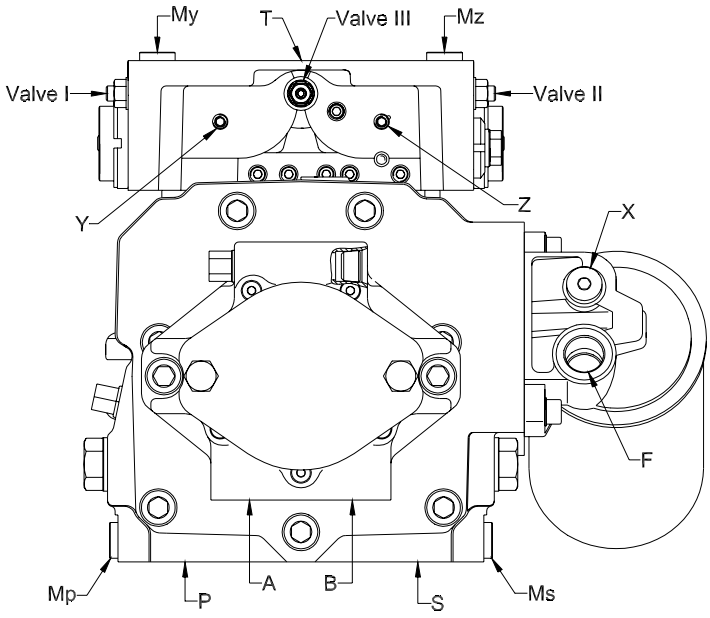
This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and H1P Control

Port Identification and Adjustment Locations:



For a CCW Rotation Pump:

	Control Pressure Into Port Y	Control Pressure Into Port Z
Pump Output Pressure At Port	S	P
Must Adjust	Valve II	Valve I



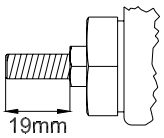
HPV CCW (Left Hand) Rotation Pumps with H1P Control with Pressure Override (POR)

Procedure

⚠ **Important**

This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and H1P Control

Pressure Override (POR) Adjustment:



1. POR Setup:

A. Measure and record the regulation begin pressures below.

"△Py-z" Regulation Begin:_____ psi…..(value "a")

"△Pz-y" Regulation Begin:_____ psi…..(value "b")

B. Turn OUT the adjustment screw for "Valve III" all the way (it is mechanically restricted from being removed completely).

C. Turn OUT the adjustment screw for "Valve I" and "Valve II" by 3-4 full turns.

⚠ **WARNING:** Care should be taken NOT to remove the adjustment screw in "Valve I" and "Valve II" completely. Do NOT turn OUT the adjustment screw more than 19mm as illustrated left.

D. Connect the 0-7500 psi liquid-filled gauges to work port gauge ports "Mp" and "Ms".

E. Connect the 0-200 psi △p-gauge/transducer to control gauge ports"My" and "Mz".

"Valve I" and "Valve II" Adjustments:

2. "Valve I" and "Valve II" Adjustments:

A. Close OFF or block both of the pump work ports "P" and "S".

B. Supply full control pressure into port "Y" and hold it.

Note: System pressure will be unstable - This is an expected pump reaction.

C. While monitoring work port pressure "S", SLOWLY turn the adjustment screw for "Valve II" IN until the pressure just stabilizes.

Important: You must slowly turn the adjustment screw in ONLY until the pressure stabilizes and then stop. If you continue to turn the adjustment screw in, system pressure will continue to increase and an unnecessary amount of oil will be forced over the main relief valve, thus the operation of the POR will become less efficient.

D. Tighten the locking nut on "Valve II" and remove the control pressure from port "Y".

E. Repeat steps "A" through "D" for control port "Z" while monitoring work port pressure "P" and adjusting "Valve I".

HPV CCW (Left Hand) Rotation Pumps with H1P Control with Pressure Override (POR)

Procedure

⚠ **Important**

This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and H1P Control

"Valve III" Adjustment:

3. "Valve III" Adjustment:

A. Keep both of the pump work ports ("P" and "S") closed off or blocked.

B. Supply full control pressure into port "Y" and hold it.

C. Slowly turn IN the adjustment screw for "Valve III" until control pressure "△Py-z" is 10 -15 psi higher than the "△Py-z" Regulation Begin pressure recorded above (value "a").

Record the "△Py-z" setting: _____ psid.....(value "e")

D. Tighten the locking nut on "Valve III" and remove the control pressure from port "Y".

E. Supply full control pressure into port "Z" and hold it. Verify that the pressure is 10 - 15 psi higher than the "△Pz-y" Regulation Begin pressure recorded above (value "b").

Record the "△Pz-y" setting: _____ psid.....(value "f")

Hint: If "Valve III" gets too hot, it will be difficult to adjust and/or get consistent results. Allow the pump to cool off if you encounter difficulty adjusting "Valve III".

Final Adjustment:

4. Final Adjustment:

A. IF the difference between (value "e") and (value "f") is 5 psi or less, then NO additional adjustments are required to the POR.

B. IF the difference between (value "e") and (value "f") is greater than 5 psi, then either "Valve I" or "Valve II" needs to be backed out. The side which has the higher value must be backed out until the difference between (value "e") and (value "f") is 5 psi or less.

C. Supply full control pressure into port "Y" and verify that work port pressure "S" is stable and control pressure does NOT increase/decrease for ~10 seconds.

D. Supply full control pressure into port "Z" and verify that work port pressure "P" is stable and control pressure does NOT increase/decrease for ~10 seconds.

Note: If either one or both work port pressures are not stable, then repeat the POR adjustment process starting with step #1 above.

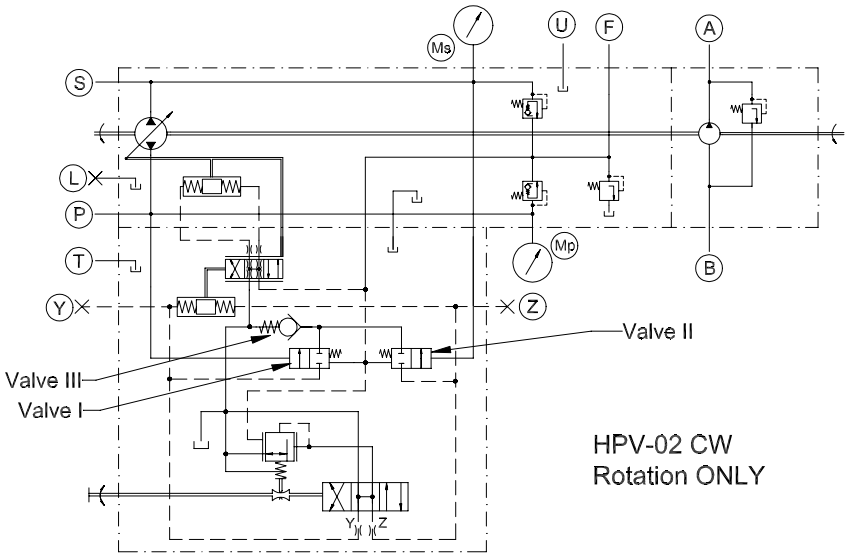
If the control pressure changes during steps "C" or "D" above, then "Valve I" and/or "Valve II" is not adjusted correctly. Repeat the POR adjustment process starting with step #1 above.

HPV CW (Right Hand) Rotation Pumps with "M2P" Control with Pressure Override (POR)

Set Up

⚠ Important

This is a "field adjustment" procedure valid for HPV pumps with CW (Right-Hand) rotation and M2P control



Notes:

- Since the oil is being bled over the main relief valves during this procedure, monitor the oil temperature in the main loop to avoid over heating.
- Oil Temperature Limitations for Eaton Components: (-4)°F to 194°F (-20)°C to 90°C
- Changes to any pump setting, control supply pressure, or system hardware after the POR has been adjusted could alter the performance of the POR. It may be necessary to readjust the POR to compensate for any of these changes.
- Recommended Gauges:
  - (Qty 1) 7,500 psi Liquid-filled gauge (Qty 2 recommended for ease of testing)
  - (Qty 1) 0-200 psi △p-gauge or △p-transducer

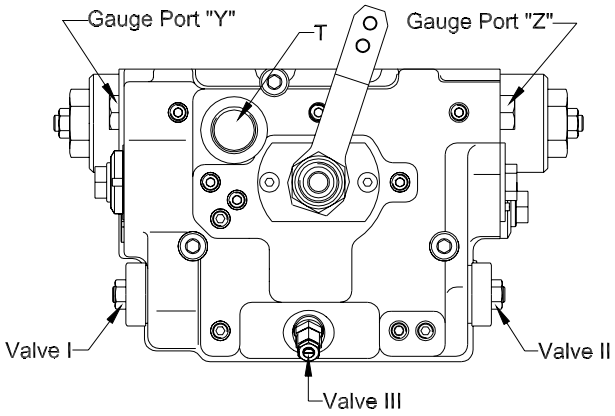
HPV CW (Right Hand) Rotation Pumps with "M2P" Control with Pressure Override (POR)

Set Up

⚠ Important

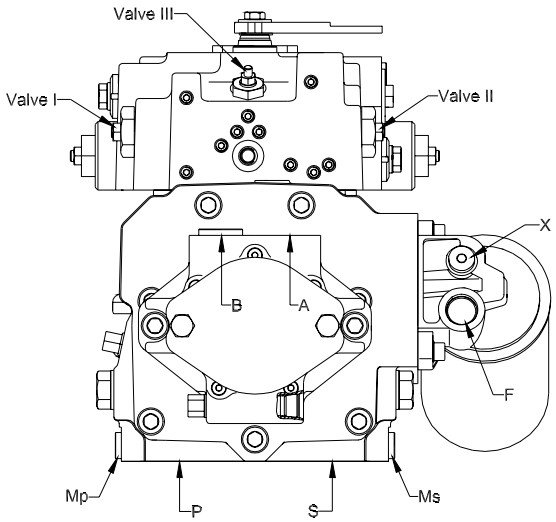
This is a "field adjustment" procedure valid for HPV pumps with CW (Right-Hand) rotation and M2P control

Port Identification and Adjustment Locations:



For a CW Rotation Pump:

	Turn Lever Clockwise	Turn Lever Counter-Clockwise
Control Pressure At Port	Z	Y
Pump Output Pressure at Port	S	P
Must Adjust	Valve II	Valve I



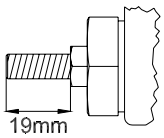
HPV CW (Right Hand) Rotation Pumps with "M2P" Control with Pressure Override (POR)

Procedure

⚠ **Important**

This is a "field adjustment" procedure valid for HPV pumps with CW (Right-Hand) rotation and M2P control

Pressure Override (POR) Adjustment:



1. POR Setup:

A. Measure and record the regulation begin pressures below.

"△Py-z" Regulation Begin:_____ psi…..(value "a")

"△Pz-y" Regulation Begin:_____ psi…..(value "b")

B. Turn OUT the adjustment screw for "Valve III" all the way (it is mechanically restricted from being removed completely).

C. Turn OUT the adjustment screw for "Valve I" and "Valve II" by 3-4 full turns.

⚠ **WARNING:** Care should be taken NOT to remove the adjustment screw in "Valve I" and "Valve II" completely. Do NOT turn OUT the adjustment screw more than 19mm as illustrated left.

D. Connect the 0-7500 psi liquid-filled gauges to work port gauge ports "Mp" and "Ms".

E. Connect the 0-200 psi △p-gauge/transducer to control gauge ports"Y" and "Z".

"Valve I" and "Valve II" Adjustments:

2. "Valve I" and "Valve II" Adjustments:

A. Close OFF or block both of the pump work ports "P" and "S".

B. Turn the control lever Counter-Clockwise (CCW) fully and hold it.

Note: System pressure will be unstable - This is an expected pump reaction.

C. While monitoring work port pressure "P", SLOWLY turn the adjustment screw for "Valve I" IN until the pressure just stabilizes.

Important: You must slowly turn the adjustment screw in ONLY until the pressure stabilizes and then stop. If you continue to turn the adjustment screw in, system pressure will continue to increase and an unnecessary amount of oil will be forced over the main relief valve, thus the operation of the POR will become less efficient.

D. Tighten the locking nut on "Valve I" and return the control lever to its neutral position.

E. Repeat steps "A" through "D" but turn the control lever Clockwise (CW) fully and monitor work port pressure "S" and adjust "Valve II".

HPV CW (Right Hand) Rotation Pumps with "M2P" Control with Pressure Override (POR)

Procedure

⚠ **Important**

This is a "field adjustment" procedure valid for HPV pumps with CW (Right-Hand) rotation and M2P control

"Valve III" Adjustment:

3. "Valve III" Adjustment:

A. Keep both of the pump work ports ("P" and "S") closed off or blocked.

B. Turn the control lever Counter-Clockwise (CCW) fully and hold it.

C. Slowly turn IN the adjustment screw for "Valve III" until control pressure "△Py-z" is 10 -15 psi higher than the "△Py-z" Regulation Begin pressure recorded above (value "a").

Record the "△Py-z" setting: _____ psid…….(value "e")

D. Tighten the locking nut on "Valve III" and return the control lever to its neutral position.

E. Turn the control lever Clockwise (CW) fully and hold it. Verify that the pressure is 10 - 15 psi higher than the "△Pz-y" Regulation Begin pressure recorded above (value "b").

Record the "△Pz-y" setting: _____ psid…….(value "f")

Hint: If "Valve III" gets too hot, it will be difficult to adjust and/or get consistent results. Allow the pump to cool off if you encounter difficulty adjusting "Valve III".

Final Adjustment:

4. Final Adjustment:

A. IF the difference between (value "e") and (value "f") is 5 psi or less, then NO additional adjustments are required to the POR.

B. IF the difference between (value "e") and (value "f") is greater than 5 psi, then either "Valve I" or "Valve II" needs to be backed out. The side which has the higher value must be backed out until the difference between (value "e") and (value "f") is 5 psi or less.

C. Turn the control lever Counter-Clockwise (CCW) fully and verify that work port pressure "P" is stable and control pressure does NOT increase/decrease for ~10 seconds.

D. Turn the control lever Clockwise (CW) fully and verify that work port pressure "S" is stable and control pressure does NOT increase/decrease for ~10 seconds.

Note: If either one or both work port pressures are not stable, then repeat the POR adjustment process starting with step #1 above.

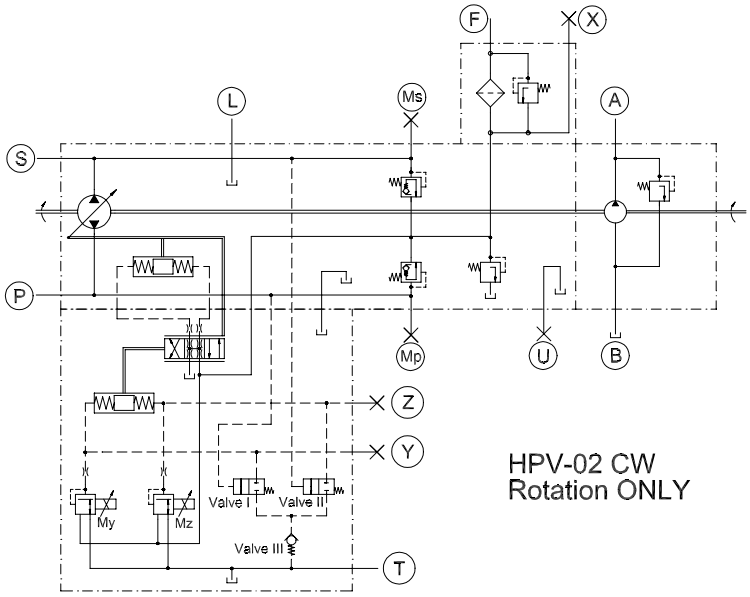
If the control pressure changes during steps "C" or "D" above, then "Valve I" and/or "Valve II" is not adjusted correctly. Repeat the POR adjustment process starting with step #1 above.

HPV CW (Right-Hand) Rotation Pumps with E1P Control with Pressure Override (POR)

Set Up

⚠ Important

This is a "field adjustment" procedure valid for HPV pumps with CW (Right-Hand) rotation and E1P Control



Notes:

- Since the oil is being bled over the main relief valves during this procedure, monitor the oil temperature in the main loop to avoid over heating.
- Oil Temperature Limitations for Eaton Components: (-4)°F to 194°F (-20)°C to 90°C
- Changes to any pump setting, control supply pressure, or system hardware after the POR has been adjusted could alter the performance of the POR. It may be necessary to readjust the POR to compensate for any of these changes.
- Recommended Gauges:
  - (Qty 1) 7,500 psi Liquid-filled gauge (Qty 2 recommended for ease of testing)
  - (Qty 1) 0-200 psi △p-gauge or △p-transducer

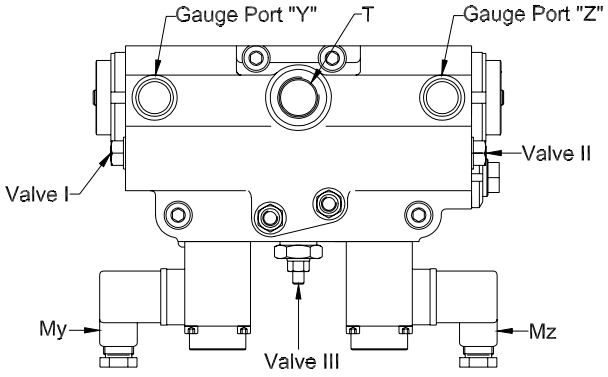
HPV CW (Right-Hand) Rotation Pumps with E1P Control with Pressure Override (POR)

Set Up

⚠ Important

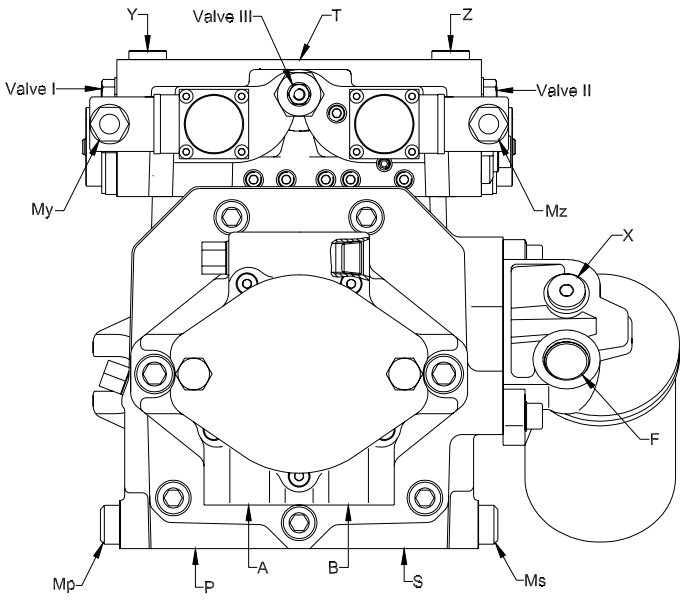
This is a "field adjustment" procedure valid for HPV pumps with CW (Right-Hand) rotation and E1P Control

Port Identification and Adjustment Locations:



For a CW Rotation Pump:

	Energize Solenoid My	Energize Solenoid Mz
Control Pressure At Port	Y	Z
Pump Output Pressure at Port	P	S
Must Adjust	Valve I	Valve II



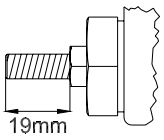
HPV CW (Right-Hand) Rotation Pumps with E1P Control with Pressure Override (POR)

Procedure

⚠ **Important**

This is a "field adjustment" procedure valid for HPV pumps with CW (Right-Hand) rotation and E1P Control

Pressure Override (POR) Adjustment:



1. POR Setup:

A. Measure and record the regulation begin pressures below.

"△Py-z" Regulation Begin:_____ psi.....(value "a")

"△Pz-y" Regulation Begin:_____ psi.....(value "b")

B. Turn OUT the adjustment screw for "Valve III" all the way (it is mechanically restricted from being removed completely).

C. Turn OUT the adjustment screw for "Valve I" and "Valve II" by 3-4 full turns.

⚠ **WARNING:** Care should be taken NOT to remove the adjustment screw in "Valve I" and "Valve II" completely. Do NOT turn OUT the adjustment screw more than 19mm as illustrated left.

D. Connect the 0-7500 psi liquid-filled gauges to work port gauge ports "Mp" and "Ms".

E. Connect the 0-200 psi △p-gauge/transducer to control gauge ports"Y" and "Z".

"Valve I" and "Valve II" Adjustments:

2. "Valve I" and "Valve II" Adjustments:

A. Close OFF or block both of the pump work ports "P" and "S".

B. Energize solenoid "My" to its maximum value and hold it.

Note: System pressure will be unstable - This is an expected pump reaction.

C. While monitoring work port pressure "P", SLOWLY turn the adjustment screw for "Valve I" IN until the pressure just stabilizes.

Important: You must slowly turn the adjustment screw in ONLY until the pressure stabilizes and then stop. If you continue to turn the adjustment screw in, system pressure will continue to increase and an unnecessary amount of oil will be forced over the main relief valve, thus the operation of the POR will become less efficient.

D. Tighten the locking nut on "Valve I" and de-energize solenoid "My".

E. Repeat steps "A" through "D" for solenoid "Mz" while monitoring work port pressure "S" and adjusting "Valve II".

HPV CW (Right-Hand) Rotation Pumps with E1P Control with Pressure Override (POR)

Procedure

⚠ **Important**

This is a "field adjustment" procedure valid for HPV pumps with CW (Right-Hand) rotation and E1P Control

"Valve III" Adjustment:

3. "Valve III" Adjustment:

A. Keep both of the pump work ports ("P" and "S") closed off or blocked.

B. Energize solenoid "My" to its maximum value and hold it.

C. Slowly turn IN the adjustment screw for "Valve III" until control pressure "△Py-z" is 10 -15 psi higher than the "△Py-z" Regulation Begin pressure recorded above (value "a").

Record the "△Py-z" setting: _____ psid…….(value "e")

D. Tighten the locking nut on "Valve III" and de-energize solenoid "My".

E. Energize solenoid "Mz" to its maximum value and hold it. Verify that the pressure is 10 - 15 psi higher than the "△Pz-y" Regulation Begin pressure recorded above (value "b").

Record the "△Pz-y" setting: _____ psid…….(value "f")

Hint: If "Valve III" gets too hot, it will be difficult to adjust and/or get consistent results. Allow the pump to cool off if you encounter difficulty adjusting "Valve III".

Final Adjustment:

4. Final Adjustment:

A. IF the difference between (value "e") and (value "f") is 5 psi or less, then NO additional adjustments are required to the POR.

B. IF the difference between (value "e") and (value "f") is greater than 5 psi, then either "Valve I" or "Valve II" needs to be backed out. The side which has the higher value must be backed out until the difference between (value "e") and (value "f") is 5 psi or less.

C. Energize solenoid "My" to its maximum value and verify that work port pressure "P" is stable and control pressure does NOT increase/decrease for ~10 seconds.

D. Energize solenoid "Mz" to its maximum value and verify that work port pressure "S" is stable and control pressure does NOT increase/decrease for ~10 seconds.

Note: If either one or both work port pressures are not stable, then repeat the POR adjustment process starting with step #1 above.

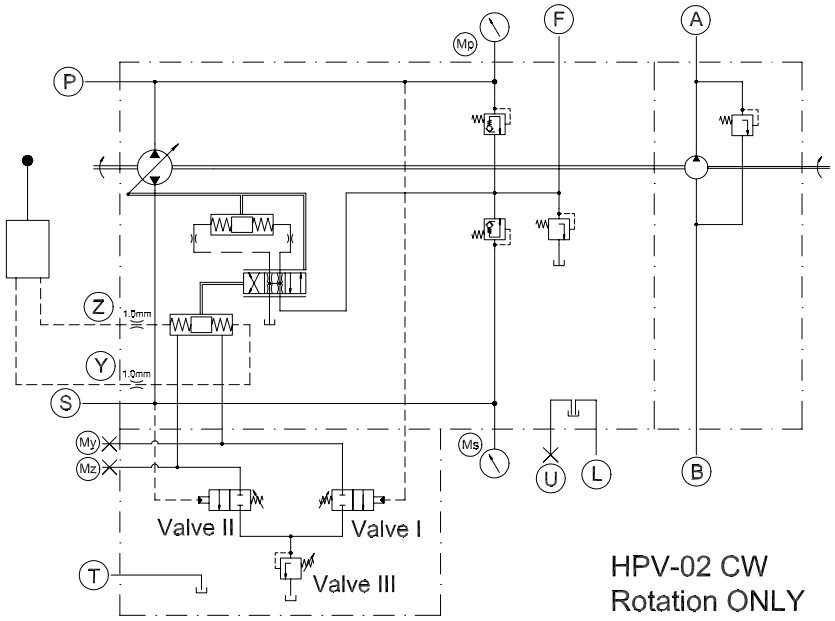
If the control pressure changes during steps "C" or "D" above, then "Valve I" and/or "Valve II" is not adjusted correctly. Repeat the POR adjustment process starting with step #1 above.

HPV CW (Right Hand) Rotation Pumps with H1P Control with Pressure Override (POR)

Set Up

⚠ Important

This is a "field adjustment" procedure valid for HPV pumps with CW (Right-Hand) rotation and H1P Control



Notes:

- Since the oil is being bled over the main relief valves during this procedure, monitor the oil temperature in the main loop to avoid over heating.
- Oil Temperature Limitations for Eaton Components: (-4)°F to 194°F (-20)°C to 90°C
- Changes to any pump setting, control supply pressure, or system hardware after the POR has been adjusted could alter the performance of the POR. It may be necessary to readjust the POR to compensate for any of these changes.
- Recommended Gauges:
  - (Qty 1) 7,500 psi Liquid-filled gauge (Qty 2 recommended for ease of testing)
  - (Qty 1) 0-200 psi △p-gauge or △p-transducer

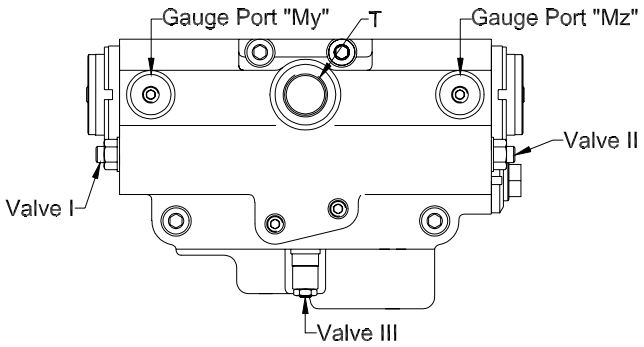
HPV CW (Right Hand) Rotation Pumps with H1P Control with Pressure Override (POR)

Set Up

⚠ Important

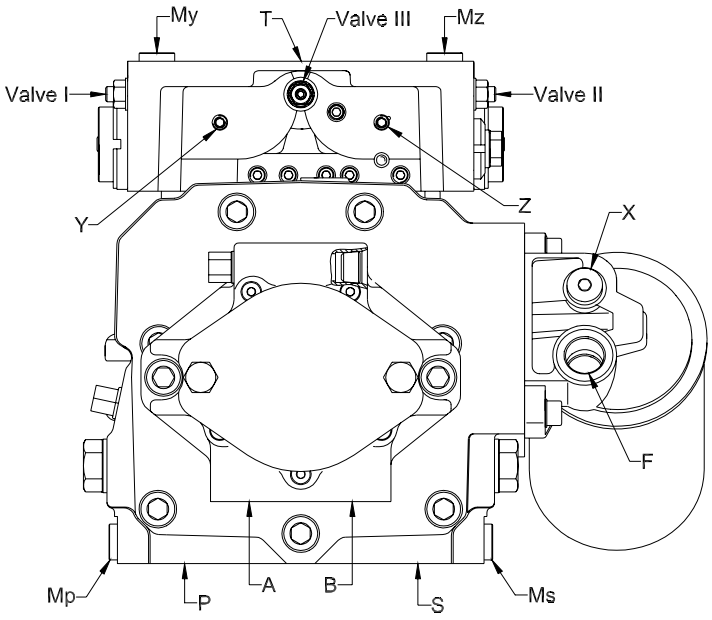
This is a "field adjustment" procedure valid for HPV pumps with CW (Right-Hand) rotation and H1P Control

Port Identification and Adjustment Locations:



For a CW Rotation Pump:

	Control Pressure Into Port Y	Control Pressure Into Port Z
Pump Output Pressure At Port	P	S
Must Adjust	Valve I	Valve II



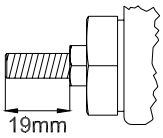
HPV CW (Right Hand) Rotation Pumps with H1P Control with Pressure Override (POR)

Procedure

⚠ **Important**

This is a "field adjustment" procedure valid for HPV pumps with CW (Right-Hand) rotation and H1P Control

Pressure Override (POR) Adjustment:



1. POR Setup:

A. Measure and record the regulation begin pressures below.

"△Py-z" Regulation Begin:_____ psi…..(value "a")

"△Pz-y" Regulation Begin:_____ psi…..(value "b")

B. Turn OUT the adjustment screw for "Valve III" all the way (it is mechanically restricted from being removed completely).

C. Turn OUT the adjustment screw for "Valve I" and "Valve II" by 3-4 full turns.

⚠ **WARNING:** Care should be taken NOT to remove the adjustment screw in "Valve I" and "Valve II" completely. Do NOT turn OUT the adjustment screw more than 19mm as illustrated left.

D. Connect the 0-7500 psi liquid-filled gauges to work port gauge ports "Mp" and "Ms".

E. Connect the 0-200 psi △p-gauge/transducer to control gauge ports"My" and "Mz".

"Valve I" and "Valve II" Adjustments:

2. "Valve I" and "Valve II" Adjustments:

A. Close OFF or block both of the pump work ports "P" and "S".

B. Supply full control pressure into port "Y" and hold it.

Note: System pressure will be unstable - This is an expected pump reaction.

C. While monitoring work port pressure "P", SLOWLY turn the adjustment screw for "Valve I" IN until the pressure just stabilizes.

Important: You must slowly turn the adjustment screw in ONLY until the pressure stabilizes and then stop. If you continue to turn the adjustment screw in, system pressure will continue to increase and an unnecessary amount of oil will be forced over the main relief valve, thus the operation of the POR will become less efficient.

D. Tighten the locking nut on "Valve I" and remove the control pressure from port "Y".

E. Repeat steps "A" through "D" for control port "Z" while monitoring work port pressure "S" and adjusting "Valve II".

HPV CW (Right Hand) Rotation Pumps with H1P Control with Pressure Override (POR)

Procedure

⚠ **Important**

This is a "field adjustment" procedure valid for HPV pumps with CW (Right-Hand) rotation and H1P Control

"Valve III" Adjustment:

3. "Valve III" Adjustment:

A. Keep both of the pump work ports ("P" and "S") closed off or blocked.

B. Supply full control pressure into port "Y" and hold it.

C. Slowly turn IN the adjustment screw for "Valve III" until control pressure "△Py-z" is 10 -15 psi higher than the "△Py-z" Regulation Begin pressure recorded above (value "a").

Record the "△Py-z" setting: _____ psid…….(value "e")

D.Tighten the locking nut on "Valve III" and remove the control pressure from port "Y".

E. Supply full control pressure into port "Z" and hold it. Verify that the pressure is 10 - 15 psi higher than the "△Pz-y" Regulation Begin pressure recorded above (value "b").

Record the "△Pz-y" setting: _____ psid…….(value "f")

Hint: If "Valve III" gets too hot, it will be difficult to adjust and/or get consistent results. Allow the pump to cool off if you encounter difficulty adjusting "Valve III".

Final Adjustment:

4. Final Adjustment:

A. IF the difference between (value "e") and (value "f") is 5 psi or less, then NO additional adjustments are required to the POR.

B. IF the difference between (value "e") and (value "f") is greater than 5 psi, then either "Valve I" or "Valve II" needs to be backed out. The side which has the higher value must be backed out until the difference between (value "e") and (value "f") is 5 psi or less.

C. Supply full control pressure into port "Y" and verify that work port pressure "P" is stable and control pressure does NOT increase/decrease for ~10 seconds.

D. Supply full control pressure into port "Z" and verify that work port pressure "S" is stable and control pressure does NOT increase/decrease for ~10 seconds.

Note: If either one or both work port pressures are not stable, then repeat the POR adjustment process starting with step #1 above.

If the control pressure changes during steps "C" or "D" above, then "Valve I" and/or "Valve II" is not adjusted correctly. Repeat the POR adjustment process starting with step #1 above.

Maximum Flow Adjustment Procedure for HPV Pumps with "M2P" (Mechanical-Hydraulic with POR) Controls

Set Up

⚠ Note

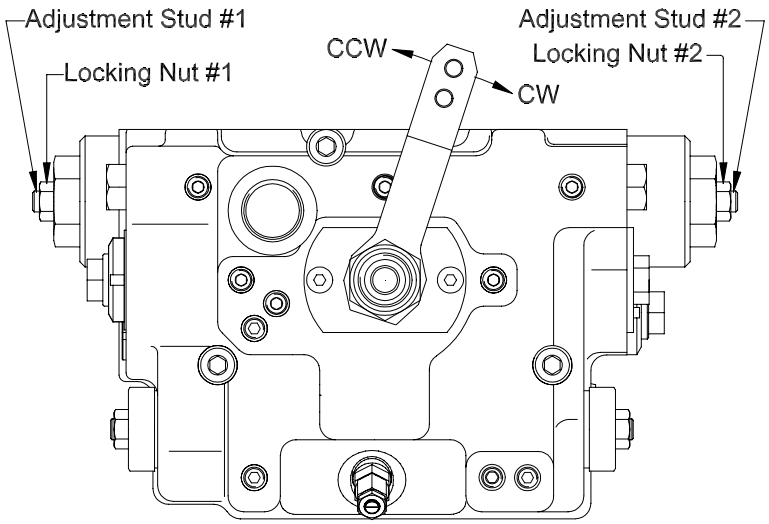
This Service Bulletin is ONLY valid for HPV pumps with the "M2P" (Mechanical-Hydraulic with POR) control.

Tools / Equipment Required

- 17mm wrench
- 5mm Allen wrench

⚠ WARNING

If performing this procedure on a vehicle, care must be taken. The pump will be put on stroke during this procedure; hence the vehicle must be safely elevated to allow the function to free-wheel. If this is NOT possible, then the pump work ports "P" and "S" must be short circuited to each other. Install a properly sized flowmeter in the short circuit line between "P" and "S" to avoid movement of the function.



Maximum Flow Adjustment Procedure for HPV Pumps with "M2P" (Mechanical-Hydraulic with POR) Controls

Procedure

⚠ Note

This Service Bulletin is ONLY valid for HPV pumps with the "M2P" (Mechanical-Hydraulic with POR) control.

Adjustment Procedure

Set the pump input speed to operational speed.

1. Turn the cam lever CCW (as illustrated above) fully.
2. Measure the rotational speed of the motor, the wheel, the gearbox, etc. and calculate if the pump is supplying enough flow. If using a short circuit line, measure the flow from the flowmeter.
3. To adjust the maximum flow:
   a. Use a 17mm wrench to loosen Locking Nut #2.
   b. Use a 5mm Allen wrench to turn Adjustment Stud #2. Turn it IN to decrease the maximum flow or OUT to increase it.

   ⚠ WARNING

   The flow adjustment stud is NOT mechanically restricted from being removed completely from the pump. Care should be taken when turning the flow adjustment stud OUT as to prevent it from being removed from the pump control.

   c. Once the desired maximum flow has been acquired, hold Adjustment Stud #2 stationary with the 5mm Allen wrench and tighten Locking Nut #2 with the 17mm wrench.
4. Turn the cam lever CW (as illustrated on the previous page) fully.
5. Measure the rotational speed of the motor, the wheel, the gearbox, etc. and calculate if the pump is supplying enough flow. If using a short circuit line, measure the flow from the flowmeter.
6. To adjust the maximum flow:
   a. Use a 17mm wrench to loosen Locking Nut #1.
   b. Use a 5mm Allen wrench to turn Adjustment Stud #1. Turn it IN to decrease the maximum flow or OUT to increase it.

   ⚠ WARNING

   The flow adjustment stud is NOT mechanically restricted from being removed completely from the pump. Care should be taken when turning the flow adjustment stud OUT as to prevent it from being removed from the pump control.

   c. Once the desired maximum flow has been acquired, hold Adjustment Stud #1 stationary with the 5mm Allen wrench and tighten Locking Nut #1 with the 17mm wrench.

Adjusting the Deadband on HPV Pumps with "M2P" (Mechanical-Hydraulic with POR) Controls

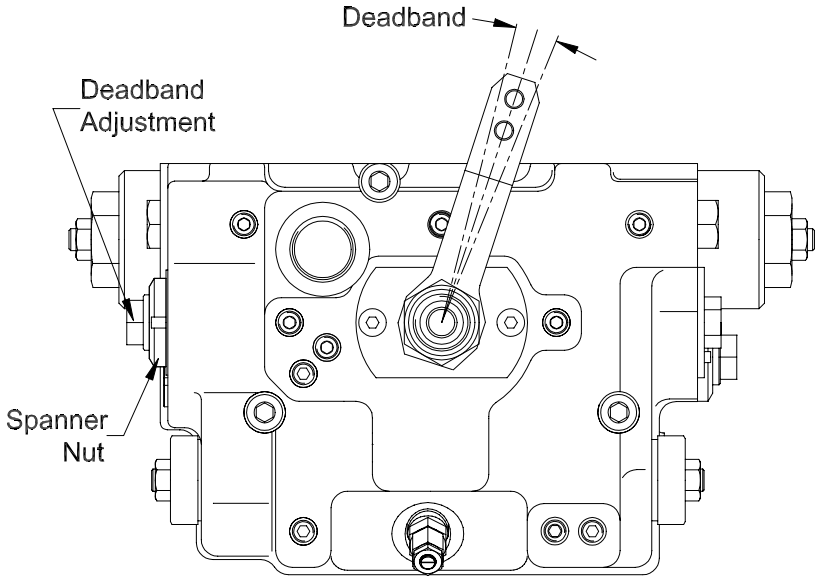
Set Up and Procedure

⚠ Note

This Service Bulletin is ONLY valid for HPV pumps with "M2P" (Mechanical-Hydraulic with POR) controls.

Tools / Equipment Required

- 16mm wrench (optional: adjustable wrench)
- Hammer and punch



Adjustment Procedure

1. With the hammer and punch, loosen the Spanner Nut on the Deadband Adjustment.
2. With the 16mm wrench, either turn the Deadband Adjustment IN or OUT to adjust the cam lever deadband to the desired range.

Hint: Turn the Deadband Adjustment IN to reduce the cam lever deadband range or OUT to increase it.

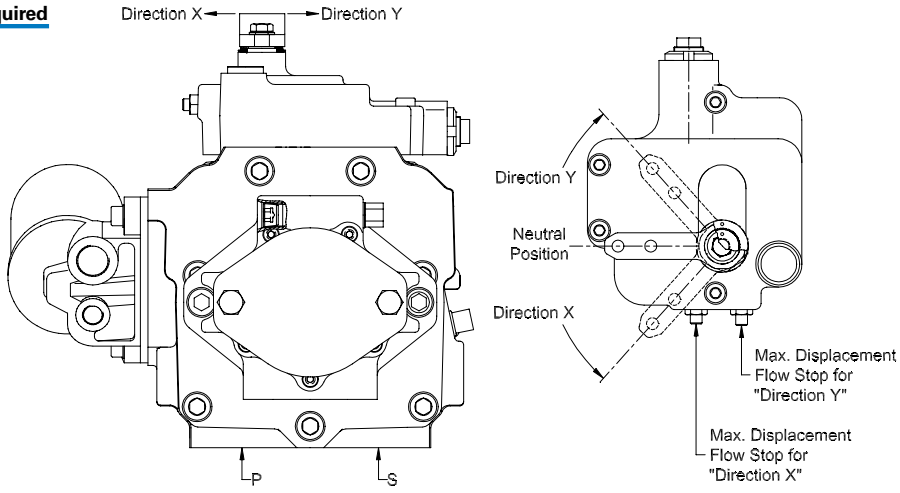
3. Once the desired deadband range is acquired, use the hammer and punch to tighten the Spanner Nut.

HPV Maximum Displacement Adjustment for M1 (Mechanical-Hydraulic) Control

Set Up and Procedure

Tools / Equipment Required

- 13mm open or close end wrench
- 4mm Allen wrench



Flow Orientation:

	Turn Lever In Direction	Pressure From Port
For CW (Right Hand) Rotation	X	P
	Y	S
For CCW (Left Hand) Rotation	X	S
	Y	P

Adjustment Procedure:

1. Loosen the flow-stop lock nut with 13mm wrench.
2. Turn the cam lever in the appropriate direction.
3. Turn the adjustment stud IN to decrease the flow or OUT to increase the flow using the 4mm Allen wrench.

When desired flow is acquired, hold the adjustment stud stationary with the 4mm Allen wrench and tighten the lock nut with the 13mm wrench (the proper torque for the lock nut is 14 N-m [10 ft-lb]).

Regulation Begin Adjustment for HPV Pump with Hydraulic Remote Control

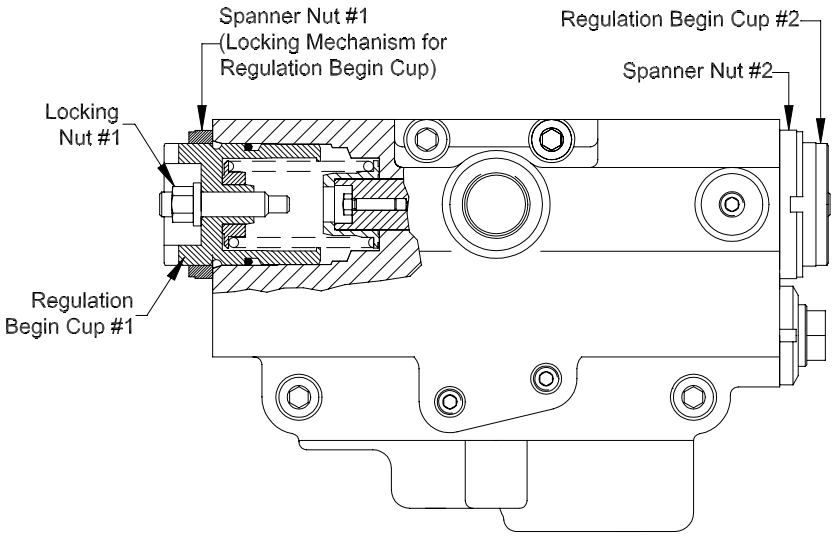
Set Up

Tools / Equipment Required

- 0-600 psi △p-gauge (optional: two(2) 0-600 psi pressure gauges or transducers)
- 0-6000 psi pressure gauge or transducer
- 13mm offset closed-end wrench
- Hammer and punch

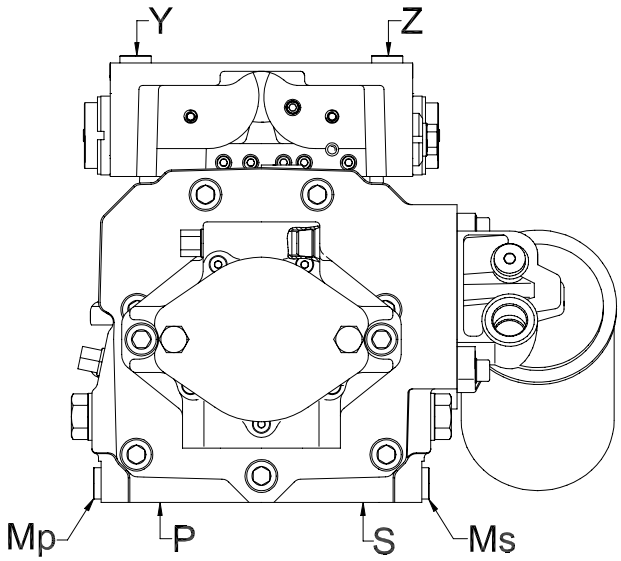
⚠ Important

AFTER adjusting the regulation begin, you must reset the pump maximum displacement setting. Follow the instructions on pages 7-8 to reset the pump maximum displacement.



⚠ WARNING

If performing this procedure on a vehicle, care must be taken. The pump will be put on stroke during this procedure, hence the vehicle must be safely elevated to allow the function to free-wheel. If this is NOT possible, then the pump workports "P" and "S" must be short circuited to each other to avoid movement of the function.



Regulation Begin Adjustment for HPV Pump with Hydraulic Remote Control

Procedure for Right-Hand (CW) Rotation

⚠ **Note**

Prior to performing this procedure, verify that the hydraulic neutral on the pump is correctly adjusted. Use the instructions on page 3 to check and adjust the hydraulic neutral setting if required.

Adjustment Procedure for Right-Hand Rotation (CW) Pump:

1. Install the 0-600 psi △p-gauge into ports "Y" and "Z" ("HI" side into "Y" and "LO" side into "Z").
2. Install the 0-6000 psi gauge into gauge port "Mp".
3. Set the input speed to Operational Speed.
4. While simultaneously monitoring both gauges, slowly supply control pressure into port "Y". Note the pressure on the △p-gauge when you first see pressure at port "Mp". This is the regulation begin pressure for workport "P".
5. To Adjust the Regulation Begin Pressure:
   a. Use the hammer and punch to loosen (rotate CCW) "Spanner Nut #2".
   b. Use the 13mm wrench on "Locking Nut #2" to adjust "Regulation Begin Cup #2". Turn it IN to increase the regulation begin pressure or turn it OUT to decrease it.
   c. Use the hammer and punch to tighten (rotate CW) "Spanner Nut #2".
   d. Repeat steps #3 and #4 to verify that the regulation begin pressure is correct.
6. Install the 0-600 psi △p-gauge into ports "Z" and "Y" ("HI" side into "Z" and "LO" side into "Y").
7. Install the 0-6000 psi gauge into gauge port "Ms".
8. Set the input speed to operational speed.
9. While simultaneously monitoring both gauges, slowly supply control pressure into port "Z". Note the pressure on the △p-gauge when you first see pressure at port "Ms". This is the regulation begin pressure for workport "S".
10. To Adjust the Regulation Begin Pressure:
    a. Use the hammer and punch to loosen (rotate CCW) "Spanner Nut #1".
    b. Use the 13mm wrench on "Locking Nut #1" to adjust "Regulation Begin Cup #1". Turn it IN to increase the regulation begin pressure or turn it OUT to decrease it.
    c. Use the hammer and punch to tighten (rotate CW) "Spanner Nut #1".
    d. Repeat steps #8 and #9 to verify that the regulation begin pressure is correct.
11. Follow all steps on pages 7-8 to reset the maximum displacement.

Regulation Begin Adjustment for HPV Pump with Hydraulic Remote Control

Procedure for Left-Hand Rotation (CCW) Pump

⚠ **Note**

Prior to performing this procedure, verify that the hydraulic neutral on the pump is correctly adjusted. Use the instructions on page 3 to check and adjust the hydraulic neutral setting if required.

Adjustment Procedure for Left-Hand Rotation (CCW) Pump:

1. Install the 0-600 psi △p-gauge into ports "Y" and "Z" ("HI" side into "Y" and "LO" side into "Z").
2. Install the 0-6000 psi gauge into gauge port "Ms".
3. Set the input speed to operational speed.
4. While simultaneously monitoring both gauges, slowly supply control pressure into port "Y". Note the pressure on the △p-gauge when you first see pressure at port "Ms". This is the regulation begin pressure for workport "S".
5. To Adjust the Regulation Begin Pressure:
   a. Use the hammer and punch to loosen (rotate CCW) "Spanner Nut #2".
   b. Use the 13mm wrench on "Locking Nut #2" to adjust "Regulation Begin Cup #2". Turn it IN to increase the regulation begin pressure or turn it OUT to decrease it.
   c. Use the hammer and punch to tighten (rotate CW) "Spanner Nut #2".
   d. Repeat steps #3 and #4 to verify that the regulation begin pressure is correct.
6. Install the 0-600 psi △p-gauge into ports "Z" and "Y" ("HI" side into "Z" and "LO" side into "Y").
7. Install the 0-6000 psi gauge into gauge port "Mp".
8. Set the input speed to operational speed.
9. While simultaneously monitoring both gauges, slowly supply control pressure into port "Z". Note the pressure on the △p-gauge when you first see pressure at port "Mp". This is the regulation begin pressure for workport "P".
10. To Adjust the Regulation Begin Pressure:
    a. Use the hammer and punch to loosen (rotate CCW) "Spanner Nut #1".
    b. Use the 13mm wrench on "Locking Nut #1" to adjust "Regulation Begin Cup #1". Turn it IN to increase the regulation begin pressure or turn it OUT to decrease it.
    c. Use the hammer and punch to tighten (rotate CW) "Spanner Nut #1".
    d. Repeat steps #8 and #9 to verify that the regulation begin pressure is correct.
11. Follow all steps on pages 7-8 to reset the maximum displacement.

Regulation Begin Adjustment for HPV Pumps with "M2P" (Mechanical-Hydraulic with POR) Controls

Set Up

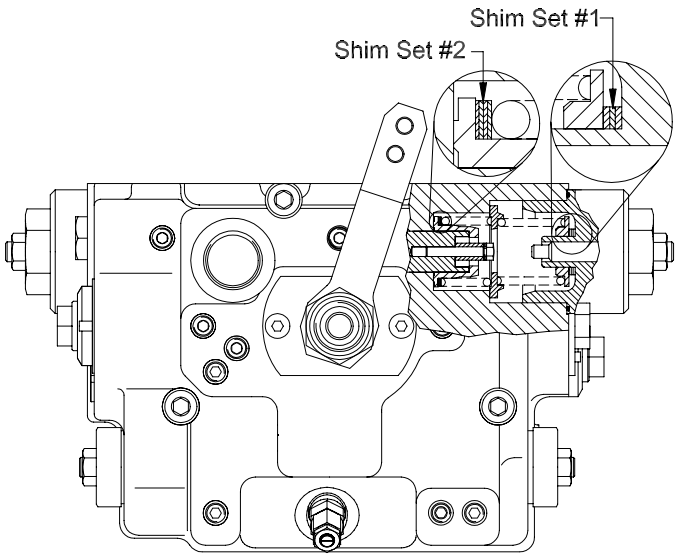
⚠ Note

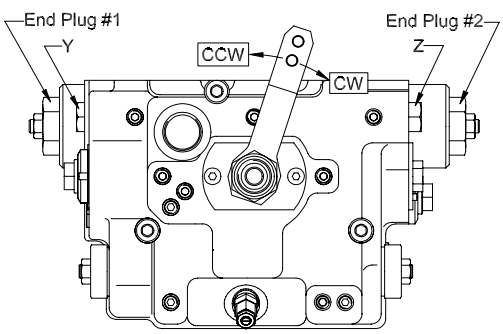
This Service Bulletin is ONLY valid for HPV pumps with "M2P" (Mechanical-Hydraulic with POR) controls.

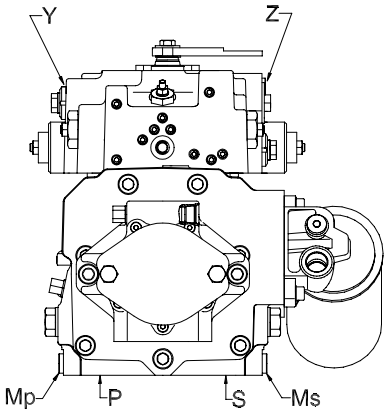
Tools / Equipment Required

- 0-600 psi △p-gauge (optional: two(2) 0-600 psi pressure gauges or transducers)
- 0-6000 psi pressure gauge or transducer
- 24mm wrench
- torque wrench capable of setting 150 N-m (111 ft-lb)
- regulation begin shims (refer to the Eaton spare parts catalog for part numbers)

Note: for shim set #2: 0.1mm shim change = 0.38° change in lever movement







⚠ WARNING

If performing this procedure on a vehicle, care must be taken. The pump will be put on stroke during this procedure, hence the vehicle must be safely elevated to allow the function to free-wheel. If this is not possible, then the pump workports "P" and "S" must be short circuited to each other to avoid movement of the function.

Regulation Begin Adjustment for HPV Pumps with "M2P" (Mechanical-Hydraulic with POR) Controls

Procedure for Right-Hand (CW) Rotation

⚠ **Note**

Prior to performing this procedure, verify that the hydraulic neutral on the pump is correctly adjusted. Use the instructions on page 3 to check and adjust the hydraulic neutral setting if required.

Adjustment Procedure for Right-Hand (CW) Rotation Pumps:

1. Install the 0-600 psi △p-gauge into port "Y" and "Z" ("HI" side into "Y" and "LO" side into "Z").
2. Install the 0-6000 psi gauge into port "Mp".
3. Set the input speed to operational speed.
4. While simultaneously monitoring both gauges, slowly turn the cam lever CCW (as illustrated on page 42). Record the pressure on the △p-gauge when you first see pressure at port "Mp". This is the regulation begin pressure for workport "P".
5. To adjust the regulation begin pressure:
   a. Remove End Plug #2 with the 24mm wrench.
   b. Add shims to Shim Set #2 to INCREASE the regulation begin setting, or remove shims to DECREASE the regulation begin setting.

   Note: You may need to add or remove shims to or from Shim Set #1 if you cannot acquire the desired regulation begin pressure by changing shims from Shim Set #2.

   c. Reinstall End Plug #2 and torque it to 150 N-m (111 ft-lb).
6. Repeat steps #4 and #5 until the desired regulation begin pressure is acquired.
7. Install the 0-600 psi △p-gauge into ports "Z" and "Y" ("HI" side into "Z" and "LO" side into "Y").
8. Install the 0-6000 psi gauge into port "Ms".
9. Set the input speed to operational speed.
10. While simultaneously monitoring both gauges, slowly turn the cam lever CW (as illustrated on page 42). Record the pressure on the △p-gauge when you first see pressure at port "Ms". This is the regulation begin pressure for workport "S".
11. To adjust the regulation begin pressure:
    a. Remove End Plug #1 with the 24mm wrench.
    b. Add shims to Shim Set #2 to INCREASE the regulation begin setting, or remove shims to DECREASE the regulation begin setting.

    Note: You may need to add or remove shims to or from Shim Set #1 if you cannot acquire the desired regulation begin pressure by changing shims from Shim Set #2.

    c. Reinstall End Plug #1 and torque it to 150 N-m (111 ft-lb).
12. Repeat steps #10 and #11 until the desired regulation begin pressure is acquired.

Regulation Begin Adjustment for HPV Pump with M2P (Mechanical-Hydraulic with POR) Controls

Procedure for Left-Hand (CCW) Rotation

⚠ **Note**

Prior to performing this procedure, verify that the hydraulic neutral on the pump is correctly adjusted. Use the instructions on page 3 to check and adjust the hydraulic neutral setting if required.

Adjustment Procedure for Left-Hand (CCW) Rotation Pumps:

1. Install the 0-600 psi △p-gauge into ports "Y" and "Z" ("HI" side into "Y" and "LO" side into "Z").
2. Install the 0-6000 psi gauge into port "Ms".
3. Set the input speed to operational speed.
4. While simultaneously monitoring both gauges, slowly turn the cam lever CCW (as illustrated on page 42). Record the pressure on the △p-gauge when you first see pressure at port "Ms". This is the regulation begin pressure for workport "S".
5. To adjust the regulation begin pressure:
   a. Remove End Plug #2 with the 24mm wrench.
   b. Add shims to Shim Set #2 to INCREASE the regulation begin setting, or remove shims to DECREASE the regulation begin setting.

   Note: You may need to add or remove shims to or from Shim Set #1 if you cannot acquire the desired regulation begin pressure by changing shims from Shim Set #2.

   c. Reinstall End Plug #2 and torque it to 150 N-m (111 ft-lb).
6. Repeat steps #4 and #5 until the desired regulation begin pressure is acquired
7. Install the 0-600 psi △p-gauge into ports "Z" and "Y" ("HI" side into "Z" and "LO" side into "Y").
8. Install the 0-6000 psi gauge into port "Mp".
9. Set the input speed to operational speed.
10. While simultaneously monitoring both gauges, slowly turn the cam lever CW (as illustrated on page 42). Record the pressure on the △p-gauge when you first see pressure at port "Mp". This is the regulation begin pressure for workport "P".
11. To adjust the regulation begin pressure:
    a. Remove End Plug #1 with the 24mm wrench.
    b. Add shims to Shim Set #2 to INCREASE the regulation begin setting, or remove shims to DECREASE the regulation begin setting.

    Note: You may need to add or remove shims to or from Shim Set #1 if you cannot acquire the desired regulation begin pressure by changing shims from Shim Set #2.

    c. Reinstall End Plug #1 and torque it to 150 N-m (111 ft-lb).
12. Repeat steps #10 and #11 until the desired regulation begin pressure is acquired.

Cold Start Valve Adjustment for HPV Pump with CA Control

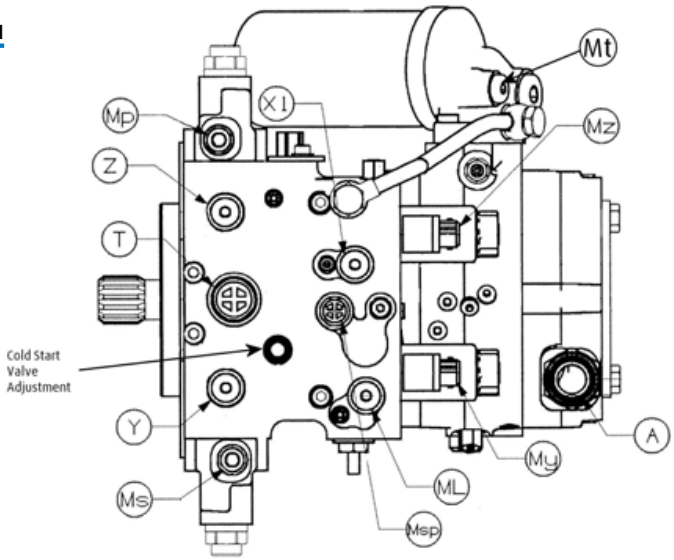
Set Up and Procedure

⚠ Important

This procedure is intended for field adjustments only.

Tools / Equipment Required

- 0-600psi Pressure Gauge.
- 10mm wrench (X2)



Adjusting the Cold Start Valve

Important

⚠ Vehicle's drive system must be kept in Neutral throughout this procedure. In order to insure this condition, it is recommended to disconnect both My and Mz solenoid connections.

This test must be performed with the oil at operating temperature.

1. Install the 0-600psi Gauge on test port "Mt" of the pump's filter block.
2. While monitoring the pressure on the "Mt" port.
   a. Increase the Engine RPM from the low idle all the way to max RPM.
   b. The pressure value at port "Mt" during max RPM is the Cold Start Valve setting. Contact Eaton Engineering for the correct value for your pump.

DANGER

In order to prevent damages to the filter element, this value must be kept lower than 580psi

3. To adjust the Cold Start Valve setting:
   a. Loosen the lock nut while holding the adjustment stud in place
   b. Turn the adjustment in to increase the Cold Start Valve setting.
   c. Turn the adjustment out to decrease the Cold Start Valve setting.
   d. Tighten the lock nut while holding the adjustment stud in place.

D3.1 Variable Orifice Adjustment for HPV with CA Control (Regulation Begin Setting)

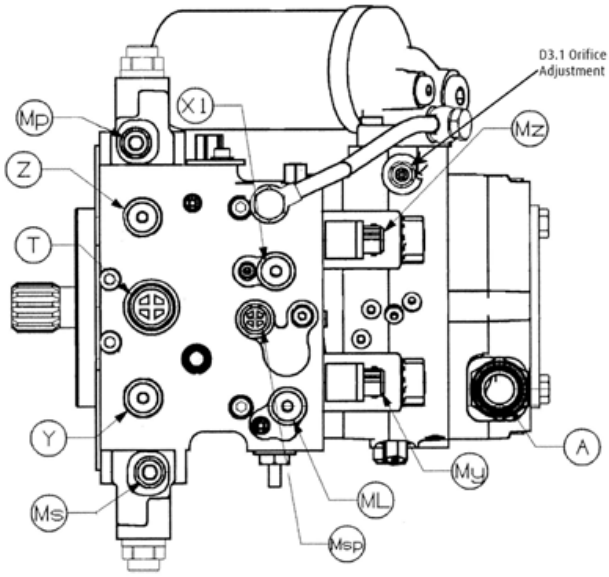
Set Up and Procedure

⚠ Important

This procedure is intended for field adjustments only.

Tools / Equipment Required

- Engine RPM Tachometer.
- 13mm wrench
- 4mm Allen key



Adjusting D3.1 Variable Orifice:

Important

⚠ Eaton recommends that the vehicle be lifted off the ground throughout this procedure.

This test must be performed with the oil at operating temperature.

DANGER

The HPVCA pump will be put on stroke during this procedure; as a result, the vehicle's propel motor(s) will be turning while measurements / adjustments are taking place.

1. While monitoring the Engine RPM, slowly increase the Engine RPM until the vehicle's propel motor(s) start to rotate.
2. Record the Engine RPM at which the propel motor(s) started their rotation. This RPM Value is the pump's regulation begin RPM and must match the value specified for the vehicle. Contact Eaton Engineering for this value
3. To adjust the D3.1 variable orifice setting:
   a. Loosen the lock nut while holding the adjustment stud in place
   b. Turn the adjustment in to decrease the Regulation Begin RPM Setting.
   c. Turn the adjustment out to increase the Regulation Begin RPM Setting.
   d. Tighten the lock nut while holding the adjustment stud in place.

Power Limiter Valve Adjustment for HPV Pump with CA Control

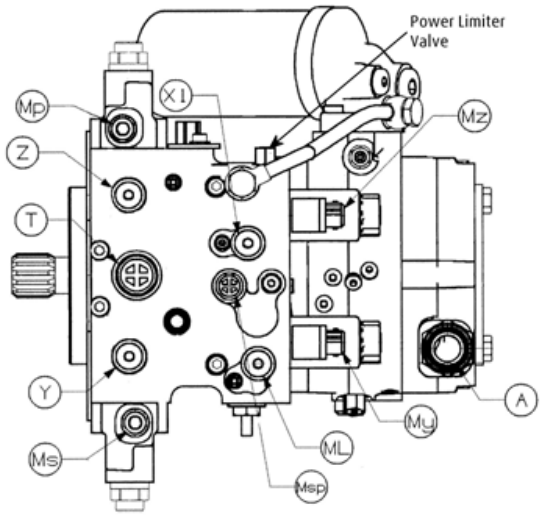
Set Up and Procedure

⚠ Important

This procedure is intended for field adjustments only.

Tools / Equipment Required

- 0-600psi Differential Pressure Gauge.
- 11mm wrench
- 10mm Wrench
- 3mm Allen Key



Adjusting the Power Limiter Valve

Important

⚠ Vehicle's drive system must be kept in Neutral throughout this procedure. In order to insure this condition, it is recommended to disconnect both My and Mz solenoid connections.

This test must be performed with the oil at operating temperature.

1. Install the 0-600psi Differential Gauge as follows:
   a. Connect the HI side to the "ML" port
   b. Connect the LO side to the "Msp" port.
2. While monitoring the pressure on the Differential Gauge:
   a. Increase the Engine RPM from the low idle all the way to max RPM.
   b. The pressure value on the Differential Gauge during max RPM is the Power Limiter Valve setting. Contact Eaton Engineering for this value.
3. To adjust the Power Limiter Valve setting:
   a Loosen the lock nut while holding the adjustment stud in place
   b Crack open the upper part of the power limiter valve body while holding the adjustment stud in place.

DANGER

Do not move this portion of the valve body more than 1/8 of a turn.
Excessive movement can result in disassembly of the valve.

   c. While holding the Valve body in place, turn the adjustment in to increase the Power Limiter Valve setting, or out to decrease it.
   d. Tighten the upper part of the Power Limiter valve while holding the adjustment stud in place.
   e. Tighten the lock nut while holding the adjustment stud in place.

Switching Valve Adjustment for HPV Pump with CA Control

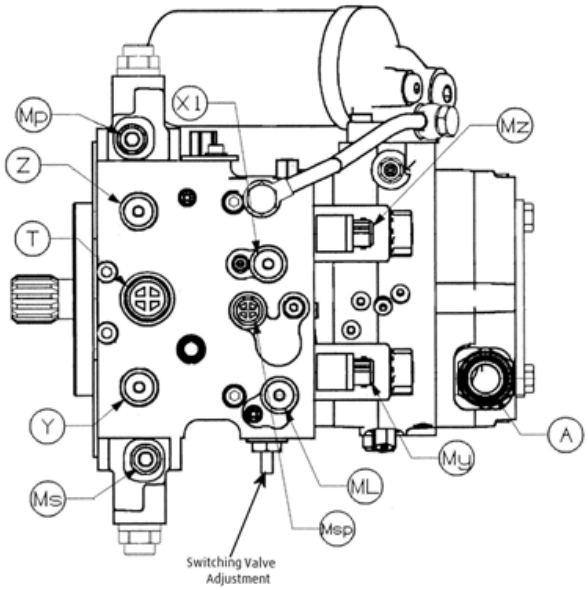
Set Up and Procedure

⚠ Important

This procedure is intended for field adjustments only.

Tools / Equipment Required

- 0-600psi Pressure Gauge.
- Engine RPM Tachometer.
- 13mm wrench
- 4mm Allen key



Adjusting the Switching Valve

Important

⚠ Eaton recommends that the vehicle be lifted off the ground throughout this procedure.

This test must be performed with the oil at operating temperature.

DANGER

The HPVCA pump will be put on stroke during this procedure; as a result, the vehicle's propel motor(s) will be turning while measurements / adjustments are taking place.

1. Install the 0-600psi Gauge on test port "Y" of the pump control.
2. With the vehicle lifted off the ground, Energize solenoid Mz.
3. While monitoring the Engine RPM and the pressure in port "Y":
   a. Slowly increase the Engine RPM from low idle.
   b. The pressure in port "Y" will increase as the Engine RPM increases, then will suddenly drop back to charge pressure.
   c. Record the Engine RPM when the pressure in port "Y" suddenly drops back to charge pressure.
4. This Engine RPM value must be equal to the mid point between "Engine low idle RPM" and "Pump's Regulation Begin Engine RPM" ± 20RPM (see page 46).
5. To adjust the Switching Valve Setting:
   a. Loosen the lock nut while holding the adjustment stud in place
   b. Turn the adjustment in to increase the Switching Valve value.
   c. Turn the adjustment out to decrease the Switching Valve value.
   d. Tighten the lock nut while holding the adjustment stud in place.

Additional Information

Environmental Concerns

Protection of the natural fundamentals of life is one of our predominant tasks. We are continuously improving the protection of the environment as far as applications are concerned. We encourage you to contribute your share to comply with this demand. In connection with work to be performed, the environmental regulations of the machine manufacturer must be respected.

In general:

- Greases and oils which cannot be used any more have to be collected. They are normally a threat to water reserves and must be kept away from the environment.
- Adhere to national and local regulations for waste disposal.

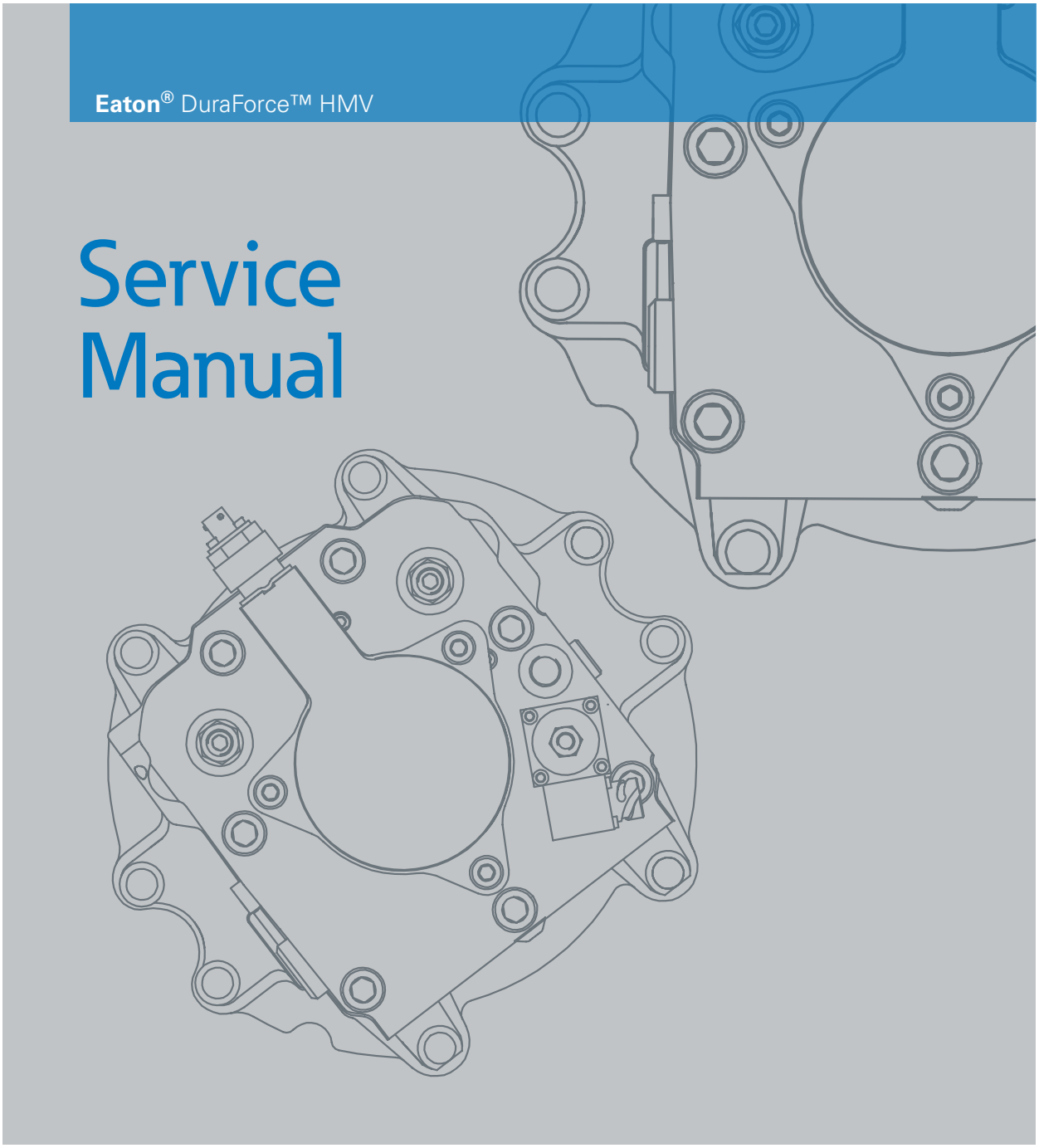
Important

You have been provided information on the conversion of DuraForce products. Proper application of the information requires specific training and may require use of specialized tooling and equipment. All requests for training must be coordinated through your Eaton Account Manager. He can also provide you price and availability of any specialized tooling. If you choose to proceed with the conversion of the DuraForce products absent the necessary training and/or these specialized tools, you do so at your risk.

Eaton will accept no claim for warranty resulting from deficiencies in the conversion. Please refer to the Eaton literature web site for warranty information at www.eaton.com/hydraulics/warranty.

This Page Intentionally Blank

51253 HYDRAULIC MOTOR SERVICE



Powering Business Worldwide

Table of Contents

Environmental Concerns

Protection of the natural fundamentals of life is one of our predominant tasks. We are continuously improving the protection of the environment as far as applications are concerned. We encourage you to contribute your share to comply with this demand. In connection with work to be performed, the environmental regulations of the machine manufacturer must be respected.

In general:

- Greases and oils which cannot be used any more have to be collected. They are normally a threat to water reserves and must be kept away from the environment.
- Adhere to national and local regulations for waste disposal.

Important

You have been provided information on the conversion of DuraForce products. Proper application of the information requires specific training and may require use of specialized tooling and equipment. All requests for training must be coordinated through your Eaton Account Manager. He can also provide you price and availability of any specialized tooling. If you choose to proceed with the conversion of the DuraForce products absent the necessary training and/or these specialized tools, you do so at your risk.

Eaton will accept no claim for warranty resulting from deficiencies in the conversion. Please refer to the Eaton literature web site for warranty information at www.eaton.com/hydraulics/warranty.

Electric Infinitely Variable Control Adjustment Procedure for HMV Motors

Set Up

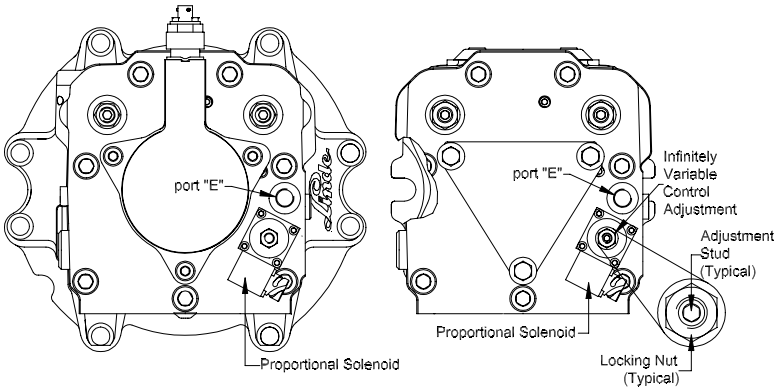
⚠ Important

This procedure does not include the E6 Control option. For E6 Control Adjustment Procedure, please refer to the related Eaton Service Bulletin.

Tools / Equipment Required

Note: Due to slight differences in the HMV controls and motor sizes, several tools will be specified to insure that you have all tool combinations that may be required.

- 13mm off-set closed-end wrench
- 6mm wrench
- 4mm Allen wrench
- Multi-Meter (capable of measuring DC Amperage up to 2 Amps Max.)



Note #1:

Make sure that the HMV minimum and maximum displacements have been adjusted prior to performing this procedure. Refer to the related Eaton Service Bulletins for information on how to make these adjustments.

Note #2:

To insure the proper operation of the motor, you must provide supply-pressure into port "E" between 290-580 psi. If the HMV has the configuration where this supply-pressure is provided internally (via the case-flushing shuttle), then ignore this note.

Note #3:

Prior to performing this procedure, it is necessary for you to know what the control range (in amperage) is for your particular HMV. The HMV motors can be equipped with spring packages that provide several different control ranges.

Note #4:

The spring package that the HMV is equipped with will provide a control range that cannot be adjusted. The only thing that can be adjusted is either the regulation begin setting or the regulation end setting.

EXAMPLE: If the HMV has a spring package to provide a control range of 626 mA (834 mA regulation begin and 1460 mA regulation end), then this control range cannot be changed. If you adjust the regulation begin from 834 mA to 750 mA, then the regulation end will automatically be changed from 1460 mA to 1376 mA.

If you need to change the control range, then you must consult Eaton Engineering for the new spring package.

Note #5:

The HMV motor automatically defaults to maximum displacement and will remain at maximum displacement unless supplied with an external pressure or power supply to force it to de-stroke. For an "electrically" controlled HMV motor, current is typically supplied to the motor's proportional solenoid to de-stroke it.

When making the adjustment to the HMV infinitely variable control, the HMV will be at maximum displacement prior to the regulation begin setting. At the regulation begin setting, the HMV will start to de-stroke towards minimum displacement. The HMV will destroke linearly throughout the control range as the current to the motor's proportional solenoid is increased.

For this procedure, the supply flow to the motor must remain constant throughout the adjustment procedure - The motor rotational speed will increase as the motor de-strokes towards minimum displacement when the supply flow is constant. Therefore, for this procedure, the motor rotational speed will be used as the indicator to determine where the regulation begin and/or regulation end settings are.

Electric Infinitely Variable Control Adjustment Procedure for HMV Motors

Procedure

Procedure for Adjusting the HMV Electric Infinitely Variable Control:

1. Install the multi-meter to measure the current to the motor's proportional solenoid. Be sure to set the multi-meter to measure DC amperage.
2. Start the prime mover and adjust it to operating speed.
3. Supply a constant flow to the HMV. As mentioned previously, maintain this constant flow throughout this procedure.
4. Slowly energize the motor's proportional solenoid.
5. Simultaneously monitor the current at the proportional solenoid and the rotational speed of the HMV.
6. When the rotational speed of the HMV increases, record the current at the solenoid. This is the regulation begin setting.
7. Continue to energize the proportional solenoid. The rotational speed of the HMV should continue to increase as the current increases.
8. Verify that the regulation end point coincides with the control range for the spring package in your HMV (as described in Notes #3 and #4 above).
9. Supply full current to the proportional solenoid. Confirm that the HMV is at minimum displacement by checking the rotational speed of the HMV.
10. To adjust the infinitely variable control:
    a. Hold the adjustment stud stationary.
    b. Loosen the locking nut.
    c. Turn the adjustment stud IN to decrease the regulation begin setting or turn it OUT to increase the regulation begin setting.
    d. Once the desired regulation begin setting has been acquired, hold the adjustment stud stationary and tighten the locking nut.
11. Turn the prime mover OFF and remove the multi-meter from the motor.

Hydraulic Infinitely Variable Control Adjustment Procedure for HMV Motors

Set Up

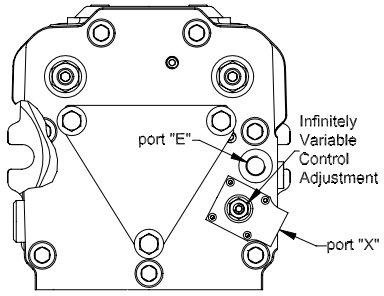
⚠ Important

This procedure does not include the "H6" or "E6" Control option. For "H6" or "E6" Control Adjustment Procedure, please refer to the related Eaton Service Bulletin.

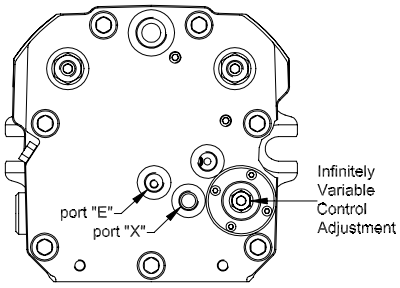
Tools / Equipment Required

Note: Due to slight differences in the HMV controls and motor sizes, several tools will be specified to insure that you have all tool combinations that may be required.

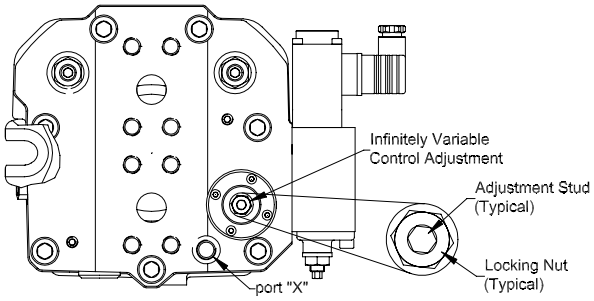
- 13mm off-set closed-end wrench
- 17mm wrench
- 6mm wrench
- 5mm Allen wrench
- 4mm Allen wrench
- 0-400 psi pressure gauge (optional: 0-400 psi pressure transducer)



Side-Ported HMV-02 with Hydraulic Infinitely Variable Control



Side-Ported HMV-02 with Hydraulic Infinitely Variable Control



Rear-Ported HMV-02 with Hydraulic Infinitely Variable Control and Pressure Compensator

Hydraulic Infinitely Variable Control Adjustment Procedure for HMV Motors

Set Up

Note #1:

Make sure that the HMV minimum and maximum displacements have been adjusted prior to performing this procedure. Refer to Related Service Bulletins for information on how to make these adjustments.

Note #2:

To insure the proper operation of the motor, you must provide supply-pressure into port "E" between 290-580 psi. If the HMV has the configuration where this supply-pressure is provided internally (via the case-flushing shuttle), then ignore this note.

Note #3:

Prior to performing this procedure, it is necessary for you to know what the control range is for your particular HMV. The HMV motors can be equipped with spring packages that provide several different control ranges.

Note #4:

The spring package that the HMV is equipped with will provide a control range that cannot be adjusted. The only thing that can be adjusted is either the regulation begin setting or the regulation end setting.

EXAMPLE: If the HMV has a spring package to provide a control range of 87 psi (116 psi regulation begin and 203 psi regulation end), then this control range cannot be changed. If you adjust the regulation begin from 116 psi to 100 psi, then the regulation end will automatically be changed from 203 psi to 187 psi.

If you need to change the control range, then you must consult Eaton Engineering for the new spring package.

Note #5:

The HMV motor automatically defaults to maximum displacement and will remain at maximum displacement unless supplied with an external pressure or power supply to force it to destroke. For a "hydraulically" controlled HMV motor, control pressure is typically supplied into port "X" of the motor to destroke it.

When making the adjustment to the HMV infinitely variable control, the HMV will be at maximum displacement prior to the regulation begin setting. At the regulation begin setting, the HMV will start to destroke towards minimum displacement. The HMV will detroke linearly throughout the control range as the pressure at port "X" is increased.

For this procedure, the supply flow to the motor must remain constant throughout the adjustment procedure - The motor rotational speed will increase as the motor destrokes towards minimum displacement when the supply flow is constant. Therefore, for this procedure, the motor rotational speed will be used as the indicator to determine where the regulation begin and/or regulation end settings are.

Hydraulic Infinitely Variable Control Adjustment Procedure for HMV Motors

Procedure

Procedure for Adjusting the HMV Hydraulic Infinitely Variable Control:

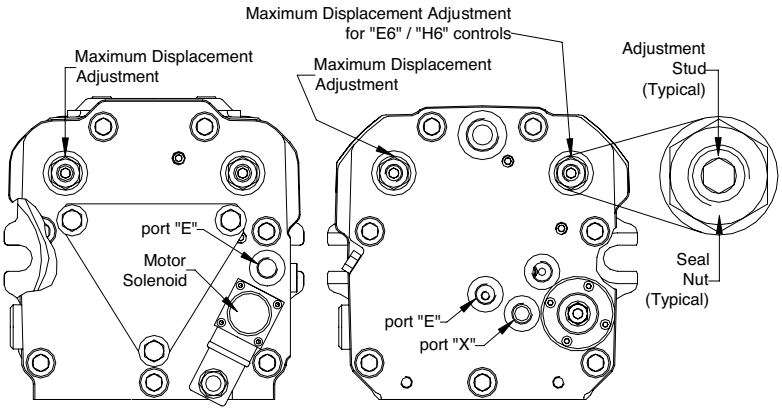
1. Install the 0-400 psi pressure gauge into port "X".
2. Start the prime mover and adjust it to operating speed.
3. Supply a constant flow to the HMV.
   As mentioned previously, maintain this constant flow throughout this procedure.
4. Slowly increase the control pressure into port "X".
5. Simultaneously monitor the pressure at port "X" and the rotational speed of the HMV.
6. When the rotational speed of the HMV increases, record the pressure at port "X".
   This is the regulation begin pressure.
7. Continue to increase the control pressure into port "X". The rotational speed of the HMV should continue to increase as the control pressure increases.
8. Verify that the regulation end point coincides with the control range for the spring package in your HMV (as described in Notes #3 and #4 above).
9. Supply full control pressure into port "X". Confirm that the HMV is at minimum displacement by checking the rotational speed of the HMV.
10. To adjust the infinitely variable control:
    a. Hold the adjustment stud stationary.
    b. Loosen the locking nut.
    c. Turn the adjustment stud IN to decrease the regulation begin setting or turn it OUT to increase the regulation begin setting.
    d. Once the desired regulation begin setting has been acquired, hold the adjustment stud stationary and tighten the locking nut.
11. Turn the prime mover OFF and remove the pressure gauge from the motor.

Maximum Displacement Adjustment Procedure for HMV Motors

Set Up

Tools / Equipment Required

- 19mm closed-end wrench
- 6mm Allen wrench



Side-Ported HMV-02 with Electric 2-Position Control

Side-Ported HMV-02 with Hydraulic Infinitely Variable Control

Note #1:

The following table illustrates the maximum displacements and allowable rotational speeds for those displacements for the HMV motors. The HMV motors should NOT be operated at higher speeds if these maximum displacement settings are used. If higher rotational speeds are required for your application, you must consult Eaton Engineering for the allowable maximum displacement setting.

Size		55	75	105	135	165	210	280
Max Displacement limit (CC)		54.8	75.9	105.0	135.6	165.0	210	280
Speed (RPM)	Continuous Max Speed at Max Displacement	4100	3800	3500	3200	3100	2700	2400
	Continuous Max Speed at Min Displacement	4700	4400	4100	3700	3500	3200	2900

Note #2:

To insure the proper operation of the motor, you must provide supply-pressure into port "E" between 290-580 psi. If the HMV has the configuration where this supply-pressure is provided internally (via the case-flushing shuttle), then ignore this note.

Maximum Displacement Adjustment Procedure for HMV Motors

Set Up and Procedure

Note #3:

The HMV motor automatically defaults to maximum displacement and will remain at maximum displacement unless supplied with an external pressure or power supply to force it to destroke. For a "hydraulically" controlled HMV motor, control pressure is typically supplied to port "X" of the motor to destroke it. For an "electrically" controlled HMV motor, current is typically supplied to the motor solenoid to destroke it. When performing this procedure, make sure that no external pressure or power supply is supplied to the HMV motor to insure that the motor remains at maximum displacement.

Note #4:

The HMV motor with "E6" and "H6" controls automatically default to minimum displacement unless:

a. For H6 Infinitely Variable Control, supply a minimum of 205 psi control pressure into port "X".

b. For 12V E6 Electric Infinitely Variable Control, You provide a minimum of 720 mA to the solenoid.

c. For 24V E6 Electric Infinitely Variable Control, You provide a minimum of 360 mA to the solenoid.

Procedure for Adjusting the HMV Maximum Displacement:

Start the prime mover and adjust it to operating speed.

1. Actuate the HMV per the requirements stated in "Note #3" and "Note #4".
2. To Adjust the Motor Maximum Displacement:

   a. Hold the adjustment stud stationary with the 6mm Allen Wrench.

   b. Loosen the seal nut with the 19mm wrench.

   c. Turn the adjustment stud IN to decrease the maximum displacement or turn it OUT to increase the maximum displacement.

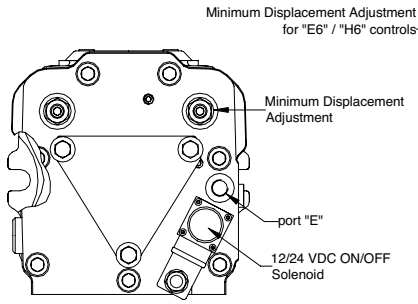
   d. Once the desired maximum displacement has been acquired, hold the adjustment stud stationary with the 6mm Allen wrench and tighten the seal nut with the 19mm wrench. The proper torque for the seal nut is 60 N-m (44 ft-lb).

Minimum Displacement Adjustment Procedure for HMV

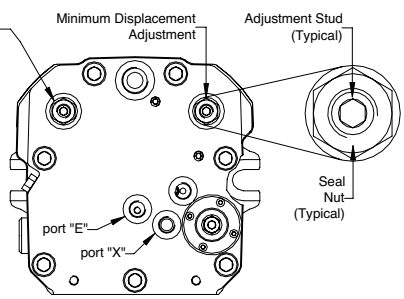
Set Up

Tools / Equipment Required

- 19mm closed-end wrench
- 6mm Allen wrench



Side-Ported HMV-02 with Electric 2-Position Control



Side-Ported HMV-02 with Hydraulic Infinitely Variable Control

Note #1:

The following table illustrates the recommended minimum displacements and allowable rotational speeds for those displacements for the HMV motors. The HMV motors should NOT be operated at higher speeds if the recommended displacements are used. If higher rotational speeds are required for your application, you must consult Eaton Engineering for the required minimum displacement setting.

Size		55	75	105	135	165	210	280
Min Displacement limit (CC)		18.3	25.3	35.0	45.2	55.2	70	93
Speed (RPM)	Continuous Max Speed at Max Displacement	4100	3800	3500	3200	3100	2700	2400
	Continuous Max Speed at Min Displacement	4700	4400	4100	3700	3500	3200	2900

Note #2:

To insure the proper operation of the motor, you must provide supply-pressure into port "E" between 290-580 psi. If the HMV has the configuration where this supply-pressure is provided internally (via the case-flushing shuttle), then ignore this note.

Minimum Displacement Adjustment Procedure for HMV

Set Up and Procedure

Note #3:

The HMV motor automatically defaults to maximum displacement unless:

a. (For Hydraulic Infinitely Variable Control) You supply a minimum of 205 psi control pressure into port "X".

b. (For 2-Position Hydraulic Control) You supply a minimum of 205 psi control pressure into port "X".

c. (For 10VDC Electric Infinitely Variable Control) You provide a minimum of 1460 mA to the solenoid.

d. (For 12VDC 2-Position Electric Control) You provide a minimum of 720 mA to the solenoid.

e. (For 24VDC 2-Position Electric control) You provide a minimum of 360 mA to the solenoid.

Under the above conditions, the HMV motor will be forced to minimum displacement.

Note #4:

For HMV motor with "E6" or "H6" controls, the motor automatically defaults to Minimum Displacement.

Procedure for Adjusting the HMV Minimum Displacement:

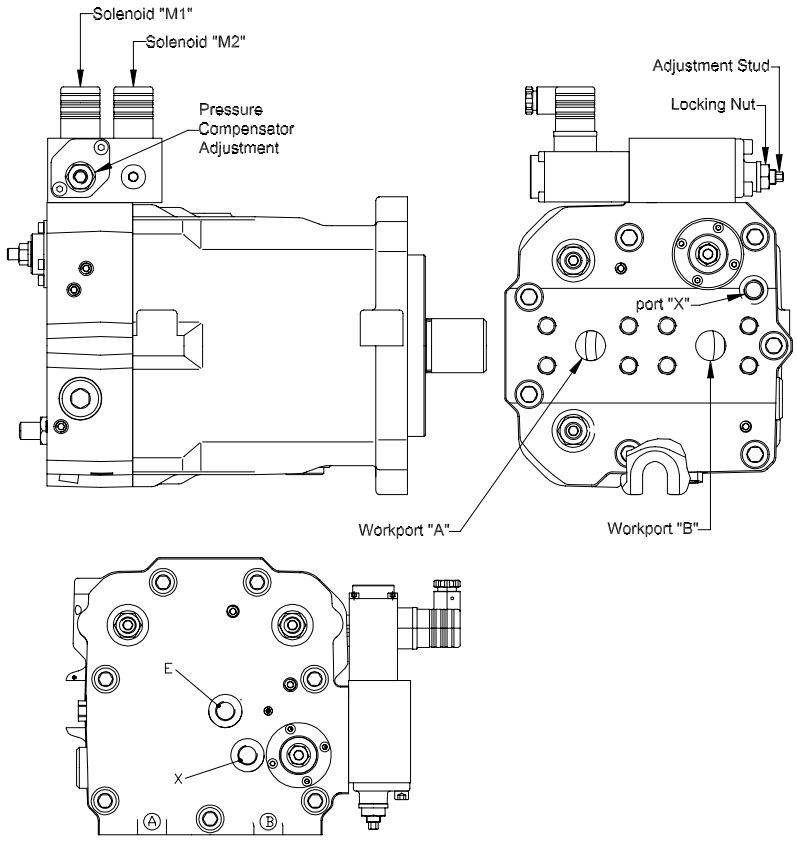
1. Start the prime mover and adjust it to operating speed.
2. Depending on the type of control on your HMV, refer to "note #3" and "note #4" above to force the motor to minimum displacement.
3. To Adjust the Motor Minimum Displacement:
   a. Hold the adjustment stud stationary with the 6mm Allen Wrench.
   b. Loosen the seal nut with the 19mm wrench.
   c. Turn the adjustment stud IN to increase the minimum displacement or turn it OUT to decrease the minimum displacement.
4. Once the desired minimum displacement has been acquired, hold the adjustment stud stationary with the 6mm Allen wrench and tighten the seal nut with the 19mm wrench. The proper torque for the seal nut is 60 N-m (44 ft-lb).

Pressure Compensator Adjustment Procedure for HMV Motors

Set Up

Tools / Equipment Required

- 17mm wrench
- 6mm wrench
- 0-7000 psi pressure gauge (optional: 0-7000 psi pressure transducer)



Note #1:

For this procedure, the motor will be forced to minimum displacement by supplying full control pressure (200 psi minimum) into port "X". The motor must then slowly be loaded to increase the workport pressure up to and greater than the desired pressure compensation setting. When the pressure compensator becomes active, the motor will automaticaly shift back to maximum displacement. When this happens, the workport pressure will suddenly decrease. Therefore, for this procedure, the motor workport pressure will be used as the indicator to determine where the pressure compensation setting is.

To use this procedure, you must be able to load the motor as described above.

Note #2:

The pressure compensation setting must be set at least 300 psi less than the settings on any cross-over relief valves used with the HMV to avoid premature cracking of the relief valves or interaction with the relief valves.

Pressure Compensator Adjustment Procedure for HMV Motors

Procedure

Procedure to Adjust the Pressure Compensation Setting:

1. Install the 0-7000 psi gauge to read either workport "A" or "B", whichever is the easiest to gain access to.
2. Use the sketches above to note which workport you are taking a pressure reading from. This is critical for the adjustment of this motor control.
   - If reading pressure from workport "A", Solenoid "M2" must be de-energized when making the pressure compensation adjustment/measurement.
   - If reading pressure from workport "B", Solenoid "M2" must be energized when making the pressure compensation adjustment/measurement.
3. Start the prime mover and adjust it to operating speed.
4. Actuate the motor and supply full control pressure into port "X" (200 psi minimum).
5. Load the motor such that the workport pressure slowly increases.
6. As mentioned in Note #1, when the pressure compensator becomes active, the workport pressure will suddenly decrease. Monitor the pressure gauge. Record the highest pressure up until the pressure suddenly decreases. This is the pressure compensation setting.
7. To Adjust the Pressure Compensation Setting:
   a. Hold the adjustment stud stationary with the 6mm wrench.
   b. Loosen the locking nut with the 17mm wrench.
   c. Turn the adjustment stud IN to increase the pressure compensation setting or turn it OUT to decrease the pressure compensation setting.
   d. When the desired pressure compensation setting is acquired, hold the adjustment stud stationary and tighten the locking nut.
8. Stop the prime mover and remove the pressure gauge from the motor.

HPV CCW (Left Hand) Rotation Pumps with "M2P" Control with Pressure Override (POR)

Procedure

⚠ Important

This is a "field adjustment" procedure valid for HPV pumps with CCW (Left-Hand) rotation and M2P control.

"Valve III" Adjustment:

3. "Valve III" Adjustment:

A. Keep both of the pump work ports ("P" and "S") closed off or blocked.

B. Turn the control lever Counter-Clockwise (CCW) fully and hold it.

C. Slowly turn IN the adjustment screw for "Valve III" until control pressure "△Py-z" is 10 -15 psi higher than the "△Py-z" Regulation Begin pressure recorded above (value "a").

Record the "△Py-z" setting: _____ psid…….(value "e")

D. Tighten the locking nut on "Valve III" and return the control lever to its neutral position.

E. Turn the control lever Clockwise (CW) fully and hold it. Verify that the pressure is 10 - 15 psi higher than the "Pz-y" Regulation Begin pressure recorded above (value "b").

Record the "△Pz-y" setting: _____ psid…….(value "f")

Hint: If "Valve III" gets too hot, it will be difficult to adjust and/or get consistent results. Allow the pump to cool off if you encounter difficulty adjusting "Valve III".

Final Adjustment:

4. Final Adjustment:

A. IF the difference between (value "e") and (value "f") is 5 psi or less, then NO additional adjustments are required to the POR.

B. IF the difference between (value "e") and (value "f") is greater than 5 psi, then either "Valve I" or "Valve II" needs to be backed out. The side which has the higher value must be backed out until the difference between (value "e") and (value "f") is 5 psi or less.

C. Turn the control lever Counter-Clockwise (CCW) fully and verify that work port pressure "S" is stable and control pressure does NOT increase/decrease for ~10 seconds.

D. Turn the control lever Clockwise (CW) fully and verify that work port pressure "P" is stable and control pressure does NOT increase/decrease for ~10 seconds.

Note: If either one or both work port pressures are not stable, then repeat the POR adjustment process starting with step #1 above.

If the control pressure changes during steps "C" or "D" above, then "Valve I" and/or "Valve II" is not adjusted correctly. Repeat the POR adjustment process starting with step #1 above.

Electric Regulation Begin Adjustment for HMV Double Motors

Part A: Procedure to Adjust the Regulation Begin for Motor #1

Note:

After Adjusting the regulation begin, you must reset the motor minimum displacement setting. Follow the instructions on pages 19-20 to reset the motor minimum displacement.

⚠ **Important**

The Electric Regulation Begin Adjustment of both motor controls are preset to the correct value by Eaton. They should **NOT** be adjusted or tampered with at any time.

The instructions included in this manual should **ONLY** be used if the Electric Regulation Begin Adjustment on either motor control has been tampered with or if one or both motor controls have been replaced.

Part A: Procedure to Adjust the Regulation Begin for Motor #1:

1. On the Motor #2 Regulation Begin Adjustment, hold the Min. Displacement Stud stationary with the 4mm Allen wrench and loosen the Locking Nut with the 13mm wrench.
2. Slowly turn the Min. Displacement Stud IN until it just touches the spool in the motor control then tighten the Locking Nut. Record the number of turns (to the nearest 1/8 turn) of the stud.

   Number of Turns Stud #2 = _____turns
3. As illustrated on the previous page, measure from the edge of the Regulation Begin Cup to the edge of the motor control for Motor #1. Use the following steps to adjust the Regulation Begin Cup:

   a. Use the hammer and punch to loosen the Spanner Nut.

   b. Use the 13mm wrench on the Locking Nut to turn the Regulation Begin Cup either IN or OUT until the dimension of 15.6mm is acquired.

   c. Use the hammer and punch to tighten the Spanner Nut.
4. Connect the multi-meter to measure the current to the motor solenoid.
5. Supply a constant flow to the motor (It is important to maintain a constant flow since changes in motor rotational speed is used as an indicator).
6. While monitoring both the multi-meter and the motor rotational speed, slowly supply current to the motor solenoid. When the motor rotational speed changes (increases), record the current on the multi-meter – This is the regulation begin setting for Motor #1.
7. For a 12VDC Solenoid, the regulation begin setting should be 450±5 mA. For a 24VDC Solenoid, the regulation begin setting should be 225±2.5 mA. To adjust the regulation begin setting, use the following steps for the control on Motor #1:

   a. Use the hammer and punch to loosen the Spanner Nut.

   b. Use the 13mm wrench on the Locking Nut to turn the Regulation Begin Cup IN to increase the regulation begin setting or OUT to decrease it.

   c. Once a regulation begin setting of 450±5 mA (12VDC Solenoid) or 225±2.5 mA (24VDC Solenoid) is acquired, use the hammer and punch to tighten the Spanner Nut.
8. On the Motor #2 Regulation Begin Adjustment, hold the Min. Displacement Stud stationary and loosen the Locking Nut.
9. Turn the Min. Displacement Stud OUT by the number of turns recorded in Step #2 (Part A) above. Tighten the Locking Nut. The proper torque for the Locking Nut is 10 ft-lb.

Electric Regulation Begin Adjustment for HMV Double Motors

Part B: Procedure to Adjust the Regulation Begin for Motor #2

Part B: Procedure to Adjust the Regulation Begin for Motor #2:

1. On the Motor #1 Regulation Begin Adjustment, hold the Min. Displacement Stud stationary with the 4mm Allen wrench and loosen the Locking Nut with the 13mm wrench.
2. Slowly turn the Min. Displacement Stud IN until it just touches the spool in the motor control then tighten the Locking Nut. Record the number of turns (to the nearest 1/8 turn) of the stud.

   Number of Turns Stud #1 = _____turns
3. As illustrated above, measure from the edge of the Regulation Begin Cup to the edge of the motor control for Motor #2. Use the following steps to adjust the Regulation Begin Cup:

   a. Use the hammer and punch to loosen the Spanner Nut.

   b. Use the 13mm wrench on the Locking Nut to turn the Regulation Begin Cup either IN or OUT until the dimension of 15.6mm is acquired.

   c. Use the hammer and punch to tighten the Spanner Nut.
4. Connect the multi-meter to measure the current to the motor solenoid.
5. Supply a constant flow to the motor (It is important to maintain a constant flow since changes in motor rotational speed is used as an indicator).
6. While monitoring both the multi-meter and the motor rotational speed, slowly supply current to the motor solenoid. When the motor rotational speed changes (increases), record the current on the multi-meter – This is the regulation begin setting for Motor #2.
7. For a 12VDC Solenoid, the regulation begin setting should be 450±5 mA. For a 24VDC Solenoid, the regulation begin setting should be 225±2.5 mA. To adjust the regulation begin setting, use the following steps for the control on Motor #2:

   a. Use the hammer and punch to loosen the Spanner Nut.

   b. Use the 13mm wrench on the Locking Nut to turn the Regulation Begin Cup IN to increase the regulation begin setting or OUT to decrease it.

   c. Once a regulation begin setting of 450±5 mA (12VDC Solenoid) or 225±2.5 mA (24VDC Solenoid) is acquired, use the hammer and punch to tighten the Spanner Nut.
8. On the Motor #1 Regulation Begin Adjustment, hold the Min. Displacement Stud stationary and loosen the Locking Nut.
9. Turn the Min. Displacement Stud OUT by the number of turns recorded in Step #2 (Part B) above. Tighten the Locking Nut. The proper torque for the Locking Nut is 10 ft-lb.
10. Follow all steps on pages 19-20 to reset the motor minimum displacement.

Maximum Displacement Adjustment Procedure for HMV Double Motors

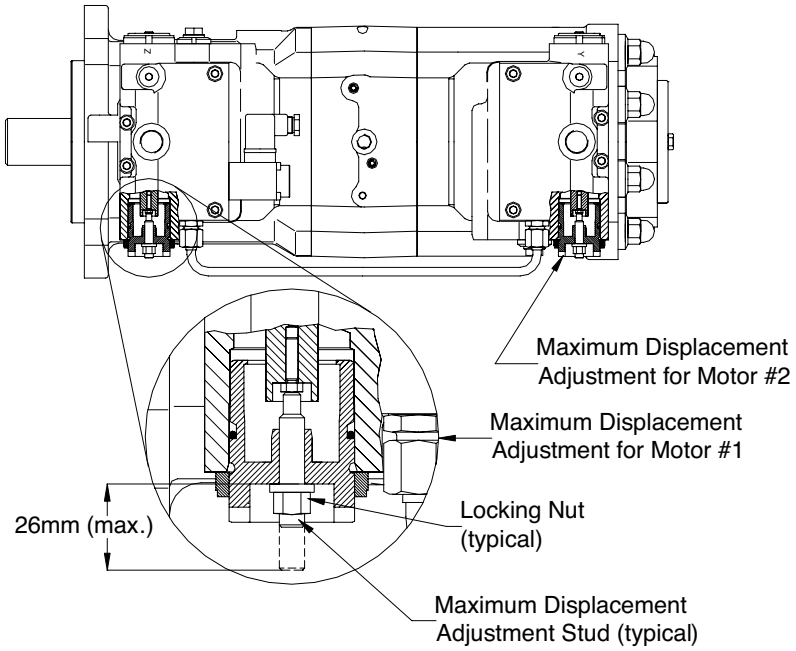
Set Up

⚠ Important

This Service Bulletin is ONLY valid for HMV double motors.

Tools / Equipment Required

- 13mm offset closed-end wrench
- 4mm Allen wrench



Note #1:

The following table illustrates the maximum displacement and allowable rotational speed for the HMV double motor. The HMV double motor should NOT be operated at higher speeds if this maximum displacement setting is used. If a higher rotational speed is required for your application, you must consult Eaton Engineering for the allowable maximum displacement setting.

Motor Size	Maximum Allowable Speed	Maximum Motor Displacement
270 CC/Rev	3000 RPM	270 CC/Rev (2 X 135 CC/Rev)

Note #2:

To insure the proper operation of the motor, you must provide supply-pressure into Port "E" between 290-580 psi.

Note #3:

The HMV double motor automatically defaults to maximum displacement and will remain at maximum displacement unless supplied with an external power supply to force it to destroke. For an "electrically" controlled HMV double motor, current is typically supplied to the motor solenoid to destroke it.

When performing this procedure, make sure that no external power supply is supplied to the HMV double motor to insure that the motor remains at maximum displacement.

Maximum Displacement Adjustment Procedure for HMV Double Motors

Procedure

Procedure for Adjusting the HMV Maximum Displacement:

1. Start the prime mover and adjust it to operating speed.
2. Provide maximum flow to the HMV double motor making sure that no current is supplied to the motor solenoid.
3. Measure the rotational speed of the motor, the wheel, the gearbox, etc. and calculate if the maximum displacement is adjusted properly.
4. To Adjust the Motor Maximum Displacement:
   a. While holding the Maximum Displacement Adjustment Stud stationary with the 4mm Allen wrench, loosen the Locking Nut for Motors #1 and #2 with the 13mm wrench.
   b. Turn the Maximum Displacement Adjustment Stud IN to decrease the maximum displacement or turn it OUT to increase the maximum displacement. Turn each adjustment stud for Motors #1 and #2 by the same amount.

⚠ **WARNING**
The flow adjustment stud is NOT mechanically restricted from being removed completely from the motor control. Care should be taken when turning the flow adjustment stud OUT. DO NOT turn the adjustment stud OUT more than 26mm as illustrated on page 17 of this manual.

5. Once the desired maximum displacement has been acquired, hold the adjustment stud stationary with the 4mm Allen wrench and tighten the locking nut with the 13mm wrench. The proper torque for the locking nut is 14 N-m (10 ft-lb).

Minimum Displacement Adjustment Procedure for HMV Double Motors

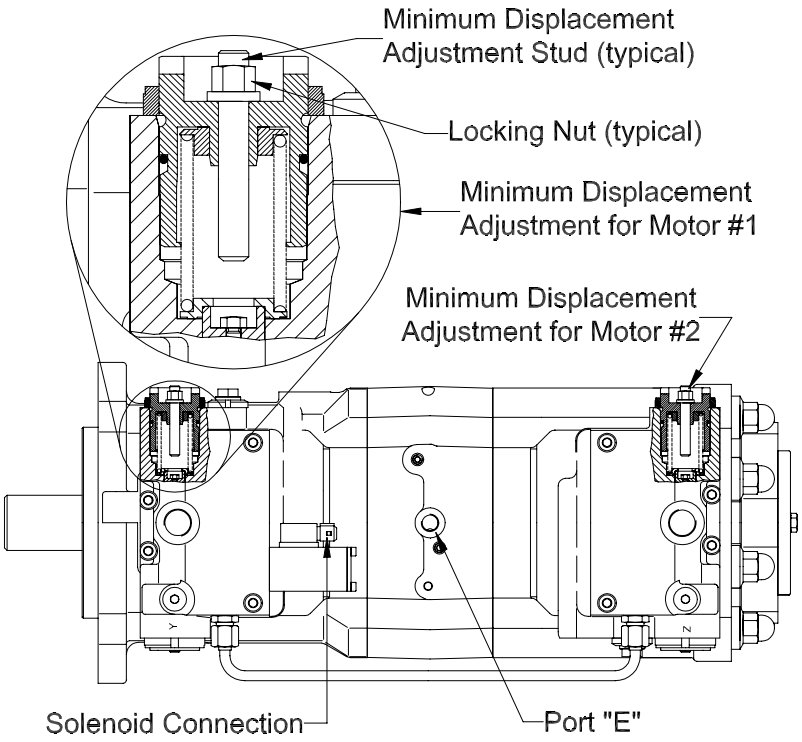
Set Up

⚠ Important

This Service Bulletin is ONLY valid for HMV double motors.

Tools / Equipment Required

- 13mm offset closed-end wrench
- 4mm Allen wrench



Note #1:

The following table illustrates the recommended minimum displacement and allowable rotational speed for the HMV135 double motors. The HMV135 double motors should NOT be operated at higher speeds if the recommended displacement is used. If a higher rotational speed is required for your application, you must consult Eaton Engineering for the required minimum displacement setting.

Motor Size	Maximum Allowable Speed	Recommended Minimum Displacement
270 CC/Rev	3600 RPM	49.0 CC/Rev (1X0 CC/Rev, 1x49 CC/Rev)

Note #2:

To insure the proper operation of the motor, you must provide 290-580 psi supplypressure into port "E".

Note #3:

The HMV double motor automatically defaults to maximum displacement. The motor will not destroke to minimum displacement unless you provide a minimum of 1250 mA (for 12VDC Solenoid) or 625 mA (for 24VDC Solenoid) to the motor solenoid. Under this condition, the HMV double motor will be forced to minimum displacement.

Prior to adjusting the minimum displacements on the motor, verify that the flow from the pump is as expected.

Minimum Displacement Adjustment Procedure for HMV Double Motors

Procedure

Procedure for Adjusting the HMV Minimum Displacement:

1. Start the prime mover and adjust it to operating speed.
2. Provide maximum flow to the HMV double motor.
3. Provide at least 1250 mA (for 12 VDC Solenoid) or 625 mA (for 24VDC Solenoid) to the motor solenoid.
4. Measure the rotational speed of the motor, the track, the gearbox, etc. and calculate if the minimum displacement is adjusted properly.
5. To Adjust the Motor Minimum Displacement:

   a. While holding the Minimum Displacement Adjustment Stud for Motor #1 stationary with the 4mm Allen wrench, loosen the Locking Nut for Motor #1 with the 13mm wrench.

   b. Turn the adjustment stud for Motor #1 OUT until the motor speed does not increase anymore. This will insure that Motor #1 has a minimum displacement of 0 cc/rev.

   c. Once the adjustment described in "b" is reached, hold the adjustment stud for Motor #1 stationary and tighten the locking nut for Motor #1. The proper torque for the locking nut is 10 ft-lb.

   d. While holding the Minimum Displacement Adjustment Stud for Motor #2 stationary, loosen the Locking Nut for Motor #2.

   e. Turn the adjustment stud IN to increase the minimum displacement of Motor #2 or OUT to decrease it.

   f. Once the desired minimum displacement has been acquired, hold the adjustment stud for Motor #2 stationary and tighten the locking nut. The proper torque for the locking nut is 10 ft-lb.

Neutral Position Adjustment Procedure for HMV Double Motors

Set Up and Procedure

⚠ Important

This Service Bulletin is ONLY valid for HMV double motors.

Tools / Equipment Required

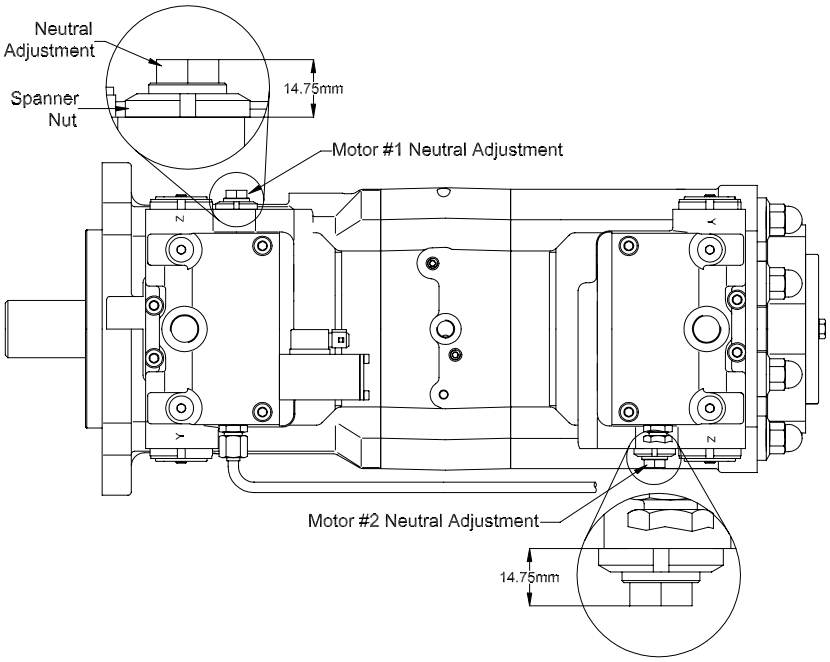
- 16mm wrench (optional: adjustable wrench)
- Digital calipers capable of displaying 0.01mm
- Hammer and punch

⚠ Important

The Neutral Adjustment of both motor controls are preset to the correct value by Eaton. They should NOT be adjusted or tampered with at any time.

The instructions included in this Service Information should ONLY be used if the Neutral Adjustment on either motor control has been tampered with or if one or both motor controls have been replaced.

After following all of the instructions below, the Maximum Displacement on each motor control must be readjusted. Please follow all steps outlined on pages 17-18 after adjusting the Neutral Adjustment.



Adjustment Procedure:

Note: You must adjust the Neutral Adjustment on both motor controls.

1. Loosen the Spanner Nut for Motor #1 with the hammer and punch.
2. Using a 16mm wrench and digital calipers, adjust the Neutral Adjustment for Motor #1 to 14.75mm as illustrated above.
3. Secure the Neutral Adjustment for Motor #1 by tightening the Spanner Nut with the hammer and punch.
4. Repeat steps #1 through #3 for Motor #2.

This Page Intentionally Blank

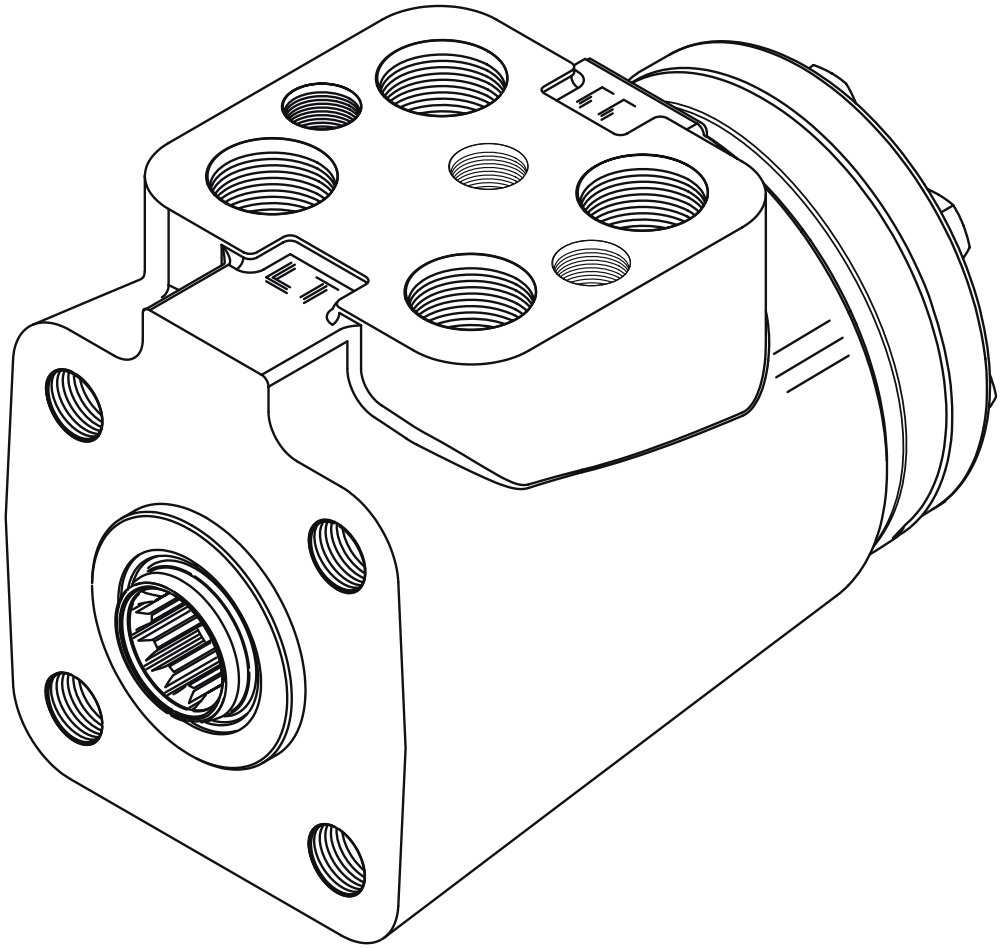
47514 STEERING UNIT SERVICE

EATON | Char-Lynn

Series 10 Steering Control Unit

Parts and Repair Information

Design -002



Series 10
Steering Control Unit
Table of Contents

Introduction

This manual provides service information for Char-Lynn® Series 10 Steering Control Units. Step by step instructions for complete disassembly, inspection and reassembly of the control unit are given.

The following recommendations should be followed to insure successful repairs.

- Most repairs require the removal of the control unit from the vehicle.
- Cleanliness is extremely important.
- Clean the port areas thoroughly before disconnecting the hydraulic lines.
- Plug the control unit ports and cover open hydraulic lines immediately after they have been disconnected.
- Drain the oil and clean the exterior of the control unit before making repairs.
- Wash all metal parts in clean solvent.
- Use filtered, moisture-free compressed air to dry the parts. Do not wipe them dry with paper towels or cloth – lint in a hydraulic system will cause damage.
- Always use new seals when reassembling hydraulic control units.
- Lubricate new rubber seals with a petroleum jelly before installation.
- Torque all bolts over gasketed joints, then repeat the torquing sequence to make up for gasket compression.

After all repairs are complete it is essential to verify the accuracy of control unit repairs on an authorized test stand.

ID Tag
Ordering Parts

How to Order Replacement Parts

Each order must include the following:

1. Product Number
2. Date Code
3. Part Name
4. Part Number
5. Quantity of Parts

Refer to specific part listings for your Char-Lynn® Steering Control Unit when ordering replacement parts. Listings are available from Eaton. Sample tag shows identification.

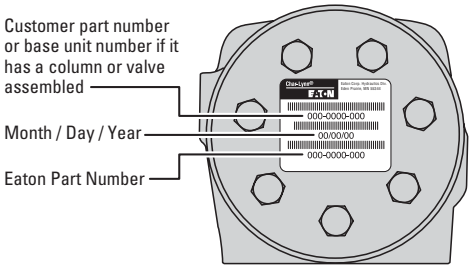
When ordering replacement parts, you must include the following information:

For additional literature contact Eaton Hydraulics at

14615 Lone Oak Road,
Eden Prairie, MN 55344

http://hydraulics.eaton.com

Bar Code Label — Launch Date June, 1999



Port Face

Tools

Tools Required For Disassembly and Assembly

- Screwdriver (102-152 mm [4 in. - 6 in.] long, x 3 mm [118 in.] wide flat blade).
- 1/2 inch socket for current hex head cap screws.
- Breaker bar wrench.
- Torque wrench (30 Nm [300 lb-in] capacity).

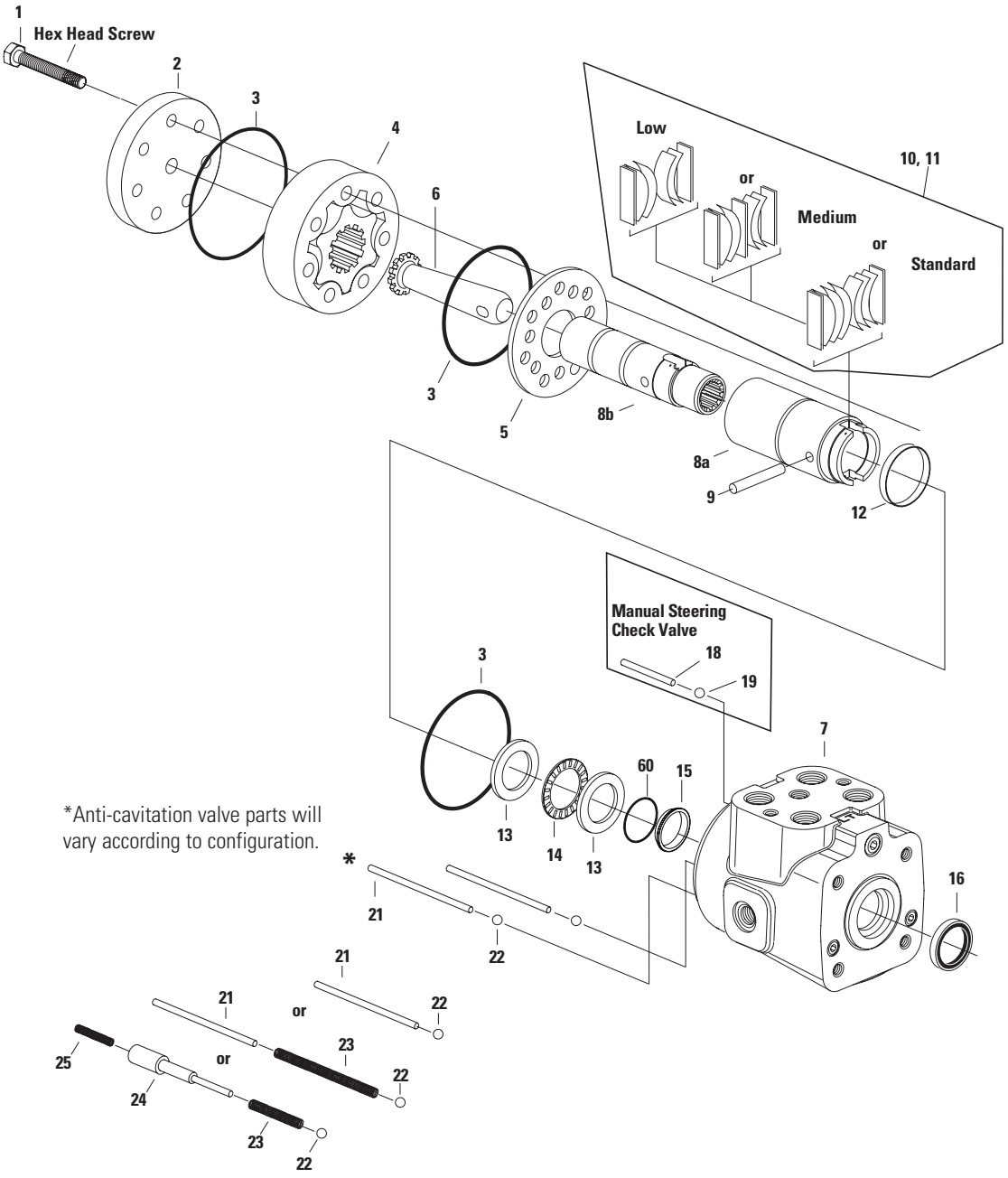
Special Tools:

- Plunger and Sleeve Tool No. 600792-001*

*Tools available—by special order—through our service department.

Parts

Assembly
Drawing



*Anti-cavitation valve parts will vary according to configuration.

Parts

Table 1.0 Parts List

Series 10

Steering Control Unit

ITEM NO.	PART NO.	QTY.	DESCRIPTION	REFERENCE PAGE
1	See Table 1.0	7	Cap Screw, Hex Head	6
2	23901-000	1	Cap, End	
3	5776-000	3	Seal, 72,6 mm [2.86 in.] ID	
4	See Table 1.0	1	Gerotor, Sub-assembly	6
5	113094-000	1	Plate, Spacer	
6	112238-000	1	Drive	
7	204107-XXX	1	Housing, Valve	
8a		1	Control Sleeve	
8b		1	Control Spool	
9	15-000	1	Pin, Centering	
10	112714-000	2 or 3	Spring, Spacer	
11	113599-000	4 or 6	Spring, Centering	
12	112737-000	1	Retainer Spring	
13	14880-000	2	Bearing Race	
14	5544-000	1	Bearing, Needle Thrust	
15	9332-000	1	Seal – 24,9 mm [.98 in.] ID	
16	844-000	1	Dust Seal	
18	16026-422P	1	Pin, Roll– 34,92 mm [1.375 in.] Length	
19	285020-080	1	Ball – 6,35 mm [.25 in.] OD	
21	16026-436	2	Pin, Roll – 40,00 mm [1.575 in.] Length	
22	18015-000	2	Ball, Check – 6,35 mm [.250 in.] OD	
23	230400-000 or 4999516-000	2 2	Compression Spring Compression Spring (See main parts assembly drawing)	
24	113598-000	2	Anti-cav plug retainer	
25	230313-000	2	Compression Spring	
60	4999651-001	1	O-ring	

Parts

Gerotor

Table 2.0

ACTUAL DISPL. cm^3/r $[in^3/r]$	REF. NO. 4 GEROTOR PART NO.	Width mm[in]	REF. NO. 29 CAP SCREW PART NO.	LENGTH mm[in]
60 [3.6]	8618-023	10,2 [.40]	16336-514	38,1 [1.50]
75 [4.5]	8618-024	10,2 [.40]	16336-514	38,1 [1.50]
95 [5.9]	8618-003	13,2 [.52]	16336-515	41,3 [1.62]
120 [7.3]	8618-009	16,5 [.65]	16336-516	44,5 [1.75]
145 [8.9]	8618-020	20,1 [.79]	16336-517	47,6 [1.87]
160 [9.7]	8618-004	21,9 [.86]	16336-520	50,8 [2.00]
185 [11.3]	8618-005	25,4 [1.00]	16336-521	54,0 [2.12]
230 [14.1]	8618-031	31,7 [1.25]	16336-523	60,3 [2.37]
295 [17.9]	8618-035	40,4 [1.59]	16336-525	66,7 [2.62]
370 [22.6]	8618-032	50,8 [2.00]	16336-531	79,4 [3.12]
460 [28.2]	8618-033	63,5 [2.50]	16336-535	92,0 [3.62]
590 [35.9]	8618-036	80,8 [3.18]	16336-542	108,0 [4.25]
740 [45.1]	8618-034	101,6[4.00]	16336-551	130,2 [5.12]

Disassembly

Cleanliness is extremely important when repairing a steering control unit. Work in a clean area. Before disconnecting lines, clean port area of unit thoroughly. Use a wire brush to remove foreign material and debris from around exterior joints of the unit.

We recommend that you keep the unit in a vise during disassembly. Follow the clamping procedures explained throughout the manual.

1. Clamp unit in vise, meter end up. Clamp lightly on edges of port face sides (see figure1). Use protective material on vise jaws. Housing distortion could result if jaws are overtightened.

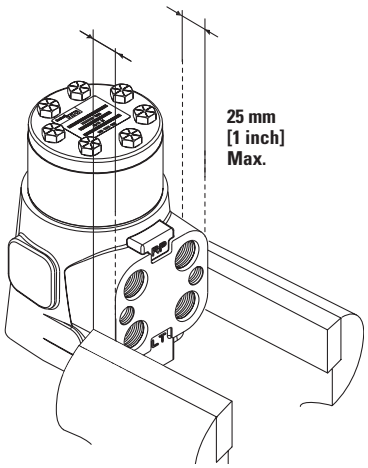


Figure 1

Disassembly

2. Remove 5/16 in. cap screws.
3. Remove end cap.
4. Remove seal from gerotor (meter).

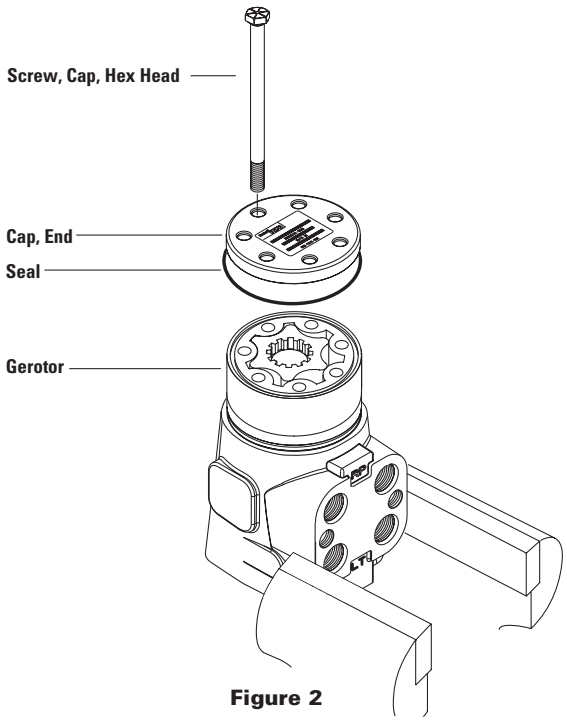
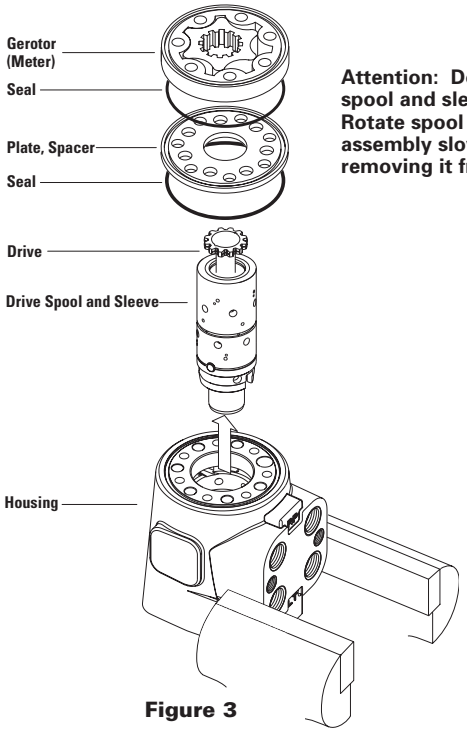


Figure 2

5. Remove gerotor (meter). Be careful not to drop star.
6. Remove seal from spacer plate.
7. Remove spacer plate.
8. Remove seal from housing.
9. Pull drive and twist to remove SP/SL drive assembly from housing.
10. Remove housing from vise.



Attention: Do not bind spool and sleeve in housing. Rotate spool and sleeve assembly slowly when removing it from housing.

Figure 3

Disassembly

11. Carefully remove bearing and races, anti-cavitation valves and manual steering check valve (roll pin and ball) from bolt holes by tipping housing Gerotor side down. (see figure 3).
12. Do not remove any valves other than manual steering check valve assembly and anti-cavitation valve assembly. All other valves are factory preset and are non-serviceable.
13. Carefully Remove Seal with a thin-blade screw driver. Do not scratch seal groove with screw driver.
14. Use thin bladed screw driver to pry dust seal from housing. Do not damage housing.

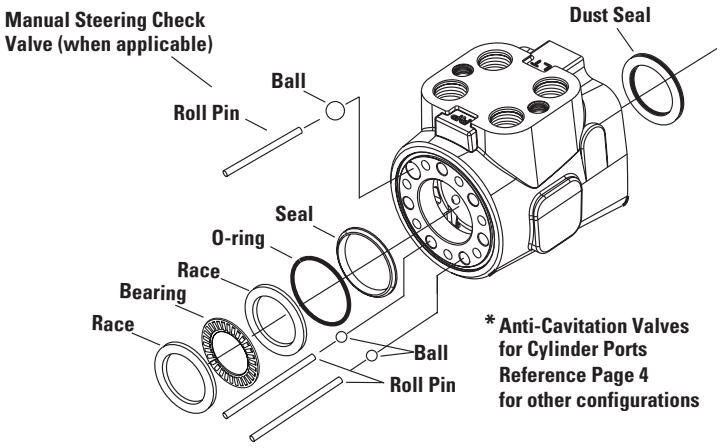


Figure 4

15. Push pin from spool and sleeve assembly.
16. Remove Drive
17. Push spool partially from control end of sleeve, then carefully remove centering springs and retaining ring from spool by hand (figure 8).

***Note**

Standard input torque unit uses six centering springs and two spacers.

Medium input torque unit uses four centering springs and three spacers.

Low input torque unit uses four centering springs and two spacers.

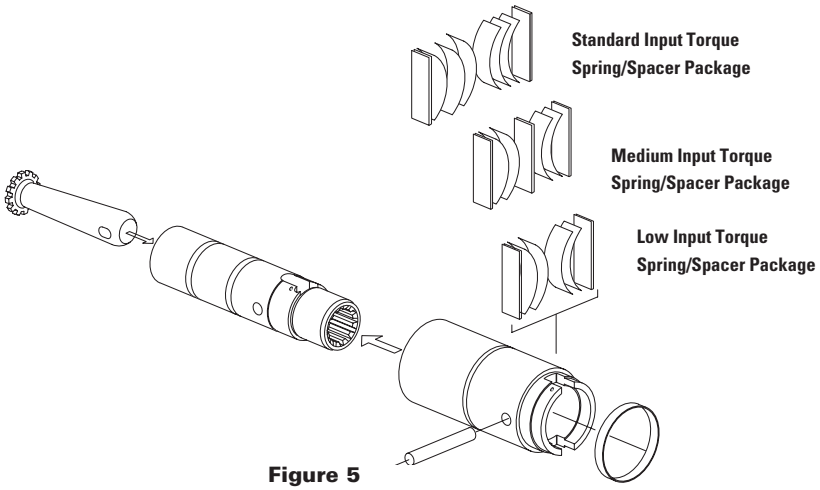


Figure 5

Assembly

Assembly Cleanliness Recommendations

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with cloth or paper towel because lint or other matter can get into the hydraulic system and cause damage. Do not use grit paper or file or grind these parts.

Note: Lubricate all seals with clean petroleum jelly. A good service policy is to replace all old seals with new seals. Do not use excessive lubricant on seals for meter section.

Refer to parts lists covering your steering control unit when ordering replacement parts.

Place housing on a flat work area on a clean lint free cloth. Install press-fit 24,9 mm[.98 in.] ID seal in housing with metal suface of seal facing toward housing (figure 6).

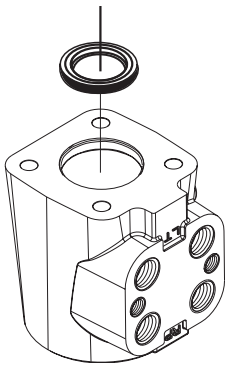


Figure 6

2-Piece Shaft Seal Installation

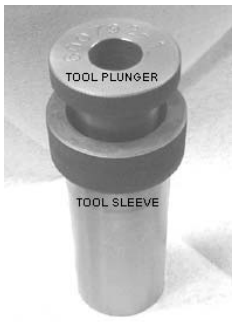
For installation of o-ring: 4999651-001

and

Seal 9332-000

1. Place housing on a flat work area as shown in figure 7.
2. Lubricate seal and o-ring with hydraulic oil before installation
3. Align sleeve with housing bore (figure 7)

Figure 7



Tool No. 600792-001

Assembly

2-Piece Shaft Seal Installation

4. Insert sleeve into housing bore (Figure 8)

Figure 8

5. Place o-ring on plunger (Figure 9).

Figure 9

6. Align seal with plunger. cross section "L" shape of seal should be upside down (figure 10).

Figure 10

7. Push seal onto plunger. Lip of seal should be between o-ring and plunger. No gap should exist between o-ring and seal (figure 11).

Figure 11

8. Align plunger with sleeve (figure 12).

Figure 12

. Push plunger into sleeve until it bottoms out, rotate 1/4 turn (figure 13).

10. While holding sleeve in housing, withdraw plunger.

11. Withdraw sleeve.

Figure 13

12. Inspect seal installation. Seal and o-ring must both be within shaft seal counterbore of housing (figure 14).

Figure 14

Assembly

13. Clamp housing in Vice (figure 15).

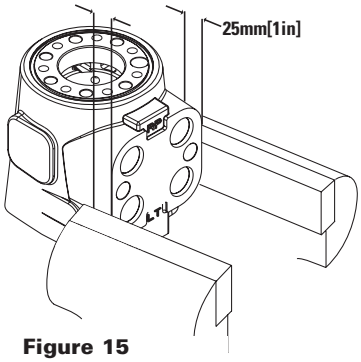


Figure 15

14. Install two bearing races and Thrust bearing as shown in figure 16.

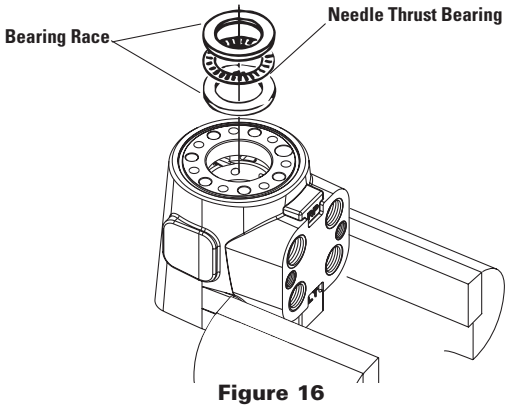


Figure 16

15. Assemble spool and sleeve carefully so that spring slots line up at the same end. Rotate spool while sliding parts together. Test for free rotation. Spool should rotate smoothly in sleeve with fingertip force applied at splined end. Align spring slots and identification marks (Figure 17) in spool and sleeve and stand parts on end of bench.

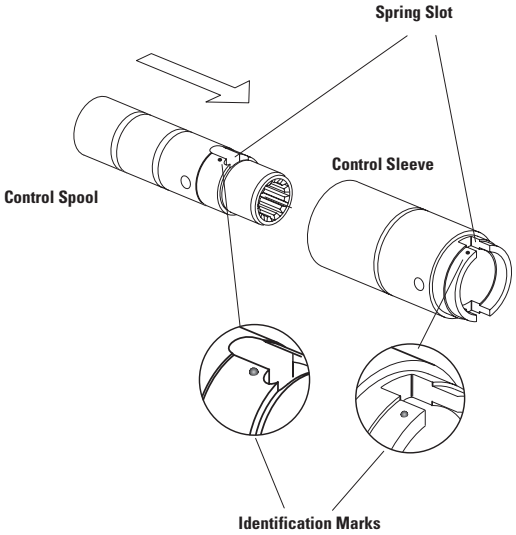


Figure 17

Assembly

16. Installation of spring spacers and springs, hold spring retainer at an angle as shown (see figure 18 reference number 1), insert spring spacers and springs one at a time in sequence noted by reference numbers 2 - 9 (standard torque), 2 - 8 (medium torque), 2- 7 (low torque), then position spring retainer correctly over all these parts. Adjust alignment of spring parts with a small screwdriver.

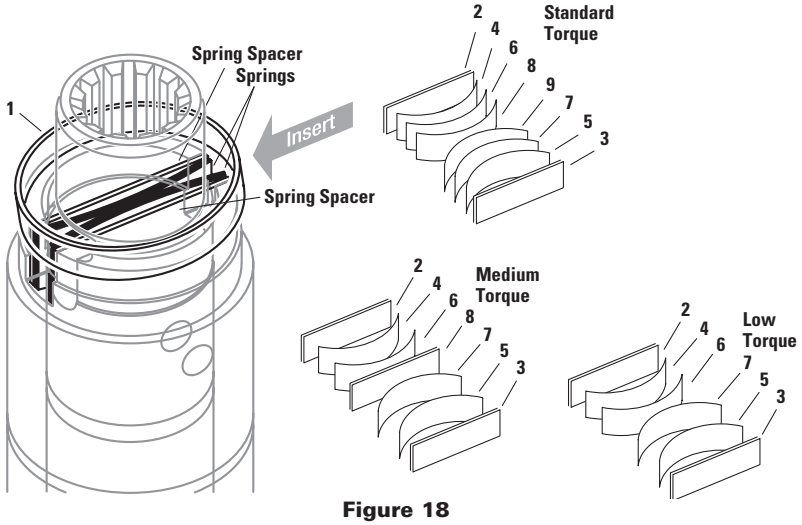


Figure 18

17. Assemble drive and spool/sleeve.

18. Insert pin through spool and sleeve assembly through hole in drive, until pin is flush at both sides of sleeve.

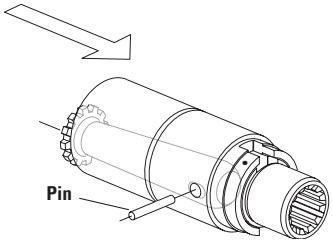


Figure 19

Assembly

19. Position spool and sleeve assembly so that splined end of spool enters 14 hole end of housing first (figure 20).

Attention: While inserting spool and sleeve assembly into housing, make sure parts do not tilt out of position. Push assembly gently into place with slight rotating action. Bring spool assembly entirely within housing bore until parts are flush at 14 hole end of housing. With spool assembly in this flush position, check for free rotation within housing by turning assembly with fingertip force at splined end.

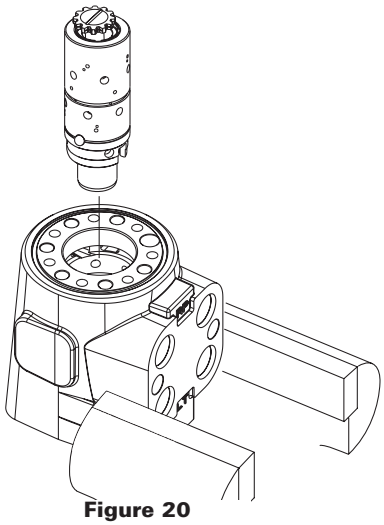


Figure 20

20. Install 72,6 mm [2.86 in.] ID O-ring in housing (figure 20).
21. Install anti-cavitation valves and manual steering check valve (if used) in holes, as shown in figure 20. After installing balls, inspect holes to make sure they are properly seated.

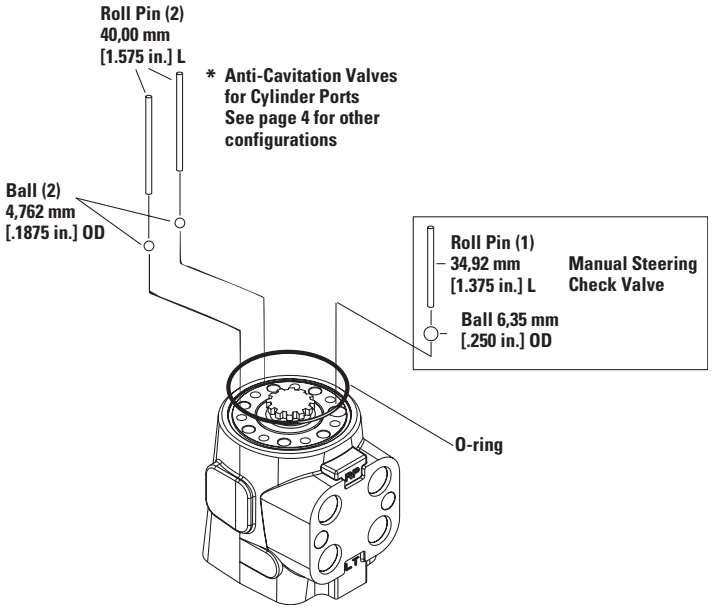


Figure 20

Assembly

Timing Reference Data — Align star valleys (reference A) with marked drive 1 and drive 2 (reference B). Valleys must align with pin. Note parallel relationship of reference lines A, B, C, and D in figure 21. Align bolt holes without disengaging gerotor (meter) from drive.

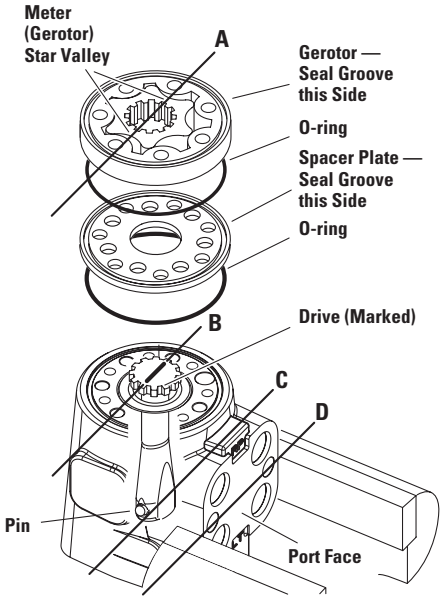


Figure 21

22. Install spacer plate. Align bolt holes in spacer plate with tapped holes in housing.
23. Lubricate and install 72,6 mm [2.86 in.] ID seal in spacer plate.
24. Install gerotor (meter) seal groove up, note position of star valleys in relation to marked drive.
25. Lubricate and install 72,6 mm [2.86 in.] ID seal in gerotor ring.
26. Lubricate and install 72,6 mm [2.86 in.] ID seal in gerotor (meter).
27. Install end cap on gerotor, aligning holes.

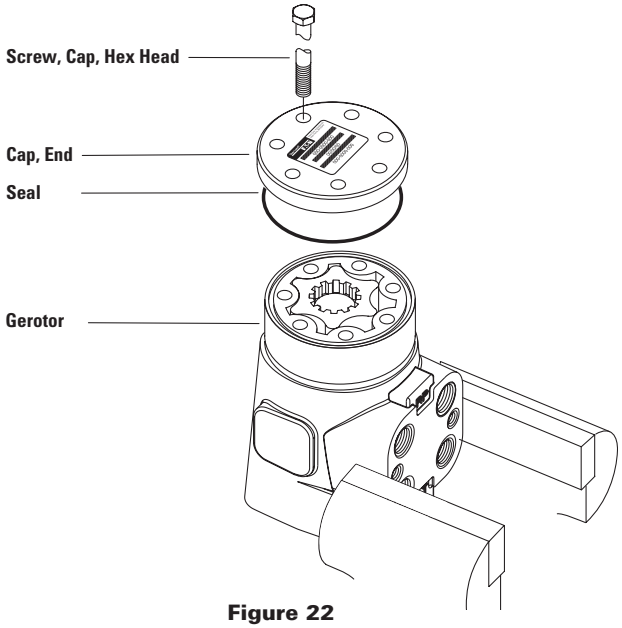


Figure 22

Note: Check to insure that spool and sleeve are flush or slightly below 14 hole surface of housing.

Attention: Clean upper surface of housing by wiping with palm of clean hand. Clean each of the flat surfaces of meter section parts in a similar way just before reassembly. Do not use cloth or paper to clean surfaces.

Assembly

28. Install 7 dry cap screws in end cap. Pretighten cap screws to 17Nm [150 lb-in], then torque screws to 28-34 Nm [250-300 lb-in] in sequence shown in figure 24.

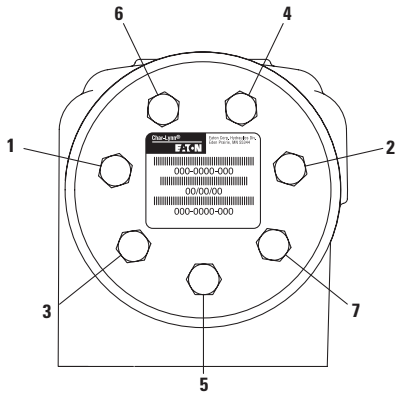


Figure 23

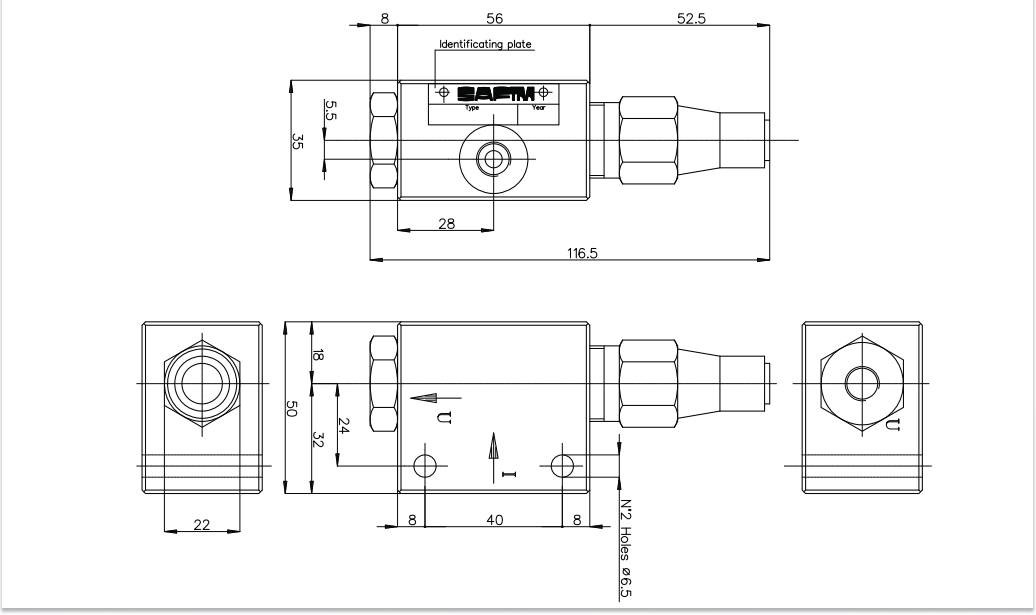
51379 VALVE, BRAKE, PRESSURE LIMIT

110.030

SAFIM

cod. 202743 Pressure limiting valve

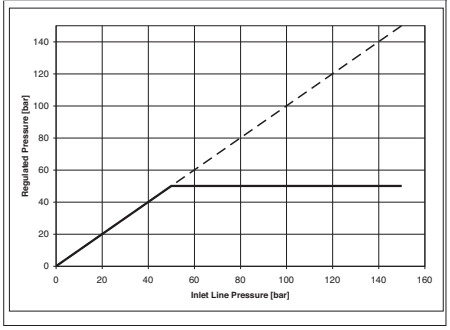
The brake force limiting valve is suitable for braking systems with brake master cylinders.
As it doesn't have an outlet for a possible overpressures, this brake force limiting valve shall be regarded as a dynamic one, because in case of dirt or oil losses the reduced pressure might reach the same level as the oil inlet pressure for very long braking time.



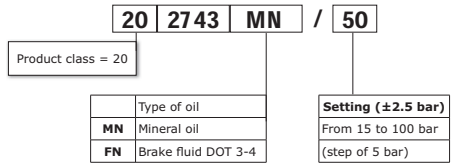
CONNECTIONS		
U	Regulated pressure	M10x1 DIN 3852-1X
I	Inlet lines pressure	M10x1 DIN 3852-1X

TECHNICAL FEATURES	
Max pressure in I	120 bar
ΔP max between I - U	80 bar
Filtration degree : NAS 1638 cat. B	
Temperature range (Mineral oil)	-20 / +90 °C
Temperature range (Brake fluid)	-30 / +100 °C

FUNCTION DIAGRAM

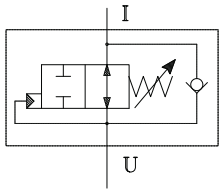


ORDER PART NUMBER



SPARE PARTS	
Valve code	**Seal kit**
202743MN/	SG13813
202743FN/	SG13814

HYDRAULIC SCHEMATIC



110

This Page Intentionally Blank