



# **CAP•START**

## **START•ALL**

**3000 A • 12/24V • 24 CFM • L**

## **HYDRAULIC-DRIVEN • 12V/24V BATTERY STARTER • CHARGER**

### **OPERATION MANUAL AND PARTS LIST**

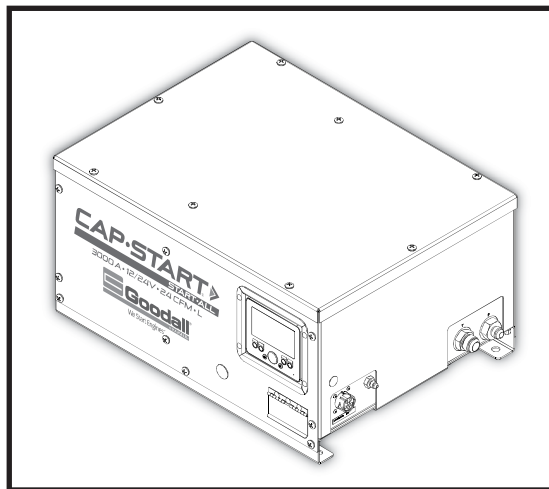
#### **NOTE**

This publication contains the latest information available at the time of preparation. Every effort has been made to ensure accuracy.

Vanair Manufacturing, Inc. reserves the right to make design change modifications or improvements without prior notification.

#### **NOTE**

Use only Vanair Vanguard™ Premium Synthetic Compressor Oil and Genuine Vanair Parts. Inspect and replace damaged components before operation. Substituting non-Vanair oil or non-genuine Vanair filter components **WILL VOID THE COMPRESSOR WARRANTY!**



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Read this manual before installing, operating or servicing this equipment. Failure to comply with the operation and maintenance instructions in this manual will **VOID THE EQUIPMENT WARRANTY.**

#### **NOTE**

Making unauthorized modifications to the system components **WILL VOID THE WARRANTY!**

Always inform Vanair Manufacturing, Inc., before beginning any changes to the Cap•Start Hydraulic-Driven Package.

**KEEP THE MANUAL  
WITH THE VEHICLE**

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**VANAIR®**  
A Lincoln Electric Company

**P/N: 090189-OP\_r1**

**Effective Date:**

**March 04, 2025**

BOOST•ALL®  
SUPER BOOST•ALL®  
CAP•START®



## GUARANTEE

**ALL WARRANTY CLAIMS  
OR RETURNS MUST BE  
PREAUTHORIZED PRIOR  
TO PERFORMING  
ANY WARRANTY WORK.**

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**EFFECTIVE: AUGUST 11, 2020**

This limited warranty supersedes all previous Vanair® warranties and is exclusive with no other guarantees or warranties expressed or implied.

**LIMITED WARRANTY**—Subject to the expressed terms and conditions set forth below, Vanair® Mfg., Inc. ("Vanair"), of Michigan City, Indiana (USA), warrants to the original retail purchaser of new Vanair® equipment that such equipment is free from defects in materials and workmanship when shipped by Vanair®.

For warranty claims received by Vanair® within the applicable warranty periods described below, Vanair® will repair or replace any warranted equipment, parts or components that fail due to defects in material or workmanship or refund the purchase price for the equipment, at Vanair's discretion. Vanair® is not responsible for time or labor to gain access to the machine to perform work. **WARRANTY WILL BE VOID IF GENUINE VANAIR® PARTS AND FLUIDS ARE NOT USED.**

Vanair® must be notified in writing within thirty (30) days of any such defect or failure. **All warranty claims or returns must be preauthorized in writing prior to performing warranty work.** Call Vanair® for process and forms. Vanair® will provide instructions on the warranty claim procedures to be followed.

Warranty will commence upon receipt of the Warranty Registration Card. If the Warranty Registration Card is not received within six (6) months of shipment from Vanair®, the warranty commencement date shall be thirty (30) days from the date of shipment from Vanair®. Records of warranty adherence are the responsibility of the end user.

1. 6 Years Parts – 3 Years Labor
  - Vanair® Super Capacitor (VSC™)
2. 2 Years Parts – 1 Year Labor
  - Reciprocating Compressor Air End
3. 1 Years Parts – 1 Year Labor
  - Generators
  - Hydraulic Motors
  - Hydraulic Pumps
5. 1 Year Parts – 1 Year Labor
  - All electronics including, but not limited to:
    - (i) I/O Boards
    - (ii) Modules
    - (iii) Panel Boxes
    - (iv) Instrumentation
    - (v) Solenoids
  - Clutches
  - Running Gear/Trailers
  - Compressor/Hydraulic Coolers, including Fan and Radiator Core

This Limited Warranty shall not apply to:

1. Consumable components, such as shaft seals, valves, belts, filters, capacitors, contactors, relays, brushes or parts that fail due to normal wear and use.
2. Items furnished by Vanair®, but manufactured by others, such as engines and trade accessories (these items are covered by the manufacturer's warranty, if any).
3. Equipment that has been modified by any party other than Vanair® or equipment which has not been used and maintained in accordance with Vanair's specifications.
4. Equipment which has been improperly installed and/or improperly operated, based upon Vanair's specifications for the equipment or industry standards.
5. Equipment installed by non-authorized or third party personnel. Vanair® products are intended for purchase and use by commercial/industrial users and persons trained and experienced in the use and maintenance of industrial equipment.

In the event of a warranty claim covered by this Limited Warranty, the exclusive remedies shall be, at Vanair's sole discretion: (i) repair; or (ii) replacement; (iii) where authorized in writing by Vanair® in appropriate cases, the reasonable cost of repair or replacement at an authorized Vanair® service facility; or (iv) payment of (or credit for) the purchase price (less reasonable depreciation based upon actual use) upon return of the equipment at the warranty claimant's risk and expense. Vanair® will pay standard ground freight for any warranty item shipped to and from Vanair® or (Vanair® designated facility) within the first year of the applicable warranty period. Any additional expedited freight cost is the responsibility of the purchaser.

TO THE GREAT EXTENT PERMITTED BY APPLICABLE LAW, THE REMEDIES PROVIDED HEREIN ARE THE SOLE AND EXCLUSIVE REMEDIES APPLICABLE TO THE VANAIR® EQUIPMENT. IN NO EVENT SHALL VANAIR® BECOME LIABLE FOR DIRECT, INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL OR CONSEQUENTIAL DAMAGES (INCLUDING LOSS OF PROFIT OR LOST BUSINESS OPPORTUNITY), WHETHER BASED ON CONTRACT, TORT OR ANY OTHER LEGAL THEORY. IN NO EVENT SHALL VANAIR® BECOME OBLIGATED TO PAY MORE ON ANY WARRANTY CLAIM THAN THE PURCHASE PRICE ACTUALLY PAID BY THE ORIGINAL RETAIL PURCHASER.

THIS LIMITED WARRANTY IS MADE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND/OR FITNESS FOR A PARTICULAR PURPOSE, OR ANY OTHER WARRANTY OR GUARANTY ARISING BY OPERATION OF LAW. ANY WARRANTY NOT EXPRESSLY PROVIDED HEREIN, IMPLIED WARRANTY, GUARANTY AND ANY REPRESENTATION REGARDING THE PERFORMANCE OF THE EQUIPMENT, AND ANY REMEDY FOR BREACH OF CONTRACT, IN TORT, OR ANY OTHER LEGAL THEORY WHICH, BUT FOR THIS PROVISION, MIGHT ARISE BY IMPLICATION, OPERATION OF LAW, CUSTOM OF TRADE, OR COURSE OF DEALING ARE EXCLUDED AND DISCLAIMED BY VANAIR®.

Some states in the United States of America do not allow limitations of how long an implied warranty lasts, or the exclusion of incidental, indirect, special or consequential damages, and as such, the above limitations and exclusions may not apply to you. This warranty provides specific legal rights. Other rights may be available to you, but may vary from state to state.

In Canada, legislation in some provinces provides for certain additional warranties or remedies other than as stated herein, and to the extent that they may not be saved, the limitations and exclusions set out forth above may not apply. This Limited Warranty provides specific legal rights, and other rights may be available, but may vary from province to province.

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# WARRANTY CLAIMS PROCEDURE

## CLAIMS PROCESS FOR WARRANTED VANAIR® PARTS

This process must be used by owners of Vanair® equipment in situations where a warranted item needs repair or replacement under the terms of the purchase warranty. Do not return items to Vanair without prior authorization from the Vanair Warranty Administrator.

### PROCEDURE:

When a customer needs assistance in troubleshooting a system and/or returning parts, follow the steps below.

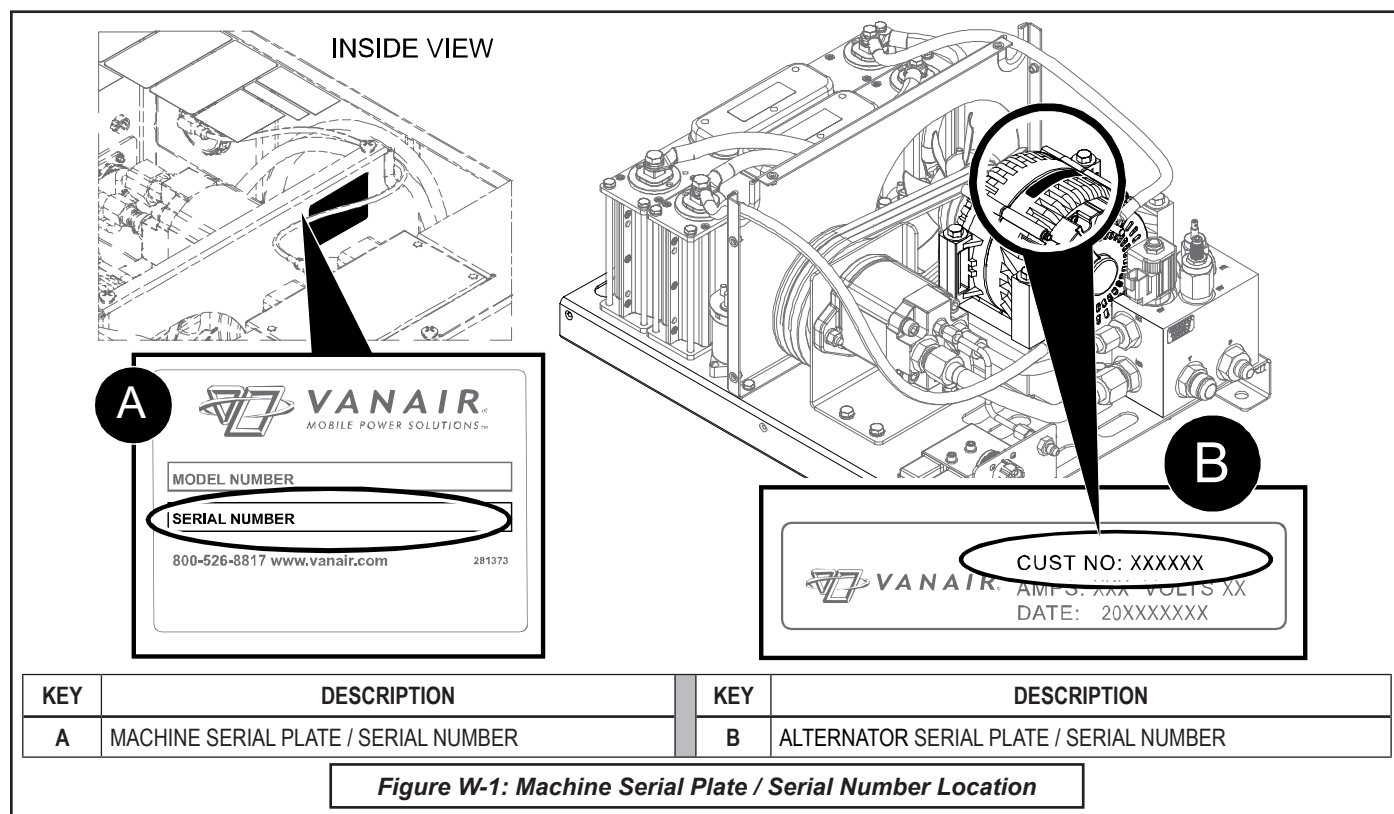
#### 1. Locate the machine's serial number:

The machine package serial number plate is located inside the machine compartment on the wall of the enclosure near the hydraulic motor unit (see **Figure W-1**).

The machine and the alternator also have individual serial numbers respectively (see **Figure W-1**). **Have a list of the symptoms/condition/malfunctions along with any applicable temperature and pressure readings, and also the number of operational hours available:**

Note that the above information will also need to be included on the Return Material Authorization Form (per Step #6); this form is necessary for warranty processing if the warranty claim is deemed valid by the service case review.

2. Contact Vanair's Service Department by phone (844) VAN-SERV, 1-844-826-7378, to speak with a Service Technician.
3. Vanair Service will troubleshoot the prob-



item based on the information provided by the customer, and attempt to return the unit to service as quickly as possible.

4. If the unit cannot be returned to service, and Vanair® determines this matter is a warranty issue, the Service Technician will assign an RMA (Return Material Authorization) number that will provide for the return of the item to Vanair for analysis and a final determination as to the item's warranty status.

### NOTE

The RMA number must be placed on the outside of the package being returned.

5. **Warranty Claims are solicited via a Return Material Authorization (RMA) Form. This form can be obtained via download from the web site, or requested directly from the Vanair Service Department:**

Once a current form has been obtained, follow the instructions given on the form to fill in the information needed. This form is used for the purpose of soliciting a warranty case. All of the field information except for the bottom section block fields, which includes Disposition of Goods, Notifications and Additional Notes, will be required.

Customers have 30 days after the RMA number is issued to return the item. If the part is not returned within this period, the RMA is void and any claims will be denied.

### NOTE

**All labor claims or invoices must be approved by the Vanair Warranty Administrator prior to starting repair work along with the cost of the repair. All paper work associated with the returned item and warranty repair cost must reference the RMA number issued against the part, and be forwarded to Vanair within 30 days of the completion of work.**

Before sending a warranty part to a customer, Vanair will need a P.O. or credit card number to cover the cost of the part and shipping. After the part is analyzed and deemed to be covered under warranty, Vanair will issue credit to the customer. All parts eligible for warranty must have the RMA

number on the invoice at the time of purchase.

No items can be returned "freight collect". Freight costs will be addressed at the time the claim is closed. The customer pays any additional costs for warranty parts delivered through expedited services (i.e., Next Day, Second Day).

### IMPORTANT

**VANAIR WILL NEVER ACCEPT ANY INVOICES FOR PARTS RETURNED: ANY PARTS RETURNED VIA INVOICE WILL BE RETURNED FREIGHT COLLECT: NO PARTS ARE TO BE RETURNED FREIGHT COLLECT!**

Vanair Mfg., Inc. strives to continuously improve its customer service. Please forward any questions, comments, or suggestions to Vanair Service:



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# SECTION 1:

# ⚠ SAFETY

## 1.1 ⚠ GENERAL INFORMATION

**IMPORTANT**



**Read this manual before operating or servicing the Cap•Start® Hydraulic-Driven Package. Failure to do could result in damage equipment, bodily injury, or death.**

The products provided by Vanair® Manufacturing, Inc., are designed and manufactured for safe operation and maintenance. But it is ultimately the responsibility of the users and maintainers for safe use of this equipment. Part of this responsibility is to read and be familiar with the contents of this manual before operation or performing maintenance actions.

## 1.2 ⚠ DANGERS, WARNINGS, CAUTIONS AND NOTES

These boxes are labeled clearly with the title block listing either Danger, Warning, Caution, or other non-safety issue. They draw attention to specific issues that are pertinent to the safe and correct operation of the machine.

The symbols shown and defined in Section 1: Safety are used throughout this manual and on the machine to call attention to, and identify, possible hazards.

The international warning symbol [⚠] is used on all decals, labels and signs that concern information pertaining to bodily harm. When you see the international warning symbol, pay extremely careful attention, and follow the given instructions or indications to avoid any possible hazard.

## 1.3 ⚠ SUMMARY OF DANGERS, WARNINGS AND CAUTIONS

These boxed inserts are placed throughout this manual in the sections where they apply. This subsection is a general summary of their con-

tents.

### 1.3.1 ⚠ DANGERS

- Keep tools or other conductive objects away from live electrical parts.
- Never touch electrical wires or components while the machine is operating. They can be sources of electrical shock.

### 1.3.2 ⚠ WARNINGS

- **DO NOT** perform any modifications to this equipment without prior factory approval.
- **DO NOT** install this Cap•Start in a confined space that lacks proper ventilation and airflow; breathing and cooling air circulation must not be compromised.
- **DO NOT** operate the Cap•Start or any of its systems if there is a known unsafe condition. Disable the equipment by disconnecting it from its power source. Install a lock-out tag to identify the equipment as inoperable to other personnel.
- **DO NOT** operate the machine with any by-pass or other safety systems disconnected or rendered inoperative.
- **DO NOT** operate the equipment while you are under the influence of alcohol or drugs.
- **DO NOT** operate the equipment while you are feeling ill.
- **DO NOT** attempt to service the equipment while it is operating.
- Before performing maintenance or replacing parts remove all electrical power.
- **DO NOT** use flammable solvents or cleaners for cleaning the machine or its parts.
- **DO NOT** operate the Cap•Start in areas where flammable, toxic, or corrosive fumes, or other damaging substance can be ingested by the Cap•Start intakes.
- Keep arms, hands, hair and other body parts,

and clothing away from fans, drive shafts, and other moving parts.

- **DO NOT** wear jewelry, unbuttoned cuffs, ties, or loose-fitting clothing when you are working near moving/rotating parts.
- **ALWAYS** confine long hair when working near moving/rotating parts.
- **NEVER** operate the equipment while wearing a headset to listen to music or the radio.
- Wear personal protective equipment such as gloves, work shoes, and eye and hearing protection as required for the task at hand.
- **DO NOT** operate the Cap•Start® with any guards removed or damaged, or other safety devices inoperative.
- **DO NOT** operate the Cap•Start® in enclosed or confined spaces where ventilation is restricted or closed-off.
- Ensure that hoses connected to service valves are fitted with correctly sized and rated flow limiting devices which comply with applicable codes. Pressurized broken or disconnected hoses can whip causing injuries or damage.
- Over speed is hazardous! **NEVER** tamper with the governor components or settings to increase the maximum speed. Severe personal injury and equipment damage can result if operated at speeds above the maximum.
- **DO NOT** use tools, hoses, or equipment that have maximum ratings below that of this machine.
- Keep metal tools, and other conductive objects away from live electrical components.
- Before performing maintenance or repair operations on the Cap•Start®, ensure that all power has been removed and been locked out to prevent accidental application.
- **DO NOT** assume that because the Cap•Start® is in a STOPPED condition that power has been removed.
- Install, operate, and maintain this equipment in full compliance with all applicable OSHA, other Federal, state, local codes, standards, and regulations.
- When lifting objects, be aware of proper lifting techniques to avoid injury.

- **ALWAYS** read and follow safety related precautions found on containers of hazardous substances.

### 1.3.3 ▲ CAUTIONS

- Check all safety devices for proper operation on a routine basis.
- Ensure that no tools, rags, or other objects are left on machine drive systems or near intakes.
- Keep the equipment clean when performing maintenance or service actions. Cover openings to prevent contamination.
- **DO NOT** operate the Cap•Start® if cooling air is not available (fan/cooler not operating) or if lubricant levels are below their specified minimum levels.
- Ensure all plugs, hoses, connectors, covers, and other parts removed for maintenance actions are replaced before applying power to the Cap•Start®.
- Avoid touching hot surfaces and components.
- Ensure that electrical wiring, terminals; hoses and fittings are kept in serviceable condition through routine inspections and maintenance. Replace any damaged or worn components.
- **DO NOT** install safety devices and/or replacement parts other than authorized Vanair® replacement parts.
- Keep personnel out of line with, and away from discharge opening of valves, hoses and tools.
- Immediately clean up any lubricant or spills.

## 1.4 ▲ SAFETY DECALS

Safety decals are placed onto, or located near, system components that can present a hazard to operators or service personnel. All pertinent decals listed in **Section 7.9, Decal Identification/Location** are located near a component, which is subject to respect in terms of safety precautions. Always heed the information noted on the safety decals.

 **WARNING**

**DO NOT REMOVE OR COVER ANY SAFETY DECAL.** Replace any safety decal that becomes damaged or illegible.

**1.5**  **CALIFORNIA PROPOSITION 65 WARNINGS**

 **WARNING**

**Discharge from this machine may cause cancer and/or reproductive harm.**

Proposition 65 requires businesses to provide warnings to Californians about significant exposures to chemicals that cause cancer, birth defects or other reproductive harm. Exposure to these chemicals may take place when products are acquired or used. Exposure may also occur in homes, workplaces, or other environments in California. By requiring that this information be provided, Proposition 65 enables Californians to make informed decisions about their exposures to these chemicals.

Proposition 65 also prohibits California businesses from knowingly discharging significant amounts of listed chemicals into sources of drinking water.

**1.6**  **DISPOSING OF MACHINE FLUIDS**

Always dispose of machine fluids under the guidance of all applicable local, regional and/or federal law.

Vanair® encourages recycling when allowed. For additional information, consult the container label of the fluid in question.

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# SECTION 2: SPECIFICATIONS

## 2.1 GENERAL INTRODUCTION

The tables and figures in this section list the specifications (including operational, output and dimensional) of the overall machine. Contact the Vanair® Service Department if additional specifications are needed that cannot be found in this

manual.

Refer to **Figure 2-1** for general machine component locations. For additional information, including measurement specifications, refer to **Figure 3-1** (machine and identification and dimensions) in **Section 3, Installation**.

| TABLE 2A: SPECIFICATIONS FOR CAP•START® HYDRAULIC MACHINE |                   |
|-----------------------------------------------------------|-------------------|
| GENERAL SYSTEM INFORMATION                                | SPECIFICATION     |
| HYDRAULIC MOTOR                                           |                   |
| Motor Speed:                                              | 2600 RPM          |
| Motor GPM:                                                | 8 - 12 @ 3000 PSI |
| Pump Size Required:                                       | 8 - 25 GPM        |
| Operating Temperature Limits:                             | -40° - 140°F      |

| TABLE 2B: CAPSCREW TIGHTENING TORQUE VALUES |       |            |
|---------------------------------------------|-------|------------|
| SIZE                                        | GRADE | LUBRICATED |
| 1/4 - 20 UNC                                | 5     | 6 ft-bs    |
| 5/16 - 18 UNC                               | 5     | 13 ft-lbs  |
| 3/8 - 16 UNC                                | 5     | 23 ft-lbs  |
| 1/2 - 13 UNC                                | 5     | 55 ft-lbs  |
| 3/4 - 10 UNC                                | 5     | 200 ft-lbs |

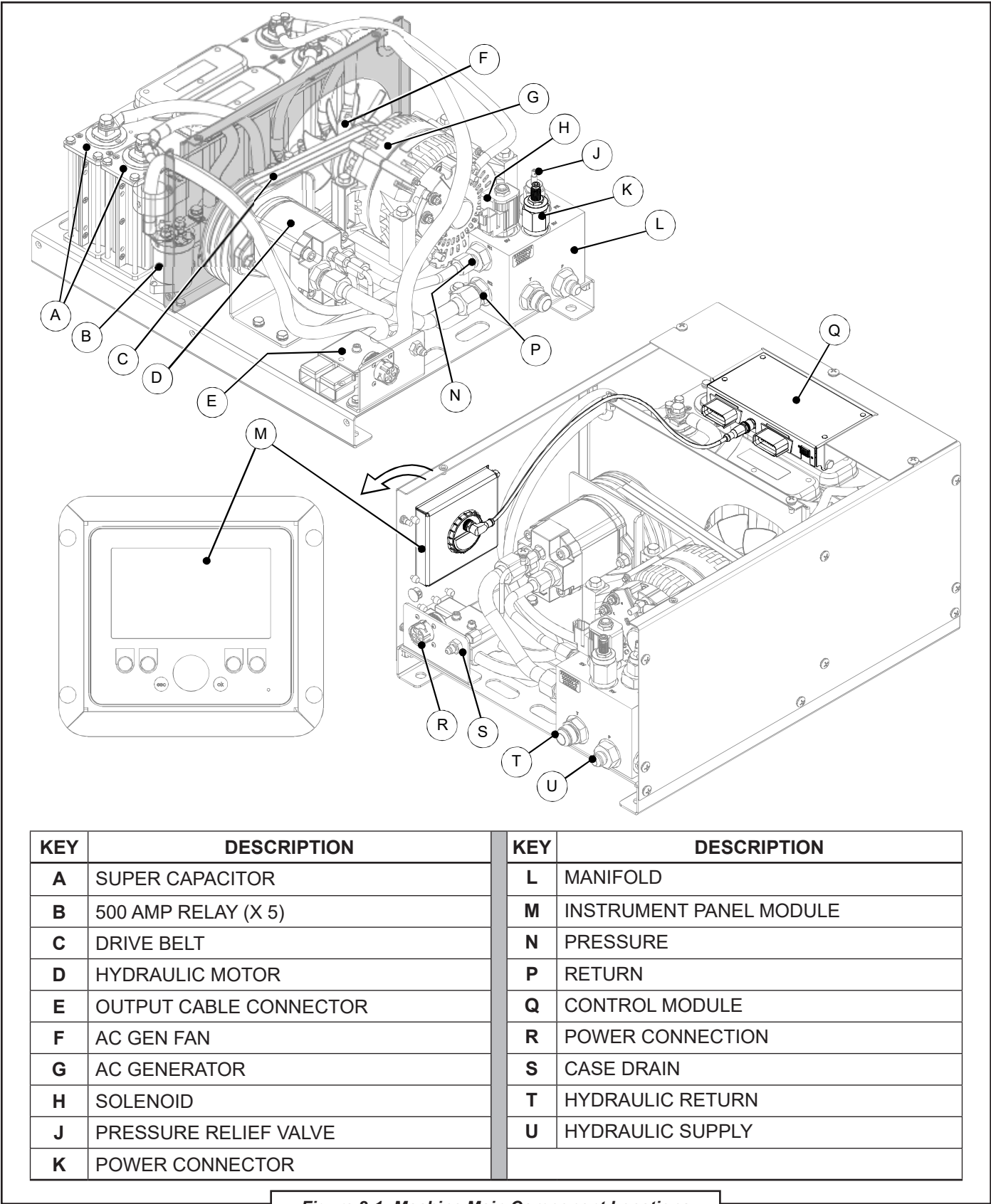


Figure 2-1: Machine Main Component Locations

# SECTION 3: INSTALLATION

## 3.1 MACHINE PACKAGE RECEIPT/INSPECTION

Upon receipt of the machine package, inspect the exterior of the shipping crate for signs of shipping/transit damage. Any damage should be reported immediately to the shipping company.

### NOTE

Before fully unpacking the unit, inspect the component parts, supports and loose-packed parts to ensure that there have been no internal movements of assemblies or components, which may have been damaged during shipment.

Should any damage be discovered during package inspection, contact the shipping company immediately.

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## 3.2 GENERAL INSTRUCTIONS

This section provides general guidance for locating and preparing the Cap•Start® Hydraulic machine package for operation. Each installation is unique and can be affected by location, ventilation, and other factors such as electrical and hydraulic power supply availability and location.

### DISCLAIMER

**DO NOT** install in any enclosed space without first contacting Vanair.

### ⚠ WARNING

Install, operate, and maintain this equipment in full compliance with all applicable OSHA, other Federal, state, local codes, standards, and regulations.

### ⚠ WARNING

Before performing maintenance or repair operations on the machine, ensure that all power has been removed and locked out to prevent accidental start-up.

**DO NOT** assume that because the machine is in a STOPPED condition that power has been removed.

### ⚠ WARNING

**DO NOT** perform any modifications to this equipment without prior factory approval.

### ⚠ WARNING

**DO NOT** use plastic pipe, or incorrectly rated piping or hose. Incorrectly rated connection material can fail and cause injury or equipment damage.

### ⚠ WARNING

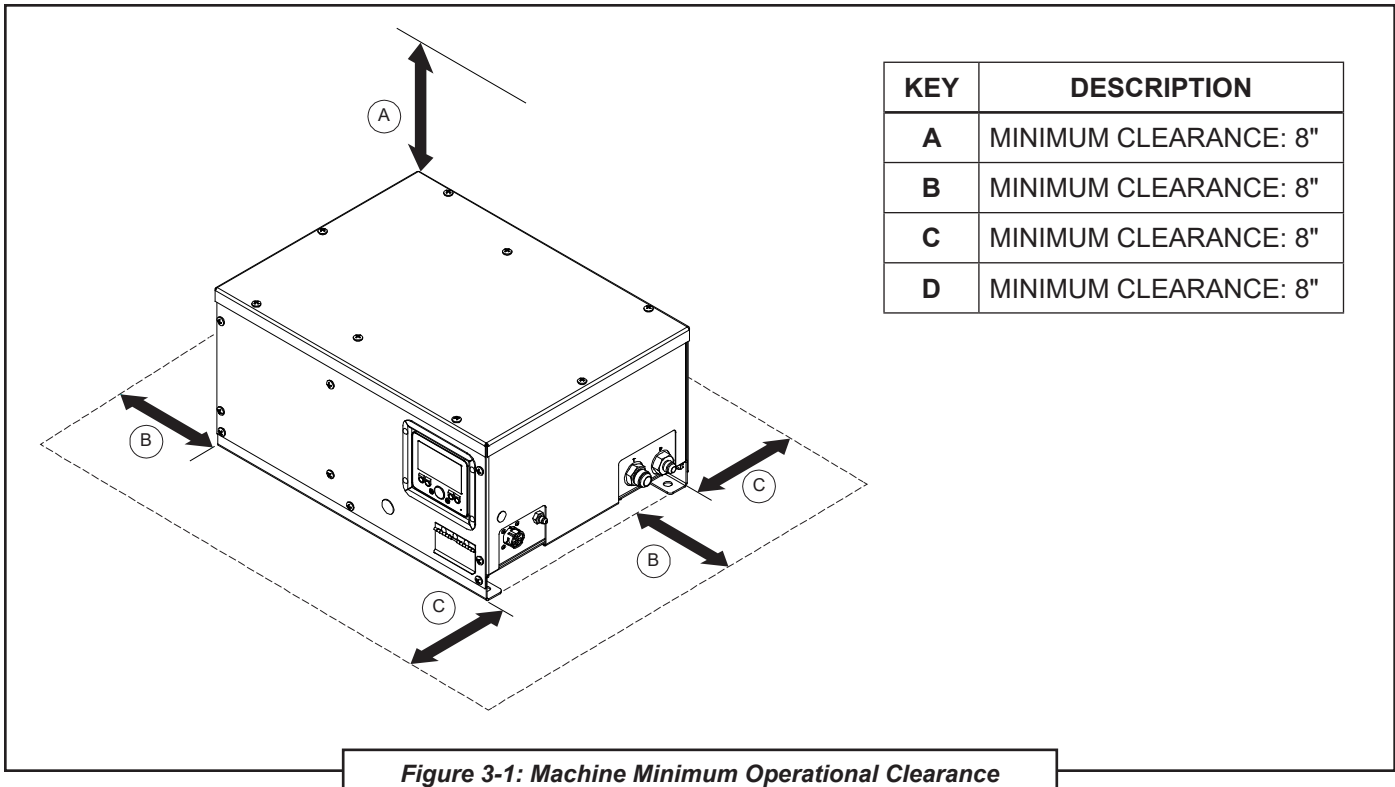
**DO NOT** operate the machine in enclosed or confined spaces where ventilation is restricted or closed off.

### NOTE

Install electrical components (circuit breakers, pressure switches, toggle switches, etc.) in locations where exposure to water or moisture will be most minimized.

### NOTE

In order to prevent accidental damage to vehicle components (fuel tanks, lines, brake lines, wiring harnesses), note their location before drilling any holes.



### 3.3 DETERMINING THE MACHINE MOUNTING LOCATION

When determining the location to mount the Cap•Start Hydraulic unit, the following criteria must be taken into consideration:

- The mounting surface must be level and able to accommodate the four (4) mounting bolts and isolators of the base frame. Refer to **Figure 3-1** or **Figure 3-2** for clearance room and layout of mounting hole slots' locations.

#### IMPORTANT

Mounting surface must be able to bear the weight of the machine (245 lbs).

- Mount the machine with a minimum of four (4) mounting locations.
- The location must allow for the machine dimensions, and additional space requirements for minimum cooling, maintenance and access. Refer to **Figure 3-3** to determine the additional minimum space requirement measurements.
- The external gauges/display must be easily visible to the operator.

ible to the operator.

It is recommended, for most installations, to mount the machine on the driver's side of the vehicle. The unit should be situated in such a manner that the fan (rear) and hydraulic cooler (front) are not obstructed. Do not place the machine in any location where it can ingest exhaust fumes, dust or debris.

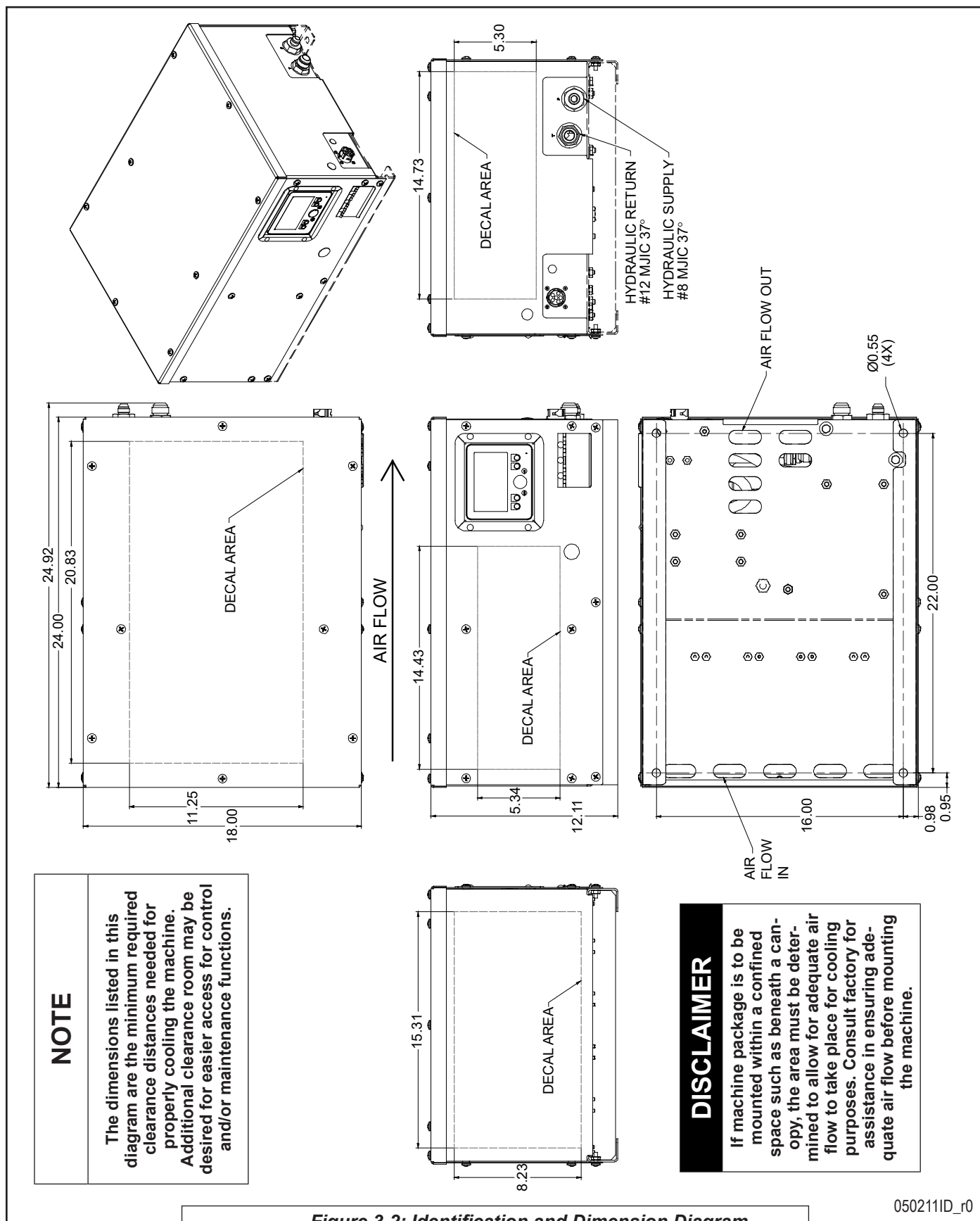
#### NOTE

When considering external system layout hoses refer to Section 7.12, Hose Guide for proper routing and mounting practices.

### 3.4 HYDRAULIC SYSTEM OVERVIEW

#### IMPORTANT

Vanair® highly recommends consulting a hydraulic supply expert for specifying the correct hydraulic supply components for vehicle-side integration (including oil reservoir size, hydraulic pressure relief, hose size, etc.) for your application.



**IMPORTANT**

Contaminated hydraulic fluid allowed to enter the pump will cause malfunction of the pump controls. Hydraulic system hoses must be flushed and cleaned prior to being connected to the unit.

Refer to **Figure 3-2** for hydraulic pump system connections.

Please take into consideration the following:

- The hydraulic flow and pressure requirements of the system.
- A continuous hydraulic load is necessary when machine is running.
- The duty cycle and ambient operating temperatures.
- Other hydraulic equipment which may share that same hydraulic supply system (Vanair recommends a dedicated pump and hydraulic circuit).

**⚠ WARNING**

Follow all applicable safety recommendations as outlined in Section 1: Safety of this manual.

**⚠ WARNING**

Improperly, or non-connected lines may cause harm, and will damage the equipment.

The hydraulic hoses must be run to the machine. Verify that hoses are hooked up properly to ensure proper flow. Also, verify that the hoses are laid out properly so that no chafing or kinking of the hoses is possible. Refer to **Section 7.12, Hose Installation Guide**, for assistance with proper hose layout and connecting functions.

**NOTE**

The temperature of the hydraulic oil should not exceed 160°F due to the rating of the Vanair-supplied hydraulic motor.

must be equal to, or greater than, the maximum GPM at which the system will be operated.

**IMPORTANT**

Use only a filter that is specifically intended for hydraulic systems.

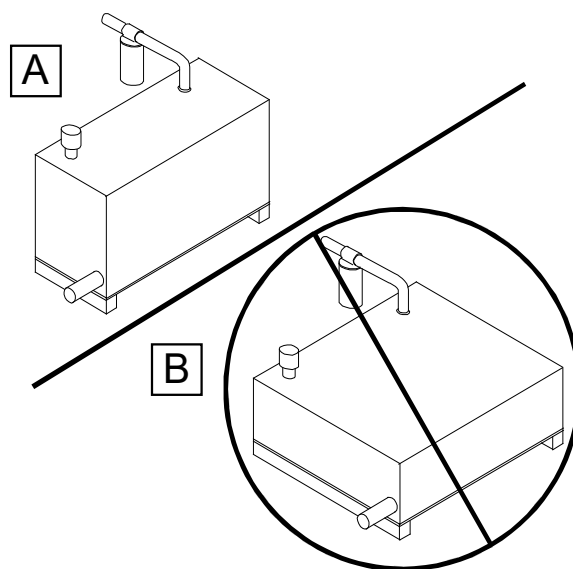
**3.4.2 HYDRAULIC OIL RESERVOIR****3.4.2.1 DETERMINING RESERVOIR SIZE**

In a conventional hydraulic system, minimum tank size, in gallons, should be equal to the maximum GPM flow rate, times two (x 2).

**3.4.2.2 DETERMINING RESERVOIR SHAPE**

The reservoir structure should be tall and narrow rather than shallow and broad (**Figure 3-3**). A tall, narrow tank is recommended because:

1. The oil level is well above suction line opening, avoiding the possibility of drawing air into the pump due to a vortex or “whirlpool” effect within the tank during operation flow.



| KEY | DESCRIPTION                       |
|-----|-----------------------------------|
| A   | PREFERRED SHAPE: TALL AND NARROW  |
| B   | SHAPE TO AVOID: BROAD AND SHALLOW |

**Figure 3-3: Reservoir Design Shape**

**3.4.1 HYDRAULIC SYSTEM FILTRATION**

Vanair recommends using a 10 micron oil filter on the hydraulic oil return line. Flow rating of the filter

2. Allows for better oil level tolerance level of the system if vehicle operates at an unusual (slightly off level) vehicle angle.
3. To keep return flow well below the surface so it does not break the surface and cause aeration (cavitation) of the oil.

### 3.4.2.3 MANDATORY RESERVOIR FEATURES

- The reservoir should incorporate the following design features:
- In terms of location of the reservoir tank within the hydraulic system, note that the hydraulic pump's inlet line (suction line out from the reservoir to the pump) should be located near the bottom of the tank, well below the oil level. The suction line should protrude a minimum of two (2") inches into the reservoir to keep it away from potential contaminant surface buildup.
- A baffle or baffles should be included to prevent sloshing, or centrifugal motion of the oil; the goal is to break up direct flow of the oil from the return point to the suction point. This allows for the cooling action contact with the tanks' inner surfaces, and promote separation of any air or contaminants that interact with the flowing oil.
- An ideal baffle design would position several (but not too many) baffles to promote an 'S' shape flow within the reservoir, as viewed from above. The area of the end gaps should be at least twice the area of the suction line diameter.
- A drain port with plug, situated at the lowest point of the reservoir, is needed to assure complete draining. It should be installed using an adapter or housing which does not protrude above the inner surface of the floor of the tank. It should be visible and accessible for removal, with sufficient space available for catching the waste oil.
- If the return line entrance to the tank is located near the top, it should be extended downward within the tank to minimize foaming and aeration of the circulating oil. This extends oil integrity, which in turn helps to maintain system performance and reliability.
- An in-line filter on the return line is needed to protect the system against contaminants be-

ing introduced into the oil. The filter should be mounted externally from the reservoir in a location that allows for easy of service access.

- A breather and fill cap is needed at the oil fill port, which needs to be located above the system oil level. The breather cap acts to both filter air that is drawn into the reservoir as the oil level diminishes, and bleeds air out as the level is regained. This maintains constant atmospheric pressure in the air volume within the reservoir.
- A sight-glass provides a direct visual indication of the oil level without having to open, or otherwise access, the reservoir.

### 3.4.2.4 RECOMMENDED RESERVOIR OPTIONS

Although not essential for an adequately functioning reservoir, the following components will contribute to maximize the hydraulic system's efficiency and maintain a quality operational level.

- Magnetic drain plug: Attracts and concentrates ferrous contaminants at the drain plug source for easier accessibility and removal when cleaning tank interior.
- A temperature gauge: Located in approximation to, or built in to, the sight glass assembly allows for temperature reading at a glance.
- Filler port strainer: Prevents large contaminant particles from blending with system oil when adding new oil.
- Return line diffuser (splash) plate reduces velocity of oil flow before return oil stream merges with the main reservoir oil volume.
- A reservoir heater: For those systems that are exposed to cold climate ambients, having the ability to preheat the hydraulic oil prior to start up will make for easier startups, and reduce the strain of warming up the system under adverse cold conditions.

### 3.4.2.5 RESERVOIR FEATURES TO AVOID

A strainer used to screen the suction line is not recommended for systems designed for mobile equipment use. Having equipment that likely experiences long suction lines, cold startups and non-tracked or infrequent maintenance practices may cause this strainer to potentially promote

system strain (cavitation) than prolong fluid integrity through filtration.

A pressurized reservoir is not recommended for vehicles, as its complexity invites too much potential for loss of system reliability if it is not properly maintained.

### 3.4.2.6 RECOMMENDED HYDRAULIC SYSTEM SPECIFICATIONS

#### **WARNING**

**Do not operate machine without hydraulic system completely assembled.**

Refer to **Figure 3-1** or **Figure 3-2**.

Flow controller is optional to reduce flow if necessary. Consult Vanair®.

#### HYDRAULIC LINES

The following is a minimum requirement and NO quick disconnects may be used. Lines are to be kept as straight and short as possible.

- Pressure port = Standard, #12, 3/4" hose (located at manifold block)
- Load sense = #4 JIC = 1/4" hose (Used for closed center system only)
- Pressure relief/case drain = #6 JIC = 3/8" hose
- Hydraulic suction = Standard, #16, 1" hose

### 3.4.3 STANDARDS GUIDELINES

- Hydraulic pressure relief factory set at 3200 PSI.

## 3.5 INSTALLATION

### 3.5.1 MACHINE LOCATION

It is vital to locate the machine so that there is no restriction of cooling air through the enclosure (Refer to **Figure 3-1**). Cooling air enters the enclosure at the rear (cooler) package end of the machine, passes through the cooler and exits through vents in the upper sides and the front.

### 3.5.2 CLEARANCES

Refer to **Figure 3-1**. Ensure that adequate surrounding clearance space exists around the machine to allow for adequate cooling ventilation

through the canopy shroud, unobstructed service access, and a clear view of the control panel. An approximate recommendation of ten (10) inches clearance, minimum, is needed for proper cooling circulation, plus any additional service access room included where needed.

### 3.5.3 MACHINE STABILIZATION AND GROUNDING

Machine should be mounted to vehicle using a minimum of four (4) isolators. Isolators absorb vibration. Isolators are included with the machine.

#### **NOTE**

**An isolator replacement kit is available from Vanair®; order bolt down isolator no. KIT1202-001 (kit contains four [x4] isolators).**

#### **WARNING**

**GROUNDING STRAP:** If the machine and/or instrument panel respectively are isolated from contacting the chassis (paint fiberglass body, rubber mounts, etc.), then the machine must be grounded to the truck chassis with a minimum two (2) ga wire (reference Vanair ground strap no. 267498).

**If the machine is bonded by traditional hard mounting (metal to metal contact with chassis), then the grounding strap is not required.**

### 3.5.4 SERVICE CONNECTIONS

Refer to **Figure 3-2**. Service connections are conveniently grouped at the lower rear section of the unit in the base frame.

### 3.5.5 ELECTRICAL CONNECTIONS

Refer to **Figure 3-2**. Connect the electrical supply connector, located at the connection port panel end of the unit. This system is offered with 12V DC circuits.

### 3.5.6 HYDRAULIC SUPPLY CIRCUIT

Refer to the proper hydraulic flow schematic drawing (**Sections 7.19 through 7.22**) that matches the machine model build. It is recommended that the Cap•Start unit possesses a separate pump/flow/return hydraulic circuit to other hydraulic equipment. This is to prevent the pos-

sibility of pressure/flow drops that may occur if other hydraulically-powered equipment is activated during Cap•Start operation, which may in turn, cause the Cap•Start to stall out. Alternatively, use of a diverter valve will permit hydraulics to power different equipment selectively.

### 3.5.7 ROUTING

Refer to **Figure 3-1** or **Figure 3-2**, and the wiring diagrams (**Sections 7.17** and **7.18**) . Ensure that all supply hoses and electrical wiring are correctly specified, adequately supported, and do not touch or rest on any sharp edges. Wiring should be protected with split loom to prevent corrosion, and consequently, loss due to down time.

### 3.5.8 HYDRAULIC SYSTEM REQUIREMENTS

Refer to **Sections 7.19** through **7.22** for hydraulic system schematic layouts and components. The following requirements should be taken into consideration before installing the hydraulic system: .

- The duty cycle and ambient operating temperatures.
- Other hydraulic equipment which may share the same hydraulic supply system (Vanair recommends a dedicated pump and hydraulic circuit).

## 3.6 CONNECTING THE HYDRAULIC SUPPLY AND RETURN

Refer to **Figure 3-1** or **Figure 3-2** for hydraulic supply and return hose location connections and layout routing. Use correctly rated hoses (3000 PSI minimum) to securely connect both supply ( $\frac{3}{4}$ " JIC 37° male) and return connectors (1" JIC 37° male).

#### NOTE

Vanair recommends:

- **SUPPLY HOSE:**  $\frac{3}{4}$ " JIC, 3000 PSI
- **RETURN HOSE:** 1" JIC, 500 PSI
- **CASE DRAIN:**  $\frac{3}{8}$ " JIC, 500 PSI (load sense  $\frac{1}{4}$ " JIC 3000 PSI; closed-center only)

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# SECTION 4: OPERATION

## 4.1 GENERAL INFORMATION

The Cap•Start® Hydraulic-Driven Package has a comprehensive array of controls and indicators. Understanding the correct operation of the system will help you to understand and recognize when it is operating optimally. The information in the Operation Section will help the operator to recognize and interpret the readings, which will call for service or indicate the beginning of a malfunction.

## 4.2 OPERATING CONDITIONS

1. Operate only in well-ventilated areas.
2. Ensure there are no obstructions of cooling air intakes and outlets around the machine.

### IMPORTANT

Be sure to leave sufficient room around the machine for cooling air circulation during operation. There must be a minimum of ten (10) inches for the cooler intake, and ten (10) inches for the sides and rear. Heated air must be able to vent away from the intake.

3. Do not leave anything resting on top of the machine. Hot cooling air will generate high heat and must not be restricted.
4. Operate machine with the top cover closed.
5. Refer to specifications (**Section 2**) for operating parameters.

## 4.3 INITIAL (FIRST-TIME) START-UP

### IMPORTANT

If start-up and shut-down procedures are not followed, damage to the system and its components may occur.

### NOTE

Flow control needs to be set by the installer for closed center units.

The Cap•Start® has been factory-tested and its air and hydraulic valves have been adjusted to their specified operating settings.

The following steps apply to the first time start-up after the machine installation. Refer to **Figure 4-1** for instrumentation panel, and **Figure 4-2** for Controller Screen information.

### ⚠ WARNING

Before engaging machine, make a final check to ensure that no hydraulic ports remain capped. DO NOT start unit with any caps still in place.

1. Ensure all service outlets are closed.
2. Ensure that the PTO ON/OFF switch is in the ON position (fully engaged).
3. Apply hydraulic power.
4. Check for hydraulic supply or return leaks and correct if required.
5. Move the PTO ON/ OFF switch to the OFF position.

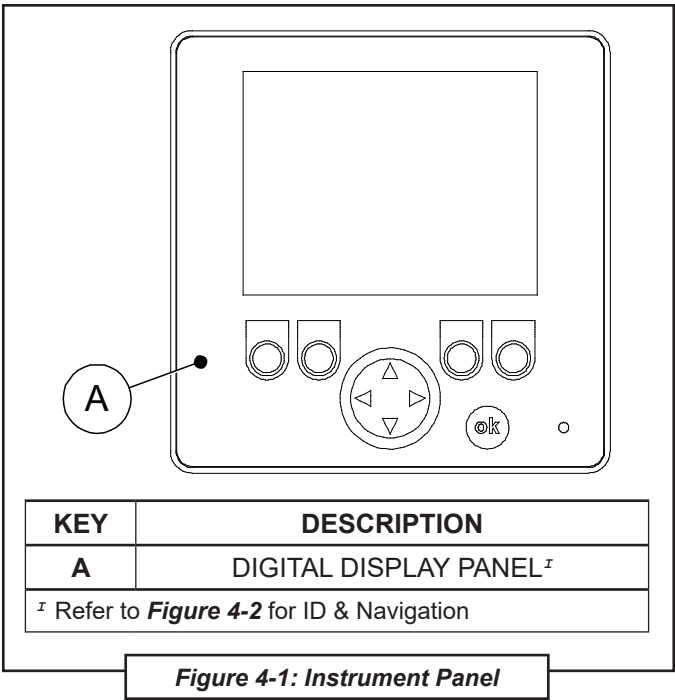
## 4.3.1 ROUTINE START-UP PROCEDURE

### IMPORTANT

If start-up and shut-down procedures are not followed, damage to the system and its components may occur.

Refer to **Figure 4-1** for instrumentation.

1. Ensure all booster cables are disconnected.
2. Ensure that the PTO ON/OFF switch is in the ON position (fully engaged).
3. Apply hydraulic power.
4. Check for hydraulic supply or return leaks and correct if required.
5. Allow air pressure to build up in the receiver tank.
6. Move the PTO ON/ OFF switch to the OFF position.



1. Shut off Charge or Start mode.
2. Shut off hydraulic power supply.

### 4.5 EXTREME CONDITION OPERATION

When operating in extreme hot or cold conditions, extra attention should be given to any indications that could lead to a serious problem. Machine review and maintenance check schedules should be more frequent than the normal suggestions given in **Section 5, Table 5A, Routine Maintenance Schedule**.

### 4.4 ROUTINE SHUTDOWN PROCEDURE (FIRST AND ROUTINE)

**IMPORTANT**

If start-up and shut-down procedures are not followed, damage to the system and its components may occur.

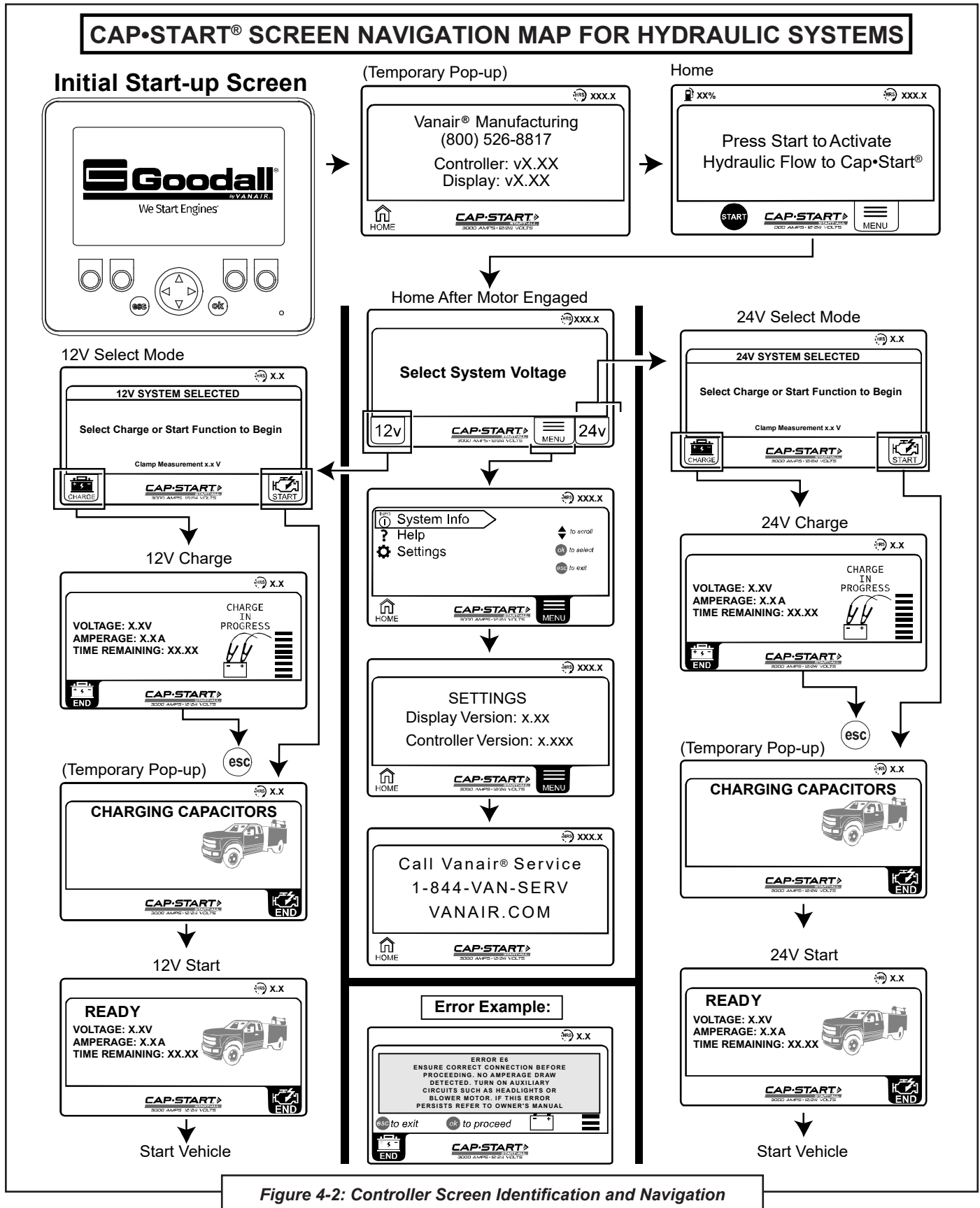


Figure 4-2: Controller Screen Identification and Navigation



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# SECTION 5: MAINTENANCE

## 5.1 GENERAL INFORMATION

A strict maintenance program is the key to long life for the Cap•Start Hydraulic-Driven Package. Below is a program that, when adhered to, should keep the package in top operating condition.

The following table lists the main topics in order of appearance for this section:

### **DANGER**

Disconnect the capacitor before performing any non-routine maintenance functions on the Cap•Start Hydraulic-Driven Package.

### **WARNING**

DO NOT discharge the capacitor.

### **WARNING**

DO NOT short the capacitor.

### **WARNING**

Follow all applicable safety recommendations as outlined in Section 1: Safety of this manual.

### **WARNING**

Wear personal protective equipment such as gloves, work boots, and eye and hearing protection as required for the task at hand.

### **NOTE**

Operating the machine package in a severe environment may require more frequent service intervals.

## 5.2 REPLACEMENT PARTS

Replacement parts should be purchased through your local Vanair® representative or where the Cap•Start Hydraulic-Driven Package was purchased. If, for any reason, parts are not available in this manner, they can be purchased from Vanair directly.

### **IMPORTANT**

Table 7A: Recommended Spare Parts List, in Section 7, contains items that require maintenance on a routine basis, and also those parts that may require maintenance over the course of the Cap•Start Hydraulic-Driven Package's performance schedule. Although this recommended list is proffered as a comprehensive guide to replacement parts, damage may occur to the machine beyond the scope of this listing.

Should any part of the Cap•Start® Hydraulic-Driven Package become damaged or inoperable, use the various sub-sections in Section 7 to best locate and identify the damaged part(s).



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5.3 PARTS REPLACEMENT AND  
ADJUSTMENT PROCEDURES

5.3.1 ADJUSTING THE BELT TENSION

Drive belt tension should be maintained to avoid premature belt wear, poor performance due to belt slippage, or damage to the alternator. The Cap•Start Hydraulic-Driven Package is adjusted by placement of the alternator slide plate.

Refer to **Figure 5-1** and the following procedure.

1. To adjust the belt tension loosen, but do not remove, the four mounting capscrews [D] securing the alternator mounting slide plate [C] to the frame.

The slide plate is mounted via four slots along which the position of the alternator can be adjusted. By adjusting the position of the alternator, the belt can be loosened or tightened.

- 2A. **TO LOOSEN BELT:** Once the mounting capscrews have been loosened enough for the alternator plate to slide, carefully move the plate toward [➡] the hydraulic motor. As the unit moves, the belt will loose tension.
- 2B. **TO TIGHTEN BELT:** The belt is tightened by moving the slide plate away from [↩] the hydraulic motor.
3. When the belt is being adjusted stop and

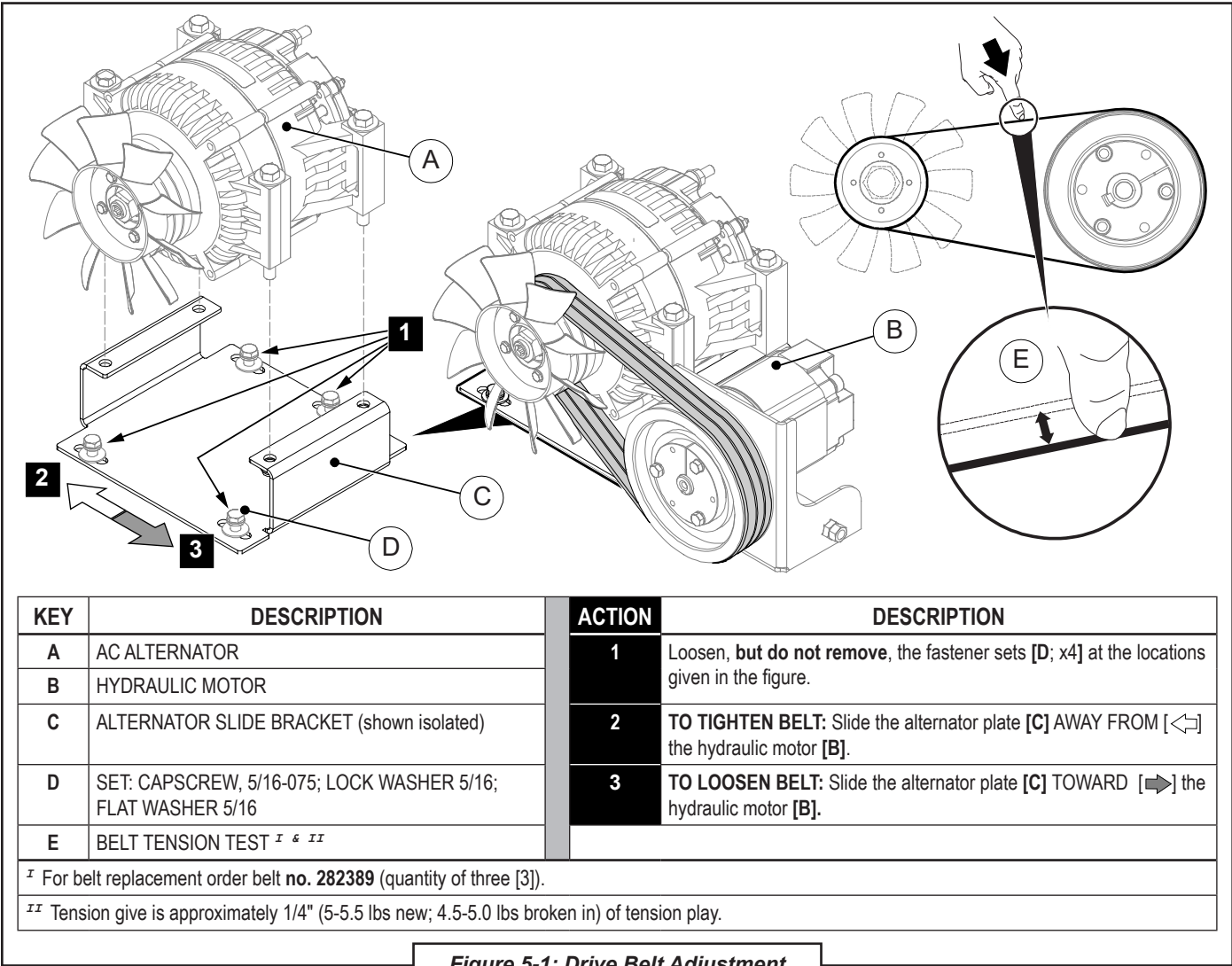


Figure 5-1: Drive Belt Adjustment

check the belt tension by performing the "tension test", which consists of pressing the center area of the belt between the sheaves (see **Figure 5-1**), to determine the tightness of the belt.

4. Once the belt shows a suitable "give" (see footnote in **Figure 5-1**), tighten the cap-screws [D], in a criss-cross pattern, torquing to 13 ft-lbs.

### 5.3.2 REPLACING THE BELT

#### IMPORTANT

The drive system consists of three belts. When changing belts always change all of the belts at the same time, regardless of variances between the condition of a less-worn belt(s) to an obviously worn belt.

If drive belts need to be replaced, order replacement belt **no. 282389** (quantity of three [3]). Refer to **Figure 5-1** and the following:

1. To replace the belts follow the instructions above (in **Section 5.4.1**) up to number **2A**. Loosen the belt enough to disengage the belt from the pulley system.
2. Route the new belt route over the fan (alternator) side of the drive assembly first, then position the belt on both sheave tracks as shown in **Figure 5-1**.
3. Once belts are properly positioned, the belt is ready to be tightened.

4. **TO TIGHTEN BELT:** Tighten the belts by nudging the slide plate [C] away from [↔] the hydraulic motor. Check the belt tension as this is being performed, until the belt tension is within the parameters given in the footnote of **Figure 5-1**.

5. When the proper belt tension is achieved, tighten the capscrews [D], in a criss-cross pattern, torquing to 13 ft-lbs.

## 5.4 STORAGE AND INTERMITTENT USE

### 5.4.1 INTERMITTENT USE

Check all belts and hoses for signs of deterioration such as visible surface cracks, stiffness or discoloration.

### 5.4.2 LONG TERM STORAGE

Disconnect the battery cable that is connected to the negative (-) side of the battery.

Cover the unit with a tarp or plastic to prevent the accumulation of dust, but leave the bottom open for air circulation.

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# SECTION 6: TROUBLESHOOTING

## 6.1 GENERAL INFORMATION

This section contains symptoms and usual causes for the most common types of problems that may occur. All available data concerning the trouble should be systematically analyzed before undertaking any repairs or component replacement.

A visual inspection is worth performing for almost all problems and may avoid unnecessary additional damage to the machine. The procedures which can be performed in the least amount of time and with the least amount of removal or disassembly of parts should be performed first.

### **WARNING**

**Before starting, performing maintenance, or replacing parts, relieve the entire system pressure by opening a service valve, which will vent all pressure to the atmosphere.**

Although Vanair® strives to anticipate situations that may occur during the operation life of the machine package, the Troubleshooting Guide may not cover all possible situations. Should the situation remain unresolved after exhausting available sources, contact the Vanair Service Department at:

**Toll Free: 844-VAN-SERV 844-[826-7378]**

**Phone: 219-879-5100**

**Fax: 219-879-5335**

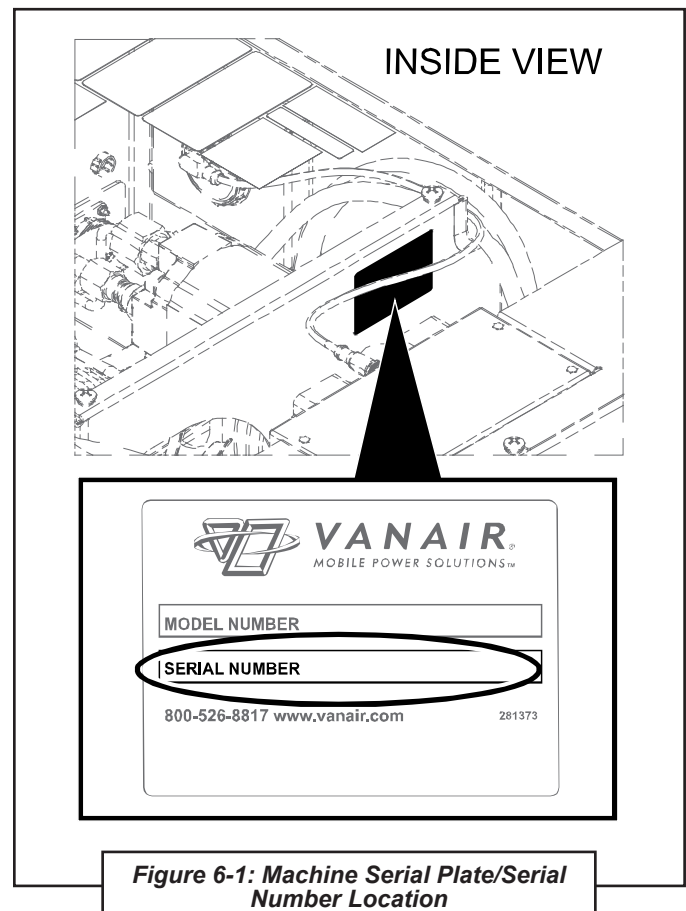
This section contains symptoms and usual causes for the most common types of problems that may occur. All available data concerning the trouble should be systematically analyzed before undertaking any repairs or component replacement.

A visual inspection is worth performing for almost all problems and may avoid unnecessary additional damage to the machine. The procedures which can be performed in the least amount of time and with the least amount of removal or disassembly of parts should be performed first.

Although Vanair strives to anticipate situations that may occur during the operation life of the machine package, the Troubleshooting Guide may not cover all possible situations. Should the situation remain unresolved after exhausting available sources, contact the Vanair Service Department, with the machine serial number readily available (refer to **Figure 6-1**).

### **NOTE**

**When contacting the Vanair Service Department, please have machine serial number on hand to quickly expedite service. Serial number can be located on the serial plate, as shown.**



**Figure 6-1: Machine Serial Plate/Serial Number Location**

## 6.2 TROUBLESHOOTING GUIDE - HYDRAULICS

| MALFUNCTION/FAULT                                       | POSSIBLE CAUSE                                                     | CORRECTIVE ACTION                                                                                                                                                                                                                                                    |
|---------------------------------------------------------|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>HYDRAULIC DRIVE SYSTEM: EXCESSIVE NOISE</b>          |                                                                    |                                                                                                                                                                                                                                                                      |
| Motor is too noisy                                      | Coupling is mis-aligned                                            | Align unit and check condition of seals, bearings and coupling.                                                                                                                                                                                                      |
|                                                         | Motor and/or coupling is/are worn or damaged                       | Regard any or all of the following: Tighten leaking connections; fill reservoir to proper level (with rare exception all return lines should be below fluid level in reservoir); bleed air from system; replace pump shaft seal (and shaft if worn at seal journal). |
| Relief valve too noisy                                  | Valve setting is set too low or too close to another valve setting | Install pressure gauge and adjust to correct pressure.                                                                                                                                                                                                               |
|                                                         | Worn poppet and/or seat                                            | Overhaul or replace poppet and/or seat.                                                                                                                                                                                                                              |
| <b>HYDRAULIC DRIVE SYSTEM: EXCESSIVE HEAT</b>           |                                                                    |                                                                                                                                                                                                                                                                      |
| Motor is heated                                         | Fluid is heated                                                    | Refer to information under "Fluid is heated" heading below.                                                                                                                                                                                                          |
|                                                         | Relief or unloading valve is set too high                          | Install pressure gauge and adjust to correct pressure (keep at least 125 psi difference between valve settings).                                                                                                                                                     |
|                                                         | Motor is worn or damaged                                           | Overhaul or replace motor.                                                                                                                                                                                                                                           |
| Relief valve is heated                                  | Fluid is heated                                                    | Refer to information under "Fluid is heated" heading below.                                                                                                                                                                                                          |
|                                                         | Valve is set incorrectly                                           | Install pressure gauge and adjust to correct pressure (keep at least 125 psi difference between valve settings).                                                                                                                                                     |
|                                                         | Valve is worn or damaged                                           | Rebuild or replace valve.                                                                                                                                                                                                                                            |
| Fluid is heated                                         | System pressure is too high                                        | Install pressure gauge and adjust to correct pressure (keep at least 125 psi difference between valve settings).                                                                                                                                                     |
|                                                         | System pressure is too high                                        | Install pressure gauge and adjust to correct pressure (keep at least 125 psi difference between valve settings).                                                                                                                                                     |
|                                                         | Fluid is fouled or quantity too low                                | Change filters and also system fluid if improper viscosity; fill reservoir to proper level.                                                                                                                                                                          |
|                                                         | Fluid viscosity is not correct                                     | Change filters and also system fluid if improper viscosity; fill reservoir to proper level.                                                                                                                                                                          |
| Oil discharge from regulator weep hole                  | Fluid cooling system is faulty                                     | Clean cooler and/or cooler strainer; replace cooler control valve; repair or replace cooler.                                                                                                                                                                         |
|                                                         | Pump, valve, motor, cylinder or other component is/are worn        | Overhaul or replace item as noted.                                                                                                                                                                                                                                   |
| <b>HYDRAULIC DRIVE SYSTEM: INCORRECT FLOW CONDITION</b> |                                                                    |                                                                                                                                                                                                                                                                      |
| No existing flow at motor                               | Motor not receiving fluid                                          | Regard any or all of the following:<br>Replace dirty filters; clean clogged inlet line; clean or replace reservoir breather vent; fill reservoir to proper level; overhaul or replace supercharge pump.                                                              |
|                                                         | Entire flow passing over relief valve                              | Adjust as necessary.                                                                                                                                                                                                                                                 |
|                                                         | Pump is damaged                                                    | Check for damaged pump or pump drive—replace as necessary, and align coupling.                                                                                                                                                                                       |
|                                                         | Pump is assembled improperly                                       | Overhaul or replace pump.                                                                                                                                                                                                                                            |

*Table continued on next page*

## 6.2 TROUBLESHOOTING GUIDE - HYDRAULICS

| MALFUNCTION/FAULT                                            | POSSIBLE CAUSE                                            | CORRECTIVE ACTION                                                                                                         |
|--------------------------------------------------------------|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| HYDRAULIC DRIVE SYSTEM: INCORRECT FLOW CONDITION (CONTINUED) |                                                           |                                                                                                                           |
| Flow is low                                                  | Flow control is set too low (Closed Center System [CCS])  | Adjust as necessary.                                                                                                      |
|                                                              | Relief valve is set too low                               | Adjust as necessary.                                                                                                      |
|                                                              | Partial flow passing over relief                          | Adjust as necessary.                                                                                                      |
|                                                              | External leak in the system exists                        | Locate and tighten leaking connections.                                                                                   |
|                                                              | Pump drive motor RPM is incorrect                         | Replace with correct unit.                                                                                                |
|                                                              | Pump, valve, motor is/are worn                            | Overhaul or replace item as noted.                                                                                        |
| Flow is excessive                                            | Flow control is set too high (Closed Center System [CCS]) | Adjust as necessary.                                                                                                      |
|                                                              | Pump drive motor RPM is incorrect                         | Replace with correct unit. Adjust vehicle RPM.                                                                            |
|                                                              | Replacement pump is not properly sized                    | Replace with correct unit.                                                                                                |
| HYDRAULIC DRIVE SYSTEM: INCORRECT PRESSURE CONDITION         |                                                           |                                                                                                                           |
| Pressure is absent                                           | No flow                                                   | Refer to information in the “No Existing Flow” column under INCORRECT FLOW CONDITION in this guide                        |
| Pressure is low                                              | Pressure relief path is present                           | Refer to information in the “No Existing Flow” and the “Flow is Low” columns under INCORRECT FLOW CONDITION in this guide |
|                                                              | Pressure relief valve is set too low                      | Adjust pressure relief valve. Rebuild or replace if necessary.                                                            |
|                                                              | Pressure relief valve is damaged or inoperable            | Rebuild or replace pressure valve.                                                                                        |
|                                                              | Pump or motor is damaged or inoperable                    | Overhaul or replace as necessary.                                                                                         |
| Pressure is erratic                                          | Air is present in fluid                                   | Tighten leaking connections, fill reservoir to proper level, and bleed air from system.                                   |
|                                                              | Relief valve is worn or inoperable                        | Rebuild or replace valve.                                                                                                 |
|                                                              | Fluid is contaminated                                     | Check system fluid and filters; replace if necessary.                                                                     |
|                                                              | Pump or motor is worn                                     | Overhaul or replace as necessary.                                                                                         |
| Pressure is excessive                                        | Pressure relief valve out of adjustment                   | Adjust; Rebuild or replace if necessary.                                                                                  |
| HYDRAULIC DRIVE SYSTEM: FAULTY OPERATION                     |                                                           |                                                                                                                           |
| Hydraulic Flow Is Present But Motor Does Not Rotate          | Mechanically bound                                        | Locate the bind, and repair.                                                                                              |
|                                                              | Command signal solenoid is absent                         | Contact the Vanair® Service Department.                                                                                   |
|                                                              | Solenoid valve is inoperative                             | Replace valve.                                                                                                            |
|                                                              | Motor is worn or damaged                                  | Overhaul or replace motor.                                                                                                |
| Hydraulic Flow Is Present But Motor Rotates Slowly           | Low system flow                                           | Refer to information under INCORRECT FLOW CONDITION in this guide.                                                        |
|                                                              | Viscosity of fluid too high                               | Fluid may be too cold; allow system to warm up.                                                                           |
|                                                              |                                                           | Fluid may be fouled; change system fluid to correct viscosity fluid.                                                      |
| Table continued on next page                                 |                                                           |                                                                                                                           |

## 6.2 TROUBLESHOOTING GUIDE - HYDRAULICS

| MALFUNCTION/FAULT                                           | POSSIBLE CAUSE                                      | CORRECTIVE ACTION                                                                             |
|-------------------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------------------------------------------------|
| <b>HYDRAULIC DRIVE SYSTEM: FAULTY OPERATION (CONTINUED)</b> |                                                     |                                                                                               |
| Hydraulic Flow Is Present But Motor Rotates Slowly          | Relief valve is out of adjustment or malfunctioning | Adjust, repair or replace.                                                                    |
|                                                             | Solenoid valve sticks                               | Repair or replace.                                                                            |
| Hydraulic Motor Moves Erratically                           | Pressure is erratic                                 | Refer to information under INCORRECT PRESSURE in this guide.                                  |
|                                                             | Air is present in fluid                             | Refer to information under EXCESSIVE NOISE in this guide.                                     |
|                                                             | Command signal is erratic                           | Repair command console or connection wire(s).                                                 |
|                                                             | Relief valve is out of adjustment or malfunctioning | Adjust, repair or replace.                                                                    |
|                                                             | Solenoid valve sticks                               | Clean and adjust; replace if necessary. Check system fluid and filters; replace if necessary. |
|                                                             | Cylinder or motor is worn or damaged                | Overhaul or replace cylinder or motor.                                                        |
| Hydraulic Motor Rotates Excessively                         | Flow is excessive                                   | Refer to information under INCORRECT FLOW CONDITION in this guide.                            |

# SECTION 7: ILLUSTRATED PARTS LIST

## 7.1 PARTS ORDERING INFORMATION

Part orders should be placed through the distributor from whom the unit was purchased. If for any reason parts cannot be obtained in this manner, contact the factory directly at the address or phone numbers below.

When ordering parts always indicate the Serial Number of the machine package. This can be obtained from the Bill of Lading for the machine package, or from the unit's serial number plate. See **Figure 7-1** for location of machine package serial plate. **Consult Table 7A: Recommended Spare Parts List** on the next page for a listing of replacement parts.

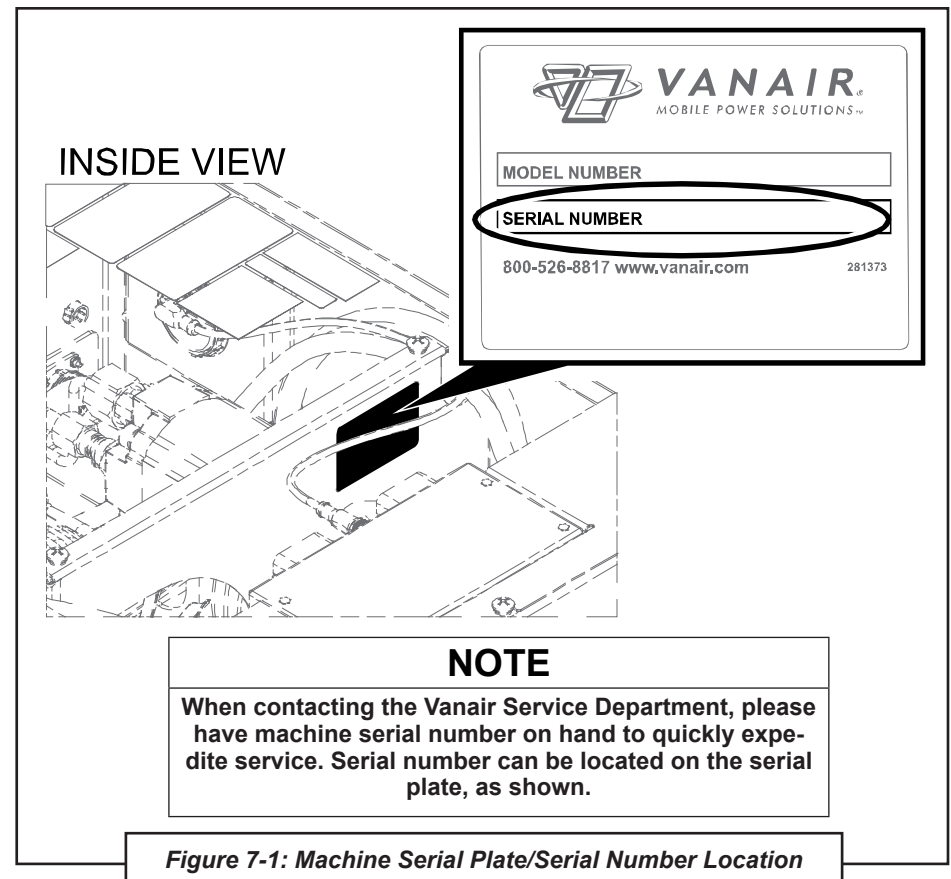
### VAN AIR® MANUFACTURING, INC.

10896 West 300 N.  
Michigan City, IN 46360

Telephone: (800) 526-8817 (219) 879-5100  
Service: (844) VAN-SERV or (844) 826-7378

Service Fax: (219) 879-5335  
Parts Fax: (219) 879-5340  
Sales Fax: (219) 879-5800

vanair.com



**TABLE 7A: RECOMMENDED SPARE PARTS LIST**

| KEY NO. | DESCRIPTION | ORDER NO. | QTY |
|---------|-------------|-----------|-----|
| 1       | Belt, Drive | 282389    | 3   |
| 2       | Relay, 500A | 280203    | 1   |
| 3       | Fuse, 10A   | EL041538  | 1   |
| 4       | Fuse, 5A    | EL270936  | 1   |

**PLEASE NOTE: WHEN ORDERING PARTS, INDICATE MACHINE SERIAL NUMBER.**

**IMPORTANT**

The above table listing contains items that require maintenance on a routine basis, and also those parts that may require maintenance over the course of the machine package's performance schedule. Although this recommended list is pro-offered as a comprehensive guide to replacement parts, damage may occur to the machine beyond the scope of this listing.

Should any part of the machine package that is not listed in Table 7A become damaged or inoperable, contact the Vanair Service Department.

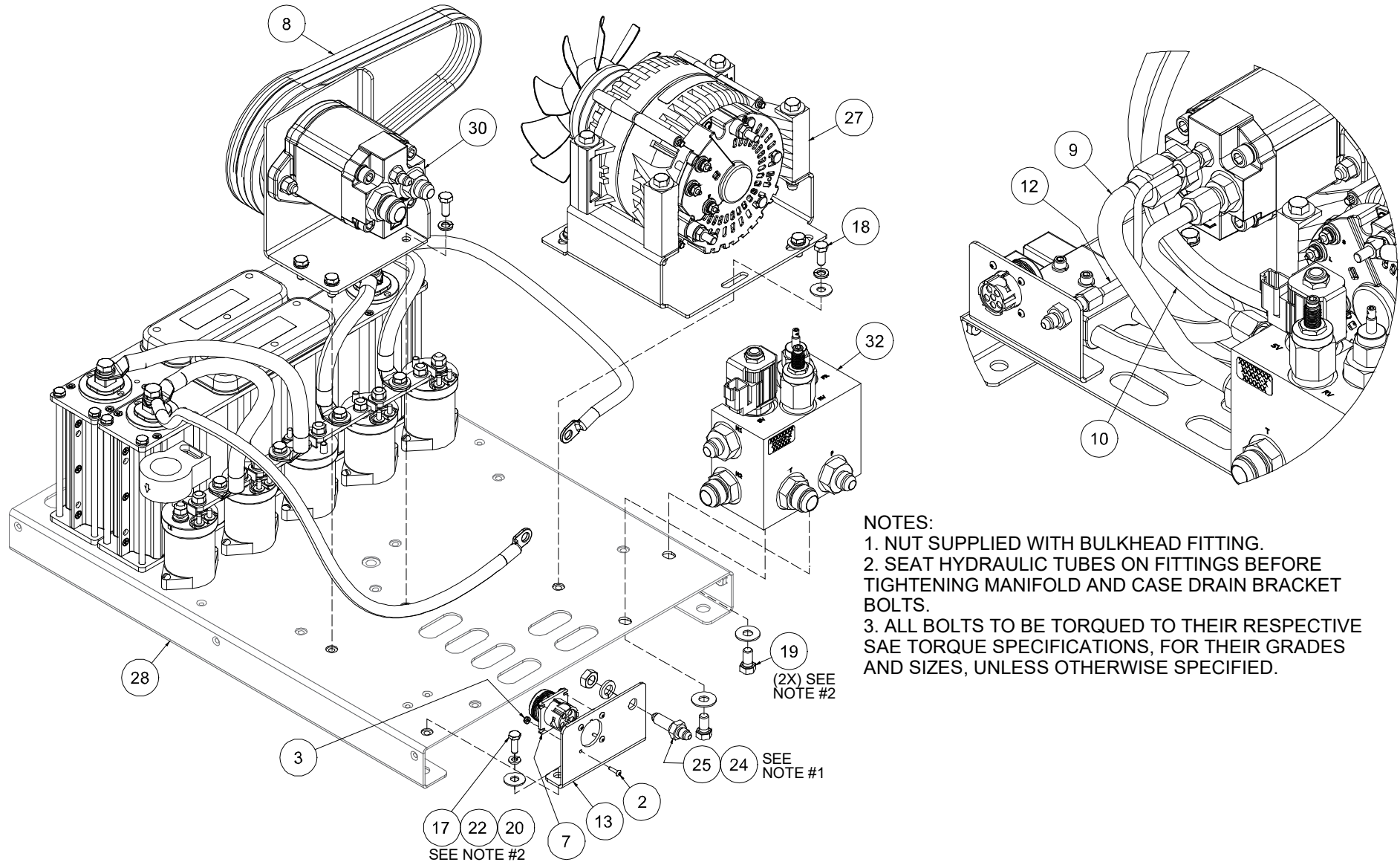
**IMPORTANT**

If additional spare parts are being stored for future use, ensure that they are stored in proper containers that allow for protection against contamination, and kept in a clean area of moderate temperature reading. For information on storing the machine package for periods of non-use, consult *Section 5.4.2, Long Term Storage*.



NOTES

## 7.2 FINISHED ASSEMBLY - 1 OF 3

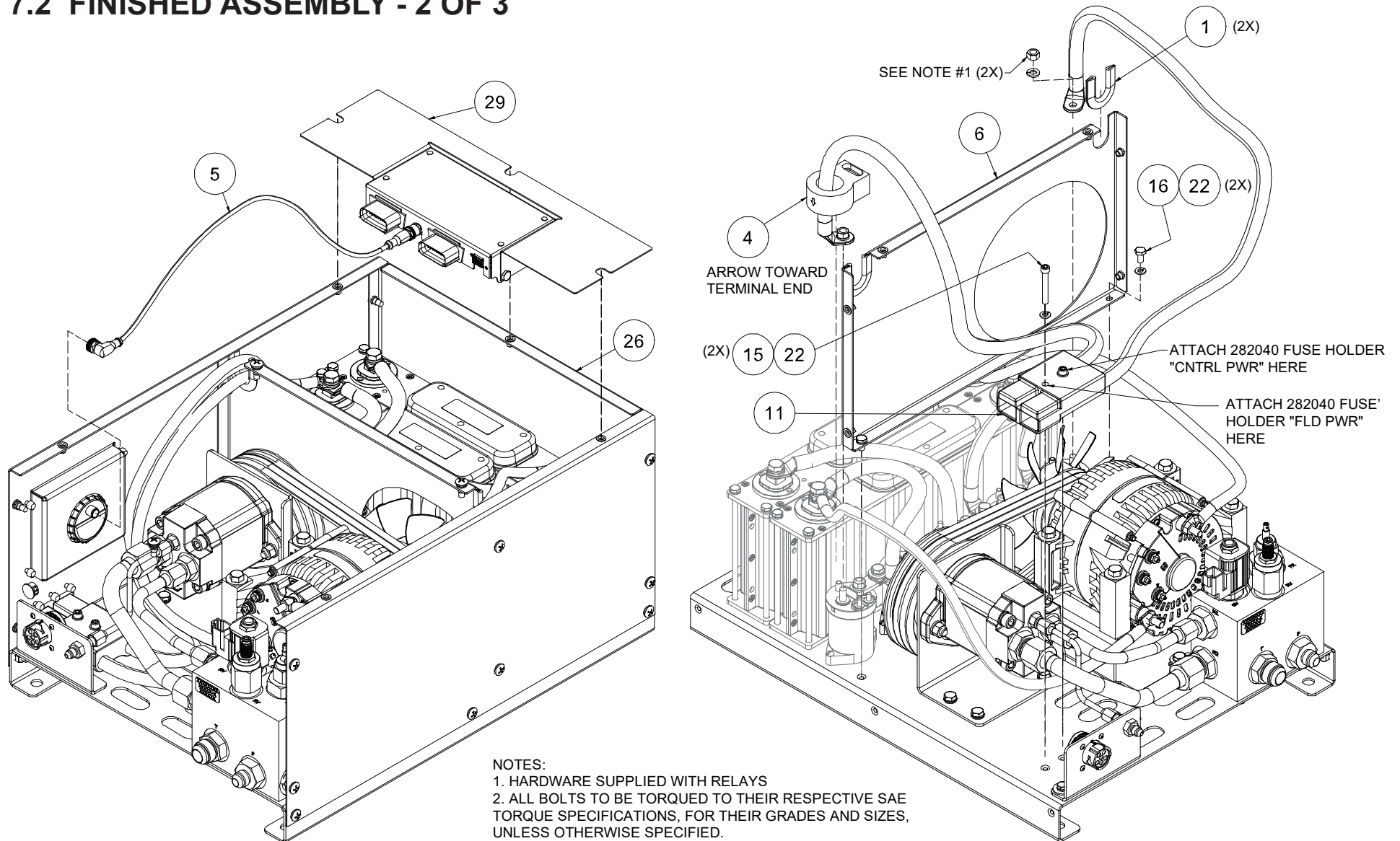


## 7.2 FINISHED ASSEMBLY - 1 OF 3

| ITEM | DESCRIPTION                                   | PART NUMBER | QTY  | ITEM | DESCRIPTION                               | PART NUMBER | QTY |
|------|-----------------------------------------------|-------------|------|------|-------------------------------------------|-------------|-----|
| 1    | TRIM-LOK, 1/16 GROOVE NEOPRENE PUSH ON        | 265257      | 3.5" | 17   | CAPSCREW, HEX GR5 1/4-20 x 0.75           | 829104-075  | 2   |
| 2    | SCREW, TRUSS #4-40 X 1/2                      | 271839      | 4    | 18   | CAPSCREW, HEX GR5 5/16-18 x 0.75          | 829105-075  | 8   |
| 3    | NUT, HEX LOCKING #4-40 UNC                    | 271840      | 4    | 19   | CAPSCREW, HEX GR8 3/8-16 x 0.75           | 829406-075  | 2   |
| 4    | SENSOR, HALL EFFECT 500 AMP                   | 275718      | 1    | 20   | WASHER, FLAT 5/16                         | 838205-071  | 6   |
| 5    | CABLE, M12 MALE/FEMALE PATCH 90/STRAIGHT 2 FT | 277892-02   | 1    | 21   | WASHER, FLAT 3/8                          | 838206-071  | 2   |
| 6    | PANEL, MIDDLE CS3KH                           | 281332      | 1    | 22   | WASHER, LOCK 1/4                          | 838504-062  | 6   |
| 7    | HARNESS, CS3KH POWER CONNECTOR A              | 282040      | 1    | 23   | WASHER, LOCK 5/16                         | 838505-078  | 10  |
| 8    | BELT, DRIVE 3VX210                            | 282389      | 3    | 24   | WASHER, LOCK 7/16                         | 838507-109  | 1   |
| 9    | TUBE, MOTOR RETURN CS3KH                      | 282391      | 1    | 25   | BULKHEAD, MJIC x MJIC #4                  | 862104-025  | 1   |
| 10   | TUBE, MOTOR PRESSURE CS3KH                    | 282392      | 1    | 26   | ID, CANOPY & PARTS CS3KH                  | 6030207ID   | 1   |
| 11   | CABLE, OUTPUT CS3KH                           | 282418      | 1    | 27   | ID, ASSY ALTERNATOR 240A CS3KH            | 6050122ID   | 1   |
| 12   | TUBE, CASE DRAIN CS3KH                        | 282598      | 1    | 28   | ID, ELEC ASSY, FRAME, CAPACITOR AND RELAY | 6060337ID   | 1   |
| 13   | BRACKET, CASE DRAIN AND CONNECTOR CS3KH       | 282599      | 1    | 29   | ASSY, CONTROL MODULE CS3KH                | 6060352ID   | 1   |
| 14   | NUT, HEX 5/16-18                              | 825205-273  | 2    | 30   | ID, ASSY MOTOR CS3KH                      | 6100281ID   | 1   |
| 15   | CAPSCREW, S.H. 1/4-20 x 1 3/4                 | 828304-175  | 2    | 31   | DECAL GROUP CAPSTART 3000, HYDRAULIC      | 6110154ID   | 1   |
| 16   | CAPSCREW, HEX GR5 1/4-20 x 1/2                | 829104-050  | 2    | 32   | ID, MANIFOLD ASSY, CS3KH                  | 6120460ID   | 1   |

**PLEASE NOTE: WHEN ORDERING PARTS, INDICATE MACHINE SERIAL NUMBER.**

## 7.2 FINISHED ASSEMBLY - 2 OF 3

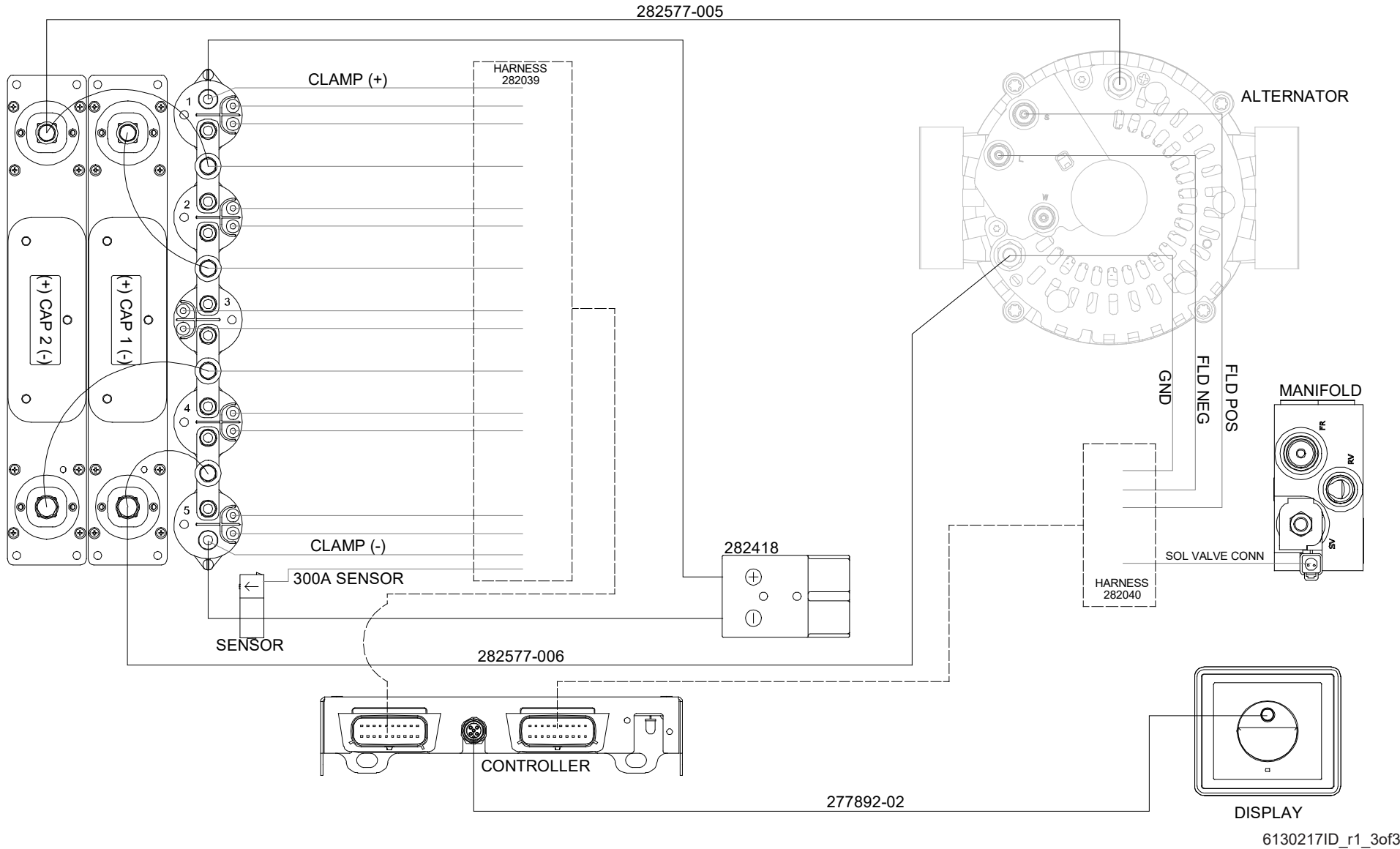


## 7.2 FINISHED ASSEMBLY - 2 OF 3

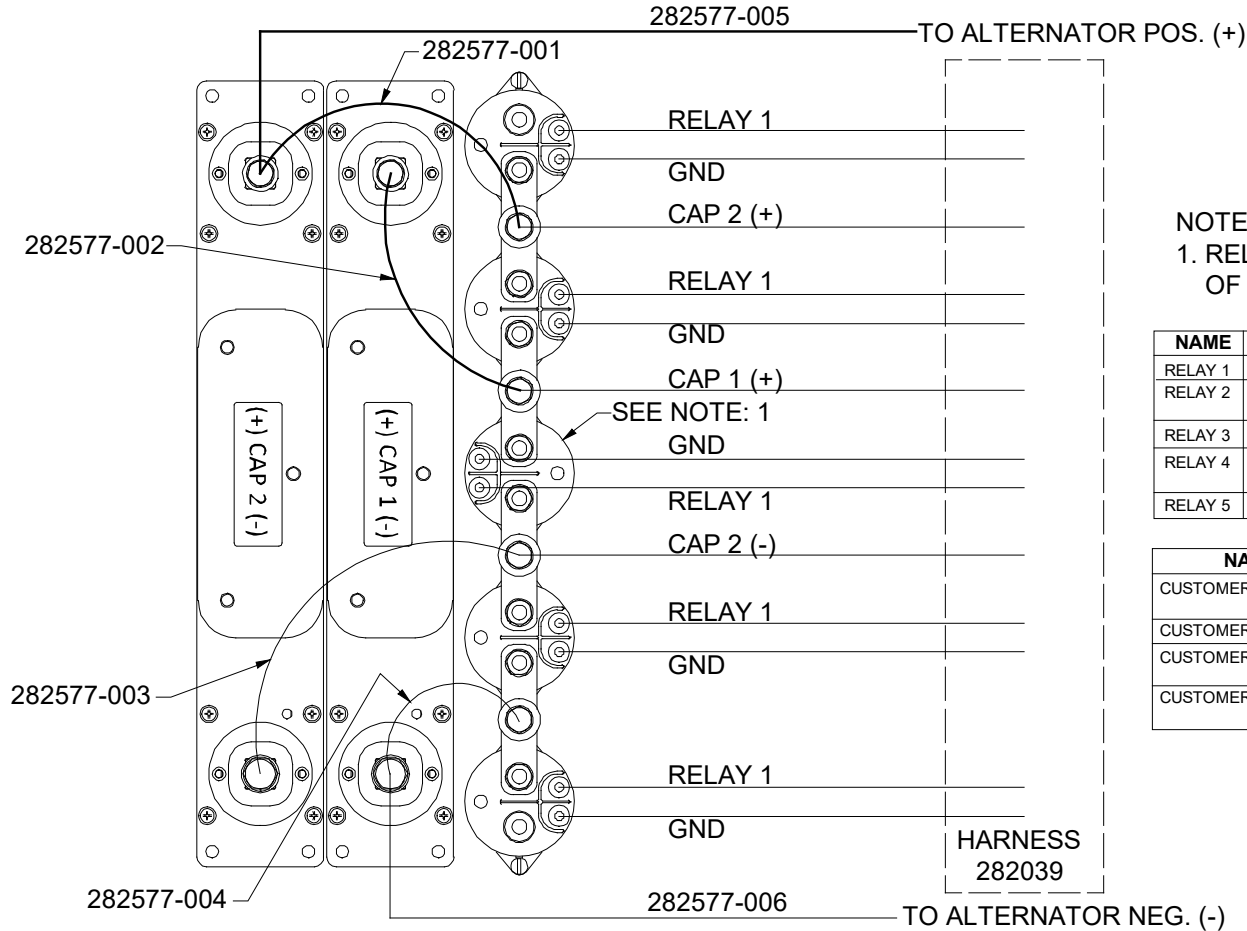
| ITEM | DESCRIPTION                                   | PART NUMBER | QTY  | ITEM | DESCRIPTION                               | PART NUMBER | QTY |
|------|-----------------------------------------------|-------------|------|------|-------------------------------------------|-------------|-----|
| 1    | TRIM-LOK, 1/16 GROOVE NEOPRENE PUSH ON        | 265257      | 3.5" | 17   | CAPSCREW, HEX GR5 1/4-20 x 0.75           | 829104-075  | 2   |
| 2    | SCREW, TRUSS #4-40 X 1/2                      | 271839      | 4    | 18   | CAPSCREW, HEX GR5 5/16-18 x 0.75          | 829105-075  | 8   |
| 3    | NUT, HEX LOCKING #4-40 UNC                    | 271840      | 4    | 19   | CAPSCREW, HEX GR8 3/8-16 x 0.75           | 829406-075  | 2   |
| 4    | SENSOR, HALL EFFECT 500 AMP                   | 275718      | 1    | 20   | WASHER, FLAT 5/16                         | 838205-071  | 6   |
| 5    | CABLE, M12 MALE/FEMALE PATCH 90/STRAIGHT 2 FT | 277892-02   | 1    | 21   | WASHER, FLAT 3/8                          | 838206-071  | 2   |
| 6    | PANEL, MIDDLE CS3KH                           | 281332      | 1    | 22   | WASHER, LOCK 1/4                          | 838504-062  | 6   |
| 7    | HARNESS,CS3KH POWER CONNECTOR A               | 282040      | 1    | 23   | WASHER, LOCK 5/16                         | 838505-078  | 10  |
| 8    | BELT, DRIVE 3VX210                            | 282389      | 3    | 24   | WASHER, LOCK 7/16                         | 838507-109  | 1   |
| 9    | TUBE, MOTOR RETURN CS3KH                      | 282391      | 1    | 25   | BULKHEAD, MJIC x MJIC #4                  | 862104-025  | 1   |
| 10   | TUBE, MOTOR PRESSURE CS3KH                    | 282392      | 1    | 26   | ID, CANOPY & PARTS CS3KH                  | 6030207ID   | 1   |
| 11   | CABLE, OUTPUT CS3KH                           | 282418      | 1    | 27   | ID, ASSY ALTERNATOR 240A CS3KH            | 6050122ID   | 1   |
| 12   | TUBE, CASE DRAIN CS3KH                        | 282598      | 1    | 28   | ID, ELEC ASSY, FRAME, CAPACITOR AND RELAY | 6060337ID   | 1   |
| 13   | BRACKET, CASE DRAIN AND CONNECTOR CS3KH       | 282599      | 1    | 29   | ASSY, CONTROL MODULE CS3KH                | 6060352ID   | 1   |
| 14   | NUT, HEX 5/16-18                              | 825205-273  | 2    | 30   | ID, ASSY MOTOR CS3KH                      | 6100281ID   | 1   |
| 15   | CAPSCREW, S.H. 1/4-20 x 1 3/4                 | 828304-175  | 2    | 31   | DECAL GROUP CAPSTART 3000, HYDRAULIC      | 6110154ID   | 1   |
| 16   | CAPSCREW, HEX GR5 1/4-20 x 1/2                | 829104-050  | 2    | 32   | ID, MANIFOLD ASSY, CS3KH                  | 6120460ID   | 1   |

**PLEASE NOTE: WHEN ORDERING PARTS, INDICATE MACHINE SERIAL NUMBER.**

7.2 FINISHED ASSEMBLY - 3 OF 3



7.3 ELECTRICAL ASSEMBLY, FRAME, CAPACITOR AND RELAY - 1 OF 2



NOTES:  
1. RELAY 3 IS ORIENTED OPPOSITE  
OF OTHER RELAYS.

| NAME    | DESCRIPTION                                                                                                                        |
|---------|------------------------------------------------------------------------------------------------------------------------------------|
| RELAY 1 | CONNECTS: ALTERNATOR POS (+) & CAP 2 POS (+), TO: JUMPER CABLE POS (+)                                                             |
| RELAY 2 | CONNECTS: CAP 1 POS (+) & CAP 2 POS (+) IN PARALLEL. FOR CAP CHARGE & 12V START MODE                                               |
| RELAY 3 | CONNECTS CAPACITORS IN SERIES FOR 24V MODE                                                                                         |
| RELAY 4 | CONNECTS CAPACITORS IN PARALLEL FOR CAP CHARGE & 12V START MODE GROUND SAFETY; CONNECTS CAP / ALT NEG.(-) TO NEG.(-) JUMPER CABLES |
| RELAY 5 | FOR VEHICLE CHARGE / VEHICLE START                                                                                                 |

| NAME             | DESCRIPTION                                                           |
|------------------|-----------------------------------------------------------------------|
| CUSTOMER CONN. A | +12VDC INPUT FROM A SWITCHED POWER SOURCE ON THE HOST VEHICLE         |
| CUSTOMER CONN. B | +12VDC INPUT FROM FROM THE HOST VEHICLE BATTERY                       |
| CUSTOMER CONN. C | -12VDC INPUT FROM THE HOST VEHICLE GROUND OR BATTERY NEGATIVE         |
| CUSTOMER CONN. D | +12VDC OUTPUT SIGNAL FOR REMOTE INDICATOR OF HYDRAULIC MOTOR BEING ON |

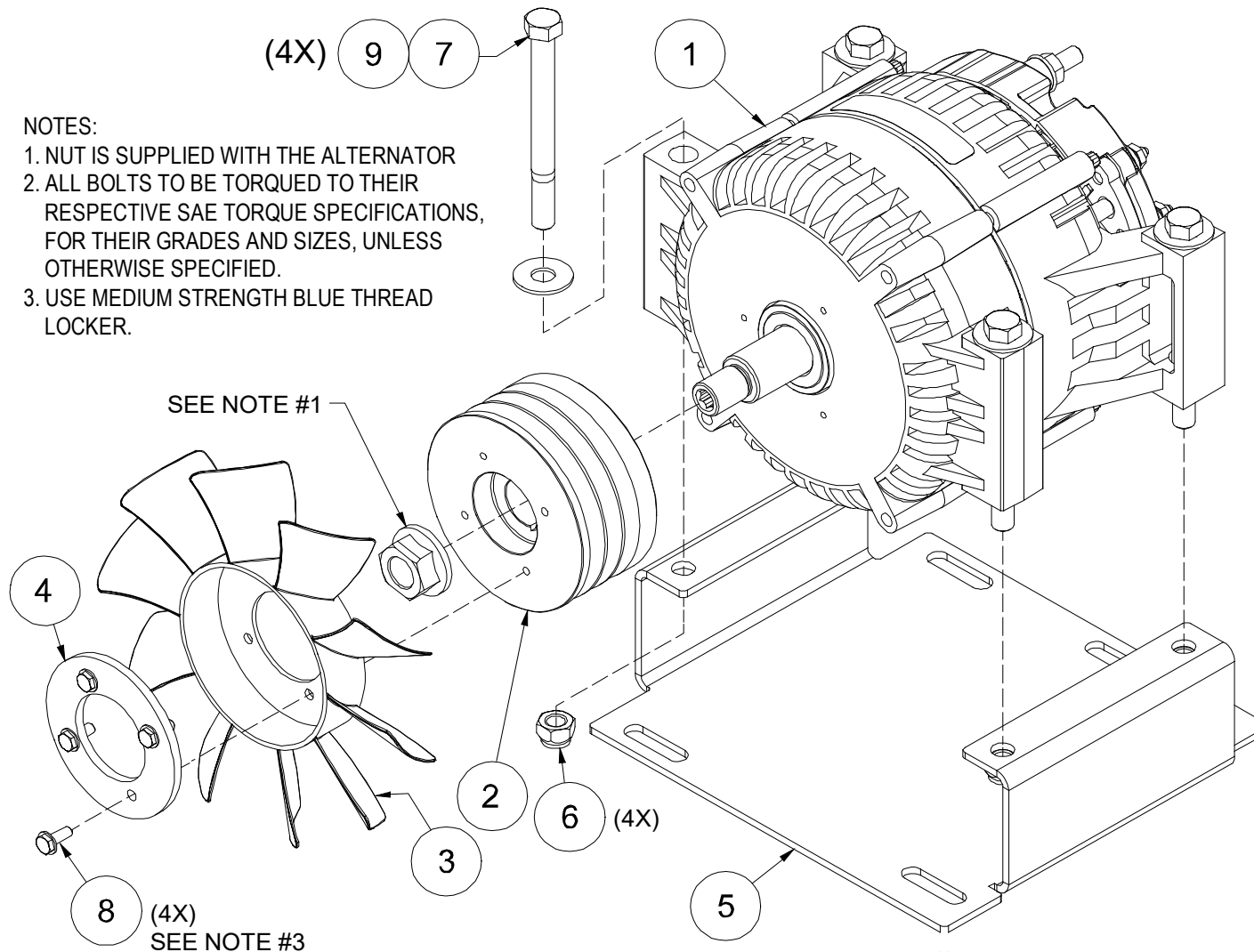


### 7.3 ELECTRICAL ASSEMBLY, FRAME, CAPACITOR AND RELAY - 2 OF 2

| ITEM | DESCRIPTION                         | PART NUMBER | QTY |
|------|-------------------------------------|-------------|-----|
| 1    | SUPER CAPACITOR, 65.52kJ 12/24V     | 277956      | 2   |
| 2    | DECAL,VSC LS MTRON                  | 278446      | 2   |
| 3    | BAR, COPPER BUS                     | 280201      | 4   |
| 4    | RELAY,500 AMP 12V COIL w/STUDS N.O. | 280203      | 5   |
| 5    | BASE,CAPSTART3000 HYDRAULIC         | 281312      | 1   |
| 6    | HARNESS,CS3KH CONTROLS CONNECTOR B  | 282039      | 1   |
| 7    | KIT,CABLE CAPSTART 3000 HYDRAULIC   | 282577      | 1   |
| 8    | CAPSCREW, HEX GR5 1/4-20 x 0.75     | 829104-075  | 8   |
| 9    | CAPSCREW, HEX GR5 5/16-18 x 0.75    | 829105-075  | 4   |
| 10   | SCREW,MACHINE 10-32 X 1.0           | 831702-100  | 10  |
| 11   | WASHER, FLAT 5/16                   | 838205-071  | 4   |
| 12   | WASHER, LOCK 1/4                    | 838504-062  | 8   |
| 13   | WASHER, LOCK 5/16                   | 838505-078  | 4   |

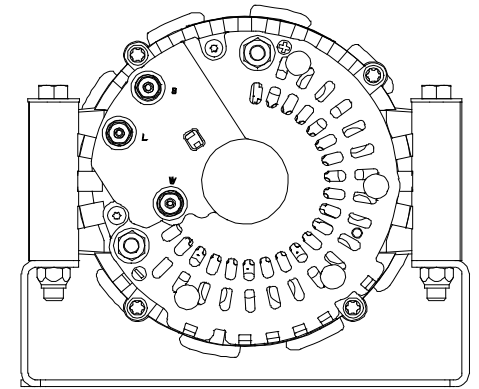
**PLEASE NOTE: WHEN ORDERING PARTS, INDICATE MACHINE SERIAL NUMBER.**

## 7.4 ALTERNATOR ASSEMBLY



### NOTES:

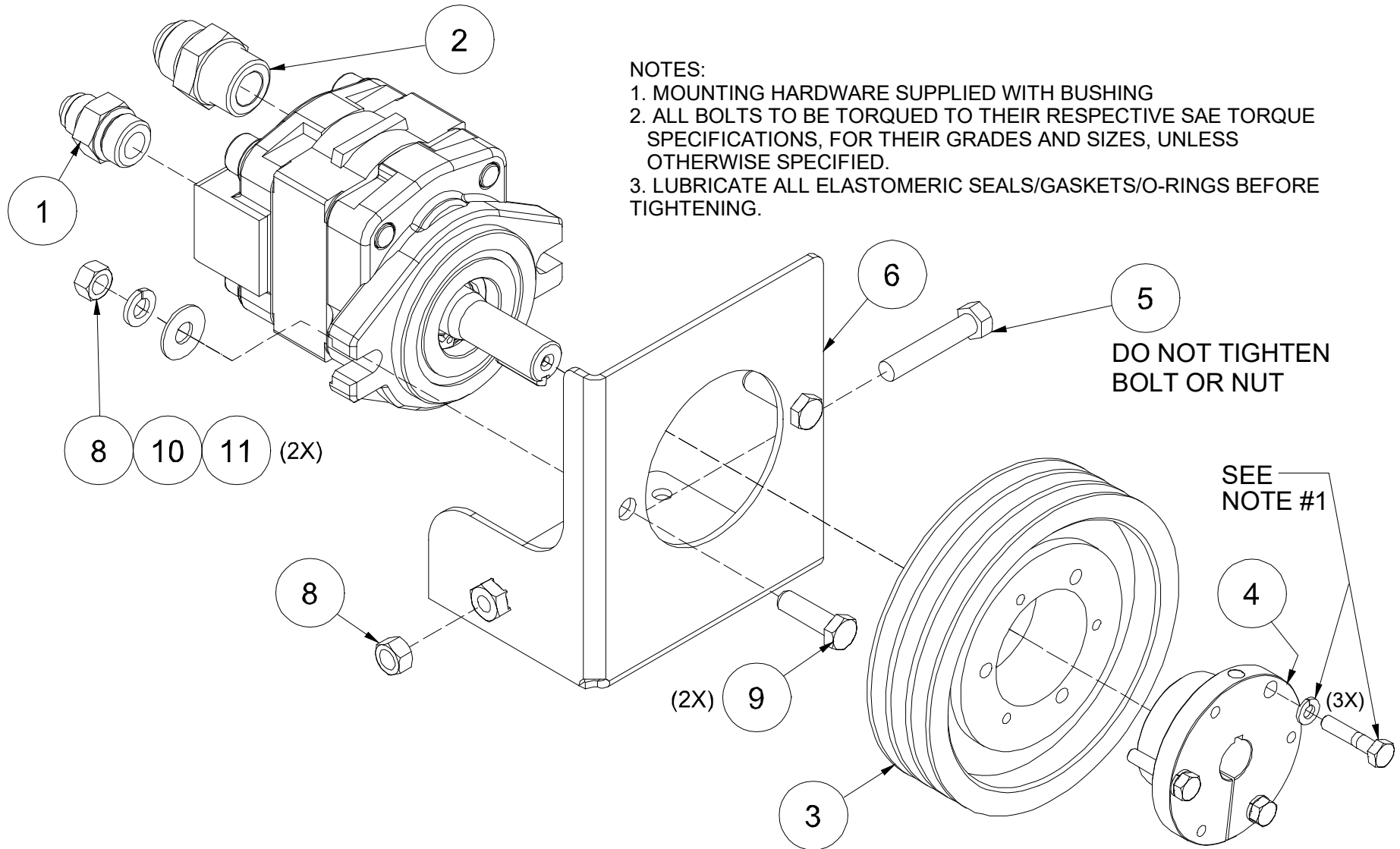
1. NUT IS SUPPLIED WITH THE ALTERNATOR
2. ALL BOLTS TO BE TORQUED TO THEIR RESPECTIVE SAE TORQUE SPECIFICATIONS, FOR THEIR GRADES AND SIZES, UNLESS OTHERWISE SPECIFIED.
3. USE MEDIUM STRENGTH BLUE THREAD LOCKER.



REAR REFERENCE

| <b>7.4 ALTERNATOR ASSEMBLY</b>                                           |                                            |                    |            |
|--------------------------------------------------------------------------|--------------------------------------------|--------------------|------------|
| <b>ITEM</b>                                                              | <b>DESCRIPTION</b>                         | <b>PART NUMBER</b> | <b>QTY</b> |
| 1                                                                        | ALTERNATOR, 240A PAD MOUNT, MULIT-VOLT     | 276942             | 1          |
| 2                                                                        | SHEAVE, 3Vx3, 3.65IN DIA                   | 277163             | 1          |
| 3                                                                        | FAN, 7IN PULL MECH                         | 280908             | 1          |
| 4                                                                        | WASHER, FAN MOUNTING                       | 280975             | 1          |
| 5                                                                        | BRACKET, ALTERNATOR SLIDE CS3KH            | 281320             | 1          |
| 6                                                                        | NUT, HEX LOCKING 3/8-16                    | 825506-198         | 4          |
| 7                                                                        | CAPSCREW, HEX HD GR 8 1-8 UNC-2A x 4.00 LG | 829406-400         | 4          |
| 8                                                                        | SCREW, SER WASH #10-24 x 0.5               | 829702-050         | 4          |
| 9                                                                        | WASHER, FLAT 3/8"                          | 838206-071         | 4          |
| <b>PLEASE NOTE: WHEN ORDERING PARTS, INDICATE MACHINE SERIAL NUMBER.</b> |                                            |                    |            |

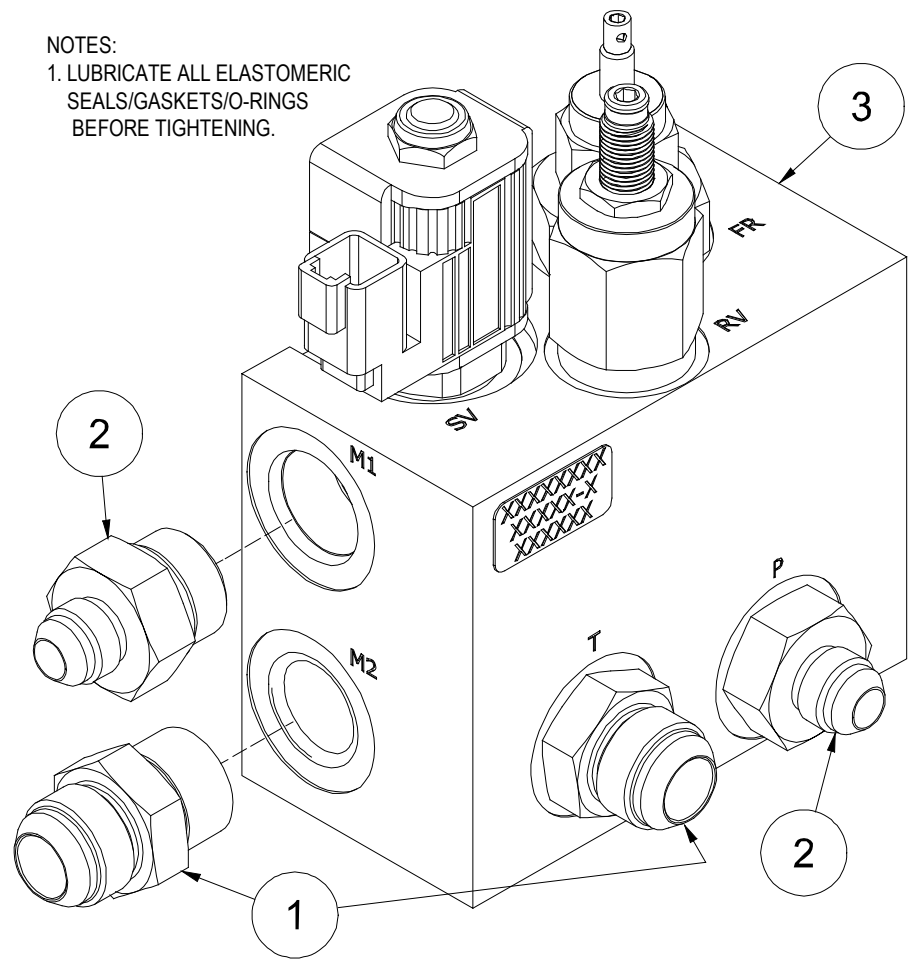
## 7.5 MOTOR ASSEMBLY



| <b>7.5 MOTOR ASSEMBLY</b>                                                |                                                        |                    |            |
|--------------------------------------------------------------------------|--------------------------------------------------------|--------------------|------------|
| <b>ITEM</b>                                                              | <b>DESCRIPTION</b>                                     | <b>PART NUMBER</b> | <b>QTY</b> |
| 1                                                                        | CONNECTOR, #10 MSAE x #8 MJIC                          | 260387-108         | 1          |
| 2                                                                        | CONNECTOR,O-RING 3/4 x 3/4 JIC                         | 260387-112         | 1          |
| 3                                                                        | SHEAVE, GATES #QD 3/3V 6.00                            | 262812             | 1          |
| 4                                                                        | BUSHING, SPLIT TAPER SDS 3/4                           | 267308             | 1          |
| 5                                                                        | BOLT, TAP 3/8-16 x 2                                   | 270075             | 1          |
| 6                                                                        | BRACKET, HYDRAULIC MOTOR                               | 281319             | 1          |
| 7                                                                        | MOTOR, HYDRAULIC 15CC 3/4" X 2" SHAFT REAR PORT PERMCO | 284045             | 1          |
| 8                                                                        | NUT, HEX 3/8-16                                        | 825206-337         | 3          |
| 9                                                                        | CAPSCREW, HEX GR5 3/8-16 x 1.25                        | 829106-125         | 2          |
| 10                                                                       | WASHER, FLAT 5/16" x 0.875"                            | 838206-071         | 2          |
| 11                                                                       | WASHER, LOCK 3/8                                       | 838506-094         | 2          |
| <b>PLEASE NOTE: WHEN ORDERING PARTS, INDICATE MACHINE SERIAL NUMBER.</b> |                                                        |                    |            |

7.6 MANIFOLD ASSEMBLY

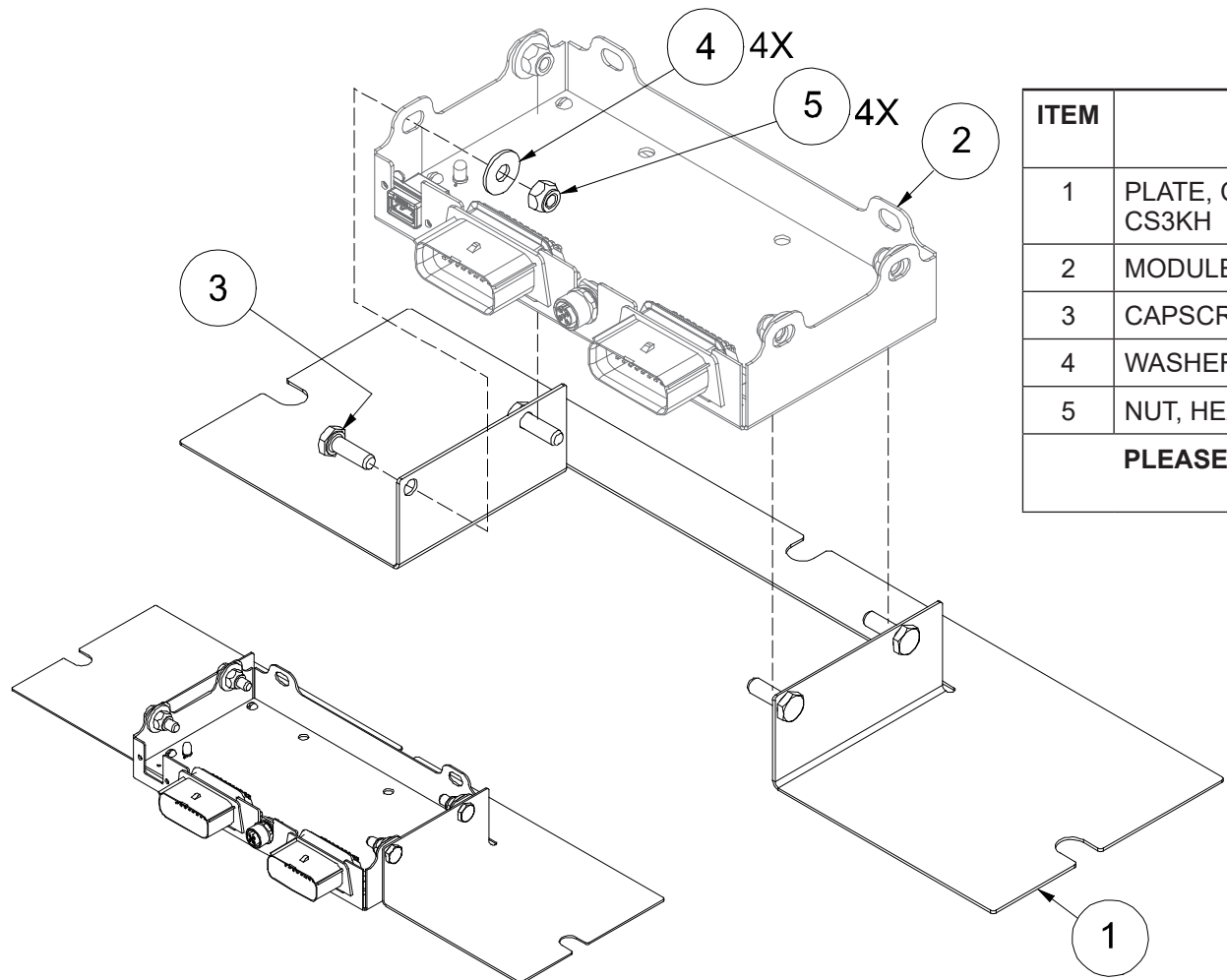
NOTES:  
1. LUBRICATE ALL ELASTOMERIC  
SEALS/GASKETS/O-RINGS  
BEFORE TIGHTENING.



| ITEM | DESCRIPTION                         | PART NUMBER | QTY |
|------|-------------------------------------|-------------|-----|
| 1    | CONNECTOR, O-RING 3/4 x 3/4 JIC     | 260387-112  | 2   |
| 2    | CONNECTOR, #12 MSAE x #8 MJIC       | 260387-132  | 2   |
| 3    | MANIFOLD, HYDRAULIC 0-25GPM 3000PSI | 281334      | 1   |

**PLEASE NOTE: WHEN ORDERING PARTS, INDICATE  
MACHINE SERIAL NUMBER.**

7.7 CONTROL MODULE ASSEMBLY



| ITEM                                                              | DESCRIPTION                     | PART NUMBER | QTY |
|-------------------------------------------------------------------|---------------------------------|-------------|-----|
| 1                                                                 | PLATE, CONTROLLER MOUNT CS3KH   | 282179      | 1   |
| 2                                                                 | MODULE, MACHINE CONTROL         | 281025      | 1   |
| 3                                                                 | CAPSCREW, HEX GR5 1/4-20 x 0.75 | 829104-075  | 4   |
| 4                                                                 | WASHER, FLAT 1/4                | 838204-071  | 4   |
| 5                                                                 | NUT, HEX LOCKING 1/4-20         | 825504-145  | 4   |
| PLEASE NOTE: WHEN ORDERING PARTS, INDICATE MACHINE SERIAL NUMBER. |                                 |             |     |

- NOTES:
1. ALL BOLTS TO BE TORQUED TO THEIR RESPECTIVE SAE TORQUE SPECIFICATION, FOR THEIR GRADES AND SIZES, UNLESS OTHERWISE SPECIFIED.

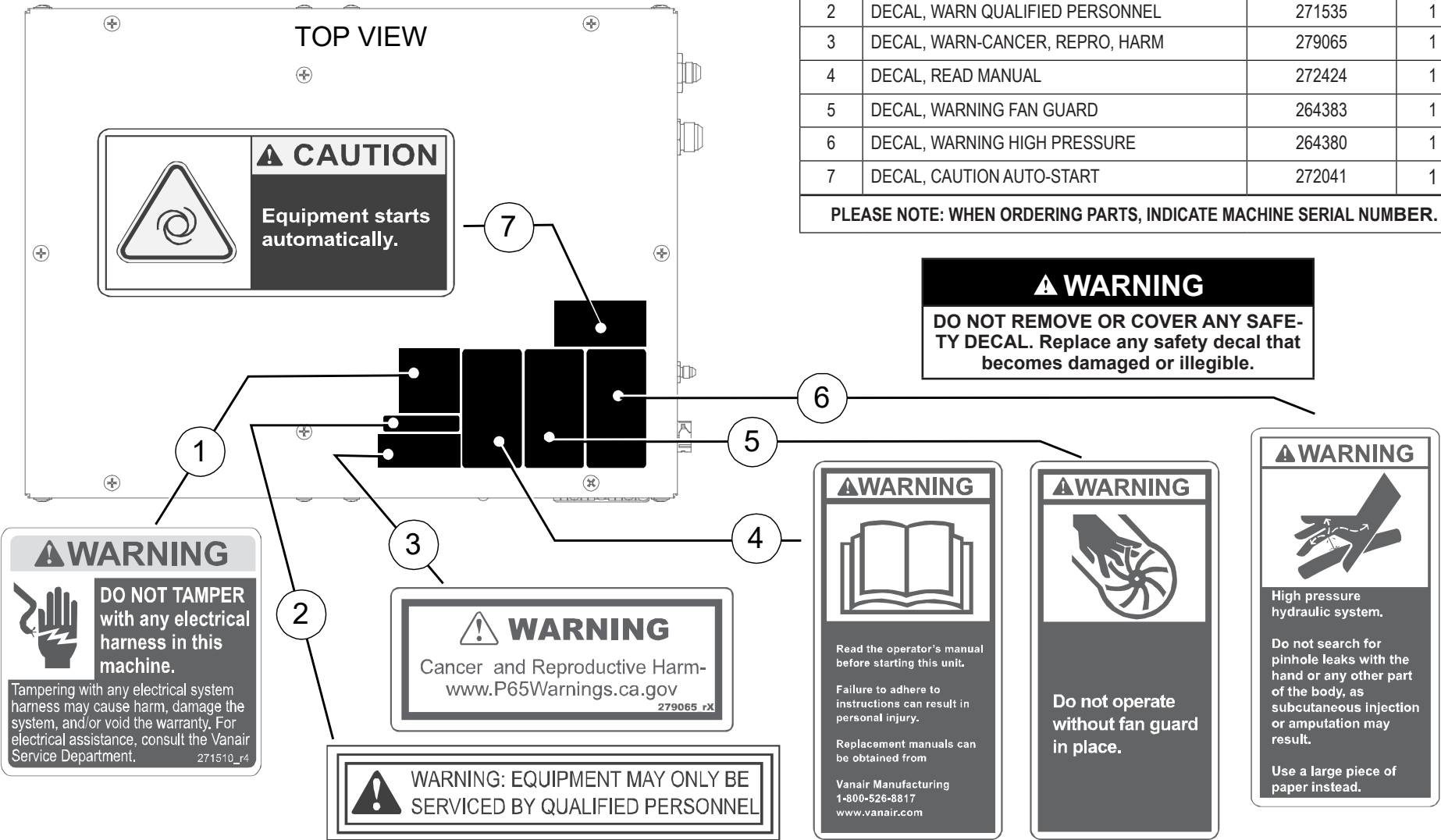


| <b>7.8 CANOPY AND PARTS</b>                                              |                              |                    |            |
|--------------------------------------------------------------------------|------------------------------|--------------------|------------|
| <b>ITEM</b>                                                              | <b>DESCRIPTION</b>           | <b>PART NUMBER</b> | <b>QTY</b> |
| 1                                                                        | PLUG, 5/8" PLASTIC LOCKING   | 680-510            | 1          |
| 2                                                                        | PLUG, 0.875 BLACK PLASTIC    | 680-892            | 1          |
| 3                                                                        | WASHER, NYLON FLAT 1/4       | 262704             | 26         |
| 4                                                                        | SCREW, TRUSS 1/4-20 X 3/4 SS | 262953             | 26         |
| 5                                                                        | PANEL, BACK CS3KH            | 281313             | 1          |
| 6                                                                        | PANEL, LEFT CS3KH            | 281315             | 1          |
| 7                                                                        | PANEL, RIGHT CS3KH           | 281316             | 1          |
| 8                                                                        | LID, CAPSTART3000 HYDRAULIC  | 281317             | 1          |
| 9                                                                        | PANEL, FRONT CS3KH           | 6030207ID-A        | 1          |
| <b>PLEASE NOTE: WHEN ORDERING PARTS, INDICATE MACHINE SERIAL NUMBER.</b> |                              |                    |            |

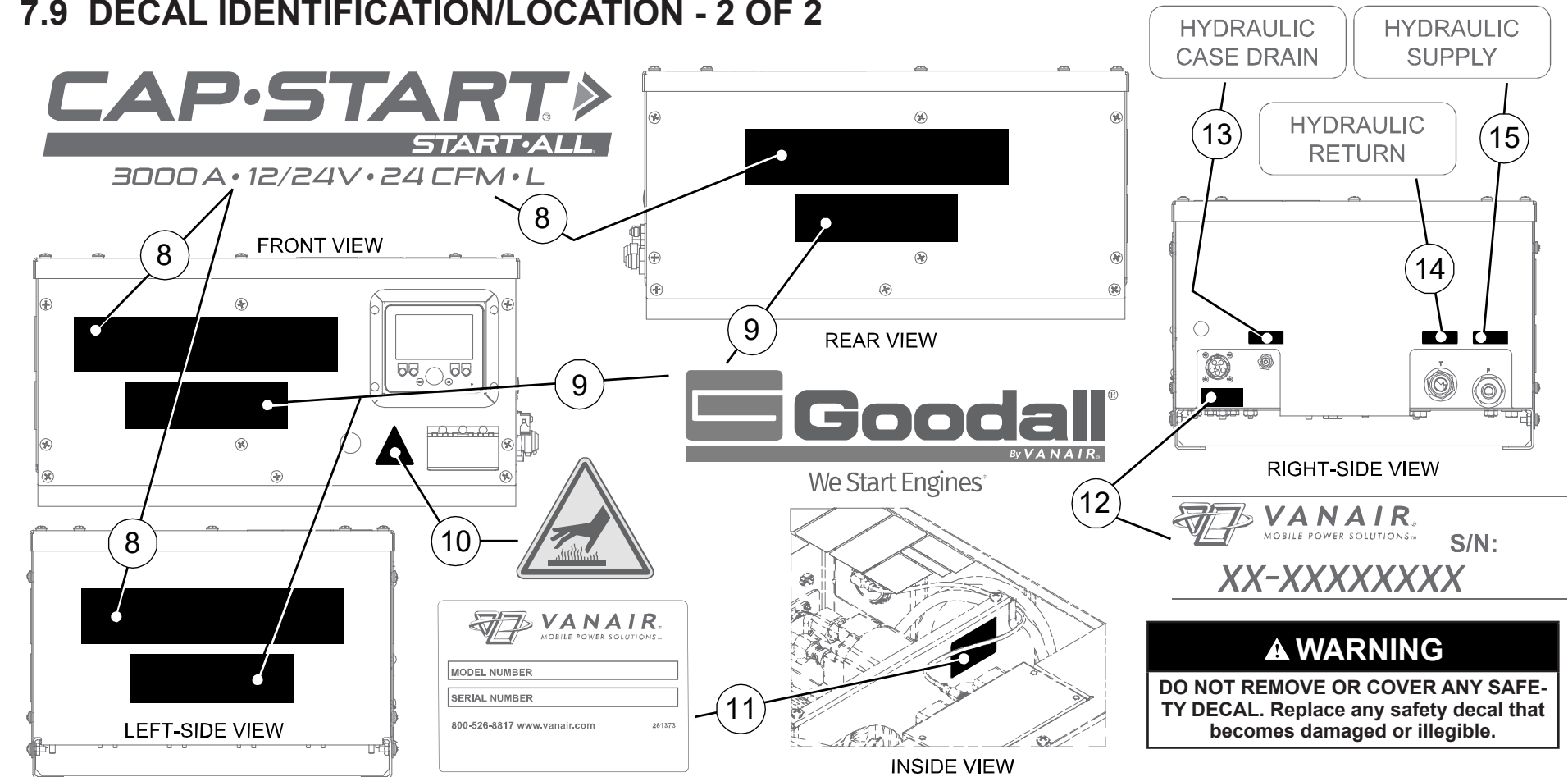
7.9 DECAL IDENTIFICATION/LOCATION - 1 OF 2

| ITEM | DESCRIPTION                     | PART NUMBER | QTY |
|------|---------------------------------|-------------|-----|
| 1    | DECAL, WARN ING ELECTRIC TAMPER | 271510      | 1   |
| 2    | DECAL, WARN QUALIFIED PERSONNEL | 271535      | 1   |
| 3    | DECAL, WARN-CANCER, REPRO, HARM | 279065      | 1   |
| 4    | DECAL, READ MANUAL              | 272424      | 1   |
| 5    | DECAL, WARNING FAN GUARD        | 264383      | 1   |
| 6    | DECAL, WARNING HIGH PRESSURE    | 264380      | 1   |
| 7    | DECAL, CAUTION AUTO-START       | 272041      | 1   |

PLEASE NOTE: WHEN ORDERING PARTS, INDICATE MACHINE SERIAL NUMBER.



7.9 DECAL IDENTIFICATION/LOCATION - 2 OF 2



| ITEM | DESCRIPTION                                    | PART NUMBER | QTY | ITEM | DESCRIPTION                   | PART NUMBER | QTY |
|------|------------------------------------------------|-------------|-----|------|-------------------------------|-------------|-----|
| 8    | LOGO, CAPSTART BY STARTALL 300 0 AMPS 12/24V   | 282481      | 3   | 12   | DECAL, VANAIR SERIAL TAG      | 281373-002  | 1   |
| 9    | LOGO, GOODALL WE START ENGINES                 | 277884      | 3   | 13   | DECAL, CASE DRAIN 5/8 X 1-3/4 | 276941      | 1   |
| 10   | DECAL, WARN ELCTRICAL SHOCK 2.0" TRIANGLE      | 281236      | 1   | 14   | DECAL, LABEL HYDRAULIC RETURN | 275972      | 1   |
| 11   | DECAL, VANAIR SERIAL TAG (MODEL/SERIAL # ONLY) | 281373-001  | 1   | 15   | DECAL, LABEL HYDRAULIC SUPPLY | 275971      | 1   |

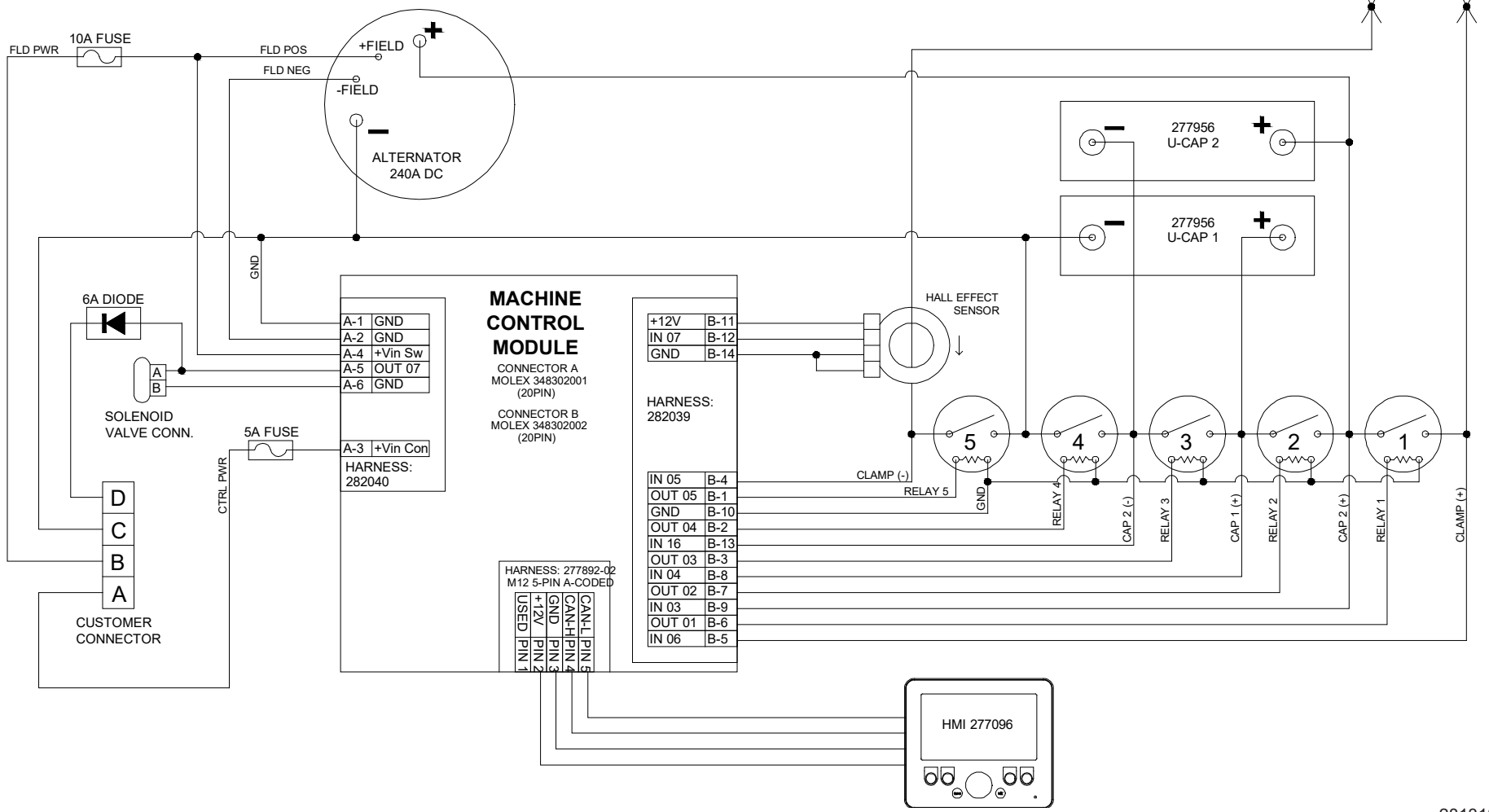
PLEASE NOTE: WHEN ORDERING PARTS, INDICATE MACHINE SERIAL NUMBER.

7.10 WIRING DIAGRAM

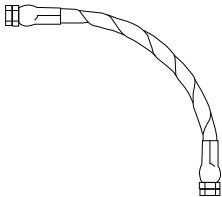
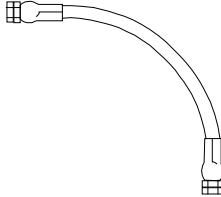
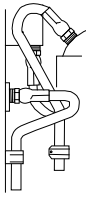
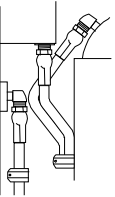
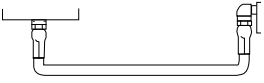
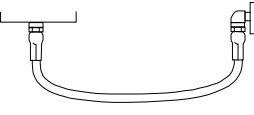
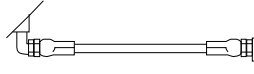
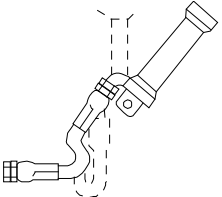
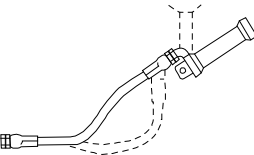
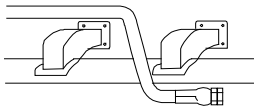
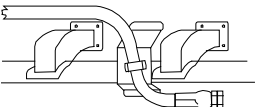
| NAME    | DESCRIPTION                                                                                            |
|---------|--------------------------------------------------------------------------------------------------------|
| RELAY 1 | CONNECTS: ALTERNATOR POS (+) & CAP 2 POS (+), TO: JUMPER CABLE POS (+)                                 |
| RELAY 2 | CONNECTS: CAP 1 POS (+) & CAP 2 POS (+) IN PARALLEL. FOR CAP CHARGE & 12V START MODE                   |
| RELAY 3 | CONNECTS CAPACITORS IN SERIES FOR 24V MODE                                                             |
| RELAY 4 | CONNECTS CAPACITORS IN PARALLEL FOR CAP CHARGE & 12V START MODE                                        |
| RELAY 5 | GROUND SAFETY; CONNECTS CAP / ALT NEG. (-) TO NEG.(-) JUMPER CABLES FOR VEHICLE CHARGE / VEHICLE START |

| NAME             | DESCRIPTION                                                           |
|------------------|-----------------------------------------------------------------------|
| CUSTOMER CONN. A | +12VDC INPUT FROM A SWITCHED POWER SOURCE ON THE HOST VEHICLE         |
| CUSTOMER CONN. B | +12VDC INPUT FROM FROM THE HOST VEHICLE BATTERY                       |
| CUSTOMER CONN. C | -12VDC INPUT FROM THE HOST VEHICLE GROUND OR BATTERY NEGATIVE         |
| CUSTOMER CONN. D | +12VDC OUTPUT SIGNAL FOR REMOTE INDICATOR OF HYDRAULIC MOTOR BEING ON |

HIGH AMPERAGE  
JUMPER CABLES

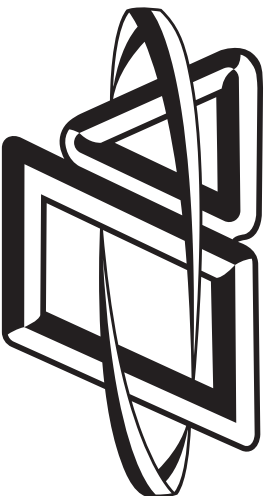


## 7.11 HOSE INSTALLATION GUIDE

| HOSE LAYOUT<br>CONSIDERATION                                                                                                                                                               | WRONG                                                                              | RIGHT                                                                               | HOSE LAYOUT<br>CONSIDERATION                                                                                                                                              | WRONG                                                                               | RIGHT                                                                               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 1. Hose is weakened when installed in twisted position. Pressure in twisted hose tends to loosen fitting connections. Design so that machine motion produces bending rather than twisting. |   |   | 4. Use elbows or other adapters as necessary to eliminate excess hose length and to insure neater installation for easier maintenance.                                    |  |  |
| 2. Ample bend radius should be provided to avoid collapsing of line and restriction of flow.                                                                                               |   |   | 5. When hose assembly is installed in a flexing application, remember that metal hose fittings are not part of the flexible portion. Allow ample free length for flexing. |  |  |
| 3. Exceeding minimum bend radius will greatly reduce hose assembly life.                                                                                                                   |  |  | 6. When properly routing, use clamps to secure the hose in its proper position.                                                                                           |  |  |



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