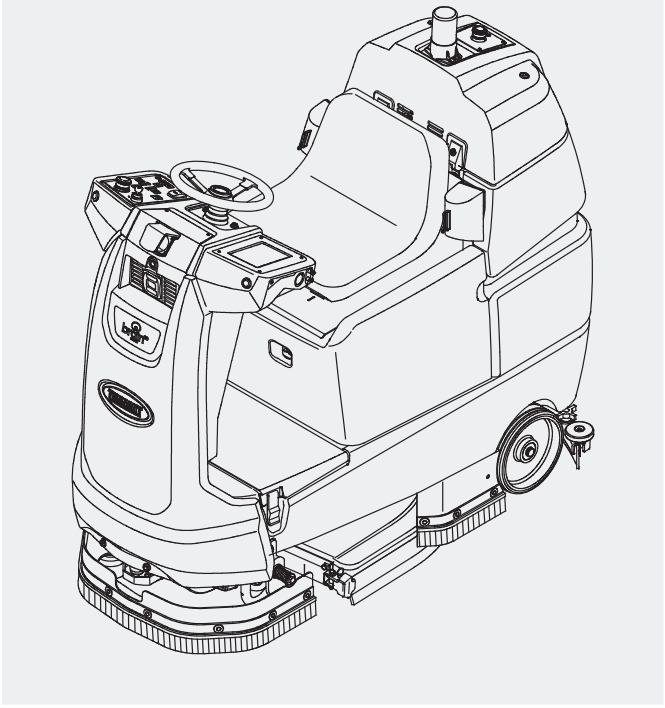
T7AMR

Rider-Scrubber

English EN
Service Manual



Hygenic® Fully Cleanable Recovery Tank
Tennant*True®* *Parts*

ec H2O® NanoClean

ATTENTION: DO NOT tip the machine onto its side to replace parts or perform any maintenance procedures. Sensitive robotic components could be damaged or bumped out of adjustment if the machine is tipped onto its side.

ATTENTION: DO NOT remove and/or adjust the upper or lower LIDARs, any of the 3D cameras, or remove/move shrouds or brackets on which these components are mounted. Due to calibration the LIDARS and 3D cameras cannot be adjusted in the field.

For the latest Parts Manuals and other language Operator Manuals, visit:

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INTRODUCTION

This manual is available for each new model. It provides necessary operation and maintenance instructions.

Read this manual completely and understand the machine before operating or servicing it.

This machine will provide excellent service. However, the best results will be obtained at minimum costs if:

- The machine is operated with reasonable care.
- The machine is maintained regularly - per the machine maintenance instructions provided.
- The machine is maintained with manufacturer supplied or equivalent parts.

To view, print or download manuals online visit www.tennantco.com/manuals

PROTECT THE ENVIRONMENT

Please dispose of packaging materials and used machine components such as batteries in an environmentally safe way according to your local waste disposal regulations.

Always remember to recycle.

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www.tennantco.com

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Specifications and parts are subject to change without notice.

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INTENDED USE

The T7AMR is an industrial/commercial autononmous rider machine designed to wet scrub both rough and smooth hard surfaces (concrete, tile, stone, synthetic, etc). This machine can be operated in either autonomous mode (without driver) or manual mode (with driver). Typical applications include schools, office buildings, and retail centers. Do not use this machine on soil, grass, artificial turf, or carpeted surfaces. This machine is intended for indoor use only. This machine is not intended for use on public roadways. Do not use this machine other than described in this Operator Manual.

MACHINE DATA

Please fill out at time of installation for future reference.

Model No. - _____

Serial No. - _____

Installation Date - _____

SERIAL NUMBER LABEL LOCATION

CONTENTS

CONTENTS

IMPORTANT SAFETY INSTRUCTIONS - SAVE THESE INSTRUCTIONS

The following precautions are used throughout this manual as indicated in their descriptions:

WARNING: To warn of hazards or unsafe practices that could result in severe personal injury or death.

FOR SAFETY: To identify actions that must be followed for safe operation of equipment.

The following information signals potentially dangerous conditions to the operator. Know when these conditions can exist. Locate all safety devices on the machine. Report machine damage or faulty operation immediately.

WARNING: Batteries emit hydrogen gas. Explosion or fire can result. Keep sparks and open flame away. Keep covers open when charging.

WARNING: Flammable materials can cause an explosion or fire. Do not use flammable materials in tank(s).

WARNING: Flammable materials or reactive metals can cause an explosion or fire. Do not pick up.

This machine is equipped with technology that automatically communicates over the cellular network. This machine is equipped with BrainOS software that is accessible via the BrainOS User Interface (UI) Touch Screen.

WARNING: This machine contains chemicals known to the state of California to cause cancer, birth defects, or other reproductive harm.

FOR SAFETY:

1. Do not operate machine:
   - Unless trained and authorized.
   - Unless operator manual is read and understood.
   - Under the influence of alcohol or drugs.
   - In Manual Mode: While using a cell phone or other types of electronic devices.
   - Unless mentally and physically capable of following machine instructions.
   - With brake disabled.
   - Without filters in place or with clogged filters.
   - If it is not in proper operating condition.
   - In areas where flammable vapors/liquids or combustible dusts are present.
   - In outdoor areas. This machine is for indoor use only.
   - In areas that are too dark to safely see the controls or operate the machine.
   - In areas with possible falling objects.
   - With pads or accessories not supplied or approved by Tennant. The use of other pads may impair safety.
2. Before Starting Machine:
   - Check machine for fluid leaks.
   - Make sure all safety devices are in place and operate properly.
   - Check brakes and steering for proper operation.
   - In Manual Mode: Adjust seat and fasten seat belt (if equipped).
3. When using machine in manual mode:
   - Use only as described in this manual.
   - Use brakes to stop machine.
   - Reduce speed when turning.
   - Go slowly on inclines and slippery surfaces.
   - Do not scrub on ramp inclines that exceed 7% grade or transport (GVWR) on ramp inclines that exceed 10.5% grade.
   - Drive slowly through doorways and narrow openings.
   - Be cautious of the squeegee near bystanders and obstacles.
   - Keep all parts of body inside operator station while machine is moving.
   - Always be aware of surroundings while operating machine.
   - Use care when reversing machine.
   - Keep children and unauthorized persons away from machine.
   - Do not allow machine to be used as a toy.
   - Do not carry passengers on any part of the machine.
   - Always follow safety and traffic rules.
   - Report machine damage or faulty operation immediately.
   - Follow mixing, handling and disposal instructions on chemical containers.
   - Place proper floor cleaning signage in areas where the machine is operating and people are present, in accordance with standard floor cleaning practices.
   - Follow site safety guidelines concerning wet floors.

4. While machine is operating in robotic mode:
   - Use only as described in this manual.
   - Remove key from ON/OFF key switch to prevent unauthorized use without disrupting robotic route.
   - Do not attempt to ride machine.
   - Do not grab steering wheel or put hands or arms through the holes of the steering wheel. Steering wheel may move rapidly and unexpectedly while in robotic mode.
   - Do not operate machine in environments requiring fail−safe performance (areas where machine failure could lead to personal injury or property damage).
   - Guard sudden drops, stairs, escalators, or moving platforms in area of machine operation with a physical barrier.
   - Do not use ladders, scaffolds, or other temporary constructed structures in area of machine operation.
   - Only scrub flat, hard surfaces of 0% incline.
   - Do not leave electrical cords or low profile items (anything having a height of less than 10 cm from ground) in area of machine operation.
   - Always operate machine in manual mode when going into elevators or through automatic doors. Robotic routes should never include going into elevators or through automatic doors.
   - Keep children and unauthorized persons away from machine.
   - Do not allow machine to be used as a toy.
   - Do not carry passengers on any part of the machine.
   - Always follow safety and traffic rules.
   - Report machine damage or faulty operation immediately.
   - Follow mixing, handling and disposal instructions on chemical containers.
   - Place proper floor cleaning signage in areas where the machine is operating and people are present, in accordance with standard floor cleaning practices.
   - Follow site safety guidelines concerning wet floors.

5. Before leaving or servicing machine:
   - Stop on level surface.
   - Turn off machine and remove key.

6. When servicing machine:
   - All work must be done with sufficient lighting and visibility.
   - Keep work area well ventilated.
   - Avoid moving parts. Do not wear loose clothing, jewelry and secure long hair.
   - Block machine tires before jacking machine up.
   - Jack machine up at designated locations only. Support machine with jack stands.
   - Use hoist or jack that will support the weight of the machine.
   - Do not push or tow the machine without an operator in the seat controlling the machine.
   - Do not push or tow the machine on inclines with the brake disabled.
   - Do not power spray or hose off machine. Electrical malfunction may occur. Use damp cloth.
   - Do not disconnect the off−board charger's DC cord from the machine's receptacle when the charger is operating. Arcing may result. If the charger must be interrupted during charging cycle, disconnect the AC power supply cord first.
   - Disconnect battery connections before working on machine.
   - Do not pull on battery charger cord to unplug. Grasp plug at outlet and pull.
   - Do not use incompatible battery chargers as this may damage battery packs and potentially cause a fire.
   - Do not charge frozen batteries.
   - Inspect charger cord regularly for damage.
   - Avoid contact with battery acid.
   - Keep all metal objects off batteries.
   - Use a non-conductive battery removal device.
   - Use a hoist and adequate assistance when lifting batteries.
   - Battery installation must be done by trained personnel.
   - Follow site safety guidelines concerning battery removal.
   - All repairs must be performed by trained personnel.
   - Do not modify the machine from its original design.
   - Use Tennant supplied or approved replacement parts.

When servicing machine (continued)
- Wear personal protective equipment as needed and where recommended in this manual.


For Safety: wear hearing protection.


For Safety: wear protective gloves.


For Safety: wear eye protection.


For Safety: wear protective dust mask.

7. When loading/unloading machine onto/off truck or trailer:
   - Drain tanks before loading machine.
   - Lower scrub head and squeegee before tying down machine.
   - Block machine tires.
   - Use ramp, truck or trailer that will support the weight of the machine and operator.
   - Do not drive on a slippery ramp.
   - Use caution when operating on a ramp.
   - Use winch. Do not push the machine onto/off the truck or trailer unless the load height is 380 mm (15 in) or less from the ground.
   - Do not load/unload on ramp inclines that exceed 15.8% grade.
   - Turn off machine and remove key.
   - Use tie-down straps to secure machine.

The following safety labels are mounted on the machine in the locations indicated. Replace damaged/ missing labels.

WARNING LABEL - Batteries emit hydrogen gas. Explosion or fire can result. Keep sparks and open flame away. Keep covers open when charging.

Located on seat panel.

WARNING LABEL - Flammable materials or reactive metals can cause explosion or fire. Do not pick up.

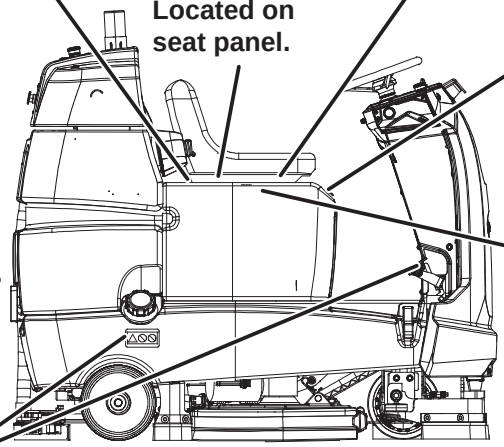
Located on seat panel.

FOR SAFETY LABEL - Read manual before operating machine.

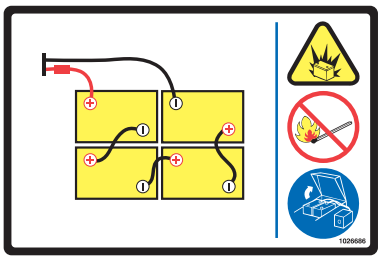
Located on seat panel.

FOR SAFETY LABEL - Electrical components, use grounding strap before opening panel.

Located on electrical panel under the seat.

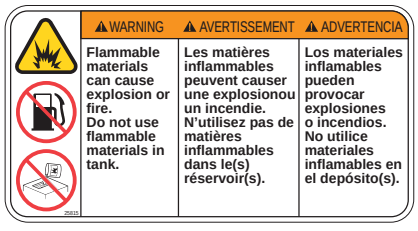


WARNING LABEL - Batteries emit hydrogen gas. Explosion or fire can result. Keep sparks and open flame away. Keep covers open when charging



Located on bottom of seat panel.

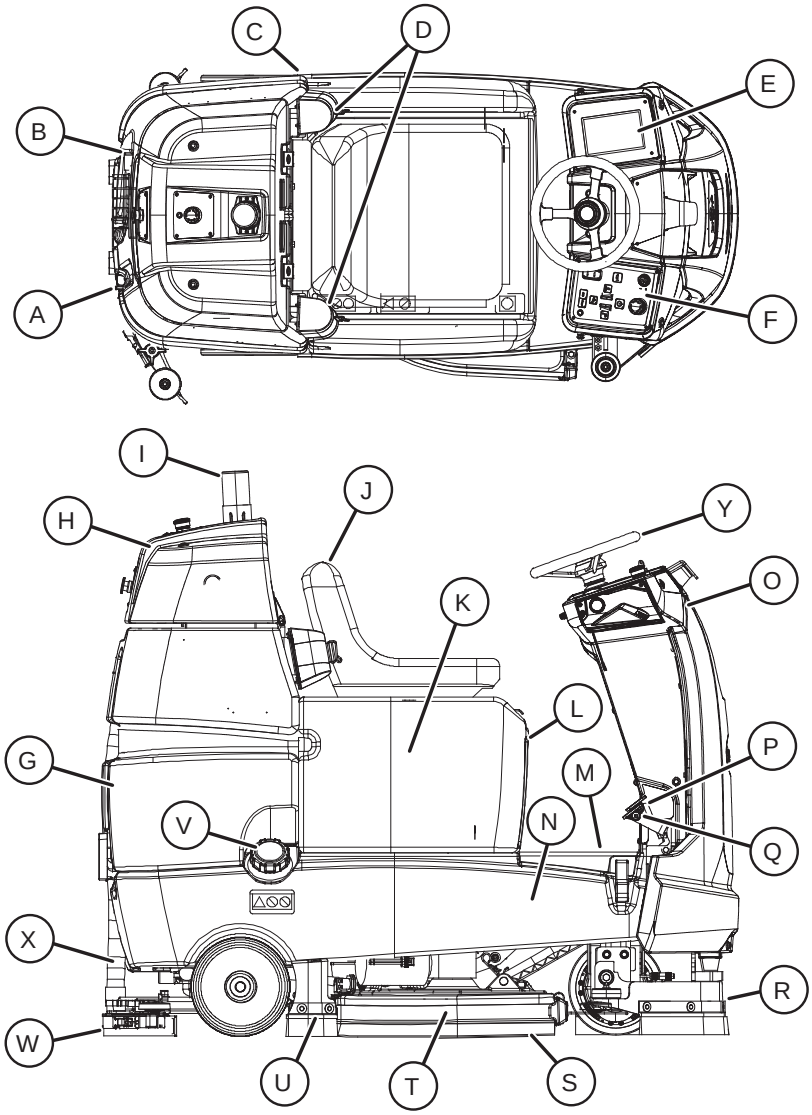
WARNING LABEL - Flammable materials can cause explosion or fire. Do not use flammable materials in tank



Located under the solution fill port and next to foot pedals.

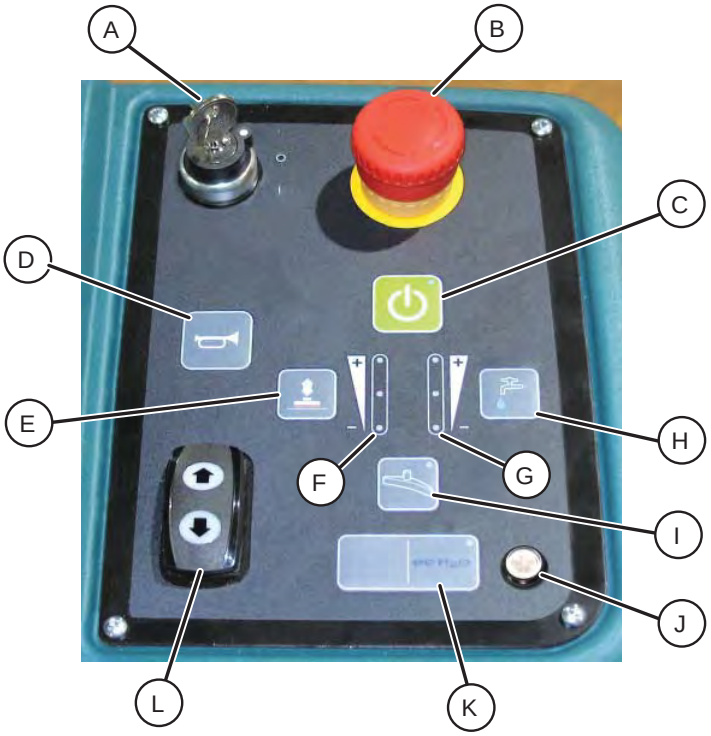
GENERAL INFORMATION

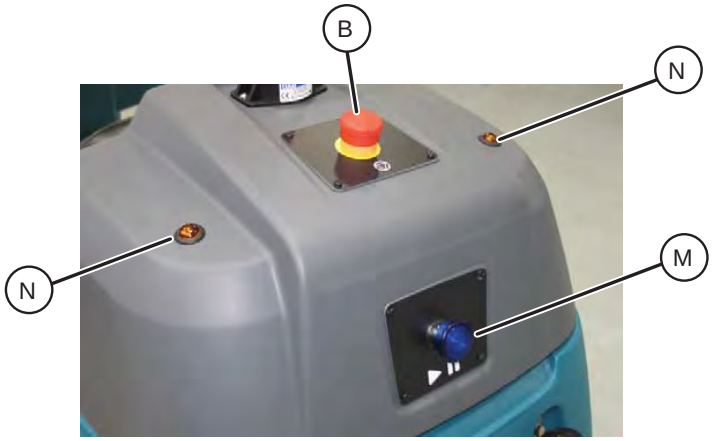
MACHINE COMPONENTS



A. Recovery tank drain hose
B. Solution tank drain hose
C. Left perimeter guard
D. Retractable straps (Anti-Joyride)
E. User Interface (UI) touchscreen
F. Control panel
G. Recovery tank
H. Recovery tank cover
I. Flashing light
J. Operator seat
K. Batteries
L. Battery charging connector
M. Solution tank front cover
N. Solution tank
O. Sensor panel
P. Brake pedal
Q. Propel pedal
R. Front perimeter guard
S. Side squeegee
T. Scrub head
U. Right perimeter guard
V. Solution tank fill cap
W. Rear squeegee
X. Squeegee vacuum hose
Y. Steering wheel

CONTROLS AND INSTRUMENTS



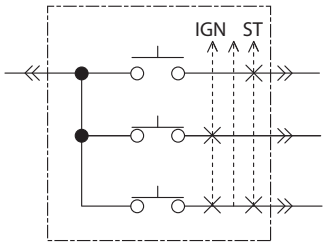


A. ON/OFF key switch
B. Emergency Stop Button (located on control panel and back of machine)
C. 1-Step button
D. Horn button
E. Brush pressure button
F. Brush pressure indicator lights
G. Solution flow indicator lights
H. Solution flow button
I. Vacuum fan/squeegee button
J. ec-H2O system indicator light (option)
K. ec-H2O system on/off button (option)
L. Directional switch
M. Blue start/pause button
N. Signal lights (Rear)

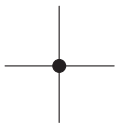
CAMERAS AND SENSORS

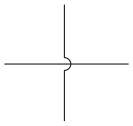
A. Sensors - Upper LIDAR
B. Signal lights (Front)
C. Sensors – Front 2D camera
D. Sensors – Front 3D camera
E. Sensors - Side 2D camera (located on each side of machine)
F. Sensors - Side 3D camera (located on each side of machine)
G. Sensors - Lower LIDAR

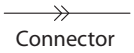
ELECTRICAL SCHEMATIC SYMBOLS



Key Switch


Connected


Not Connected


Connector

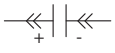

Energized


Adaptor Harness


Notes


Assembly


AC Plug


Capacitor

Battery

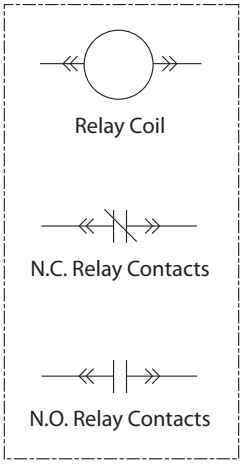

Circuit Breaker

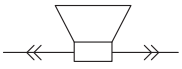

Fuse

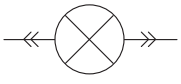

Diode

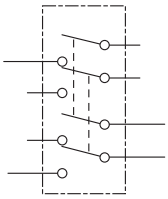

Single Continuation Tab

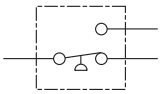

Double Continuation Tab

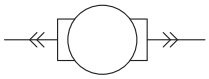


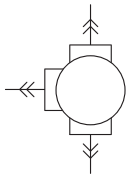

Horn or Alarm

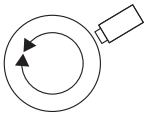

Light


DPDT Switch


Pressure Switch

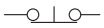

Motor


3 Phase AC
Induction Motor


Motor Encoder

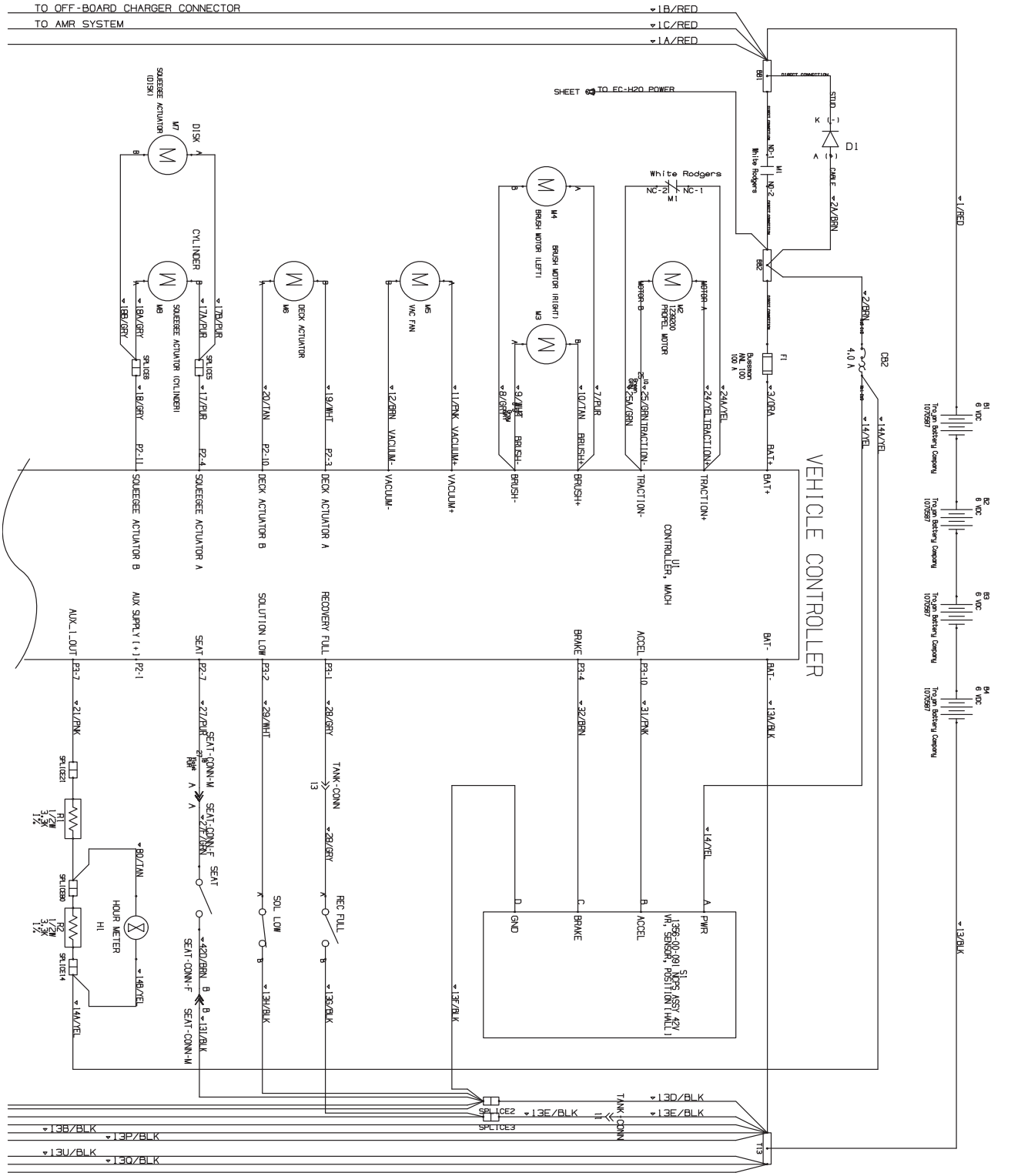

Sensor
(Variable Resistor)


Momenary Switch N.O.

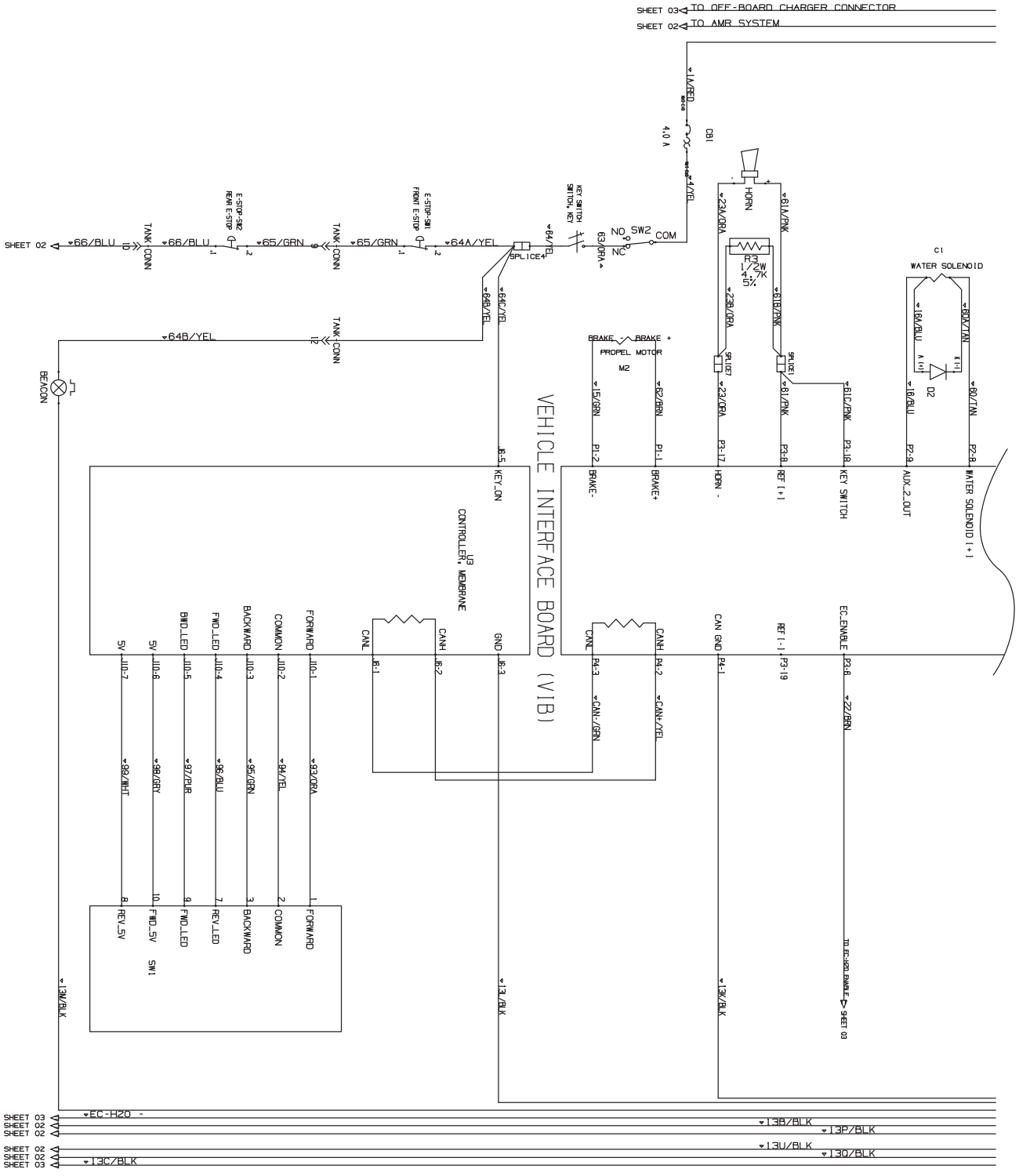

Contact Switch N.C.


Solenoid Valve

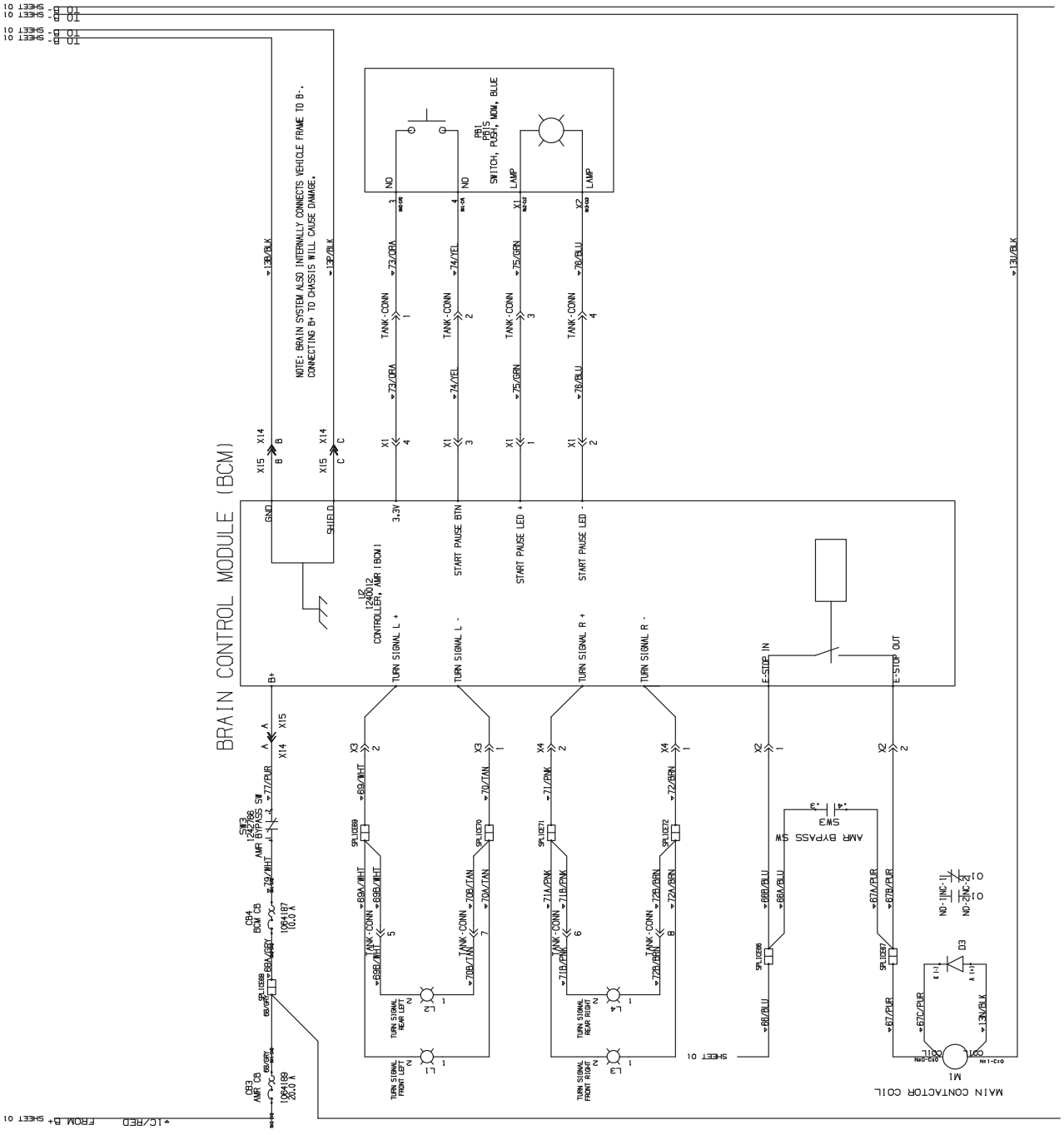
ELECTRICAL SCHEMATIC - PAGE 1



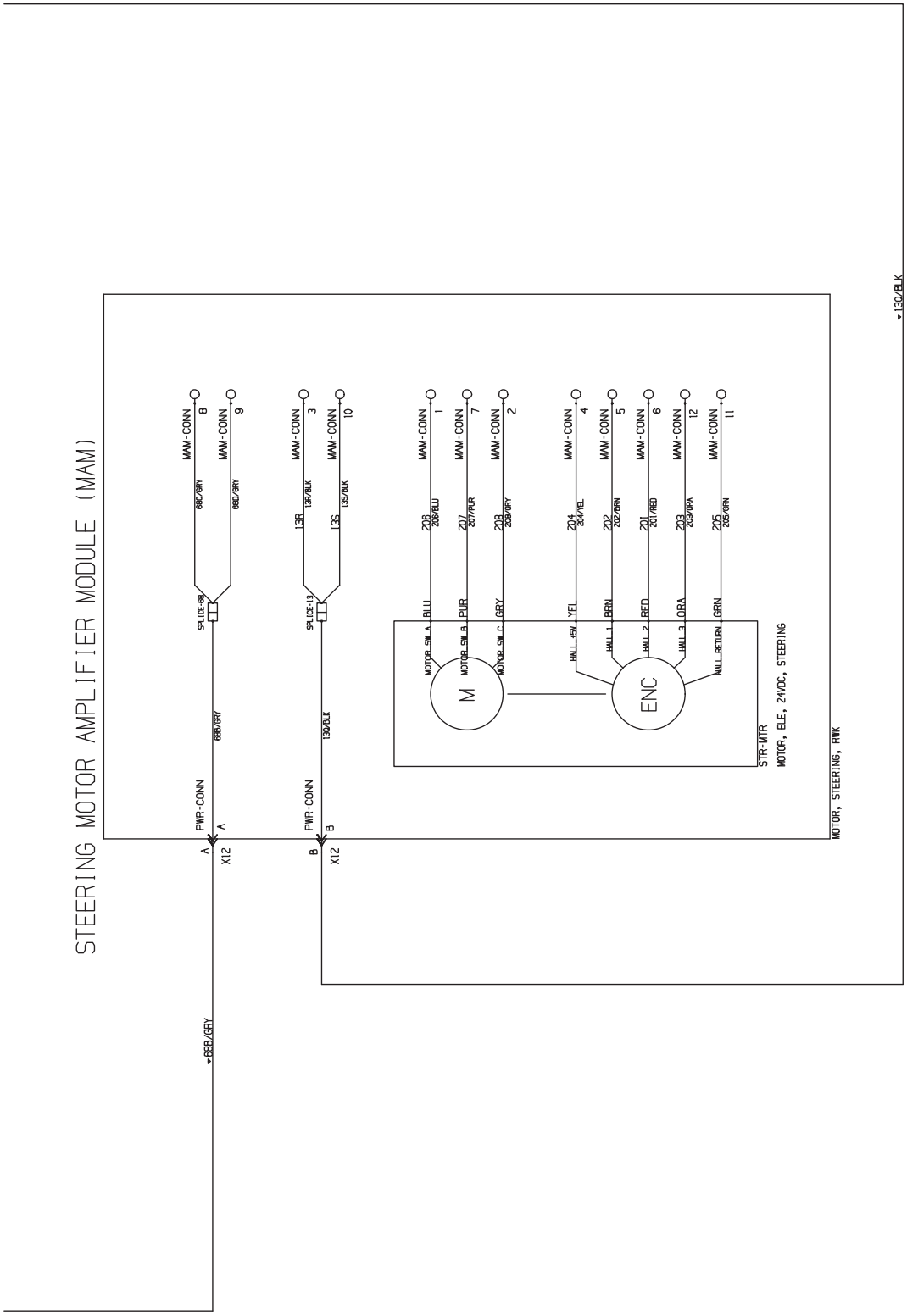
ELECTRICAL SCHEMATIC - PAGE 2



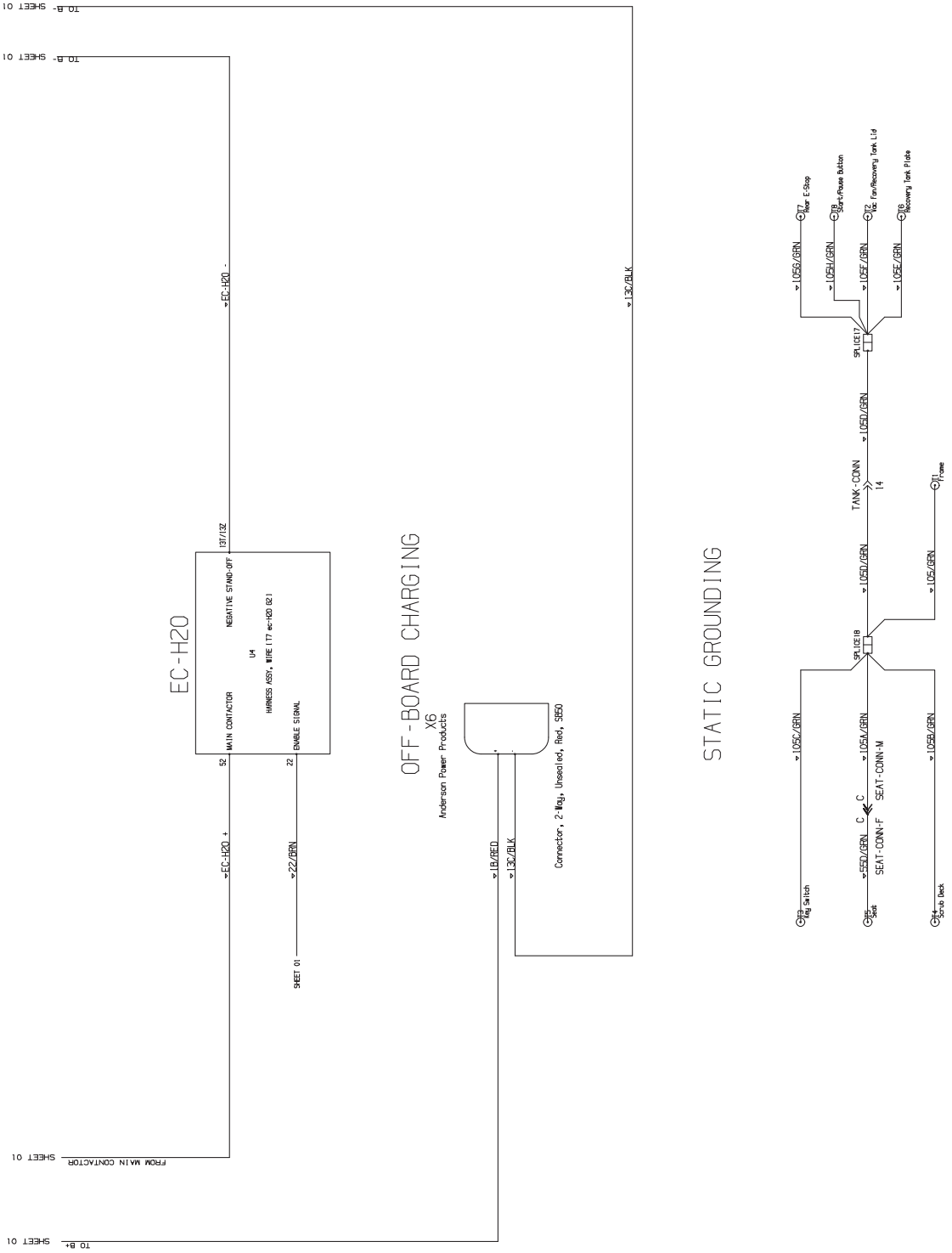
ELECTRICAL SCHEMATIC - PAGE 3



ELECTRICAL SCHEMATIC - PAGE 4



ELECTRICAL SCHEMATIC - PAGE 5



FASTENER TORQUE

SAE (STANDARD)

Thread Size	SAE Grade 1	SAE Grade 2 Carriage Bolts	Thread Cutting Thread Rolling	SAE Grade 5 Socket & Stainless Steel	SAE Grade 8	Headless Socket Set Screws	Square Head Set Screws	
4 (.112)	(5) - (6.5)					(4) - (6)		Inch Pounds
5 (.125)	(6) - (8)					(9) - (11)		
6 (.138)	(7) - (9)		(20) - (24)			(9) - (11)		
8 (.164)	(12) - (16)		(40) - (47)			(17) - (23)		
10 (.190)	(20) - (26)		(50) - (60)			(31) - (41)		
1/4 (.250)	4 - 5	5 - 6	7 - 10	7 - 10	10 - 13	6 - 8	17 - 19	Foot Pounds
5/16 (.312)	7 - 9	9 - 12	15 - 20	15 - 20	20 - 26	13 - 15	32 - 38	
3/8 (.375)	13 - 17	16 - 21		27 - 35	36 - 47	22 - 26	65 - 75	
7/16 (.438)	20 - 26	26 - 34		43 - 56	53 - 76	33 - 39	106 - 124	
1/2 (.500)	27 - 35	39 - 51		65 - 85	89 - 116	48 - 56	162 - 188	
5/8 (.625)		80 - 104		130 - 170	171 - 265		228 - 383	
3/4 (.750)		129 - 168		215 - 280	313 - 407		592 - 688	
1 (1.000)		258 - 335		500 - 650	757 - 984		1281 - 1489	

METRIC

Thread Size	4.8/5.6	8.8 Stainless Steel	10.9	12.9	Set Screws
M3	43 - 56 Ncm	99 - 128 Ncm	139 - 180 Ncm	166 - 215 Ncm	61 - 79 Ncm
M4	99 - 128 Ncm	223 - 290 Ncm	316 - 410 Ncm	381 - 495 Ncm	219 - 285 Ncm
M5	193 - 250 Ncm	443 - 575 Ncm	624 - 810 Ncm	747 - 970 Ncm	427 - 554 Ncm
M6	3.3 - 4.3 Nm	7.6 - 9.9 Nm	10.8 - 14 Nm	12.7 - 16.5 Nm	7.5 - 9.8 Nm
M8	8.1 - 10.5 Nm	18.5 - 24 Nm	26.2 - 34 Nm	31 - 40 Nm	18.3 - 23.7 Nm
M10	16 - 21 Nm	37 - 48 Nm	52 - 67 Nm	63 - 81 Nm	
M12	28 - 36 Nm	64 - 83 Nm	90 - 117 Nm	108 - 140 Nm	
M14	45 - 58 Nm	102 - 132 Nm	142 - 185 Nm	169 - 220 Nm	
M16	68 - 88 Nm	154 - 200 Nm	219 - 285 Nm	262 - 340 Nm	
M20	132 - 171 Nm	300 - 390 Nm	424 - 550 Nm	508 - 660 Nm	
M22	177 - 230 Nm	409 - 530 Nm	574 - 745 Nm	686 - 890 Nm	
M24	227 - 295 Nm	520 - 675 Nm	732 - 950 Nm	879 - 1140 Nm	

GENERAL MACHINE DIMENSIONS/CAPACITIES/PERFORMANCE

GENERAL MACHINE DIMENSIONS / CAPABILITIES

Item	Dimension / Capacity
Length	1645 mm (65 in)
Height (to light)	1450 mm (57 in)
Width/frame	740 mm (29 in)
Width/machine with scrub head	800 mm (31.5 in)
Width/rear squeegee (roller to roller)	850 mm (33.25 in)
Brush diameter	330 mm (13 in)
Scrubbing path width	650 mm (26 in)
Track	724 mm (28.5 in)
Wheel base	971 mm (31.2 in)
Solution tank capacity	110 L (29 gallons)
Recovery tank capacity	110 L (29 gallons)
Demisting chamber	23 L (6 gallons)
Weight/net less batteries	311 Kg (685 lbs)
Weight/with standard battery package	492 Kg (1085 lbs)
GVWR	714 Kg (1575 lbs)
Protection Grade	IPX3

Values determined as per IEC 60335-2-72	Measure
Sound pressure level LpA	75 dB(A)
Sound pressure uncertainty KpA	3 dB(A)
Sound power level LWA + Uncertainty KWA	94.63 dB(A) + 2.98 dB
Vibration - Hand-arm	<2.5 m/s^2
Vibration - Whole body	<0.5 m/s^2

GENERAL MACHINE PERFORMANCE

Item	Measure
Aisle turnaround (right)	1732 mm (68 in)
Aisle turnaround (left)	1818 mm (72 in)
Travel Speed Forward (maximum) - Manual Mode	6.4 Km/h (4 mph)
Travel Speed Forward (maximum) - Robotic Mode	4.0 Km/h (2.5 mph)
Travel Speed Reverse - Manual Mode Only	4.0 Km/h (2.5 mph)
Maximum rated climb and descent angle with full tanks (Robotic Mode)	0%
Maximum rated climb and descent angle when scrubbing (Robotic Mode)	0%
Maximum rated climb and descent angle with full tanks (Manual Mode)	10.5%
Maximum rated climb and descent angle with empty tanks (Manual Mode)	15.8%
Maximum rated climb and descent angle when scrubbing (Manual Mode)	7%
Maximum ambient temperature for machine operation	40° C (104° F)
Minimum temperature for operating machine scrubbing functions	2° C (36° F)

GENERAL MACHINE DIMENSIONS/CAPACITIES/PERFORMANCE

POWER TYPE

Type	Quantity	Volts	Ah Rating	Weight (each)
Batteries (heavy duty lead acid)	4	6	360@20 hr rate	44.5 kg (97.5 lb)

Type	Use	VDC	kW (hp)
Electric Motors	Scrub brush	24	0.45 kW (0.6 hp)
	Vacuum fan	24	0.45 kW (0.6 hp)
	Propelling	24	0.85 kW (1.1 hp)S

Type	VDC	amp	Hz	Phase	VAC
Charger (Smart)	24	41.3	50/60	1	100-240

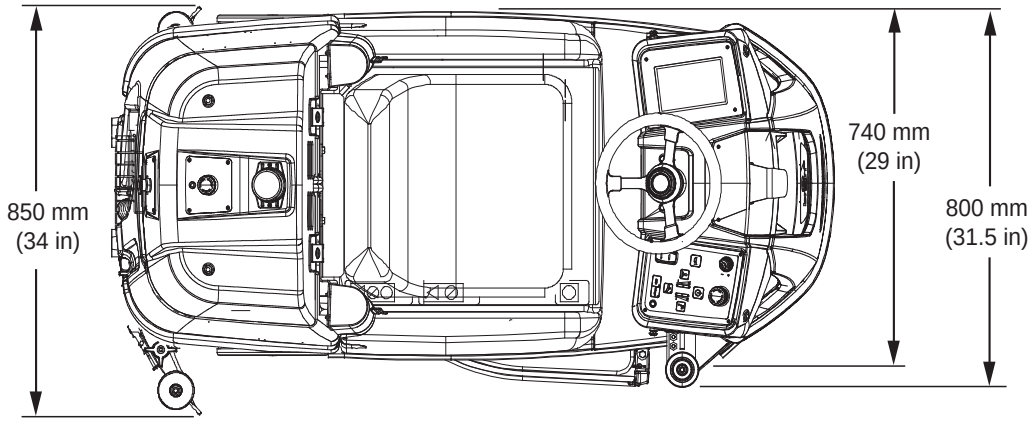
TIRES

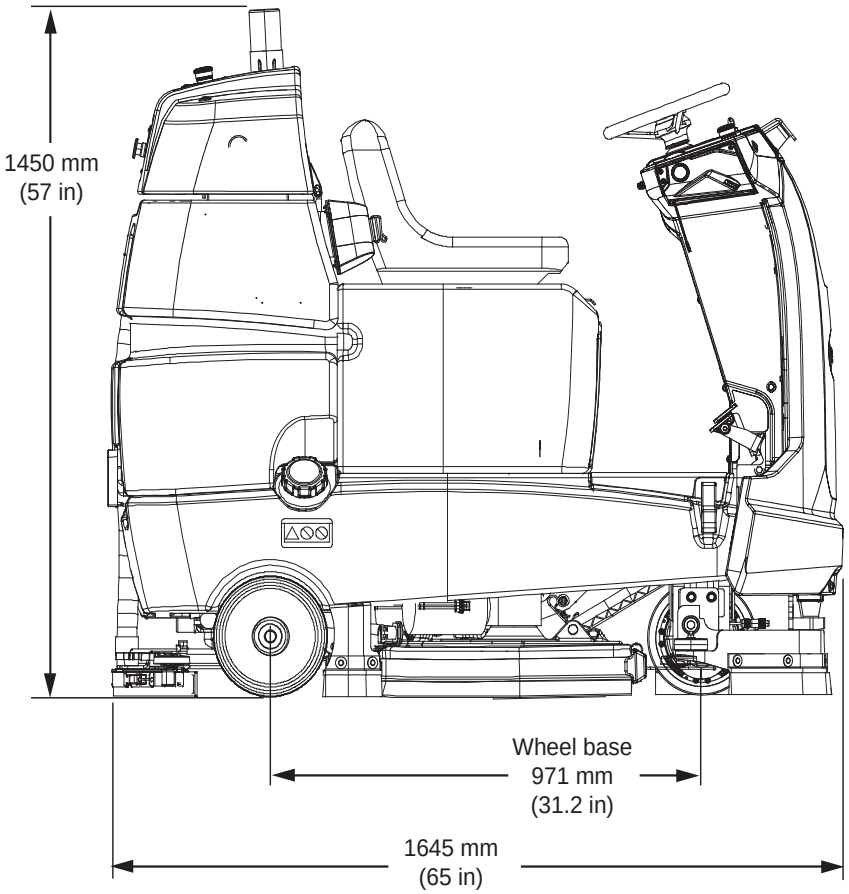
Location	Type	Size
Front (1)	Solid	90 mm wide x 260 mm OD (3.5 in wide x 10 in OD)
Rear (2)	Solid	80 mm wide x 260 mm OD (3.0 in wide x 10 in OD)

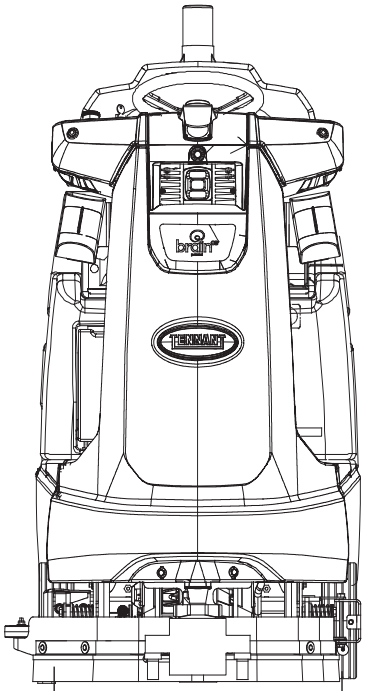
***ec−H2O* SYSTEM**

Item	Measure
Solution pump	24 Volt DC, 5A, 5.7 LPM (1.5 GPM) open flow, 70 psi bypass setting
Solution flow rate	Low: 0.14 gpm
	Medium: 0.25 gpm
	High: 0.35 gpm

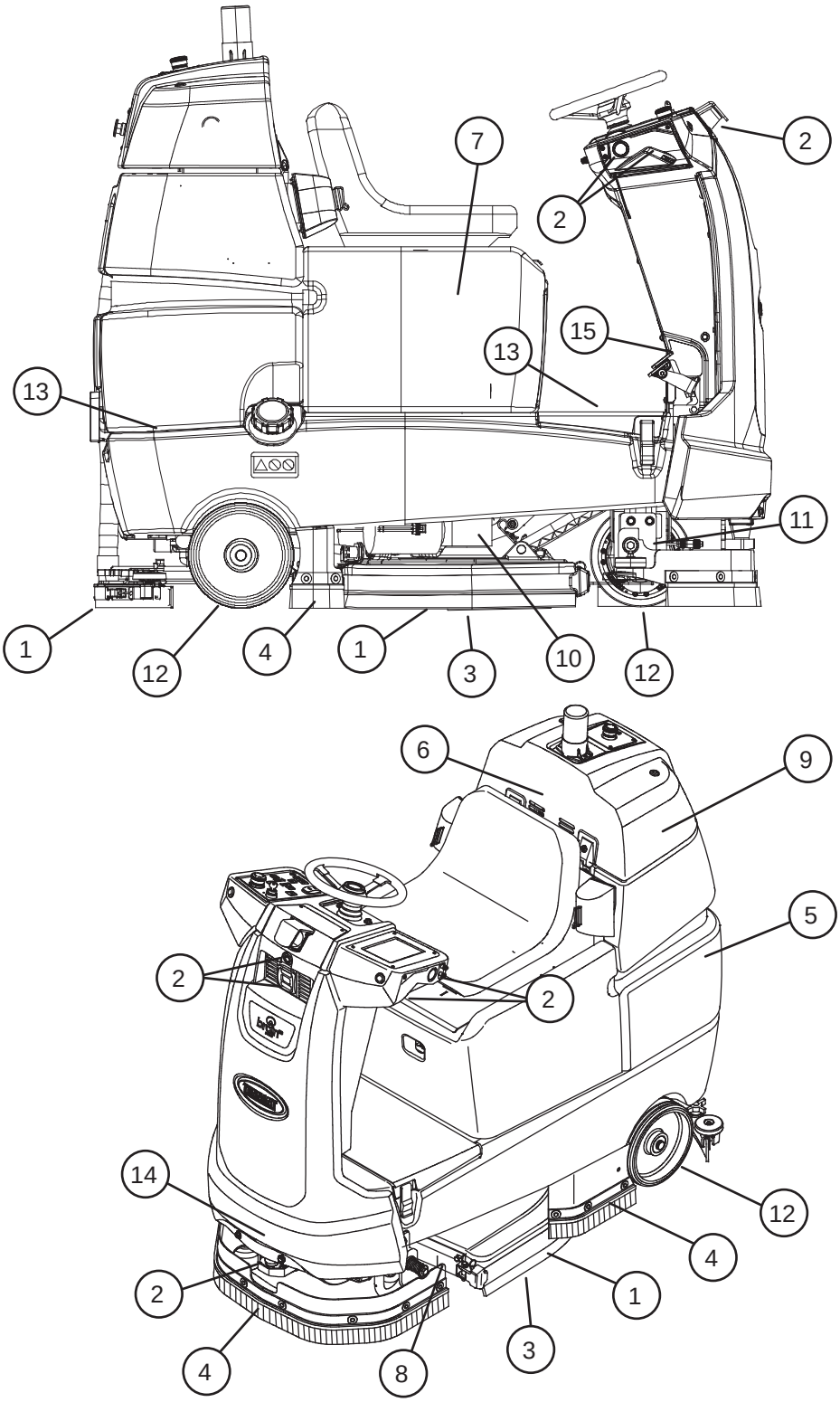
MACHINE DIMENSIONS







MAINTENANCE



MAINTENANCE CHART

The table below indicates the Person Responsible for each procedure.

O = Operator.
T = Trained Personnel.

Interval	Person Resp.	Key	Description	Procedure	Lubricant/ Fluid	No. of Service Points
Daily	O	1	Side and rear squeegees	Check, flip or replace	-	3
				Check deflection and leveling	-	6
	O	2	Front/side 2D and 3D sensors and upper/ lower LIDAR sensors	Check for damage. Clean with provided microfiber cloth	-	8
	O	3	Scrub brushes/pads	Check for damage, wear, debris	-	2
	O	4	Perimeter guards (left, right, and front)	Check for debris, damage, and wear	-	3
	O	5	Recovery tank	Clean tank, screen filter, and float sensor	-	1
	O	6	Vacuum fan filter	Clean	-	1
Weekly	T	7	Battery cells	Check electrolyte level	DW	3
50 Hours	O	8	Scrub head floor skirt	Check for damage and wear	-	2
100 Hours	T	9	Vacuum fan and recovery tank seals	Check for damage and wear	-	3
	O	13	Solution tank seals	Check for damage and wear		2
	O	7	Battery watering system (option)	Check hoses for damage and wear	-	All
200 Hours	T	7	Battery terminals and cables	Check and clean	-	12
	T	14	Steering gear chain	Lubricate, check tension, and check for damage and wear.	GL	1
	T	15	Steering u-joint	Lubricate and check for damage and wear.	GL	1
500 Hours	T	6	Vacuum fan motor(s)	Check motor brushes **(Check every 100 hours after initial 500 hour check)**	-	1
	T	10	Scrub brush motors	Check motor brushes **(Check every 100 hours after initial 500 hour check)**	-	2
	T	11	Propelling motor	Check motor brushes **(Check every 100 hours after initial 500 hour check)**	-	1
	T	12	Tires	Check for damage and wear	-	3

LUBRICANT/FLUID

DW Distilled water
GL SAE 90 weight gear lubricant

BATTERIES

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

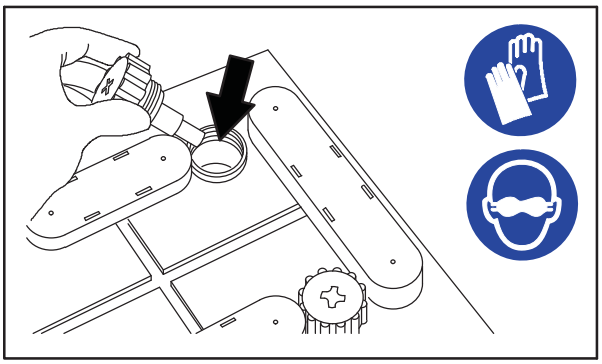
The lifetime of the batteries depends on their proper maintenance. To get the most life from the batteries;

- Do not charge the batteries more than once a day and only after running the machine for a minimum of 15 minutes.
- Do not leave the batteries partially discharged for long period of time.
- Only charge the batteries in a well-ventilated area to prevent gas build up. Charge batteries in areas with ambient temperatures 27°C (80°F) or less.
- Allow the charger to complete charging the batteries before re-using the machine.
- Maintain the proper electrolyte levels of flooded (wet) batteries by checking levels weekly.

CHECKING THE ELECTROLYTE LEVEL

The flooded (wet) lead-acid batteries require routine watering as described below. Check the battery electrolyte level weekly.

*NOTE: **Do Not** check the electrolyte level if the machine is equipped with a battery watering system.*



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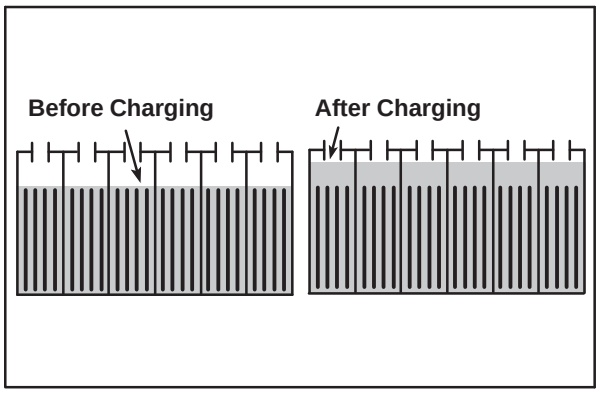
FOR SAFETY: When servicing machine, keep all metal objects off batteries. Avoid contact with battery acid.

The electrolyte level should be slightly above the battery plates as shown before charging. Add distilled water if low. DO NOT OVERFILL. The electrolyte will expand and may overflow when charging. After charging, distilled water can be added up to about 3 mm (0.12 in) below the sight tubes.



NOTE: Make sure the battery caps are in place while charging. There may be a sulfur smell after charging batteries. This is normal.

CHECKING CONNECTIONS / CLEANING

After every 200 hours of use check for loose battery connections and clean the surface of the batteries, including terminals and cable clamps, with a strong solution of baking soda and water. Replace any worn or damaged wires. Do not remove battery caps when cleaning batteries.

CHARGING THE BATTERIES

The charging instructions in this manual are intended for the battery charger supplied with the machine. The use of other battery chargers that are not supplied and approved by Tennant are prohibited. Refer to the charger owners manual for additional information. Contact distributor or Tennant for battery charger recommendations.

FOR SAFETY: The use of incompatible battery chargers may damage battery packs and potentially cause a fire hazard.

IMPORTANT NOTICE: The battery charger is set to charge the battery type supplied with the machine.

1. Transport the machine to a well-ventilated area.

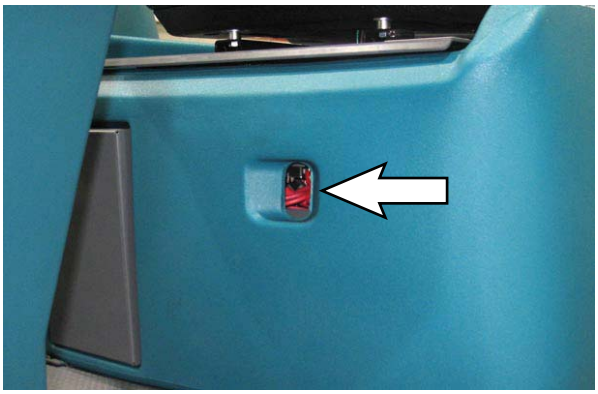
WARNING: Batteries emit hydrogen gas. Explosion or fire can result. Keep sparks and open flame away. Keep covers open when charging.

2. Park the machine on a flat, dry surface, turn off machine and remove key.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

3. Check the battery electrolyte level weekly before charging. For models equipped with the automatic battery watering system, check electrolyte the level indicators located on the battery covers. Add distilled water as needed.
4. Connect the charger DC cord into the machine battery charge receptacle then plug the AC power supply cord into a properly grounded wall outlet. Refer to the off-board battery charger owners manual for operating instructions.

FOR SAFETY: Do not disconnect the off-board charger's DC cord from the machine's receptacle when the charger is operating. Arcing may result. If the charger must be interrupted during charging, disconnect the AC power supply cord first.



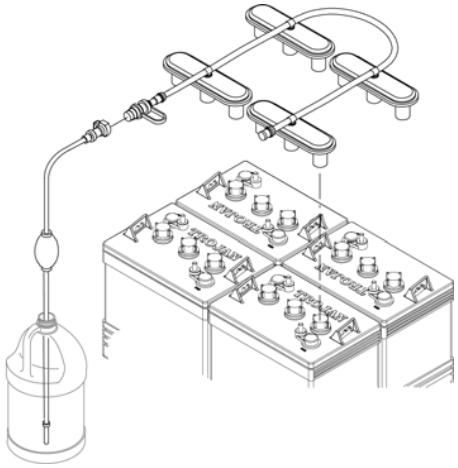
5. The charger will automatically begin charging and shut off when fully charged. The maximum charging cycle may take up to 6-12 hours depending on battery type.

*NOTE: **Do Not** disconnect battery cables while charger is plugged in, circuit board damage may result.*

6. After charging batteries unplug the AC power supply cord from the outlet before disconnecting the charger from the machine.
7. Disconnect the battery charger from the machine.

HYDROLINK® BATTERY WATERING SYSTEM (Trojan® Battery OPTION)

The following instructions are for models equipped with the HydroLink battery watering system option.

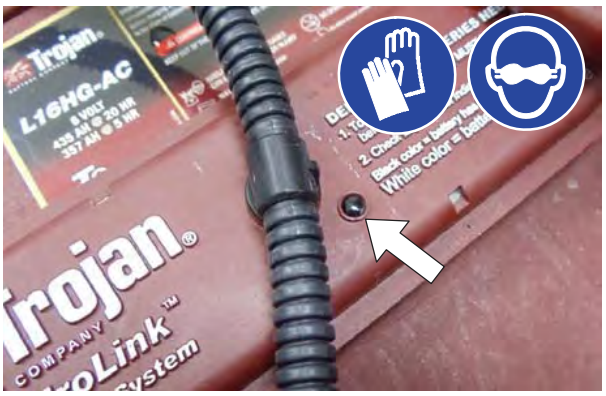


The optional HydroLink battery watering system provides a safe and easy way to maintain the proper electrolyte levels in the batteries. It is designed exclusively for Trojan flooded (wet) lead-acid batteries.

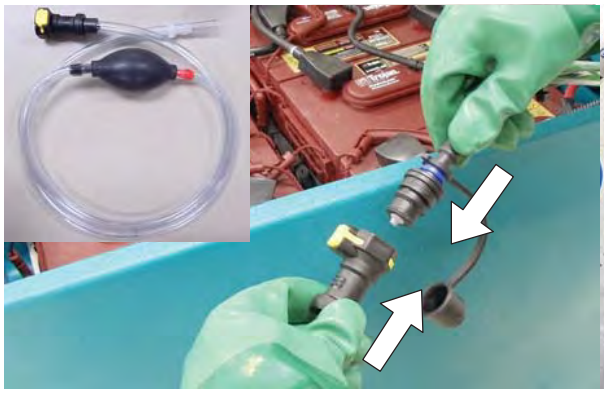
FOR SAFETY: When servicing machine, wear personal protection equipment as needed. Avoid contact with battery acid.

Before using the battery watering system check hoses and connections for damage or wear.

1. Fully charge batteries prior to using the battery watering system. Do not add water to batteries before charging, the electrolyte level will expand and may overflow when charging.
2. After charging batteries, check the battery electrolyte level indicators located on the battery covers. If the level indicators are white add water as described in the following instructions. If the level indicators are black the electrolyte is at the correct level, no water is required.

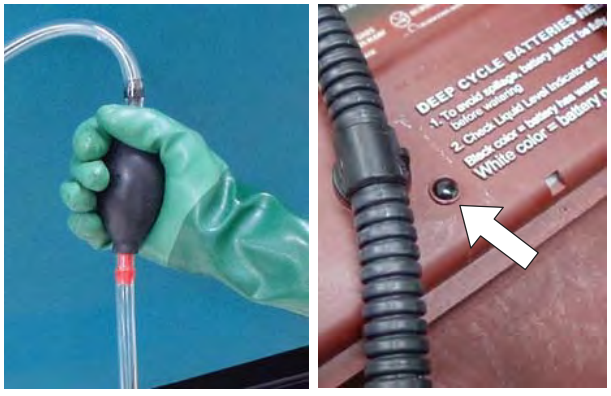


3. Locate the battery fill hose coupler inside the battery compartment. Remove the dust cap and connect the hand pump hose.



4. Submerge the other end of the hand pump hose into a bottle of distilled water.

5. Squeeze the bulb on the hand pump hose until firm. The level indicators will turn black when full.

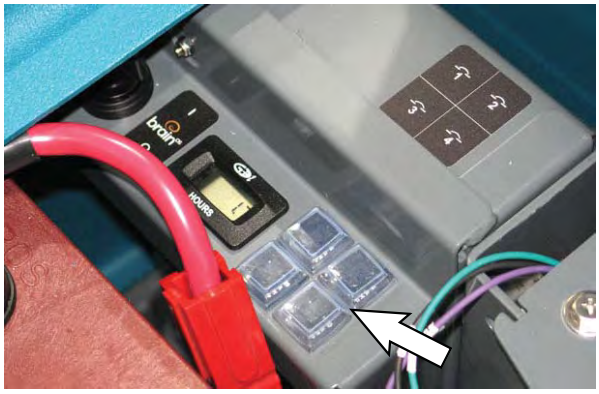


6. After adding water, replace the dust cap on the battery fill hose and store the hand pump hose inside the machine's battery compartment for future use.

CIRCUIT BREAKERS AND FUSES

CIRCUIT BREAKERS

Circuit breakers are resettable electrical circuit protection devices that stop the flow of current in the event of a circuit overload. Once a circuit breaker is tripped, allow breaker to cool and then press the reset button to manually reset the breaker.



If the overload that caused the circuit breaker to trip is still there, the circuit breaker will continue to stop current flow until the problem is corrected.

The circuit breakers are located inside the battery compartment next to the hour meter.

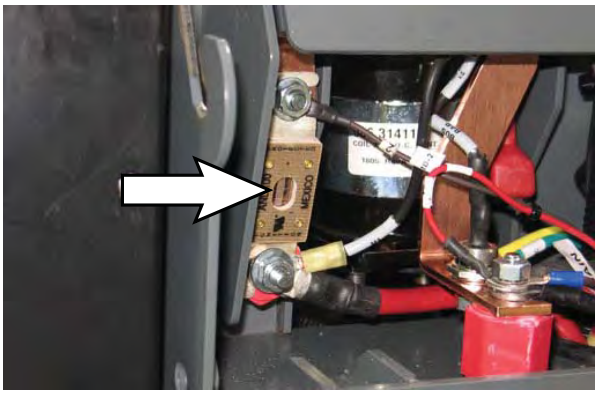
The chart shows the circuit breakers and the electrical components they protect.

Circuit Breaker	Rating	Circuit Protected
CB1	4 A	Instrument panel - power
CB2	4 A	Accessories
CB3	20 A	AMR system
CB4	10 A	Brain module

FUSES

The fuse is a one-time protection device designed to stop the flow of current in the event of a circuit overload. The 100 A fuse is located in the seat support column near the scrub head actuator. The fuse protects the machine controller.

NOTE: Always replace the fuse with a fuse of the same amperage.



ELECTRIC MOTORS

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

The carbon brushes in the vacuum fan motor, the propelling motor, and the scrub brush motors should be inspected after the initial 500 hours of machine operation and then every 100 hours after the initial 500 hours.

CAMERAS AND SENSORS

FRONT AND SIDE 2D AND 3D CAMERAS

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

Check the front and side 2D and 3D cameras for dirt, dust, smudges, and damage daily (or before each robotic run). Debris, streaks, or smudges could deliver false environmental information to the machine. Use the provided microfiber cloth to clean the cameras. Do not apply water to the cameras or the microfiber cloth.

NOTE: Do not scratch or damage the 2D or 3D camera lenses. Robotic machine performance could be adversely affected if camera lenses are scratched or damaged.

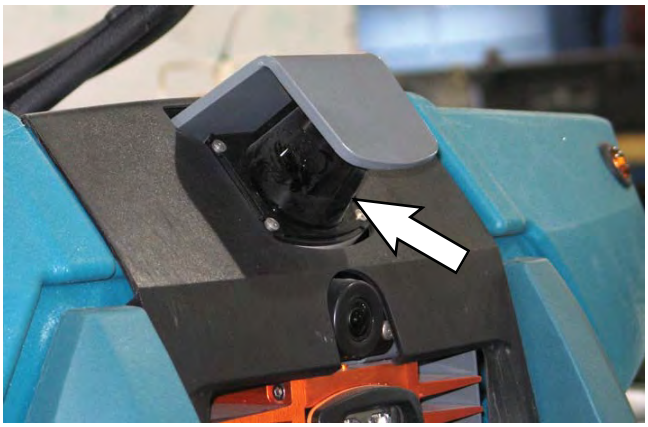
Side 2D and 3D cameras are located on each side of the machine.

UPPER AND LOWER LIDAR SENSORS

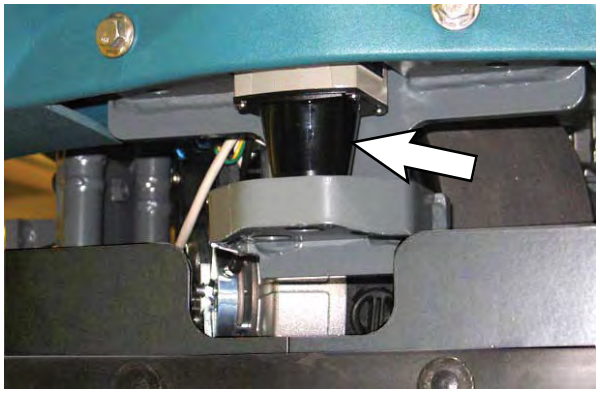
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

Check the upper and lower LIDAR sensors for dirt, dust, smudges, and damage daily (or before each robotic run). Debris, streaks, or smudges could deliver false environmental information to the machine. Use the provided microfiber cloth to clean the sensors. Do not apply water to the sensors or the microfiber cloth.

NOTE: Do not scratch or damage the upper or lower LIDAR sensor surfaces. Robotic machine performance could be adversely affected if sensor surfaces are scratched or damaged.



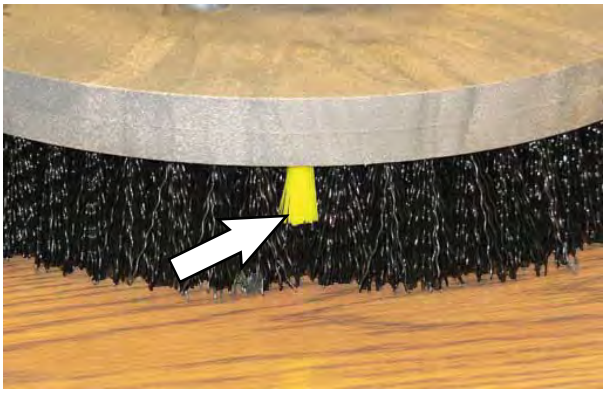
NOTE: Due to the lower LIDAR sensor being located near the cleaning surface, pay particular attention to ensure the front, side, back, and bottom surfaces are completely clear of all dirt, smudges, and/or other debris. Use a flash light to inspect these sensor surfaces and ensure they are thoroughly cleaned.



SCRUB BRUSHES AND PADS

Check scrub brushes daily for wire or string tangled around the brush or brush drive hub. Also check brushes for damage and wear.

Replace the pads when they no longer clean effectively. Replaces the brushes when they no longer clean effectively or when the bristles are worn to the yellow indicator.



Cleaning pads must be placed on pad drivers before they are ready to use. The cleaning pad is held in place by a pad holder.

Cleaning pads need to be cleaned immediately after use with soap and water. Do not wash the pads with a pressure washer. Hang pads, or lie pads flat to dry.

NOTE: Always replace brushes and pads in sets. Otherwise one brush or pad will clean more aggressively than the other.

REPLACING BRUSHES OR PAD DRIVERS

1. Stop machine on a level surface. Make sure the scrub head is in the raised position.
2. Turn the machine *ON/OFF key switch* off.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

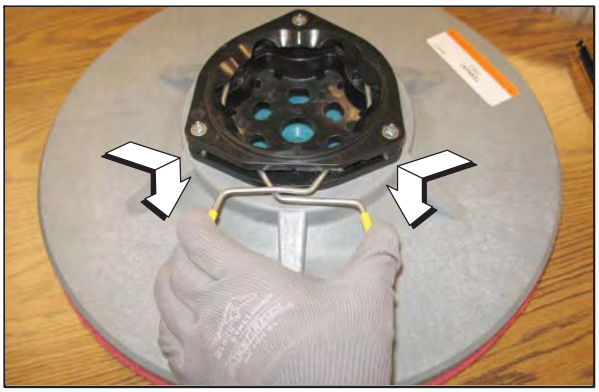
3. When changing the scrub brush located on the left side of the machine only: Remove the pin from the left perimeter guard and open the perimeter guard to access the scrub brush.

4. Pull the pin from the side squeegee retainer pivot.

5. Open the side squeegee retainer pivot toward the front of the machine, then pull the side squeegee toward the rear of the machine to access the scrub brushes or pads.

6. Press the spring clip together with the thumb and index finger. The brush/pad driver will drop off the drive hub. Remove the brush from under the machine.

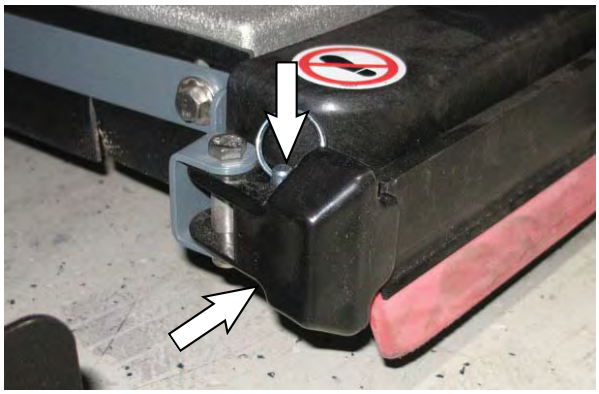
7. Set the yellow spring clip to the open position to make brush installation easier. Press spring clip together and downward to set.



8. Align the pad driver or brush under the motor hub and push it upward to engage hub. Ensure that it is securely mounted onto the motor hub.

9. Close the side squeegee and the retainer pivot, then insert the pin.

NOTE: Be sure the pin is inserted completely through the bottom.



10. If the scrub brush located on the left side of the machine was changed/removed: Close and resecure the left perimeter guard.

REPLACING DISK PADS

1. Remove the pad driver from the machine.
2. Squeeze the spring clip together to remove the center disk.

3. Flip or replace the scrub pad, center the scrub pad on the pad driver. Then reinstall the center disk to secure the pad in place on the pad driver.

4. Reinsert the pad driver into the machine.

ec-H2O SYSTEM

ec-H2O WATER CONDITIONING CARTRIDGE REPLACEMENT

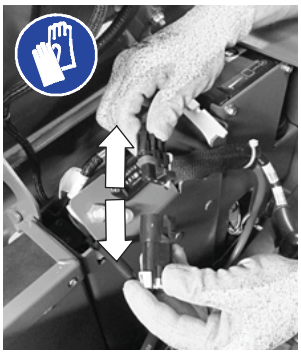
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

The water conditioning cartridge is required to be replaced when it reaches its maximum water usage or expiration time of when the cartridge was activated, which ever comes first. The *ec-H2O* system indicator light will blink green/red when it is time to replace cartridge.

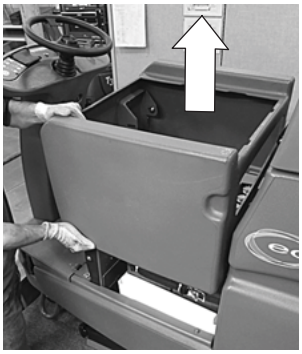
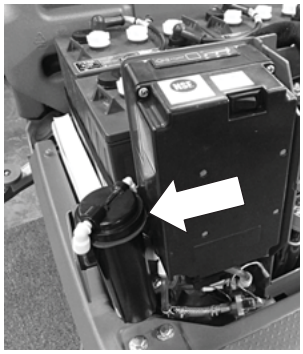
Depending on machine usage, on average, a new cartridge can last anywhere from 12 months for heavy machine usage to 24 months for light machine usage.

NOTE: During first time use and after replacing the water conditioning cartridge, the ec-H2O system will automatically override the selected solution flow rate for up to 75 minutes.

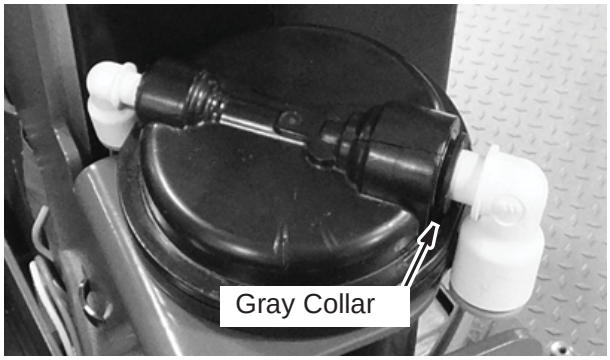
1. Disconnect the wire harness from operator seat and carefully remove seat from machine.




2. Remove the battery compartment shroud from machine to access cartridge.

3. Disconnect the two hose connectors from cartridge by pressing the gray collars inward and pulling the connectors outward. Lift cartridge to remove.



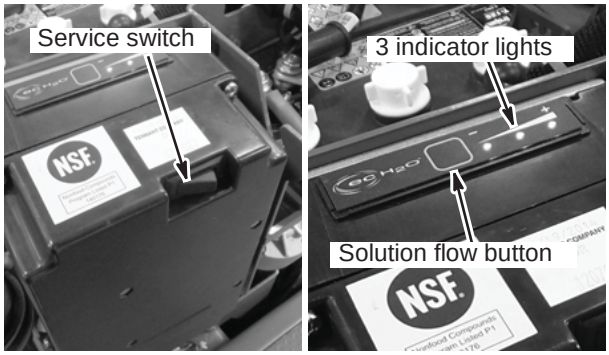
4. Fill in the installation date on the new cartridge label.

5. Install the new cartridge and reconnect the two hoses. Make sure the hose connectors are fully inserted into new cartridge.

6. Reset timer for new cartridge.

   Carefully read and understand all steps first before performing procedure.

   a. Turn the *ON/OFF key switch* on.
   b. Press and hold the service switch, located on the *ec-H2O* module, for 10 seconds. After releasing service switch, the three solution flow indicator lights will begin to (ripple) move back and forth.
   c. Within 5 seconds after releasing the service switch, while the three indicator lights are moving back and forth, quickly press and release the solution flow button located on *ec-H2O* module.
   The three indicator lights will then blink three times to indicate timer has been reset. Repeat process if the three indicator lights do not blink three times.



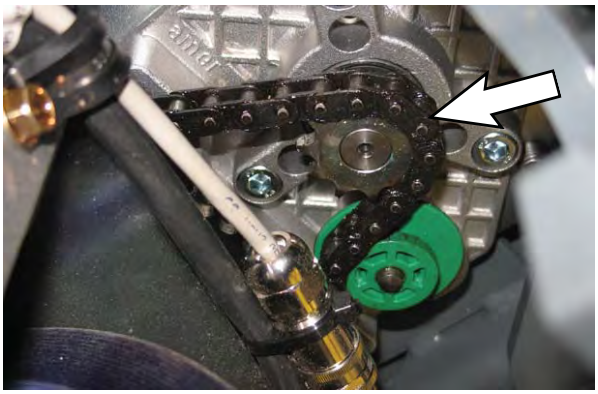
7. Reinstall the battery compartment shroud and operator seat.

LUBRICATION

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

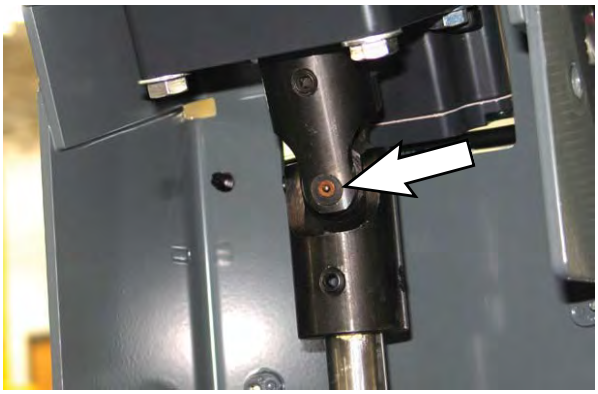
STEERING GEAR CHAIN

The steering gear chain is located directly above the front tire. Check for damage or wear and lubricate the steering gear chain after every 200 hours.



STEERING U-JOINT

The steering u-joint is located directly below the steering motor. Check for damage or wear and lubricate the steering u-joint after every 200 hours.



SQUEEGEE BLADES

Check the squeegee blades for damage and wear daily. When the blades become worn, rotate the blades end-for-end or top-to-bottom to a new wiping edge. Replace blades when all edges are worn.

Check the deflection of the squeegee blades daily or when scrubbing a different type of surface. Check the leveling of the rear squeegee every 50 hours of operation.

The rear squeegee assembly can be removed from the squeegee pivot to prevent damage during transport of the machine.

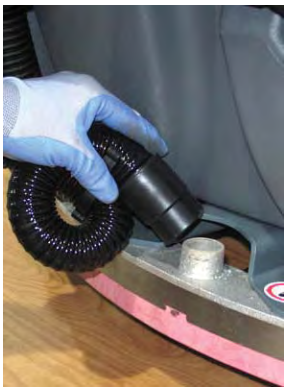
REPLACING (OR ROTATING) THE REAR SQUEEGEE BLADES

1. Stop machine on a level surface. Make sure the scrub head is in the raised position.

2. Turn the machine ON/OFF key switch off.

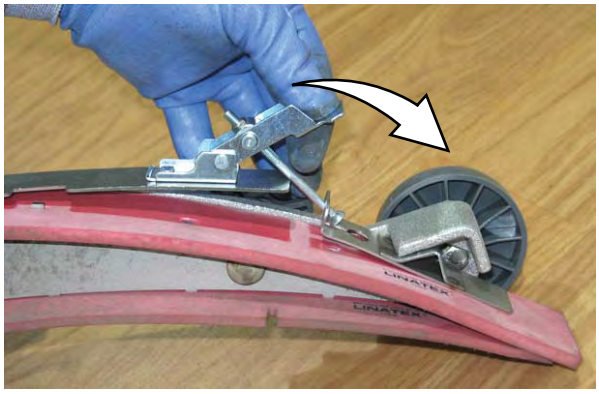
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

3. Remove the squeegee vacuum hose from the rear squeegee assembly. Then loosen both rear squeegee assembly mounting knobs.

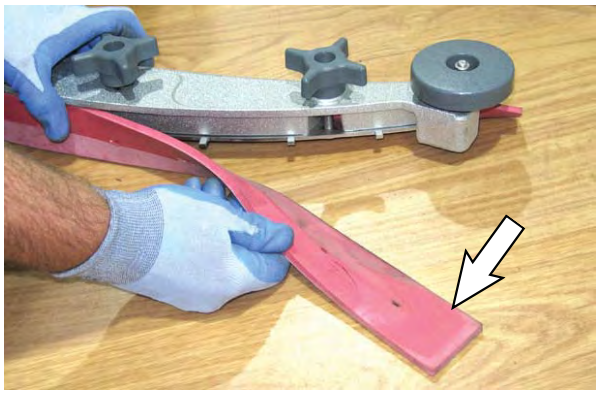


4. Pull the rear squeegee assembly from the machine.

5. Loosen the rear squeegee retaining band tension latch and remove the retaining band.



6. Remove rear squeegee blade from the rear squeegee assembly.



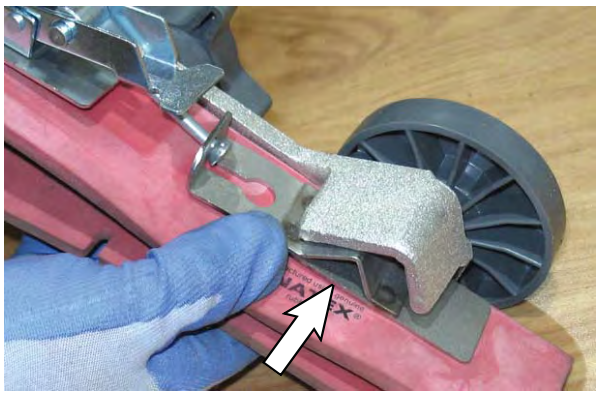
7. Loosen the two outer knobs on the rear squeegee assembly. Remove the front squeegee blade from the squeegee assembly.

8. Install the new front squeegee blade or rotate the existing blade to the new edge. Be sure the holes in the front squeegee blade are hooked onto the tabs on the front blade clamp.

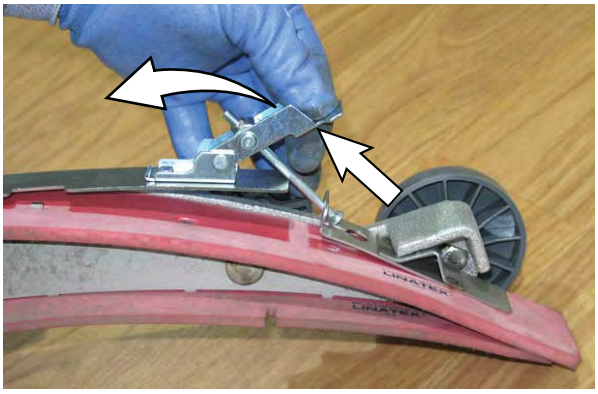
9. Lightly tighten the two outer knobs.

10. Install the new rear squeegee blade or rotate the existing blade to the new edge. Be sure the holes in the squeegee blade are hooked onto the tabs on the squeegee assembly.

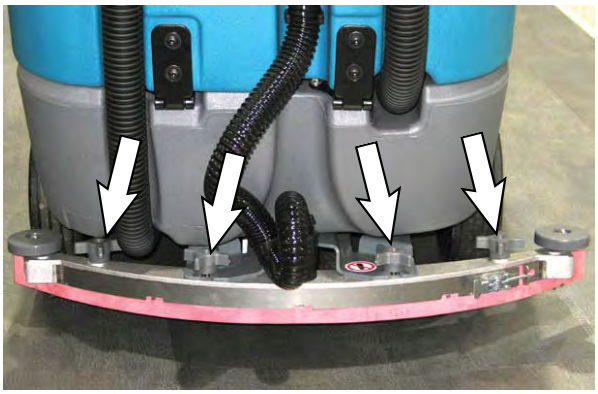
11. Reinstall the rear squeegee retaining band onto the squeegee assembly. Be sure each of the flanges on the retaining band are seated in the cut outs in the rear squeegee assembly.



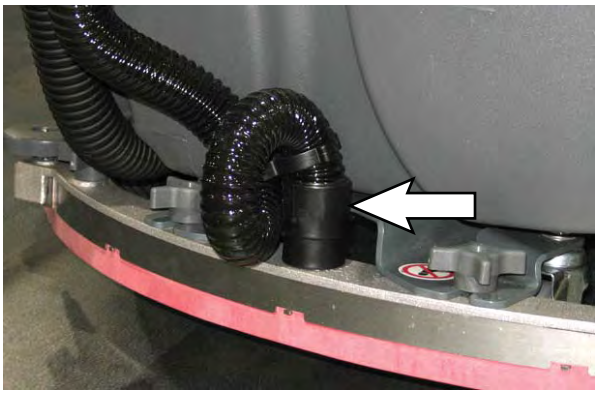
12. Tighten the rear squeegee retaining band tension latch.



13. Reinstall the rear squeegee under the squeegee mount bracket and tighten all four knobs.



14. Reinstall the squeegee vacuum hose onto the rear squeegee assembly.



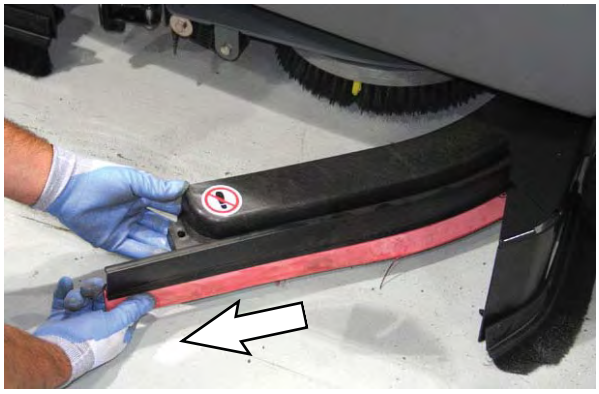
REPLACING THE SIDE SQUEEGEE BLADES

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. When changing the left side squeegee only: Remove the pin from the left perimeter guard and open the left perimeter guard to access the squeegee.

2. Open the side squeegee.

3. Pull the old side squeegee blade from the side squeegee retainer. Slide the new blade onto the retainer.



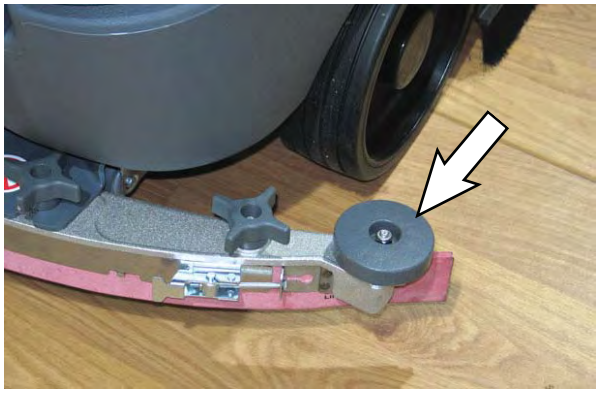
4. Close the side squeegee.

5. If the side squeegee located on the left side of the machine was changed: Close and resecure the left perimeter guard.

ADJUSTING THE SQUEEGEE GUIDE ROLLER

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

The squeegee guide rollers are located on both ends of the rear squeegee. The rollers guide the squeegee blade end along a wall. Loosen the nut located at the top of the guide roller and move the roller in or out to adjust how close the end of the squeegee blade is to the wall. The squeegee blade end should be further away from the wall when the floor curves up into the wall.



LEVELING THE REAR SQUEEGEE

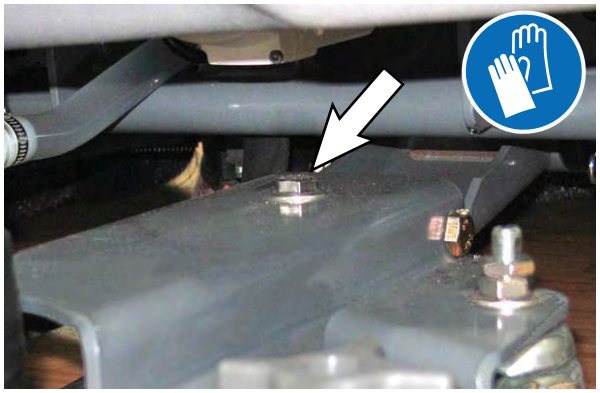
Leveling of the squeegee assures the entire length of the squeegee is in even contact with the surface being scrubbed. Perform this adjustment on an even and level floor.

1. Lower the squeegee and drive the machine forward a few feet.
2. Turn off the machine ON/OFF key switch.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

3. Look at the deflection of the squeegee over the full length of the squeegee blade.
4. If the deflection is not the same over the full length of the blade, turn the squeegee leveling bolt to make adjustments.

   The squeegee leveling bolt is located directly behind the squeegee suction hose. ***DO NOT*** *disconnect the suction hose from the squeegee frame when leveling squeegee.*



   Turn the squeegee leveling bolt counter-clockwise to increase the deflection at the ends of the squeegee.

   Turn the squeegee leveling bolt clockwise to decrease the deflection at the ends of the squeegee blade.

5. Drive the machine forward with the squeegee down to recheck the squeegee blade deflection if adjustments were made.
6. Readjust the squeegee blade deflection if necessary.

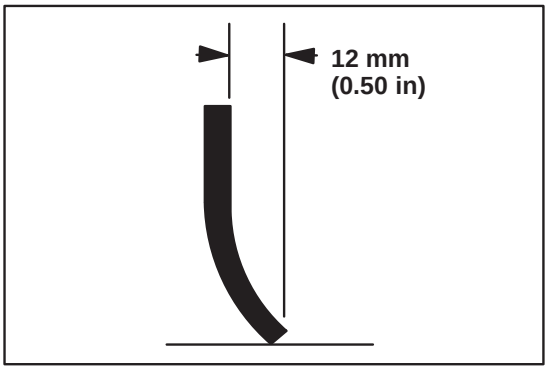
ADJUST REAR SQUEEGEE BLADE DEFLECTION

Deflection is the amount of curl the overall squeegee blade has when the machine moves forward. The best deflection is when the squeegee wipes the floor dry with a minimal amount of deflection.

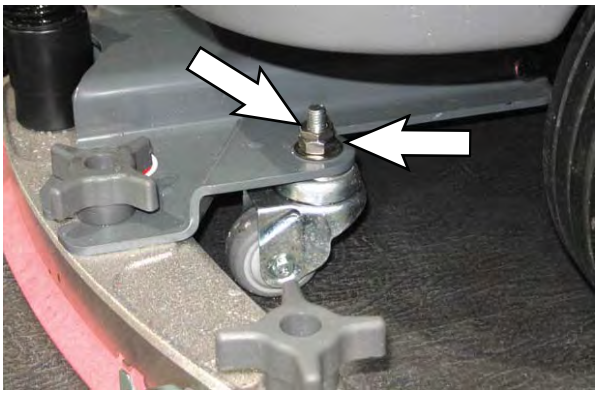
1. Lower the squeegee and drive the machine forward a few meters (feet).
2. Turn off the machine ON/OFF key switch.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

3. Look at the amount of deflection or “curl” of the squeegee blade. The correct amount of deflection is 12 mm (0.50 in) for scrubbing smooth floors and 15 mm (0.62 in) for rough floors.



4. If the overall squeegee blade deflection needs to be adjusted, loosen the jam nuts on the squeegee casters and adjust the height.



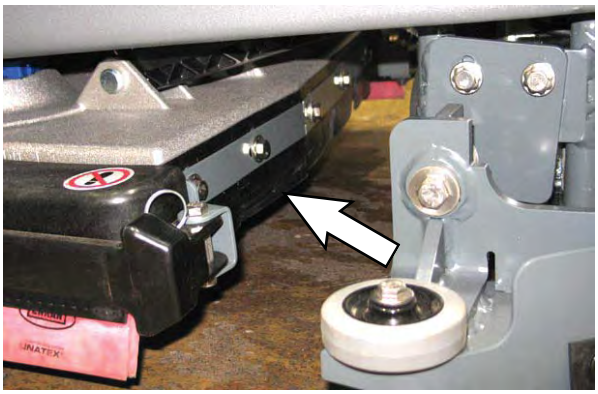
5. Drive the machine forward again to recheck the squeegee blade deflection after adjustments are made.
6. Readjust the squeegee blade deflection if necessary.

SKIRTS AND SEALS

SCRUB HEAD FLOOR SKIRT

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

The skirt is located in front of the scrub head. Check the skirt for damage and wear after every 50 hours of operation.

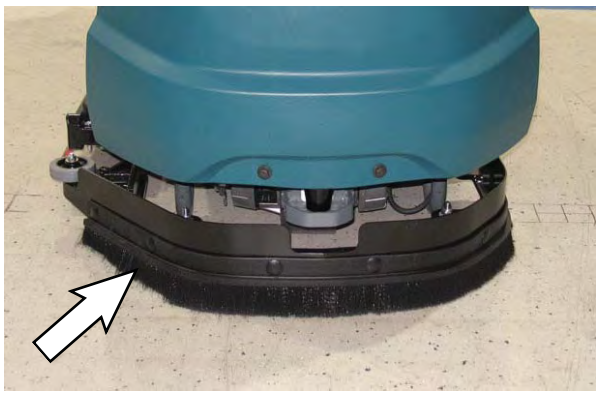


The skirts should clear the floor by 0 to 6 mm (0 to 0.25 in) when the scrub brushes are new and the scrub head is down.

LEFT PERIMETER GUARD, RIGHT PERIMETER GUARD, AND FRONT PERIMETER GUARD

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

Check the left perimeter guard, right perimeter guard, front perimeter guard, and perimeter guard bristles for debris, damage, and wear daily.

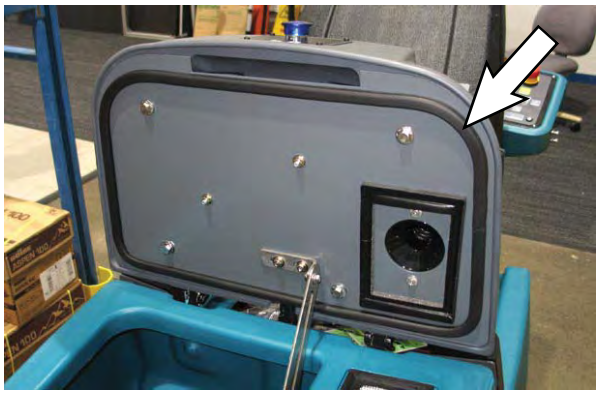


The bristles should lightly touch the floor. Replace damaged and/or worn bristle assemblies.

RECOVERY TANK SEAL

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

The recovery tank seal is located on the bottom of the recovery tank cover. Check the seal for damage and wear after every 100 hours of operation.



SOLUTION TANK SEALS

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

There are two solution tank seals. Check the seal for damage and wear after every 100 hours of operation.

A front seal is located on the bottom of the solution tank cover. A rear seal is located on the bottom of the recovery tank.

TIRES

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

The machine has three solid rubber tires: one tire is front and two are in the rear. Check the tires for damage and wear after every 500 hours of operation.

PUSHING, TOWING, AND TRANSPORTING THE MACHINE

PUSHING OR TOWING THE MACHINE

If the machine becomes disabled, it can be pushed from the front or rear, but only tow it from the front.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

Before attempting to push or tow the machine, disengage the brake as described below.

To disengage the brake, insert the tip of a small screw driver between the brake release lever and the body of the encoder.

Only push or tow the machine for a very short distance and do not exceed 3.2 kp/h (2 mph). It is NOT intended to be pushed or towed for a long distance or at a high speed.

*NOTE: **Do** **Not** push or tow machine for a long distance or damage may occur to the propelling system.*

Immediately after pushing the machine, remove the screw driver from between the brake release lever and the body of the encoder. NEVER operate the machine with the parking brake disabled.

FOR SAFETY: Do not operate machine with the brake disabled.

TRANSPORTING THE MACHINE

When transporting the machine by trailer or truck, be certain to follow the tie-down procedure below:

1. Raise the squeegee and scrub head.

FOR SAFETY: When loading/unloading machine onto/off truck or trailer, drain tanks before loading machine.

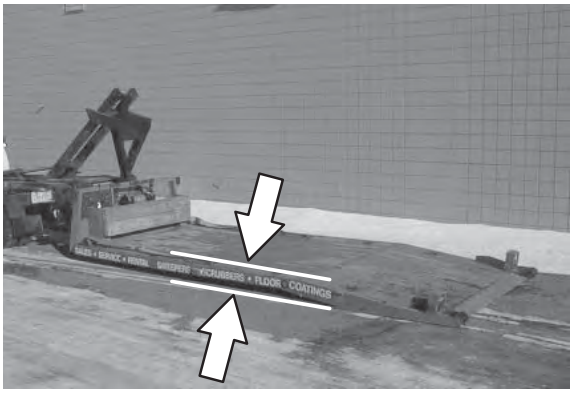
2. Remove the front perimeter guard from the front perimeter guard brackets located at the front of the machine.

3. Position the machine at the loading edge of the truck or trailer.

FOR SAFETY: When transporting machine, use a recommended ramp when loading/unloading into/off truck or trailer.

4. If the loading surface is not horizontal or is higher than 380 mm (15 in) from the ground, use a winch to load machine.

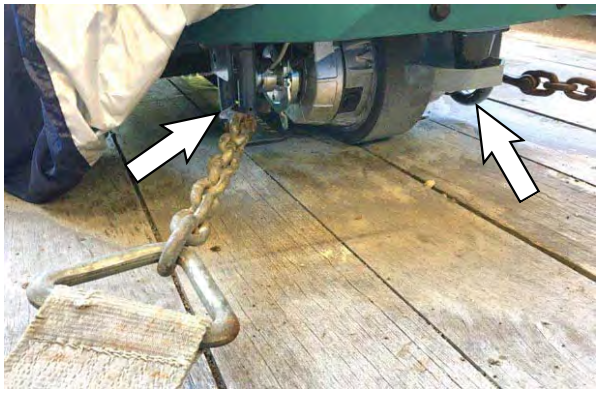
   If the loading surface is horizontal AND is 380 mm (15 in) or less from the ground, the machine may be driven onto the truck or trailer.



FOR SAFETY: When loading machine onto truck or trailer, use winch. Do not drive the machine onto the truck or trailer unless the loading surface is horizontal AND is 380 mm (15 in) or less from the ground.

5. Position the machine as close to the front of the trailer or truck as possible. If the machine starts to veer off the center line of the truck or trailer, stop and turn the steering wheel to center the machine.
6. Lower the scrub head and squeegee after the machine is positioned on the trailer or truck.
7. Place a block behind each wheel to prevent the machine from rolling.
8. Route the front tie-down straps through the stabilizer arms and then secure the tie-downs to the trailer or truck to prevent the machine from tipping.

   Do Not wrap the tie-down straps around the lower LIDAR sensor or route the tie-down straps over the front of the LIDAR sensor.



NOTE: It may be necessary to install tie-down brackets to the floor of the trailer or truck.

FOR SAFETY: When loading/unloading machine onto/off truck or trailer, use tie-down straps to secure machine.

9. If necessary, remove the rear squeegee from the machine.
10. Route the rear tie-down straps through the opening at the center part of the rear axle.
11. Stow/secure all parts removed from the machine in a safe place where they will not be lost or damaged.

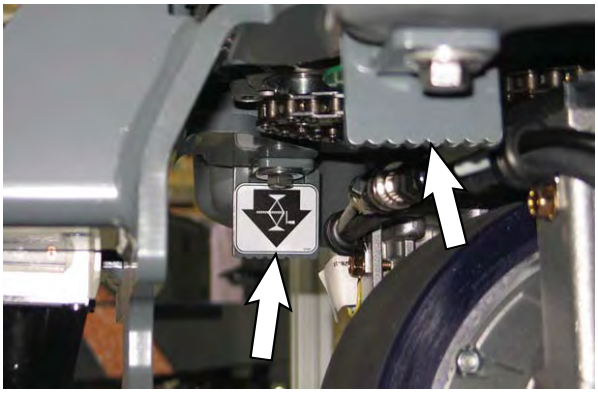
JACKING UP THE MACHINE

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

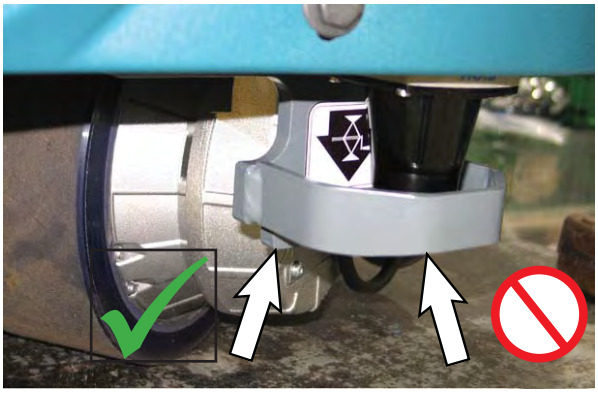
Empty the recovery and solution tanks before jacking the machine.

Remove the front perimeter guard from the front perimeter guard brackets located at the front of the machine before jacking up the front end of the machine.

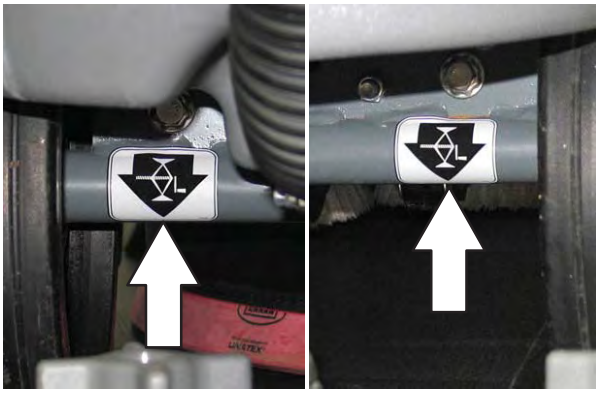
Two front jacking locations are located on the sides of the machine.



A third location at the front of the machine is located on the back of the LIDAR bracket. **Do Not** position the jack or jack stand at the front of the LIDAR bracket.



Rear jacking locations are located on both sides of the machine at the axles.



FOR SAFETY: When servicing machine, block machine tires before jacking machine up. Use a hoist or jack that will support the weight of the machine. Jack machine up at designated locations only. Block machine up with jack stands.

STORAGE INFORMATION

The following steps should be taken when storing the machine for extended periods of time.

1. Drain and clean the solution and recovery tanks. Open the recovery tank cover to promote air circulation.
2. Charge the batteries before storing machine to prolong the life of the batteries. Recharge batteries once a month.
3. Disconnect batteries before storing.
4. Park the machine in a cool, dry area. Do not expose the machine to rain. Store indoors.

FREEZE PROTECTION

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Drain the solution tank and recovery tank of all water.
2. Pour 2 gallons (8 liters) of full strength Propylene Glycol Based / Recreational Vehicle (RV) antifreeze into the solution tank. Do not dilute.

FOR SAFETY: Avoid eye contact with antifreeze. Wear safety glasses.

3. Turn the machine power on and operate the solution flow system. Turn the machine off when the antifreeze appears at the scrub head.

Continue with the freeze protection procedure if machine is equipped with the *ec-H2O* system.

ec-H2O MODELS

Operate machine in the *ec-H2O* mode to cycle antifreeze through *ec-H2O* system.

After storing machine in freezing temperatures, drain any remaining antifreeze from the solution tank. Add clean water to solution tank and operate the machine to flush system.

TROUBLESHOOTING

TROUBLESHOOTING/DIAGNOSTICS

INITIAL TROUBLESHOOTING MATRIX

Use the Initial Troubleshooting Matrix to conduct preliminary troubleshooting. Some errors may be caused by a blocked vacuum hose or debris preventing the actuator(s) from moving in the complete range of motion. Always check these items before conducting more labor intensive troubleshooting requiring the machine to be disassembled and the T7AMR SERVICE CONNECTION diagnostics software application to be used.

Function	Enabled	Disabled
Propel	• Key ON (I) • Battery voltage > 18V • Operator in seat • Propel pedal pressed • E-Stops not engaged • Charger interlock not engaged • No faults on propel motor output	• Key OFF (O) • Battery voltage < 18V • Operator not in seat • Propel pedal not pressed • E-Stops engaged • Charger interlock engaged • Faults on propel motor output
Vacuum Fan	• Key ON (I) • Battery voltage > 21V • 1-Step or water-pickup enabled • Directional switch set to forward • Vacuum fan continues to operate for a period of time after disabling • Adjusts during scrubbing to maintain down pressure • Recovery tank not full • E-Stops not engaged • Charger interlock not engaged • No faults on vacuum fan output	• Key OFF (O) • Battery voltage < 21V • 1-Step or water-pickup not enabled • Directional switch set to reverse • Vacuum off timer expired • Recovery tank full • E-Stops engaged • Charger interlock engaged • Faults on vacuum fan output
Scrub Head Actuator	• Key ON (I) • Battery voltage > 21V • 1-Step enabled/disabled • Lifts until current limits are reached on power-up and end of scrub • Lowers for fixed time duration at beginning of scrub • Adjusts during scrubbing to maintain down pressure • Solution tank not empty • Recovery tank not full • E-Stops not engaged • Charger interlock not engaged • No faults on scrub deck actuator output	• Key OFF (O) • Battery voltage < 21V • 1-Step not enabled • Lifting current limit is reached • Machine scrubbing at desired down pressure target • E-Stops engaged • Charger interlock engaged • Faults on scrub deck actuator output

Function	Enabled	Disabled
Squeegee Actuator	• Key ON (I) • Battery voltage > 21V • 1-Step or water pickup is enabled/disabled • Directional switch set to forward • Lifts when directional switch is set to reverse • Lifts until internal limit switch is hit on power-up and at end of 1-Step/water pickup • Lowers until internal limit switch is hit at beginning of 1-Step/water pickup • Recovery tank not full • E-Stops not engaged • Charger interlock not engaged • No faults on squeegee actuator output	• Key OFF (O) • Battery voltage < 21V • 1-Step or Water Pickup are not enabled • Will not lower if directional switch is set to reverse • Internal limit switches are hit • Recovery tank full • E-Stops engaged • Charger interlock engaged • Faults on squeegee actuator output
Scrub Motor(s)	• Key ON (I) • Battery voltage > 21V • 1-Step enabled • Scrub deck lowered • Machine is propelling • Solution tank not empty • Recovery tank not full • E-Stops not engaged • Charger interlock not engaged • No faults on scrub motor output	• Key OFF (O) • Battery voltage < 21V • 1-Step disabled • Scrub deck raised/raising • Machine not propelling • Solution tank empty • Recovery tank full • E-Stops engaged • Charger interlock engaged • Faults on scrub motor output
Solution Control (Conventional)	• Key ON (I) • Battery voltage > 21V • 1-Step enabled • ec-H2O (if equipped) not enabled • Machine is scrubbing • Solution tank not empty • Recovery tank not full • E-Stops not engaged • Charger interlock not engaged • No faults on water valve output	• Key OFF (O) • Battery voltage < 21V • 1-Step not enabled • ec-H2O (if equipped) is enabled • Machine not scrubbing • Solution tank empty • Recovery tank full • E-Stops engaged • Charger interlock engaged • Faults on water valve output
Solution Control (ec-H2O NanoClean - Optional)	• Key ON (I) • Battery voltage > 21V • 1-Step enabled • ec-H2O enabled • Machine is scrubbing • Solution tank not empty • Recovery tank not full • E-Stops not engaged • Charger interlock not engaged • No faults on ec-H2O enable output	• Key OFF (O) • Battery voltage < 21V • 1-Step not enabled • ec-H2O disabled • Machine not scrubbing • Solution tank empty • Recovery tank full • E-Stops engaged • Charger interlock engaged • Faults on ec-H2O enable output

SERVICE DIAGNOSTICS TOOL

Machine configuration software is stored in the Kinetek Control Module. It may be necessary to reload the machine configuration software if there are issues/ errors with the machine configuration software requiring the software to be reloaded into the Kinetek Control Module.

Authorized service providers can download the Service Diagnostics software. Tennant Service personnel have this software installed on their service devices.

Use the AMR Service Connector to connect the service device to the Kinetek Control Module. The Kinetek Control Module stores configuration data and communicates via the AMR SERVICE CONNECTOR communication with the Kinetek Control Module.

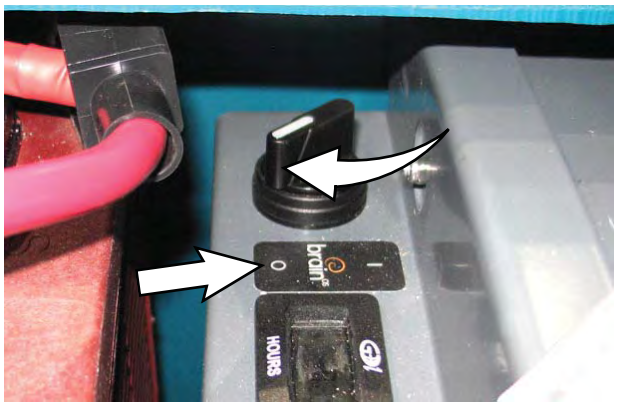
- **VIB (Vehicle Interface Board):** The VIB interface module is located in the operator console.
- **Kinetek Vehicle Controller:** The machine controller is located beneath on the controller mounting panel located at the front of the battery compartment.
- **BCM (Brain Control Module):** The BCM is located under the shroud on the front of the steering support.
- **ec-H2O NanoClean Module (option):** The ec-H2O module is located at the front of the battery compartment.

ISOLATING THE MACHINE FROM THE AMR SYSTEM

Initial machine troubleshooting is required to determine whether a malfunction/error code is an AMR related or non-AMR issue. To begin troubleshooting the machine the machine must first be isolated from the AMR system.

NOTE: Use the AMR bypass switch only when performing machine diagnostics/maintenance procedures. Do Not leave the machine isolated from the AMR system during regular use.

1. Turn the ON/OFF key switch OFF.
2. Lift and lock the operator seat open to access the hour meter/circuit breaker bracket located at the front of the battery compartment.
3. Turn the AMR bypass switch clockwise to isolate the machine from the AMR system.

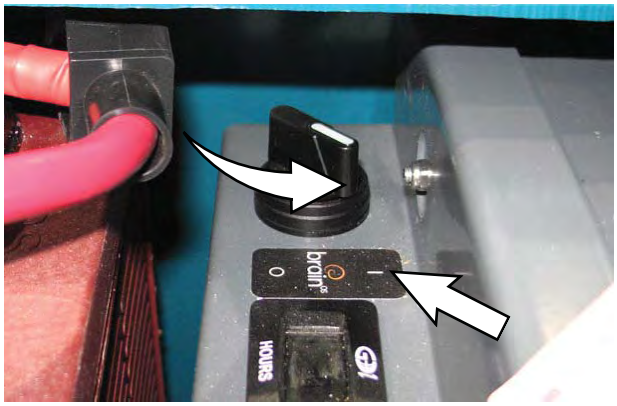


4. Lower the operator seat.
5. Turn the ON/OFF key switch ON.
6. Operate the machine in the Manual Mode.

   Are all scrubbing functions fully operational while the machine is in the manual mode? If yes, there is an issue with the AMR system. Proceed to PREPARING THE MACHINE FOR EXTERNAL TROUBLESHOOTING/DIAGNOSTICS/FILE TRANSFERS.

   Are there scrubbing function issues while the machine is in the Manual Mode? If yes there is an issue with the T7 portion of the machine. Troubleshoot the machine to determine possible issues. Make necessary repairs and/ or adjustments. Proceed to PREPARE THE MACHINE FOR TROUBLESHOOTING/ DIAGNOSTICS/FILE TRANSFERS and CHECK THE KINETEK CONTROL MODULE/MACHINE DIAGNOSTICS.

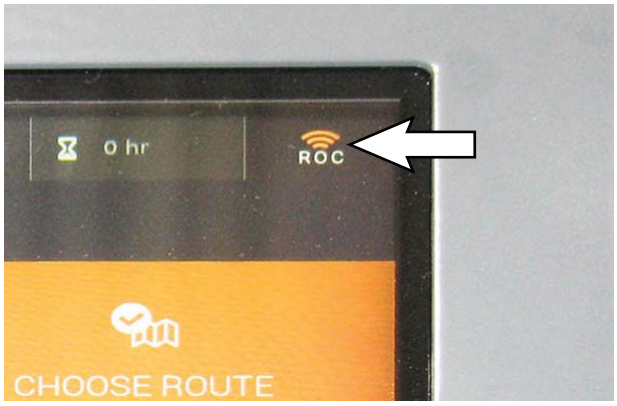
7. Turn the AMR bypass switch counterclockwise to link the machine to the AMR system if finished with diagnostic procedures.

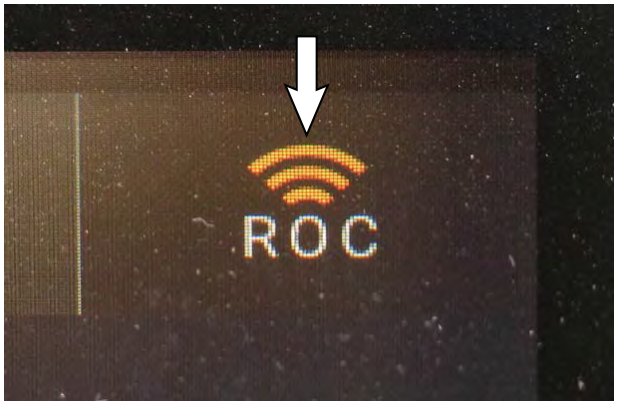


PREPARE THE MACHINE FOR TROUBLESHOOTING/DIAGNOSTICS/FILE TRANSFERS

There will be instances when troubleshooting/diagnostics/file transfers will be necessary to get the machine functioning. The ROC (Robotics Operation Center) allows external entities (Tennant Service/Brain Corp.) to communicate with the machine to troubleshoot problems, provide diagnostic information, and transfer files that may be required to update/fix malfunctioning robotic functions.

1. Turn the ON/OFF key switch ON.
2. If necessary, drive the machine to an area where the ROC light located on the user interface touchscreen. The ROC light must be illuminated for there to be any external troubleshooting/diagnostics/file transfers completed.





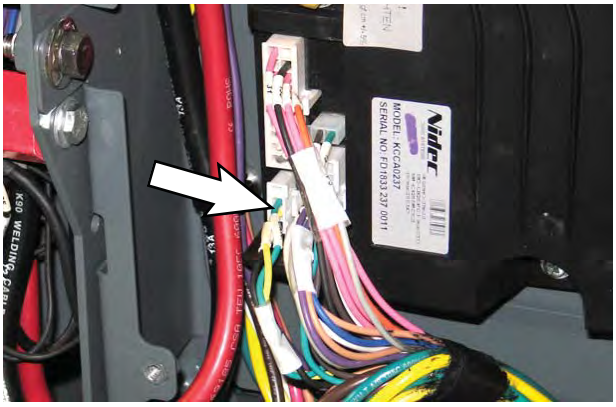
3. Contact the Tennant Customer Service Department for additional troubleshooting/diagnostic guidance.

CHECK THE KINETEK CONTROL MODULE/ MACHINE DIAGNOSTICS

SYSTEM REQUIREMENTS: Windows® 7 Operating System or newer version.

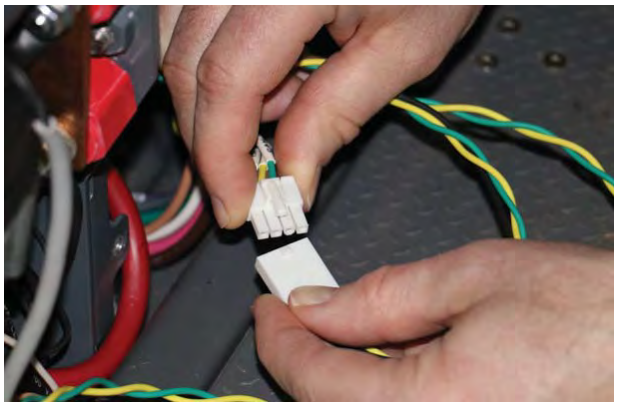
1. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/ REINSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
2. Remove the controller cover plate from the machine.

3. Disconnect the main wire harness SCRUB CONTROLLER connector from the Kinetek Control Module P4: CAN/Programming terminal.



4. Connect the AMR SERVICE CONNECTOR to the service device.

5. Connect the AMR Service Connector to the main wire harness SCRUB CONTROLLER connector previously connected to the Kinetek Control Module P4: CAN/Programming terminal.

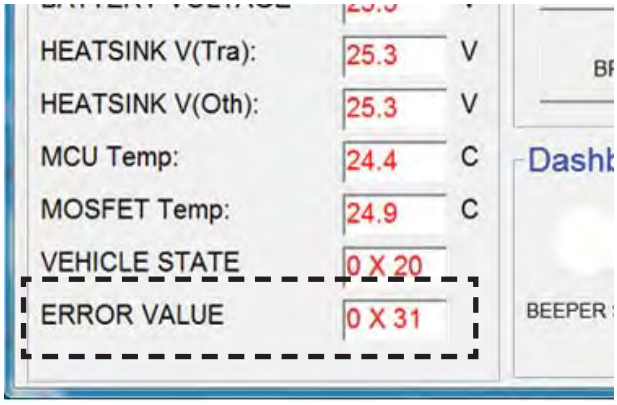


6. Connect the AMR Service Connector to the Kinetek Control Module P4: CAN/Programming terminal where the main wire harness SCRUB CONTROLLER connector was previously connected.

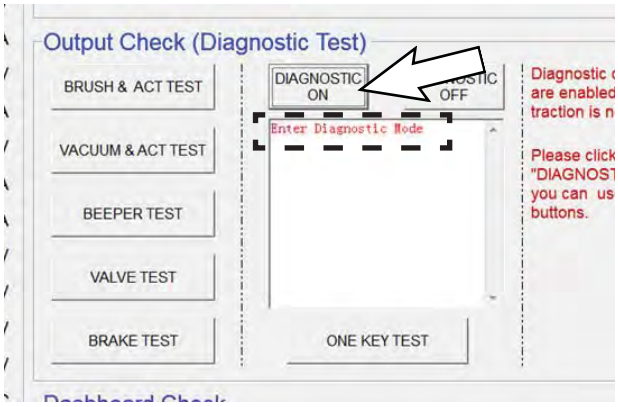
7. Remove the front perimeter guard from the machine.
8. Chock the rear wheels to prevent the machine from rolling.
9. Position a jack under the front jack point at the back of the LIDAR bracket. **Do Not** position the jack at the front of the LIDAR bracket.
10. Jack the front end of the machine approximately 12.7 mm (0.50 in) from the floor (high enough so the front drive wheel moves freely when the propel pedal is pressed).

FOR SAFETY: When servicing machine, block machine tires before jacking machine up. Use a hoist or jack that will support the weight of the machine. Jack machine up at designated locations only.

11. Turn the ON/OFF key switch ON.
12. Bypass the seat switch harness.
13. Click the desktop icon start menu to open the T7AMR SERVICE CONNECTION diagnostics software application.
14. Check the ERROR VALUES located at the bottom of the Current and Volts column for an error code. See OUTPUT INFORMATION/CURRENT AND VOLTS.



15. Proceed to FAULT CODES for fault codes, fault code conditions, cause(s) for the fault code(s), and corrective actions to be taken.
16. Press the DIAGNOSTIC ON button to activate the Output Check (Diagnostic Test) function of the T7AMR Diagnostic Test application. See INPUT CHECK/OUTPUT CHECK (DIAGNOSTIC TEST).



17. Observe the diagnostics status box for error codes.
18. Observe the Output Information column for possible short circuits and open circuits. Check the Current and Volts column to ensure circuits being tested are operating within the correct voltage and amp ranges. See OUTPUT INFORMATION/CURRENT AND VOLTS.

19. If further diagnostic testing is required, conduct a dashboard Check. See DASHBOARD CHECK.

20. If necessary,perform diagnostics tests to find where there may be machine operation/performance issues. See FAULTS CODES for fault codes. See DIAGNOSTIC TOOLS for diagnostic tool information.

21. Disconnect the AMR SERVICE CONNECTOR from the Kinetek controller.

22. Turn the ON/OFF key switch OFF.

23. Reconnect the main wire harness SCRUB CONTROLLER connector to the Kinetek Control Module P4: CAN/Programming terminal.

24. Reinstall the controller cover plate onto the machine.

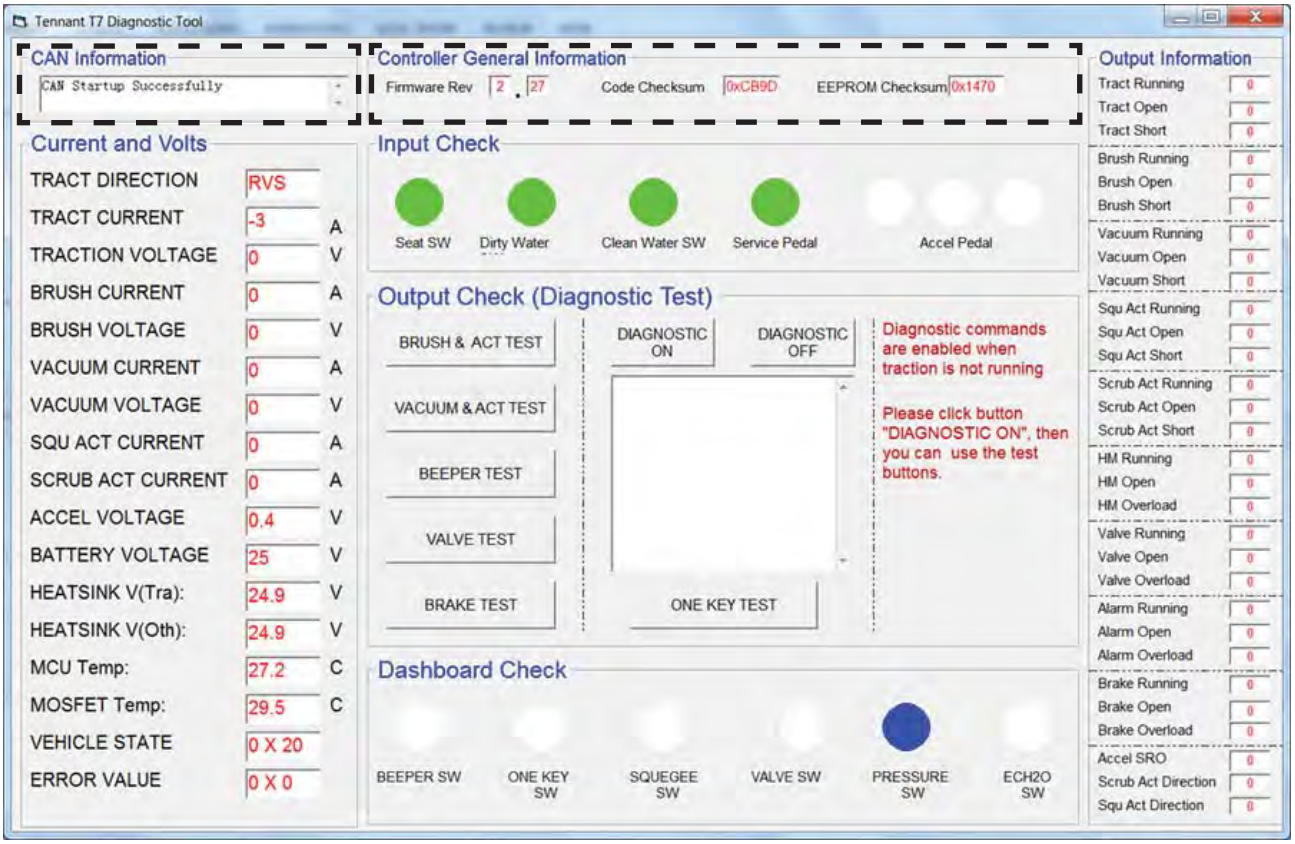
25. Reinstall the battery box cover and operator seat/ seat plate onto the machine. See REMOVE/ INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.

26. Reconnect the main wire harness to the operator seat switch cable.

DIAGNOSTIC TOOLS

The T7AMR SERVICE CONNECTION diagnostics software application provides detailed information for testing the machine for open circuits, shorts, and current and volt information for all machine operating and scrubbing systems. This information can be used for troubleshooting the various machine circuits and finding any problems that could be adversely affecting machine operation and performance.

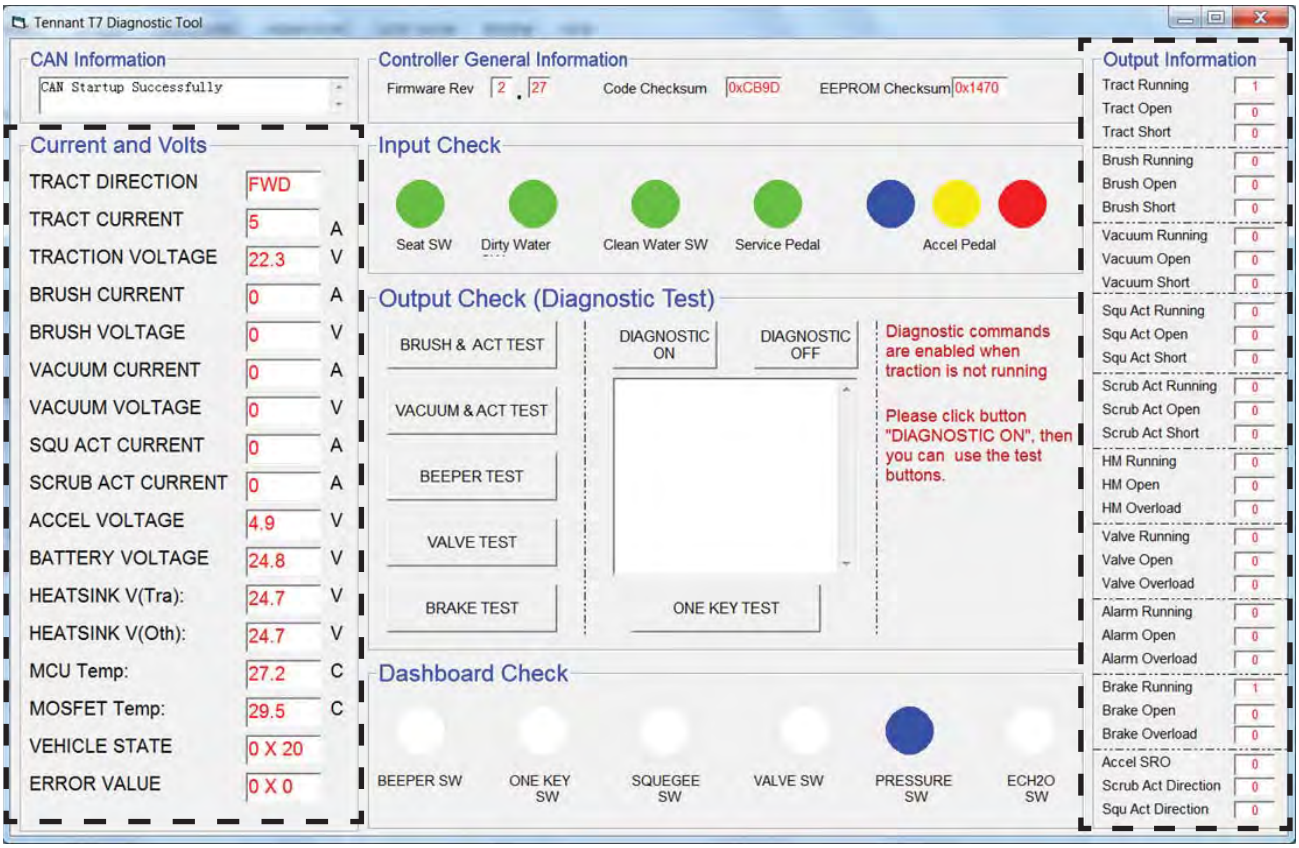
CAN INFORMATION/CONTROLLER GENERAL INFORMATION



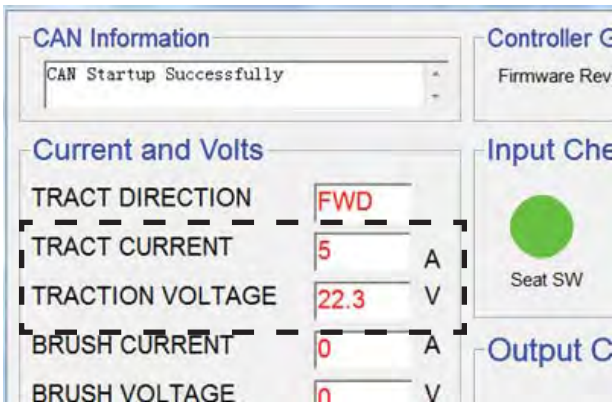
CAN Information: Indicates CAN system is operational.

Controller General Information: Indicates the controller firmware version, the Firmware Rev (firmware revision), Code Checksum, and EEPROM (Electrically Erasable Programmable Read-Only Memory) Checksum are listed. Confirm these three numbers to ensure the latest version of the firmware is installed on the machine. Contact the Tennant Customer Service Department for the latest controller firmware version, Firmware Rev, and EEPROM.

OUTPUT INFORMATION/CURRENT AND VOLTS

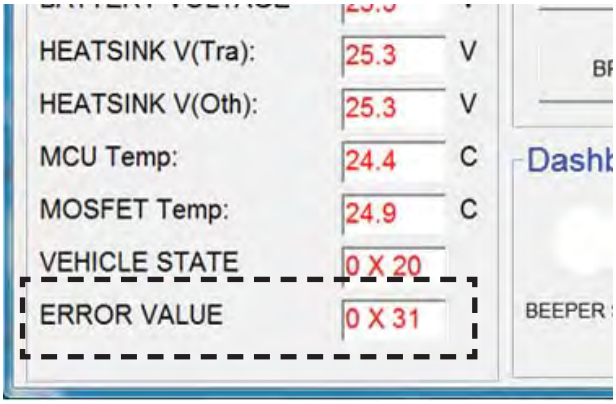


Current and Volts: This column indicates the current and volt ranges for the listed machine operating systems. In the below example the TRACT CURRENT A (Amps) and TRACT VOLTAGE V (Voltage) measure are displayed. See MACHINE SYSTEM RANGES for normal voltage and amp ranges.



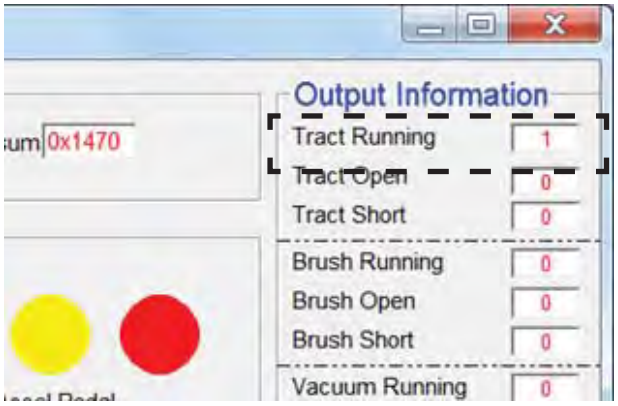
NOTE: The letters FWD in the TRACT DIRECT cell indicate the machine is in the forward direction for the testing being conducted.

ERROR VALUE: Error codes are located at the bottom for the Currents and Volts column. See FAULTS AND WARNINGS for error code and further troubleshooting information.

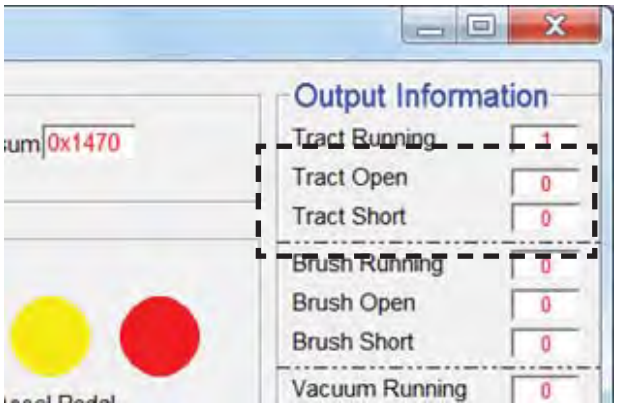


In the above example the error code of 0X31 shows there is a brush adjustment timeout error.

Output Information: This column indicates whether a system is running, open, or short. A numeral 1 appears in the corresponding cell if the cell is active. A numeral 0 appears in the cell if the cell is inactive. In the below example the numeral 1 is in the Tract Running cell, indicating the Tract Running cell is active and there are no faults.



If the numeral 1 was in either the Tract Open or Tract Short cell, this would indicated there was either an Open or Short fault condition with that system and additional troubleshooting is required.

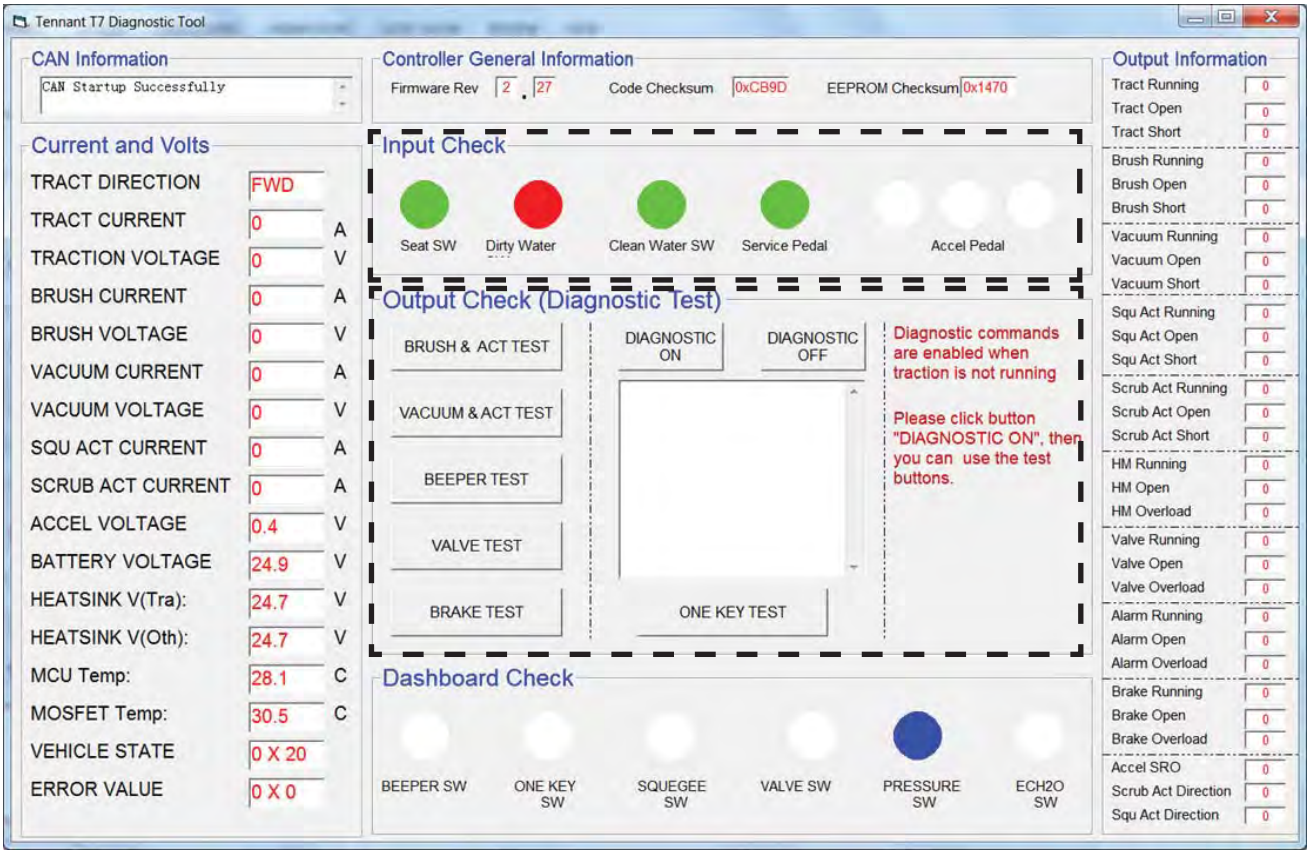


MACHINE SYSTEM RANGES

Refer to the below table to confirm voltage/amp when using the T7AMR SERVICE CONNECTION diagnostics software application for machine troubleshooting.

System	Component	Minimum Value	Nominal Value	Maximum Value	Measure
Propel	Traction Current	-120		110	Amps
	Traction Voltage (Forward)	0		93	% of VBat
	Traction Voltage (Reverse)	0		60	% of VBat
	Traction Voltage (Low Battery)	0		30	% of VBat
	Propel Pedal Voltage (Released)	0.2	0.3	0.5	Volts
	Propel Pedal Voltage (Fully Pressed)	3.8	4.2	4.6	Volts
	Brake Pedal Voltage (Released)	0.2	0.3	0.5	Volts
	Brake Pedal Voltage (Pressed)	3.8	4.2	4.6	Volts
	Parking Brake Voltage (Applied)	0			Volts
	Parking Brake Voltage (Released)		24		Volts
	Propel Disabled Voltage		18		Volts
Scrub	Combined Scrub Motor Current (High Down Pressure)	38	41	44	Amps
	Combined Scrub Motor Current (Medium Down Pressure)	28	31	34	Amps
	Combined Scrub Motor Current (Low Down Pressure)	21	24	27	Amps
	Scrub Motor Voltage	0		22	Volts
	Scrub Actuator Current (Lowering)	0		5	Amps
	Scrub Actuator Current (Raising)	0		3	Amps
	Scrub Actuator Voltage (Lowering)	0	9	9	Volts
	Scrub Actuator Voltage (Raising)	0	9	9	Volts
	Scrub Actuator Voltage (Adjusting for Down Pressure)	3		11	Volts
	Scrubbing Disabled Voltage (Propel Only)		21		Volts
	Water Valve (Conventional)		24		Volts
	ec-H2O Enable (Active)	0			Volts
	ec-H2O Enable (Inactive)		12		Volts
Water Pickup	Vacuum Current	0		42	Amps
	Vacuum Voltage	0		22	Volts
	Squeegee Actuator Current (Lowering)	0		7	Amps
	Squeegee Actuator Current (Raising)	0		7	Amps
	Squeegee Actuator Voltage (Lowering)	0	12	12	Volts
	Squeegee Actuator Voltage (Raising)	0	12	12	Volts
	Horn Voltage (Active)		24		Volts
	Vehicle State		0x20		
	Error Value (See FAULTS AND ERRORS for all error codes)		0x00		No Errors

INPUT CHECK/OUTPUT CHECK (DIAGNOSTIC TEST)



Input Check: When these indicators are green the machine is ready for operation. If any indicator is red, the machine is not ready for operation and corrective action must be taken to correct the problem before the machine can be operated. If any of the Input Check indicators is showing a “false red” (indicating an error or action is occurring that is not occurring) further troubleshooting will be necessary to find what is causing the indicator to turn red.

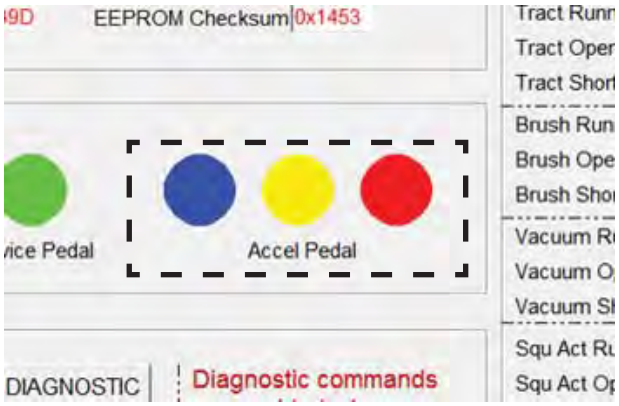
Seat SW: The seat switch indicator is green when the seat switch recognizes there is an operator sitting in the operator seat. The indicator is red to indicate there is no operator in the operator seat.

Dirty Water: The Dirty Water (recovery tank) indicator is green to indicate the recovery tank is not full. The indicator is red when the recovery tank is full.

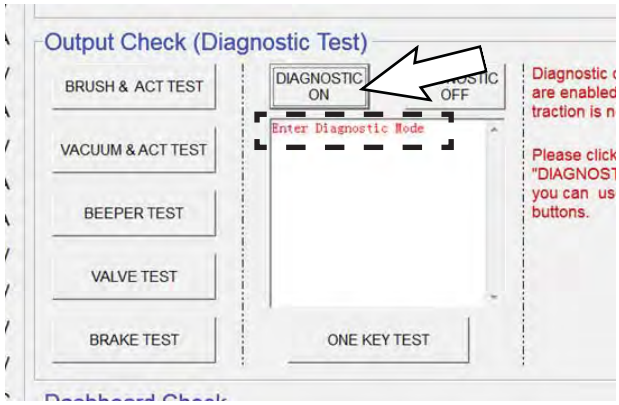
Clean Water SW. The Clean Water SW (solution tank) indicator is green when there is solution for cleaning in the solution tank. The indicator is red when the solution tank is empty.

Service Pedal: The Service Pedal indicator is green when the service brake is not depressed. The indicator is red when the brake pedal is pressed.

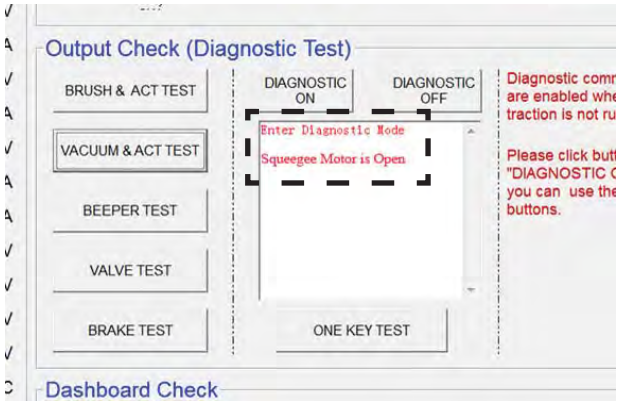
Accel Pedal: The three Accel Pedal (propel pedal) indicators illuminate to indicate low, medium, and high travel speed. The first indicator is blue when the machine is travelling at low speed. The next indicator is yellow when the machine is travelling at medium speed (the blue light low speed indicator is also illuminated). The last button is red when the machine is travelling at high speed (the previous two lower speed lights are also illuminated).



Output Check (Diagnostic Test): Press the DIAGNOSTIC ON button to activate the Output Check (Diagnostic Test) function Enter Diagnostics Mode will appear in the diagnostics status box.



Text appears in the diagnostic status box indicating the diagnostics on/off status and the result(s) of the diagnostic test(s).



NOTE: Allow the diagnostic results of the previously chosen test to appear in diagnostic status box before initiating another test.

Press the BRUSH & ACT TEST button to test the scrub brush and scrub head actuator function.

Press the VACUUM & ACT TEST button to test the squeegee actuator and vacuum functions.

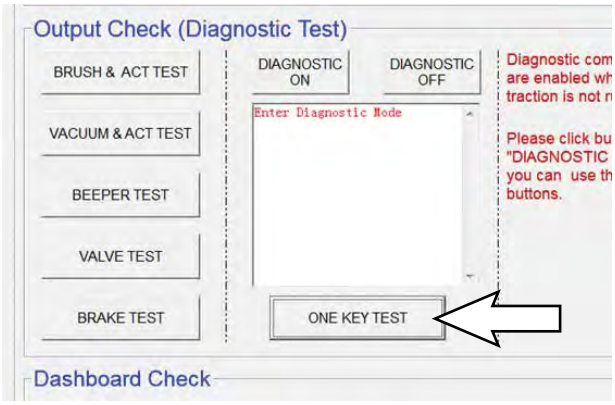
Press the BEEPER TEST button to test the horn and audible alarm.

Press the VALVE TEST button to test the solution control system.

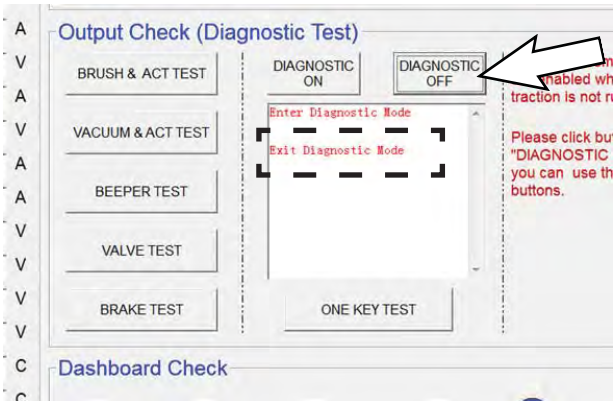
Press the BRAKE TEST button to test the service brakes.

NOTE: There is no indicator that the test is completed if no fault is noted in the diagnostic status box. Check the Output Information column to confirm the tests are completed. If all cells in the Output Information column are 0 (zero), then no tests are active.

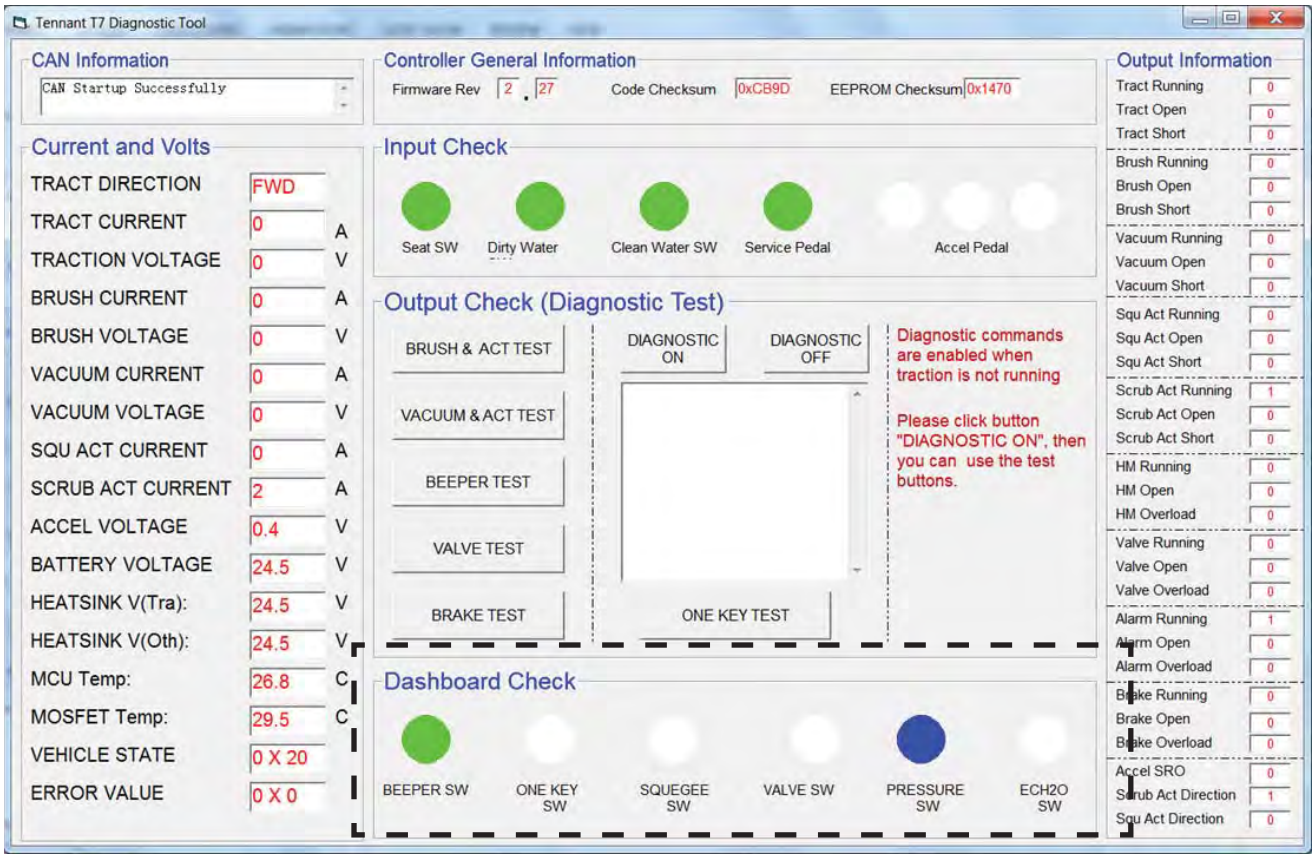
Press the ONE KEY TEST button to test all previously mentioned systems. All systems will briefly activate separately in sequential order after the button is pressed.



Press the DIAGNOSTICS OFF button when through testing machine diagnostics. Exit Diagnostics Mode will appear in the diagnostics status box.



DASHBOARD CHECK



Dashboard Check: Each of these indicators will change colors, depending on the input from the button being pushed to activate a particular system and at what level the chosen system is functioning at in the case of systems that have different operating levels. If one of the indicators does not turn green in the case of single function button or blue, yellow, red in the case of multifunction buttons, further troubleshooting is needed to determine why the button is not functioning.

BEEPER SW: When the beeper/alarm is activated the indicator will be green.

ONE KEY SW: When the 1-Step button is activated the indicator will be green.

SQUEEGEE SW: When the squeegee is activated the indicator will be green.

VALVE SW: When the solution flow is activated the indicator will be blue when the flow is set to the lowest level, yellow when the solution flow is set to the medium level, and red when the solution flow is at the high level.

PRESSURE SW: The pressure is always illuminated blue, yellow, or red. The pressure cannot be turned off like the other machine functions. Blue indicates the lowest pressure setting, yellow indicated the medium pressure setting, and red indicates the high pressure setting.

ECH2O SW: This indicator turns green after the machine is moving and all other scrubbing functions are active.

FAULT CODES

When the machine or battery charger detects a fault, the service indicator will flash. A fault code is provided to determine problem. Refer to the Faults and Warnings table for fault codes, conditions, reasons, and corrective action for the various fault codes.

Error Code	Fault Condition	Reason	Correction
0x12	EEPROM Error	1. Controller parameter setting out of range. 2. Controller Problem (EEPROM fault).	
0x1A	Battery Low (All Functions Off)	1. Battery voltage is less than 18V. 2. Parameter"Battery Voltage" set to 1 but actual battery is 24V. 3. Controller hardware fault.	1. Charge batteries. 2. Power cycle machine. 3. Contact Tennant Customer Service Department.
0x21	Battery Low (Traction Only)	1. Battery voltage is less than set parameter value (Class 0 Volt). 2. Controller hardware fault.	1. Charge batteries. 2. Power cycle machine. 3. Contact Tennant Customer Service Department.
0x23	MCU Over Temperature	1. Controller is over temperature.	1. Power cycle machine. 3. Contact Tennant Customer Service Department.
0x26	Precharge Failure (Traction)	1. Wiring problem. 2. Controller hardware fault.	
0x29	Traction Left Null Error	1. Controller firmware fault. 2. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x2D	Brush Null Error	1. Controller firmware fault. 2. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x2E	Vacuum Null Error	1. Controller firmware fault. 2. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x2F	Squeegee Null Error	1. Controller firmware fault. 2. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x31	Brush Adjustment Time Out	1. Brush pressure adjustment parameters setting not reasonable.	1. Adjust brush pressure. 2. Power cycle machine.
0x32	Solenoid Welded (Traction)	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x33	Solenoid Did Not Close (Traction)	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x37	Throttle Fault	1. Hall accelerator output more than 5V.	1. Power cycle machine. 2. Troubleshoot propel pedal/brake pedal sensor.
0X3A	Brake Fault	1. Brake output over current. 2. Controller hardware fault.	1. Power cycle machine. 2. Troubleshoot brake circuit.
0X3B	Alarm Fault	1. Alarm output over current. 2. Controller hardware fault.	1. Power cycle machine. 2. Troubleshoot horn circuit.
0X3C	Aux1 Fault	1. Aux1 output over current. 2. Controller hardware fault.	1. Power cycle machine. 2. Troubleshoot hour meter circuit.
0X3D	Aux2 Fault	1. Aux2 output over current. 2. Controller hardware fault.	1. Power cycle machine. 2. Troubleshoot conventional solution valve circuit.
0x3F	Brush Deck Null Error	1. Controller firmware fault. 2. Controller hardware fault.	1. Contact Tennant Customer Service Department.

Error Code	Fault Condition	Reason	Correction
0x42	Traction Motor Stalled	1. Traction motor stalled. 2. Parameter ”Traction I Limit” set too low.	1. Power cycle machine.
0x44	Traction Reverse Short Circuit Protection	1. Traction motor short circuit.	1. Power cycle machine. 2. Troubleshoot propel circuit.
0x4C	Traction Forward Short Circuit Protection	1. Traction motor short circuit.	1. Power cycle machine. 2. Troubleshoot propel circuit.
0x4D	Brush Over Current Protection	1. Brush motor peak current more than 150A.	1. Power cycle machine. 2. Troubleshoot scrub motor circuit.
0x4E	Brush Short Circuit Protection	1. Brush motor short circuit.	1. Power cycle machine. 2. Troubleshoot scrub motor circuit.
0x59	Traction Left Drain Fault	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x5B	Traction Right Drain Fault	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x5C	Traction Reverse Over Current Protection	1. Traction motor peak current greater than 190A.	1. Power cycle machine. 2. Troubleshoot propel circuit.
0x5D	Traction Forward Over Current Protection	1. Traction motor peak current greater than 190A.	1. Power cycle machine. 2. Troubleshoot propel circuit.
0x62	Supply Out Of Range	1. Controller hardware fault	1. Contact Tennant Customer Service Department.
0X64	Brush Deck Over Current Protection	1. Brush deck motor peak current greater than 9A.	1. Power cycle machine. 2. Troubleshoot scrub head lift/lower circuit.
0x65	Vacuum Short Circuit Protection	1. Vacuum motor short circuit.	1. Power cycle machine. 2. Troubleshoot vacuum circuit.
0X66	Brush Deck Short Circuit Protection	1. Brush deck motor short circuit.	1. Power cycle machine. 2. Troubleshoot scrub head lift/lower circuit.
0X67	Squeegee Over Current Protection	1. Squeegee motor peak current greater than 9A.	1. Power cycle machine. 2. Troubleshoot squeegee lift/lower circuit.
0x68	Vacuum Over Current Protection	1. Vacuum motor peak current greater than 60A.	1. Power cycle machine. 2. Troubleshoot vacuum circuit.
0X69	Squeegee Short Circuit Protection	1. Squeegee motor short circuit.	1. Power cycle machine. 2. Troubleshoot squeegee lift/lower circuit.
0X6A	Valve Fault	1. Valve output over current. 2. Controller hardware fault.	1. Power cycle machine. 2. Troubleshoot conventional solution valve circuit.
0x6C	Traction Right Null Error	1. Controller firmware fault. 2. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x72	Solenoid Welded (Others)	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x73	Solenoid Did Not Close (Others)	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x74	Squeegee Motor Stalled	1. Squeegee motor stalled. 2. Parameter ”Squeegee Current Limit” set too low.	1. Power cycle machine. 2. Troubleshoot squeegee lift/lower circuit.

Error Code	Fault Condition	Reason	Correction
0x75	Brush Deck Motor Stalled	1. Brush deck motor stalled. 2. Parameter ”Bru-D Current Limit” set too low.	1. Power cycle machine. 2. Troubleshoot scrub head lift/lower circuit.
0x76	Precharge Failure (Others)	1. Wiring problem. 2. Controller hardware fault.	1. Power cycle machine. 2. Contact Tennant Customer Service Department.
0x77	Brush Motor Stalled	1. Brush motor stalled. 2. Parameter ”Brush Current Limit” set too low.	1. Power cycle machine. 2. Troubleshoot scrub motor circuit.
0x78	Vacuum Motor Stalled	1. Vacuum motor stalled. 2. Parameter ”Vacuum Current Limit” set too low.	1. Power cycle machine. 2. Troubleshoot vacuum circuit.
0x7E	Tract_Left_Low_FET_ Short	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0X83	MOSFET Over Temperature	1. Output current too big. 2. Controller heat dissipation not good (installation baseplate, etc...). 3 Controller hardware fault.	1. Power cycle machine. 2. Contact Tennant Customer Service Department.
0x8E	Tract_Left_High_FET_ Short	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0xA2	High Battery Protection	1. Battery voltage greater than 45V. 2. Parameter ”Battery Voltage” set to 0 but battery 36V. 3. Controller Hardware fault.	1. Power cycle machine. 2. Contact Tennant Customer Service Department.
0x9A	Tract_Right_Low_FET_ Short	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x9B	Tract_Right_High_FET_ Short	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.

ec-H2O NANOCLEAN ICON FAULTS

Machine Indicator	Module Status	Fault Code	Fault Condition	Cause	Correction
Solid Red	Off	0x0711	ec-H2O Pump Open Fault	1. ec-H2O pump wiring, connector or control board issue.	Control board is not detecting pump current. Check connections for voltage and verify pump is operating.
	Off	0x0713	ec-H2O Pump Over Current Fault	1. Current draw higher than expected.	Check pump operating current.
	Off	0x0716	ec-H2O Pump Short Fault	1. Shorted load condition 2. Higher current draw than hardware design limit.	Refer to ec-H2O NanoClean Troubleshooting Guide.
	Off	0x0717	ec-H2O Pump FET Short	1. Current detected on pump drive circuit when not actively operating.	Refer to ec-H2O NanoClean Troubleshooting Guide.
	Off	0x0727	ec-H2O Cell FET Faults	1. Control board problem. 2. Power/battery issue on startup.	Replace control board. FET detection includes motor, actuator, detergent pump, vacuum and battery watering pump.
	Off	0x0741	ec-H2O WCM Pump Open Warning	1. Wiring, connector or control board issue on ec-H2O pump.	Verify the water conditioning module micro pump is connected to machine harness and pump is functional.
	Off	0x0746	ec-H2O WCM Pump Short Warning	1. Shorted load condition 2. Some higher current draw than hardware design limit.	Check harness. Verify water conditioning module micro pump is functional.
Flashing Red	Off	0x0702	ec-H2O Pressure Switch Active	1. The system pressure switch is detecting a trip or unconnected.	1. System pressure too high. 2. Check connections. Connectors possibly wired to incorrect switches.
	Fast blink	0x0708	ec-H2O System Over Regulation Warning	1. Cell has operated over target current condition for last 50 treated gallons.	Check water in solution tank for presence of detergents.
	Slow blink	0x0721	ec-H2O Cell Open Fault	1. ec-H2O cell wiring, connector or control board issue.	Check connector/wire connections.
	Slow blink	0x072A	ec-H2O Cell Electrode Fault	1. Cell current is operating below allowed operating condition.	Refer to ec-H2O NanoClean Troubleshooting Guide.
	Fast blink	0x0726	ec-H2O Cell Short Warning	1. Shorted load condition 2. Higher current draw than hardware design limit.	Refer to ec-H2O NanoClean Troubleshooting Guide

Machine Indicator	Module Status	Fault Code	Fault Condition	Cause	Correction
Green/ Blue	Fast blink	0x0728	ec-H2O Cell Over Regulation	1. Cell current exceeds set point for expected operation. Fault is indicated via a flashing blue light on ec-H2O module.	Refer to ec-H2O NanoClean Troubleshooting Guide.
	Fast blink	0x072B	ec-H2O Cell Over Current Warning	1. Cell current is exceeding set point during the first 60 seconds when machine is powered on. Will most likely lead to a cell short fault if conditions persists.	Refer to ec-H2O NanoClean Troubleshooting Guide.
	Slow blink	0x0729	ec-H2O Cell Under Regulation	1. Cell Current under set point for expected operation. Fault is indicated via a flashing blue light on ec-H2O module.	Refer to ec-H2O NanoClean Troubleshooting Guide.
Red-Green/ Red-Blue	-	0x0707	ec-H2O Water Conditioning Cartridge Expired Warning	1. ec-H2O water cartridge has expired due to either gallons of usage or 2 years of use.	1. Replace ec-H2O water conditioning cartridge.

OFF-BOARD CHARGER ERROR AND FAULT CODES

Code	Description	Cause	Solution
E-0-0-1 E-0-2-1	Battery high voltage	1. Wrong battery voltage for charger. 2. Other charger also attached. 3. Resistive battery.	Check battery voltage and cable connections. Check battery size and condition. Error will automatically clear once voltage is in range.
E-0-0-2 E-0-2-2	Battery low voltage	1. Battery disconnected. 2. Battery over discharged.	Check battery voltage and cable connections. Check battery size and condition. Error will automatically clear once voltage is in range.
E-0-0-3	Charge time out caused by battery pack not reaching required voltage within safe time limit. (charge profile dependent)	1. Charger output reduced due to high temperatures. 2. Poor battery health. 3. Very deeply discharged battery. 4. Poorly connected battery.	Operate at lower ambient temperature. Replace battery pack. Check DC connections. Error will clear once charger is reset by cycling DC or AC.
E-0-0-4	Battery could not meet minimum voltage (charge profile dependent)	1. Shorted or damaged cells.	Replace battery pack. Check DC connections. Error will automatically clear once charger is reset by cycling DC or AC.
E-0-0-7	Battery amp hour limit exceeded	1. Poor battery health. 2. Very deeply discharged battery. 3. Poorly connected battery. 4. High parasitic loads on battery while charging	Replace battery pack. Check DC connections. Disconnect parasitic loads. Error will automatically clear once charger is reset by cycling DC or AC.
E-0-0-8	Battery temperature is out of range	1. Possible battery temperature sensor error.	Check temperature sensor and connections. Reset charger. Error will clear once condition has been corrected.
E-0-1-2	Reverse polarity error	1. Battery incorrectly connected to charger.	Check battery connections. Error will clear once condition has been corrected
E-0-1-6 E-0-1-8 E-0-2-6	USB operation failed (software)	1. Software upgrade failure. 2. Script operation failure.	Ensure USB flash drive is properly formatted and reinsert USB flash drive.
E-0-1-7	USB operation failed (hardware)	1. Hardware upgrade failure.	Remove and reinsert USB drive. If condition persists, cycle AC and retry by reinserting USB drive.
E-0-2-3	High AC voltage error (>270VAC)	1. Voltage error.	Connect charger to an AC source that provides stable AC between 85 - 270 VAC / 45-65 Hz. Error will clear once condition has been corrected.
E-0-2-4	Charger failed to initialize	1. Charger has failed to turn on properly	Disconnect AC input and battery for 30 seconds before retrying.
E-0-2-5	Low AC voltage oscillation error	1. AC source is unstable. 2. Undersized generator. 3. Severely undersized input cables	Connect charger to an AC source that provides stable AC between 85 - 270 VAC / 45-65 Hz. Error will clear once condition has been corrected.
F-0-0-1 F-0-0-2 F-0-0-3 F-0-0-4 F-0-0-6	Internal charger fault	1. Internal charger fault.	Remove AC and battery for minimum 30 seconds and retry charger. If it fails again, contact vehicle or machine manufacturer.

Off-Board Charger Error and Fault Codes table taken from the Delta-Q IC650 Charger Manual.

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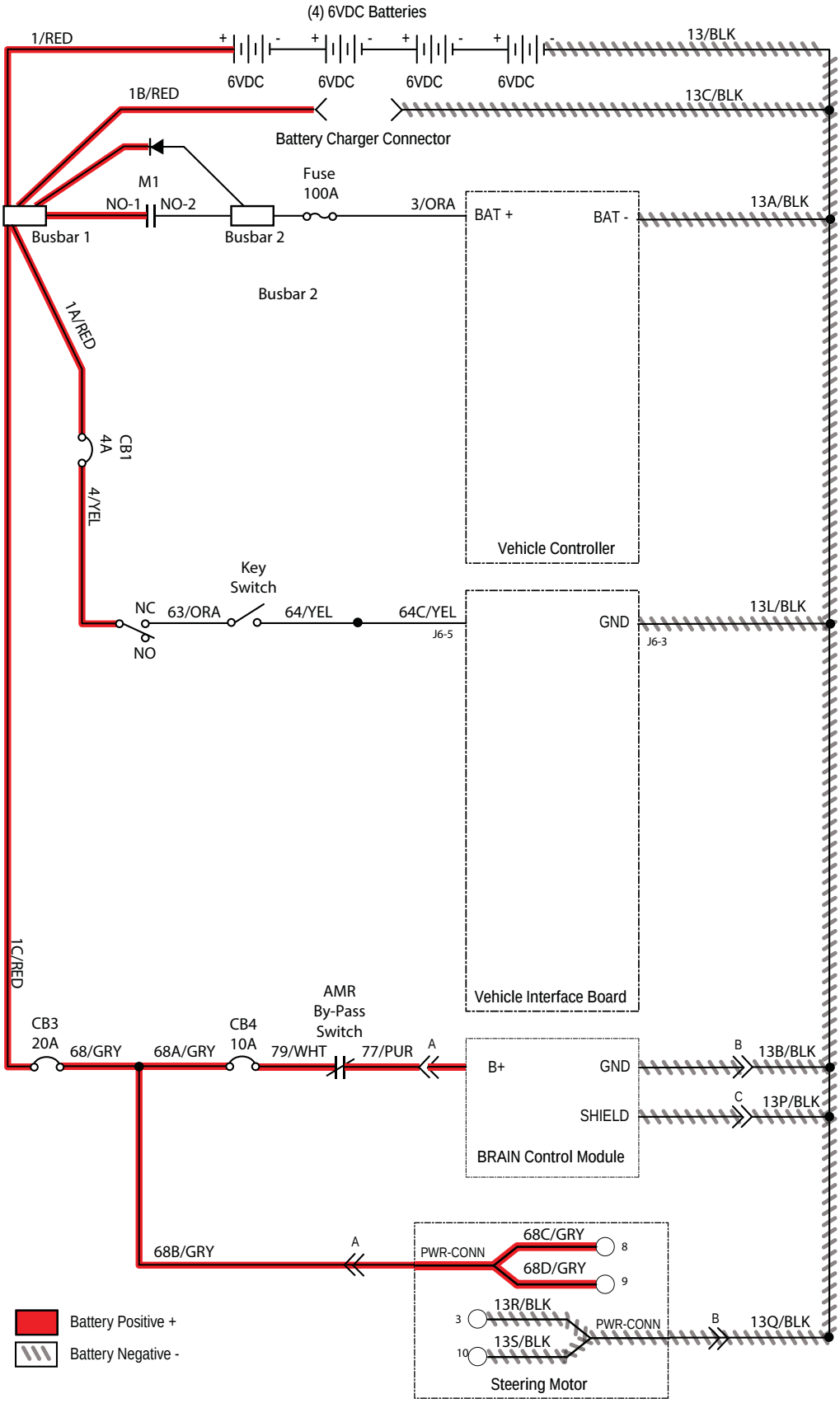
OFF-BOARD BATTERY CHARGING ON



BATTERIES FAIL TO CHARGE/REDUCED RUN TIME (OFF-BOARD CHARGER)

Step	Action	Value(s)	Yes	No
1	• Key OFF • Are batteries disconnected?		Connect the batteries	Proceed to STEP 2
2	• Key OFF • Check AC power supply • Is the rated AC supply voltage present?		Proceed to STEP 4	Check AC supply circuit protection
3	• Key OFF • Inspect battery and charger cables for damage/ corrosion/contamination/terminal problems		Repair or replace battery/battery charger cables	Proceed to STEP 4
4	• Key OFF • Disconnect batteries • Check water level in all battery cells • Are the lead plates submerged?		Proceed to STEP 5	Add distilled water as necessary until lead plates are covered
5	• Key OFF • Use a hydrometer or refractometer to test specific gravity of each cell (Lead-Acid) • Are all battery cells within 0.050 (50 points) specific gravity of each other?		Replace battery charger	Replace battery charger or batteries

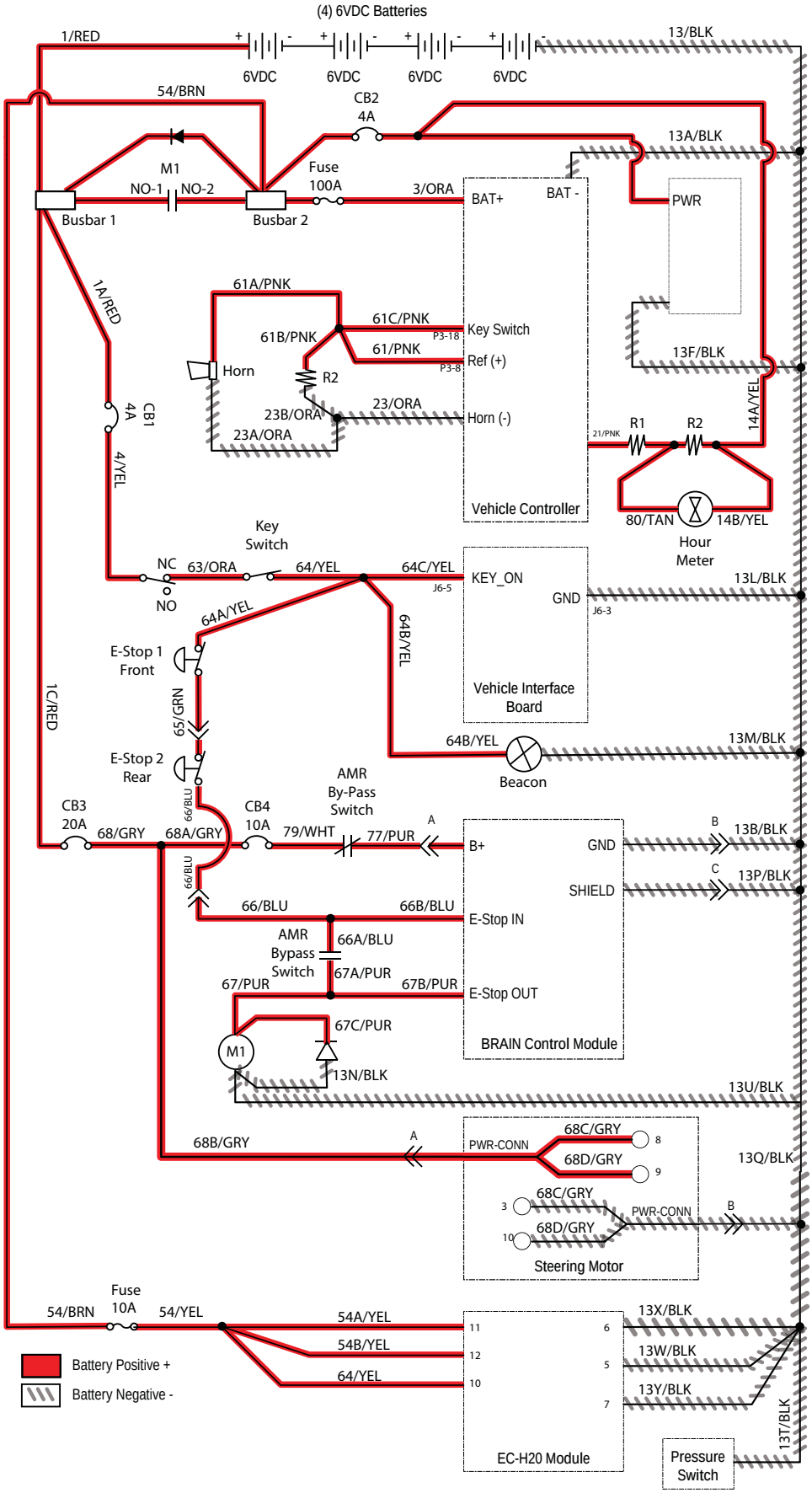
Terms:

AC = Alternating Current

AGM = Absorbed Glass Mat

Specific Gravity = Relative density of a substance compared to water (1.000 specific gravity)

POWER UP ON


(4) 6VDC Batteries
1/RED
6VDC
6VDC
6VDC
6VDC
13/BLK
54/BRN
CB2
4A
13A/BLK
M1
NO-1
NO-2
Busbar 1
Busbar 2
Fuse
100A
3/ORA
BAT+
BAT -
PWR
Vehicle Controller
1A/RED
61A/PNK
61C/PNK
61B/PNK
61/PNK
Key Switch
P3-18
Ref (+)
P3-8
Horn
R2
23B/ORA
23/ORA
23A/ORA
Horn (-)
13F/BLK
14A/YEL
21/PNK
R1
R2
80/TAN
14B/YEL
Hour
Meter
CB1
4A
4/YEL
Key
Switch
NC
NO
63/ORA
64/YEL
64C/YEL
J6-5
KEY_ON
GND
J6-3
13L/BLK
64A/YEL
64B/YEL
Vehicle Interface
Board
E-Stop 1
Front
1C/RED
65/GRN
E-Stop 2
Rear
64B/YEL
13M/BLK
Beacon
66/BLU
AMR
By-Pass
Switch
CB3
20A
68/GRY
68A/GRY
CB4
10A
79/WHT
77/PUR
A
B+
GND
B
13B/BLK
SHIELD
C
13P/BLK
66/BLU
66B/BLU
E-Stop IN
AMR
Bypass
Switch
66A/BLU
67A/PUR
67/PUR
67B/PUR
E-Stop OUT
BRAIN Control Module
M1
67C/PUR
13N/BLK
13U/BLK
68B/GRY
A
PWR-CONN
68C/GRY
8
68D/GRY
9
13Q/BLK
68C/GRY
3
PWR-CONN
B
68D/GRY
10
Steering Motor
Fuse
10A
54/BRN
54/YEL
54A/YEL
54B/YEL
64/YEL
11
12
10
6
5
7
13X/BLK
13W/BLK
13Y/BLK
13T/BLK
EC-H20 Module
Pressure
Switch
Battery Positive +
Battery Negative -

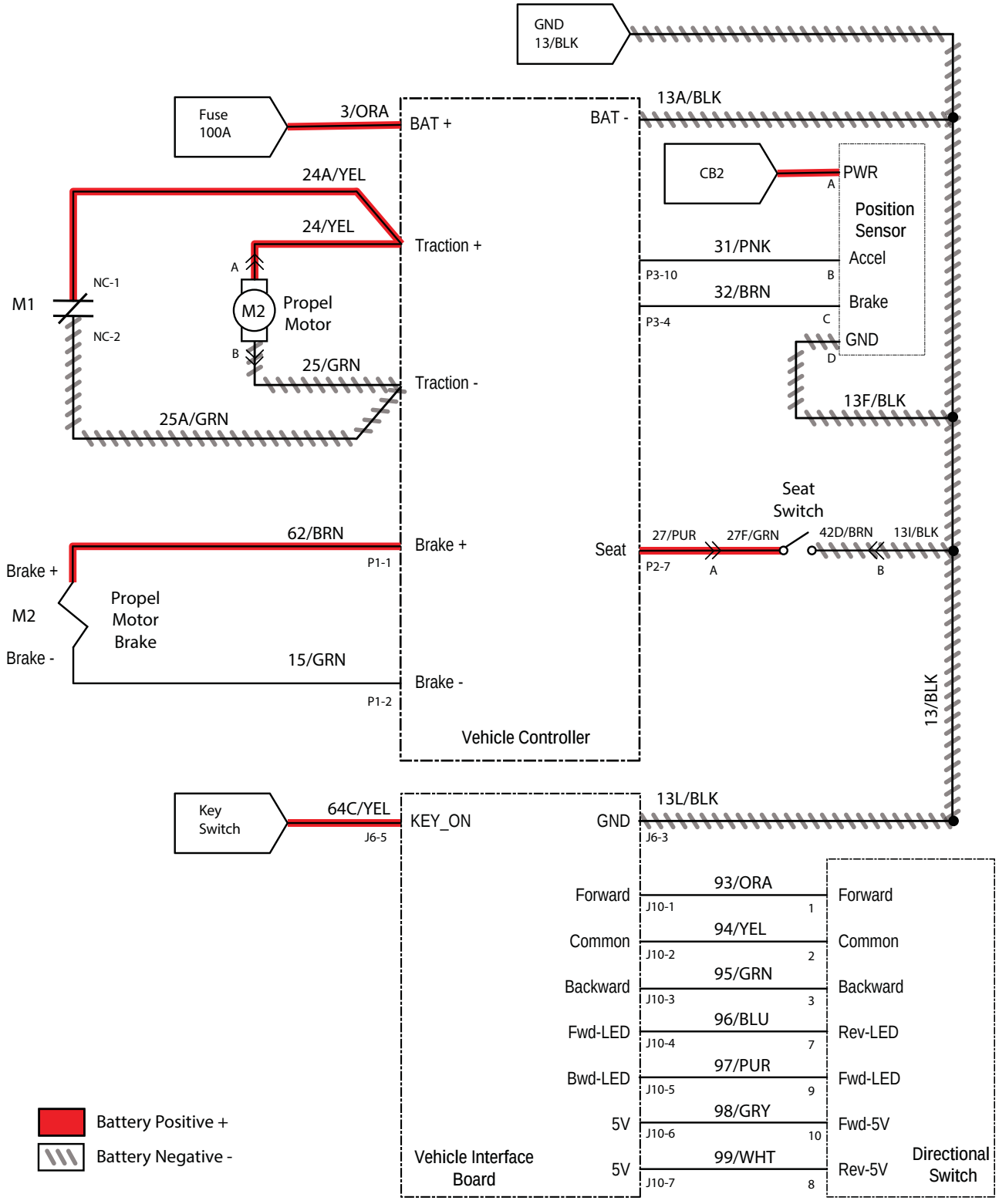
MACHINE FAILED TO POWER UP

Step	Action	Value(s)	Yes	No
1	• Key ON • AMR Bypass Switch in “I” (ON) position • Use a voltmeter to test the total battery voltage • Is total battery voltage greater than 23.5 VDC?		Proceed to STEP 2	Recharge batteries and test power-up circuit operation
2	• Key OFF • AMR Bypass Switch in “I” (ON) position • Firmly press circuit breaker #1 to reset • Is circuit breaker #1 tripped?		Reset and test power-up circuit operation	Proceed to STEP 3
3	• Key ON • AMR Bypass Switch in “I” (ON) position • Test voltage applied to power-up subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components
4	• Key ON • Move the AMR Bypass Switch to “O” (OFF) position • Test voltage applied to power-up subsystem as shown on electrical schematic • Are electrical circuit operating as shown on electrical schematic?		Replace Brain Control Module or Brain Control Module lower harness	Identify voltage drop location and repair or replace necessary components

Terms:

VDC = DC Voltage

PROPEL SYSTEM



PROPEL SYSTEM OPERATIONAL MATRIX

Enabled	Disabled
• Battery voltage > 18V • Operator in seat • Propel pedal pressed • E-Stops not engaged • Charger interlock not engaged • No faults on propel motor output	• Battery voltage < 18V • Operator not in seat • Propel pedal not pressed • E-Stops engaged • Charger interlock engaged • Faults on propel motor output

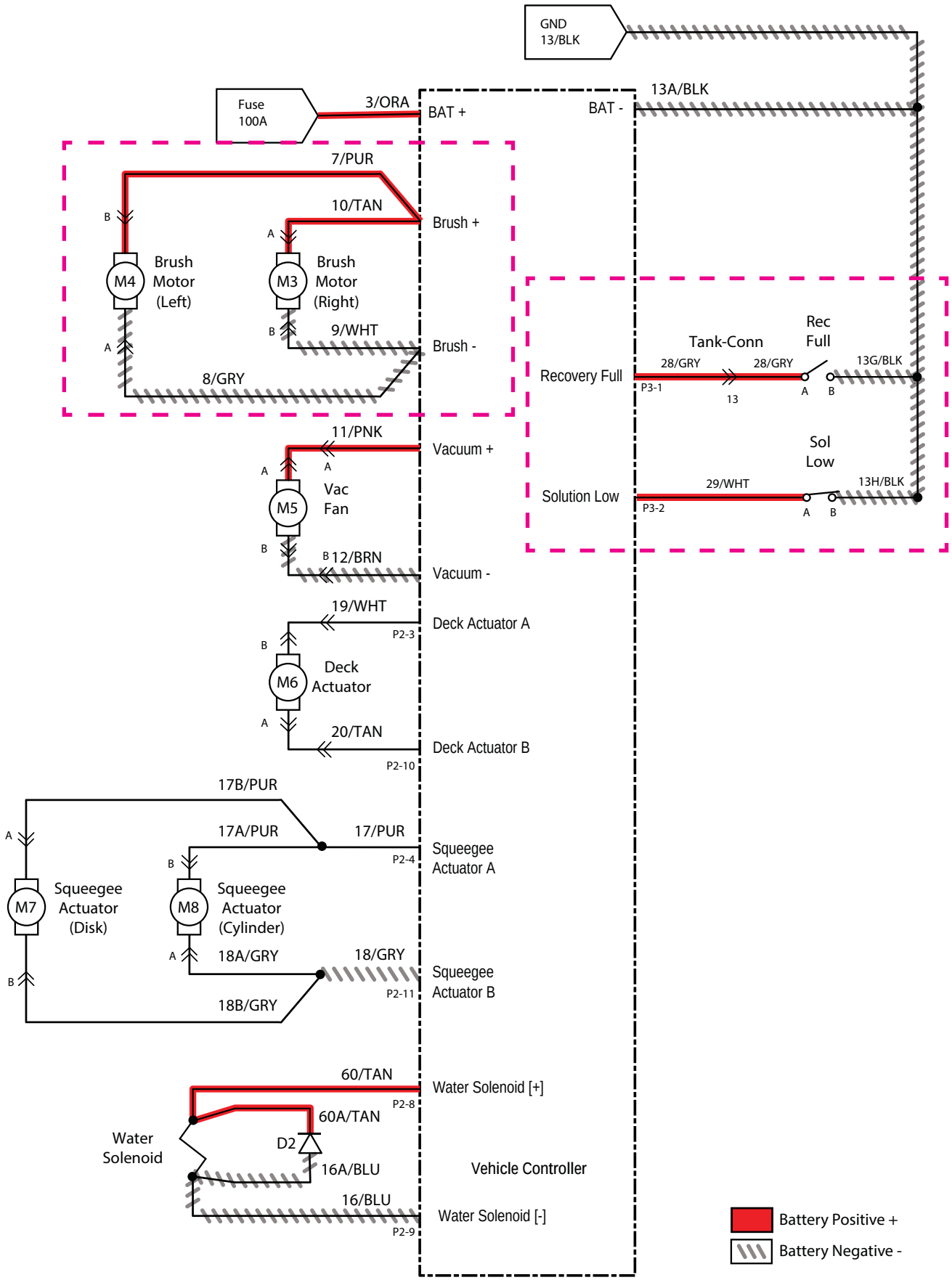
MACHINE FAILED TO PROPEL

Step	Action	Value(s)	Yes	No
1	• Key OFF • Are all interlocks in the proper state to enable manual propel? * Front E-stop not engaged * Rear E-stop not engaged * Operator in seat		Proceed to STEP 2	Ensure all interlocks are in the proper state to enable manual propel
2	• Key OFF • Firmly press circuit breaker #1 to reset • Is circuit breaker #1 tripped?		Reset and test power-up circuit operation	Proceed to STEP 3
3	• Key OFF • Firmly press circuit breaker #2 to reset • Is circuit breaker #2 tripped?		Reset and test power-up circuit operation	Proceed to STEP 4
4	• Key ON • Use a voltmeter to test the total battery voltage • Is total battery voltage greater than 18 VDC?		Proceed to STEP 5	Recharge batteries and test power-up circuit operation
5	• Key OFF • Place machine on blocks so drive wheel is lifted from floor • Key ON • Enable propel • Test voltage applied to propel subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Use T7AMR Service Connection to read error code from controller	Identify voltage drop location and repair or replace necessary components

Terms:

VDC = DC Voltage

SCRUB MOTOR ON



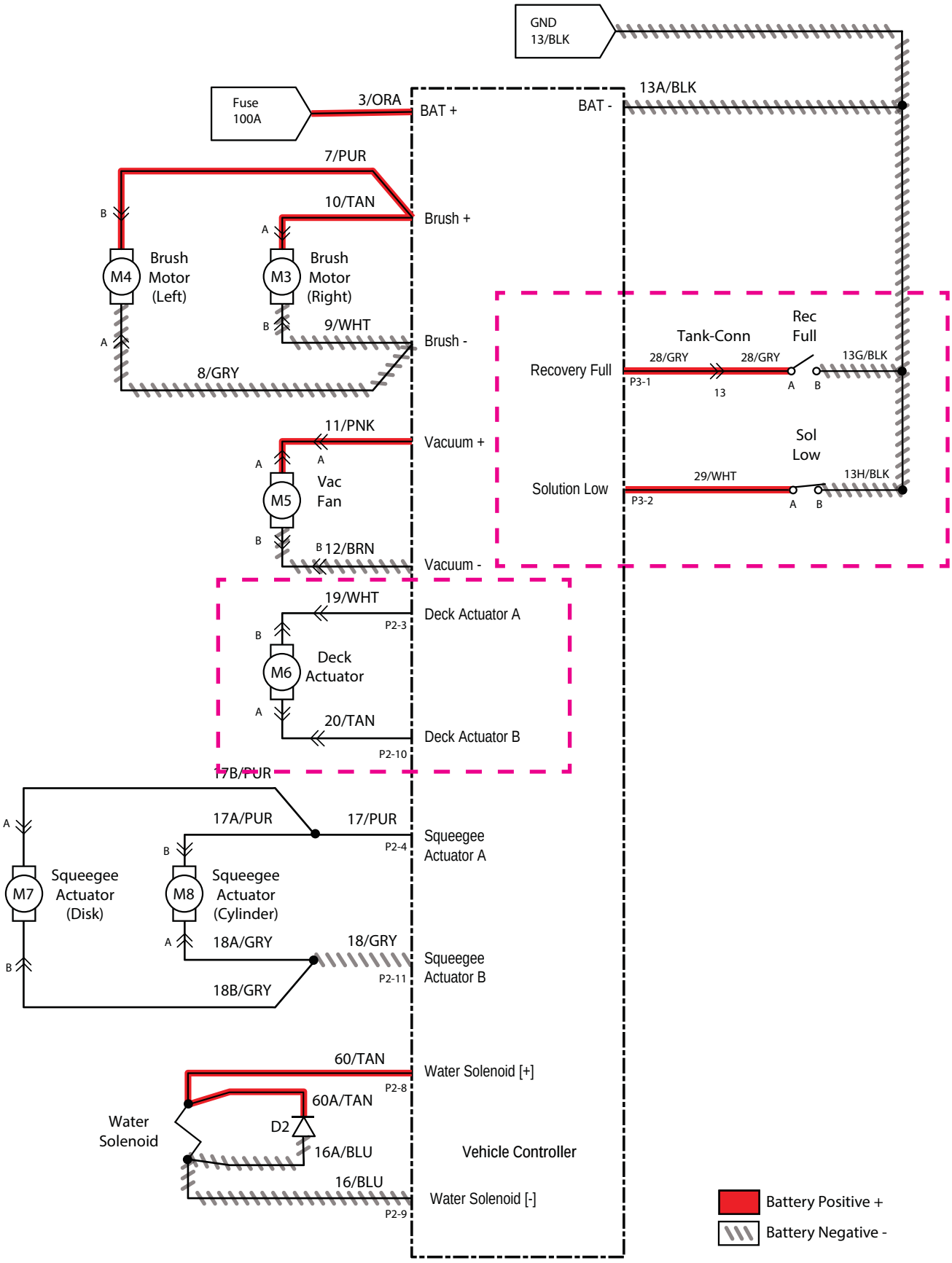
SCRUB MOTOR OPERATIONAL MATRIX

Enabled	Disabled
• Battery voltage > 21V • 1-Step enabled • Scrub deck lowered • Machine is propelling • Solution tank not empty • Recovery tank not full • E-Stops not engaged • Charger interlock not engaged • No faults on scrub motor output	• Battery voltage < 21V • 1-Step disabled • Scrub deck raised/raising • Machine not propelling • Solution tank empty • Recovery tank full • E-Stops engaged • Charger interlock engaged • Faults on scrub motor output

SCRUB MOTOR FAILED TO TURN ON

Step	Action	Value(s)	Yes	No
1	• Key ON • Enable scrub motor • Is there a fault on the membrane panel?		Use T7AMR Service Connection to read error code from controller	Proceed to STEP 2
2	• Key ON • Enable scrub motor • Test voltage applied to scrub motor subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components

SCRUB HEAD LIFT



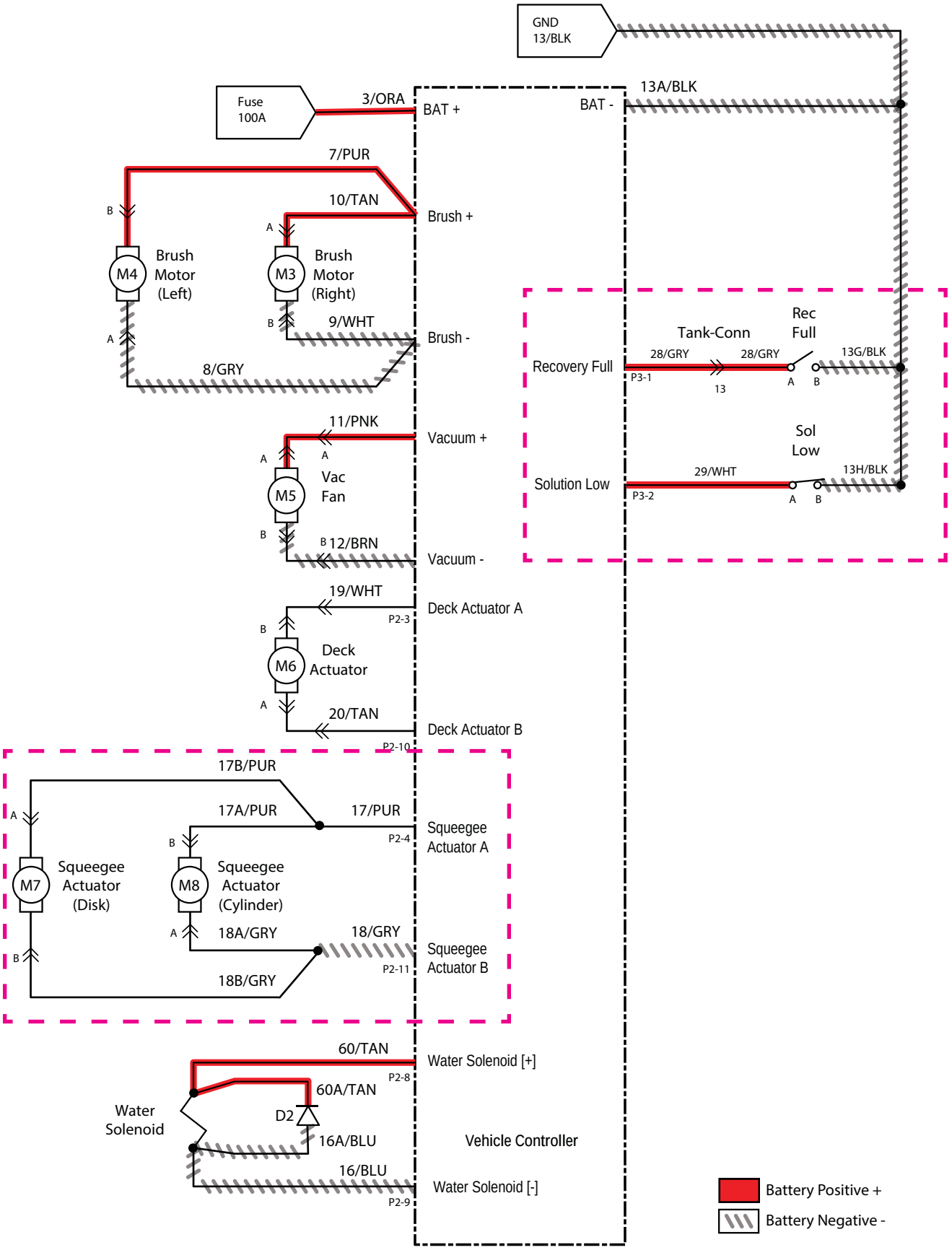
SCRUB HEAD ACTUATOR OPERATIONAL MATRIX

Enabled	Disabled
• Battery voltage > 21V • 1-Step enabled/disabled • Lifts until current limits is reached on power-up and end of scrub • Lowers for fixed time duration at beginning of scrub • Adjusts during scrubbing to maintain down pressure • Solution tank not empty • Recovery tank not full • E-Stops not engaged • Charger interlock not engaged • No faults on scrub deck actuator output	• Battery voltage < 21V • 1-Step not enabled • Lifting current limit is reached • Machine is scrubbing at desired down pressure target • E-Stops engaged • Charger interlock engaged • Faults on scrub deck actuator output

SCRUB HEAD FAILED TO LIFT/LOWER

Step	Action	Value(s)	Yes	No
1	• Key ON • Enable lift actuator • Is there a fault on the membrane panel?		Use T7AMR Service Connection to read error code from controller	Proceed to STEP 2
2	• Key OFF • Inspect actuator and lift mechanism • Is there anything causing the actuator or lift linkage to bind?		Remove anything causing the actuator/ lift linkage to bind	Proceed to STEP 3
3	• Key ON • Enable scrub motor • Test voltage applied to actuator subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components

REAR SQUEEGEE LIFT



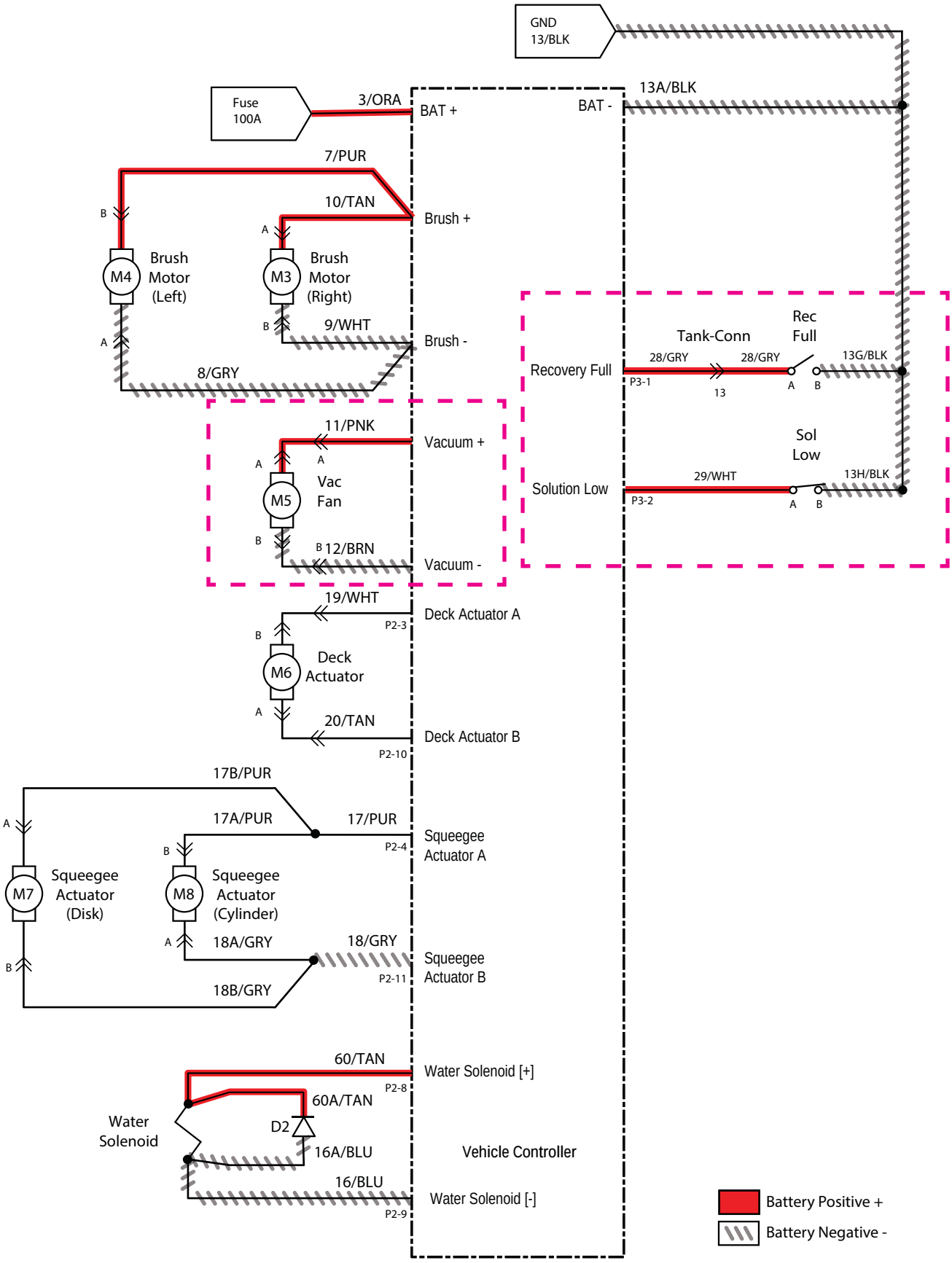
REAR SQUEEGEE ACTUATOR OPERATIONAL MATRIX

Enabled	Disabled
• Battery voltage > 21V • 1-Step or water-pickup enabled • Directional switch set to forward • Lifts when directional switch is set to reverse • Lifts until internal limit switch is hit on power-up and at end of 1-Step/water pickup • Lowers until internal limit switch is hit at beginning of 1-Step/water pickup • Recovery tank not full • E-Stops not engaged • Charger interlock not engaged • No faults on squeegee actuator output	• Battery voltage < 21V • 1-Step or water-pickup not enabled • Will not lower if directional switch set to reverse • Internal limit switches are hit • Recovery tank full • E-Stops engaged • Charger interlock engaged • Faults on squeegee actuator output

REAR SQUEEGEE FAILED TO LIFT/LOWER

Step	Action	Value(s)	Yes	No
1	• Key ON • Enable lift actuator • Is there a fault on the membrane panel?		Use T7AMR Service Connection to read error code from controller	Proceed to STEP 2
2	• Key OFF • Inspect actuator and lift mechanism • Is there anything causing the actuator or lift linkage to bind?		Remove anything causing the actuator/ lift linkage to bind	Proceed to STEP 3
3	• Key ON • Enable lift actuator • Test voltage applied to actuator subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components

VACUUM FAN ON



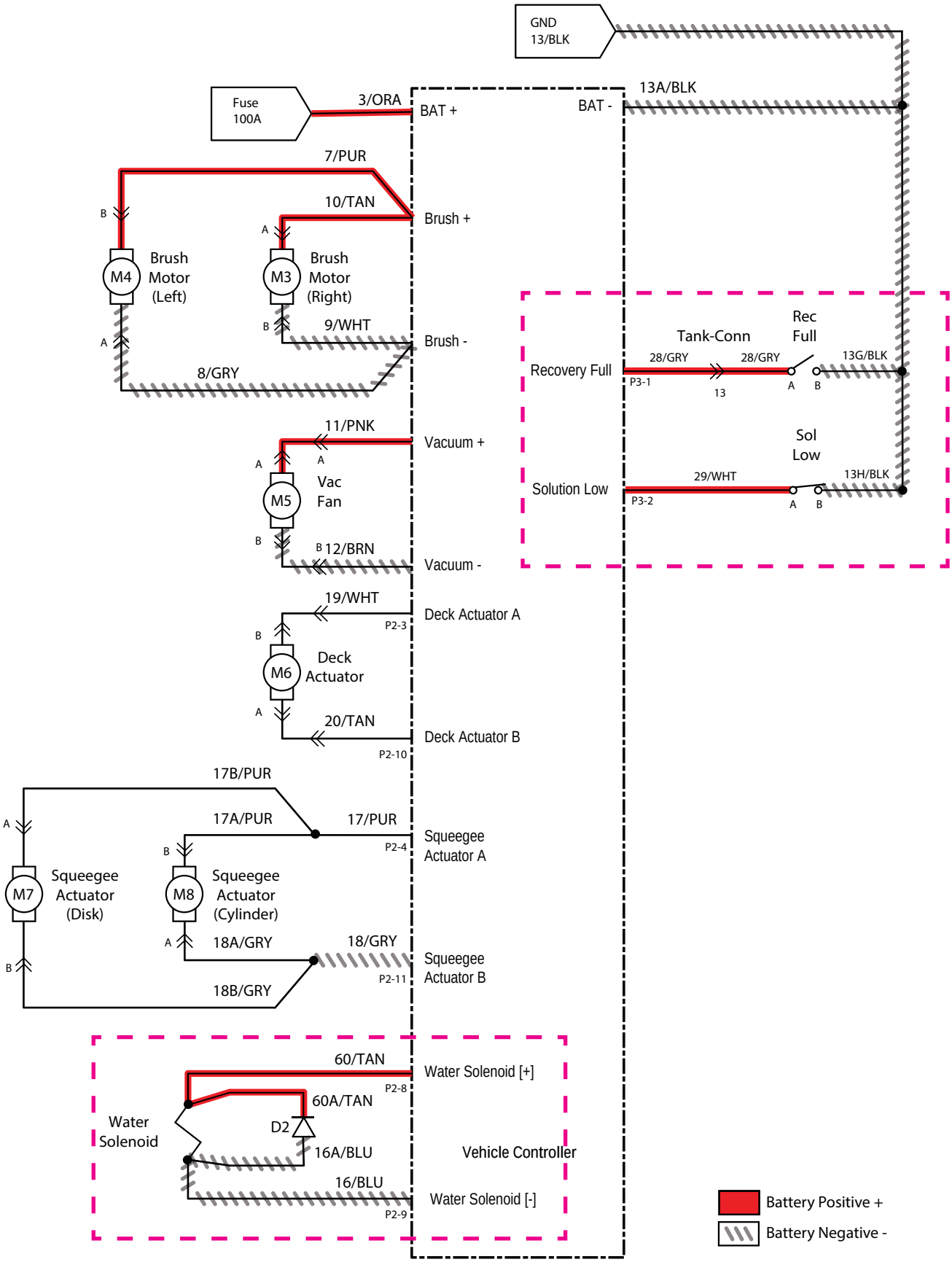
VACUUM FAN OPERATIONAL MATRIX

Enabled	Disabled
• Battery voltage > 21V • 1-Step or water-pickup enabled • Direction switch set to forward • Vacuum fan continues to operate for a period of time after disabling • Adjusts during scrubbing to maintain down pressure • Recovery tank not full • E-Stops not engaged • Charger interlock not engaged • No faults on vacuum fan output	• Battery voltage < 21V • 1-Step or water-pickup not enabled • Direction switch set to reverse • Vacuum off timer expired • Recovery tank full • E-Stops engaged • Charger interlock engaged • Faults on vacuum fan output

VACUUM FAN FAILED TO TURN ON

Step	Action	Value(s)	Yes	No
1	• Key ON • Enable vacuum fan • Is there a fault on the membrane panel?		Use T7AMR Service Connection to read error code from controller	Proceed to STEP 2
2	• Key ON • Enable vacuum fan • Test voltage applied to scrub motor subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components

SOLUTION CONTROL ON (CONVENTIONAL)



SOLUTION CONTROL OPERATIONAL MATRIX

Enabled	Disabled
• Battery voltage > 21V • 1-Step enabled • ec-H2O (if equipped) not enabled • Machine is scrubbing • Solution tank not empty • Recovery tank not full • E-Stops not engaged • Charger interlock not engaged • No faults on water valve output	• Battery voltage < 21V • 1-Step not enabled • ec-H2O (if equipped) is enabled • Machine not scrubbing • Solution tank empty • Recovery tank full • E-Stops engaged • Charger interlock engaged • Faults on water valve output

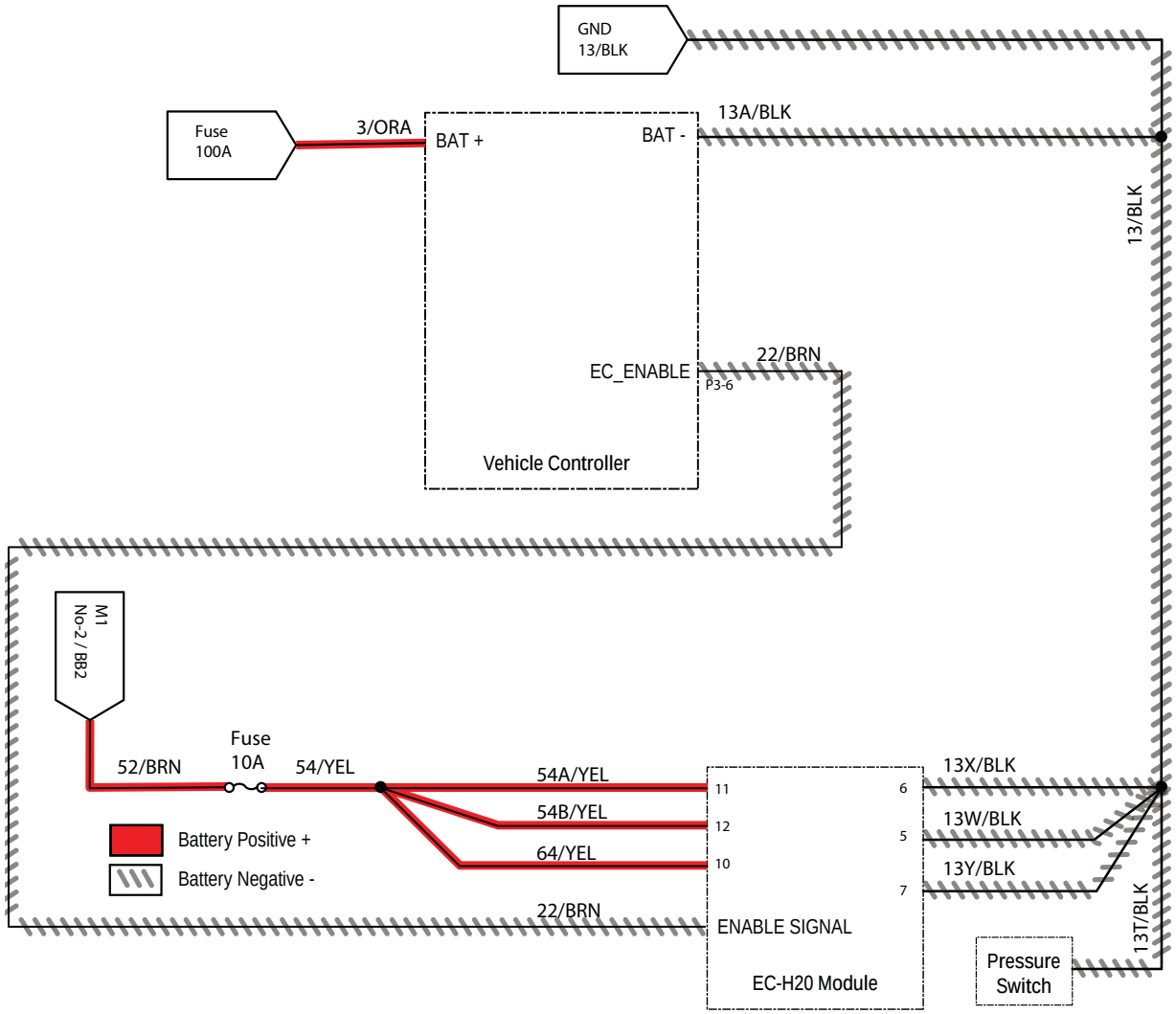
SOLUTION CONTROL DUTY CYCLE

SV-2 Level	On Time %	Period 2.0 SEC
Off (No LEDs)	0%	0.0 S On / 2.0 S Off
Low (1 LED)	50%	1.0 S On / 1.0 S Off
Medium (2 LEDs)	78%	1.6 S On / 0.4 S Off
High (3 LEDs)	100%	2.0 S On / 0.0 S Off

SOLUTION CONTROL FAILED TO TURN ON

Step	Action	Value(s)	Yes	No
1	• Key ON • Enable solution control (conventional) • Is there a fault on the membrane panel?		Use T7AMR Service Connection to read error code from controller	Proceed to STEP 2
2	• Key ON • Enable solution control (conventional) • Test voltage applied to solution control (conventional) subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components

SOLUTION CONTROL ON (ec-H2O) (OPTION)



SOLUTION CONTROL (ec-H2O) OPERATIONAL MATRIX (OPTIONAL)

Enabled	Disabled
• Battery voltage > 21V • 1-Step enabled • ec-H2O enabled • Machine is scrubbing • Solution tank not empty • Recovery tank not full • E-Stops not engaged • Charger interlock not engaged • No faults on ec-H2O enable output	• Battery voltage < 21V • 1-Step not enabled • ec-H2O disabled • Machine not scrubbing • Solution tank empty • Recovery tank full • E-Stops engaged • Charger interlock engaged • Faults on ec-H2O enable output

SOLUTION CONTROL FAILED TO TURN ON (ec-H2O) (OPTIONAL)

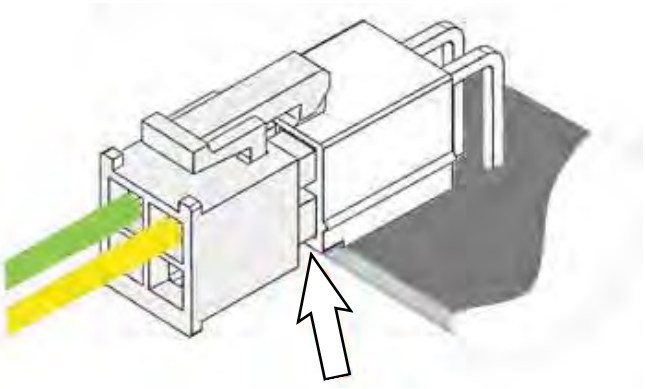
Step	Action	Value(s)	Yes	No
1	• Key ON • Enable solution control (ec-H2O) • Is there a fault on the membrane panel?		Use T7AMR Service Connection to read error code from controller	Proceed to STEP 2
2	• Key OFF • Is the in-line ec-H2O fuse blown?		Replace fuse	Proceed to STEP 3
3	• Key ON • Enable solution control (ec-H2O) • Test voltage applied to solution control (ec-H2O) subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components

CAN OPEN NETWORK ISSUES

The following items include procedures to investigate a fault related to a CAN open network.

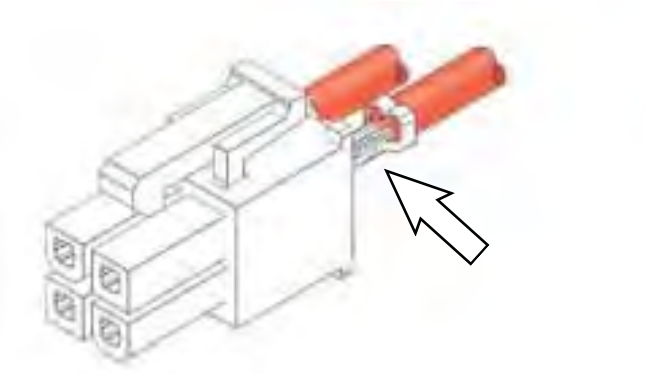
CONNECTOR FULLY SEATED

Each node on the network has a connector for the CAN communication wires. A loose connection could cause a fault code error. Check each board individual to ensure the connectors are fully seated. There may also be other connectors within the harness that should be checked. If the connector is not fully seated, fully seat the connector and power cycle the machine to see if the fault clears.



PIN FULLY SEATED

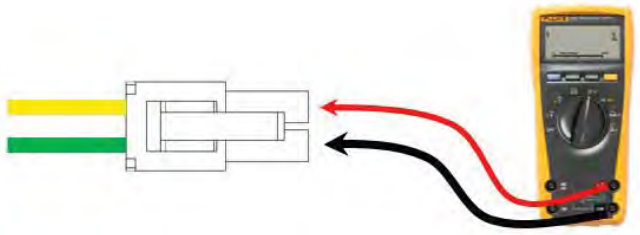
A pin within the harness side of the connector may not be fully seated or may come loose over time causing a fault. If the pin is not fully seated, push it back in and power cycle the machine to see if the fault clears.



NETWORK RESISTANCE

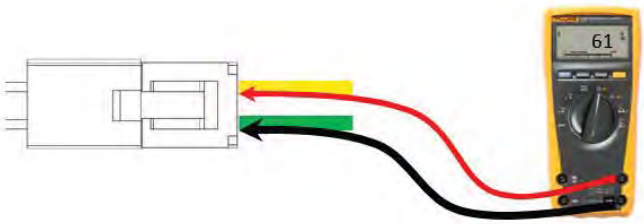
The network resistance must be correct for the network to operate correctly. Depending on which node the measurement is taken at and the method of measurement, the resistance may be one of two values: 121 or 61 Ohms. Any value other than these two means something is wrong with the network.

Method 1



1. Turn off the machine.
2. Locate a CAN node location on the machine.
3. Disconnect the connector containing the CAN wires.
4. Measure the resistance between the green and yellow wires.
5. Depending which nodes are still connected, resistance should be 61 Ohms of 121 Ohms.

Method 2

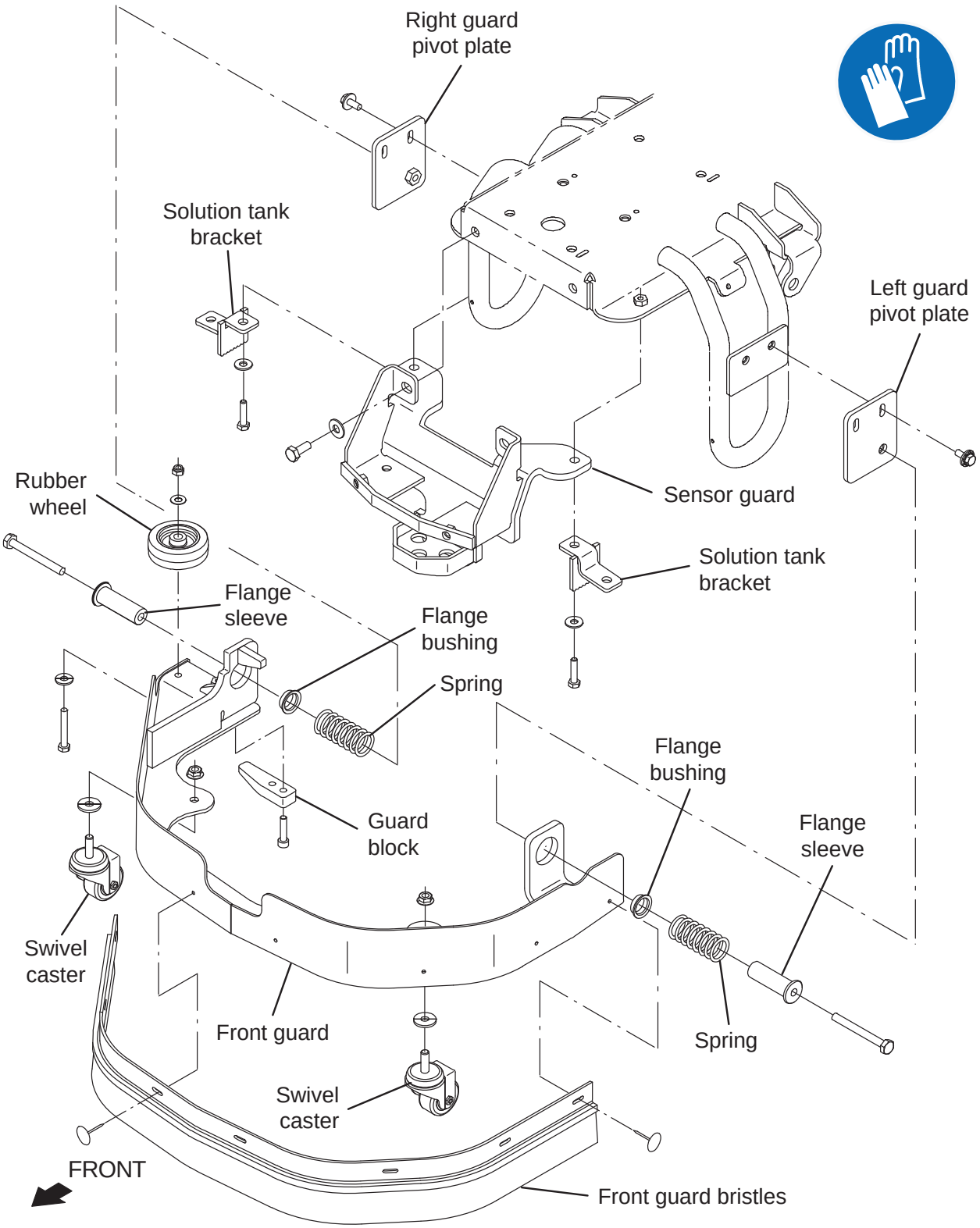


1. Turn off the machine.
2. Locate a CAN node location on the machine.
3. Carefully push probes into the back of the connector containing the CAN wires.
4. Since the network remains connected in this node, resistance should measure approximately 61 Ohms.

SERVICE

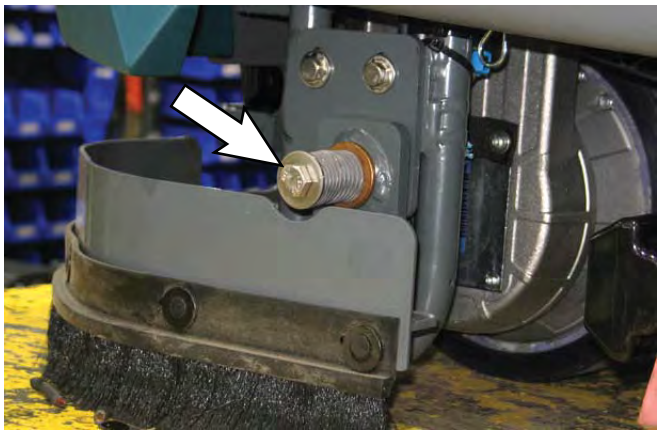
COVERS/SHROUDS/SUPPORT BRACKET/ OPERATOR SEAT/CHASSIS

REMOVE/REINSTALL THE FRONT GUARD

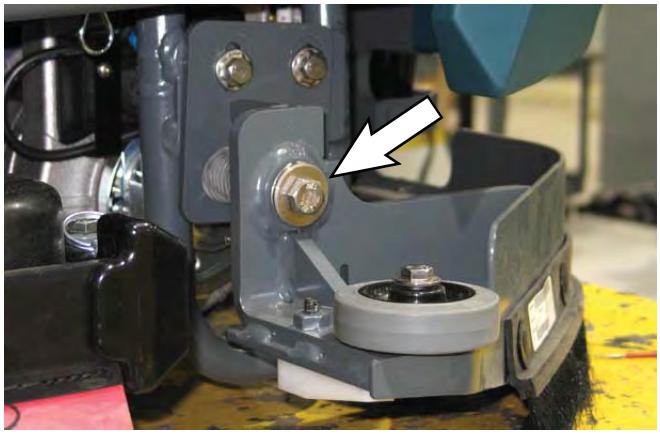


FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Completely lower the scrub head.
2. Turn the ON/OFF key switch OFF.
3. Remove all hardware (hex screws, springs, flat washers, and pins) securing the support bracket to the mounting bracket installed on the stabilizer located on the front left side of the machine.



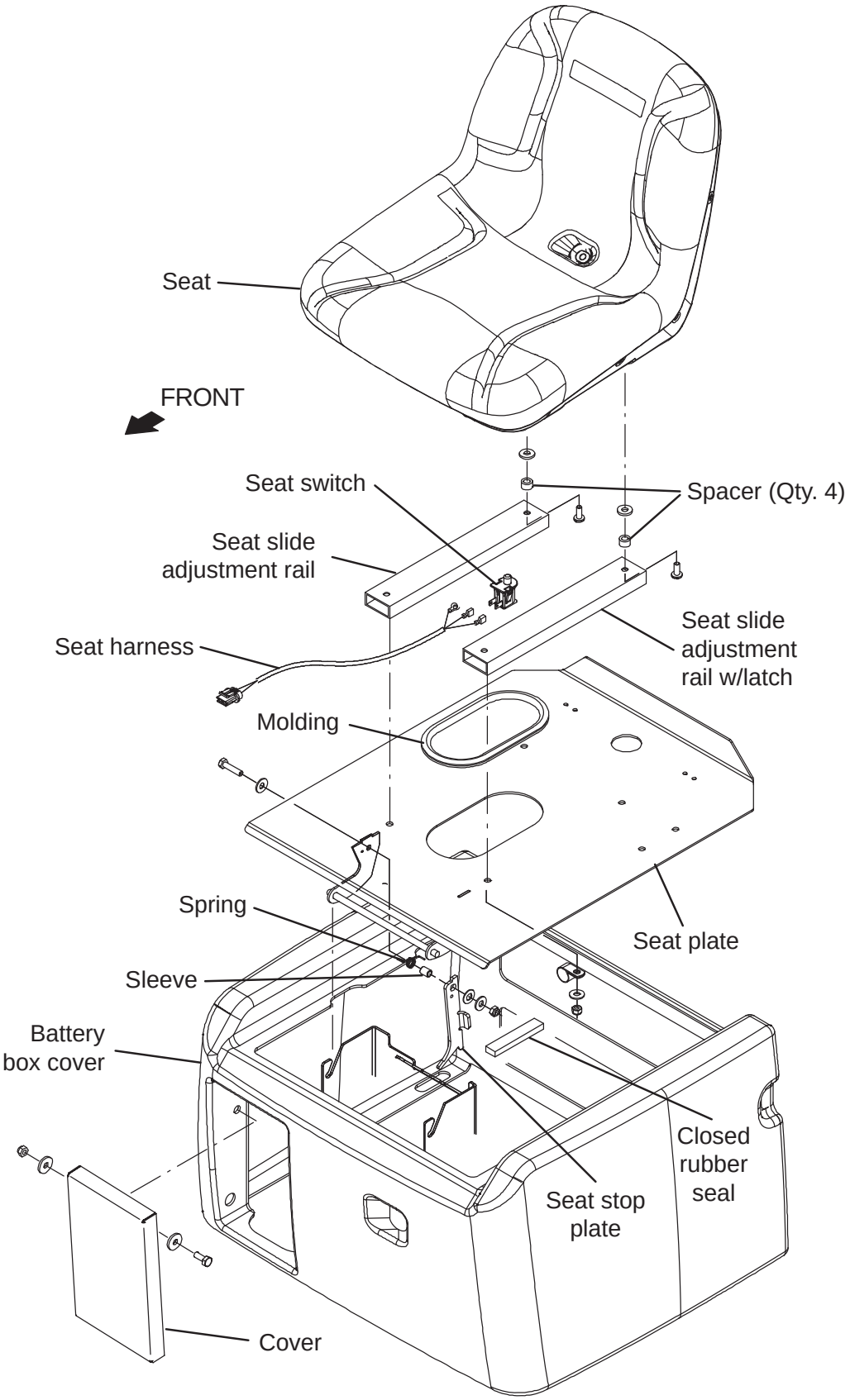
4. Remove all hardware (hex screws, springs, flat washers, and pins) securing the support bracket to the mounting bracket installed on the stabilizer located on the front right side of the machine.



5. Pull the support bracket assembly from under the machine.
6. If replacing the support bracket assembly, remove both caster wheels and the bumper wheel from the support bracket assembly.

7. Install the caster wheels and the bumper wheel removed from the removed support bracket assembly onto the new support bracket assembly.
8. Reinstall the removed support bracket assembly/ new support bracket assembly onto the machine in the reverse order of disassembly.

REMOVE/REINSTALL OPERATOR SEAT/BATTERY BOX COVER



FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Completely empty the recovery tank.
2. Turn the ON/OFF key switch OFF.
3. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

4. Disconnect the main wire harness from the operator seat switch harness.

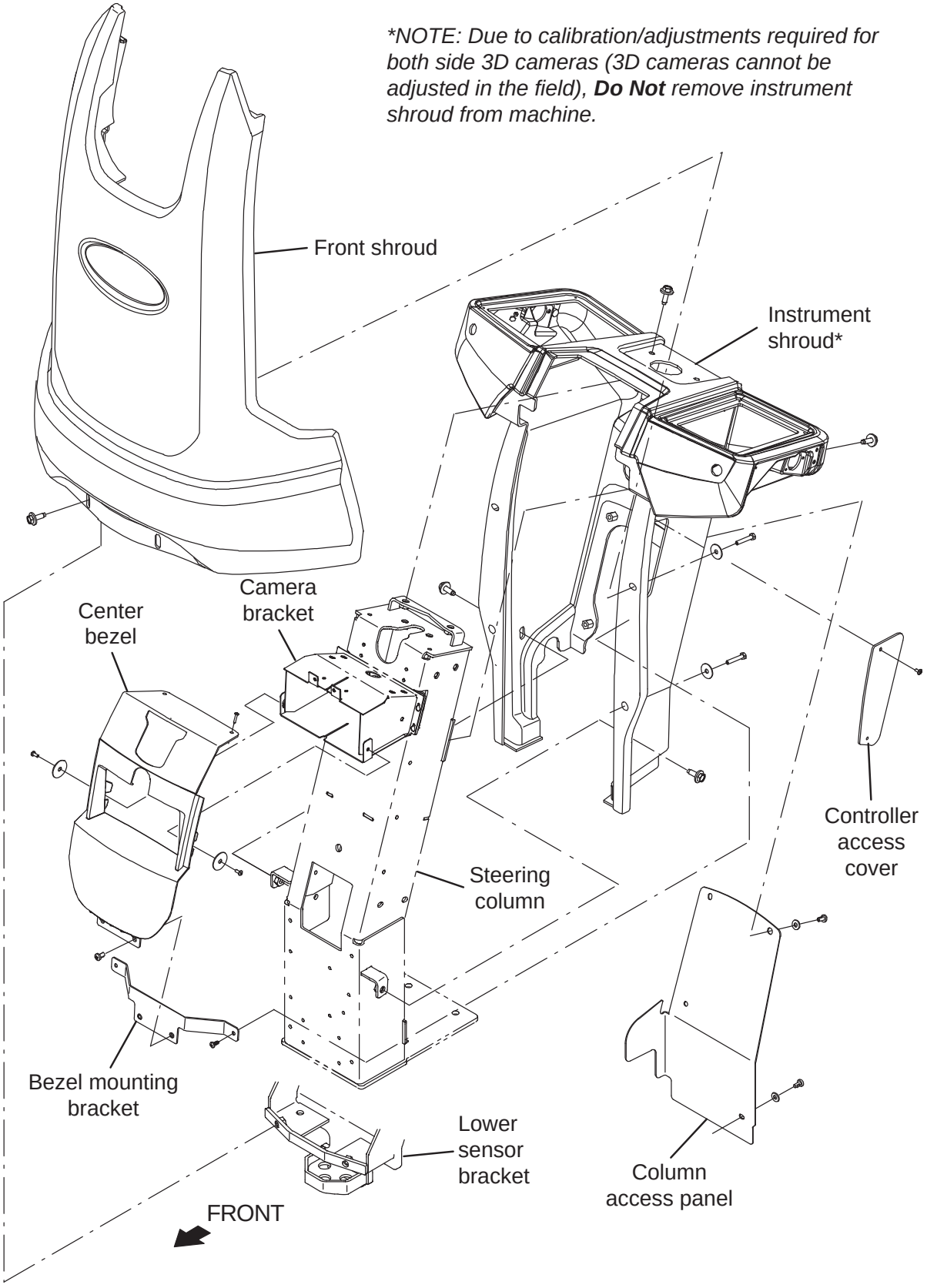
5. Tilt the recovery tank back. Ensure the recovery tank is empty before tilting.

6. Remove the operator seat/seat plate from the machine.

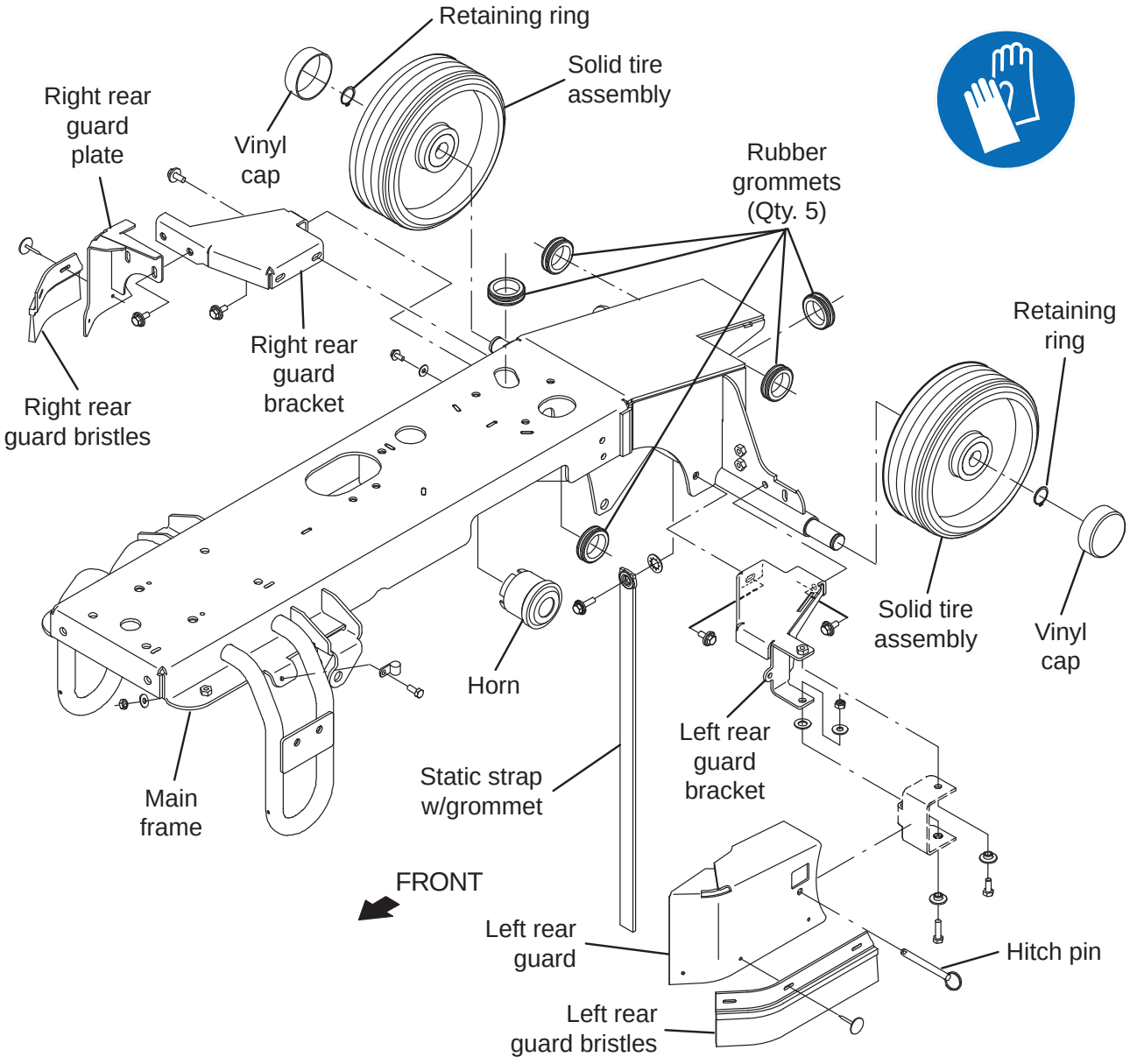
7. Remove the battery box cover from the machine.

8. Reinstall removed items in reverse order of disassembly.

FRONT COVERS GROUP



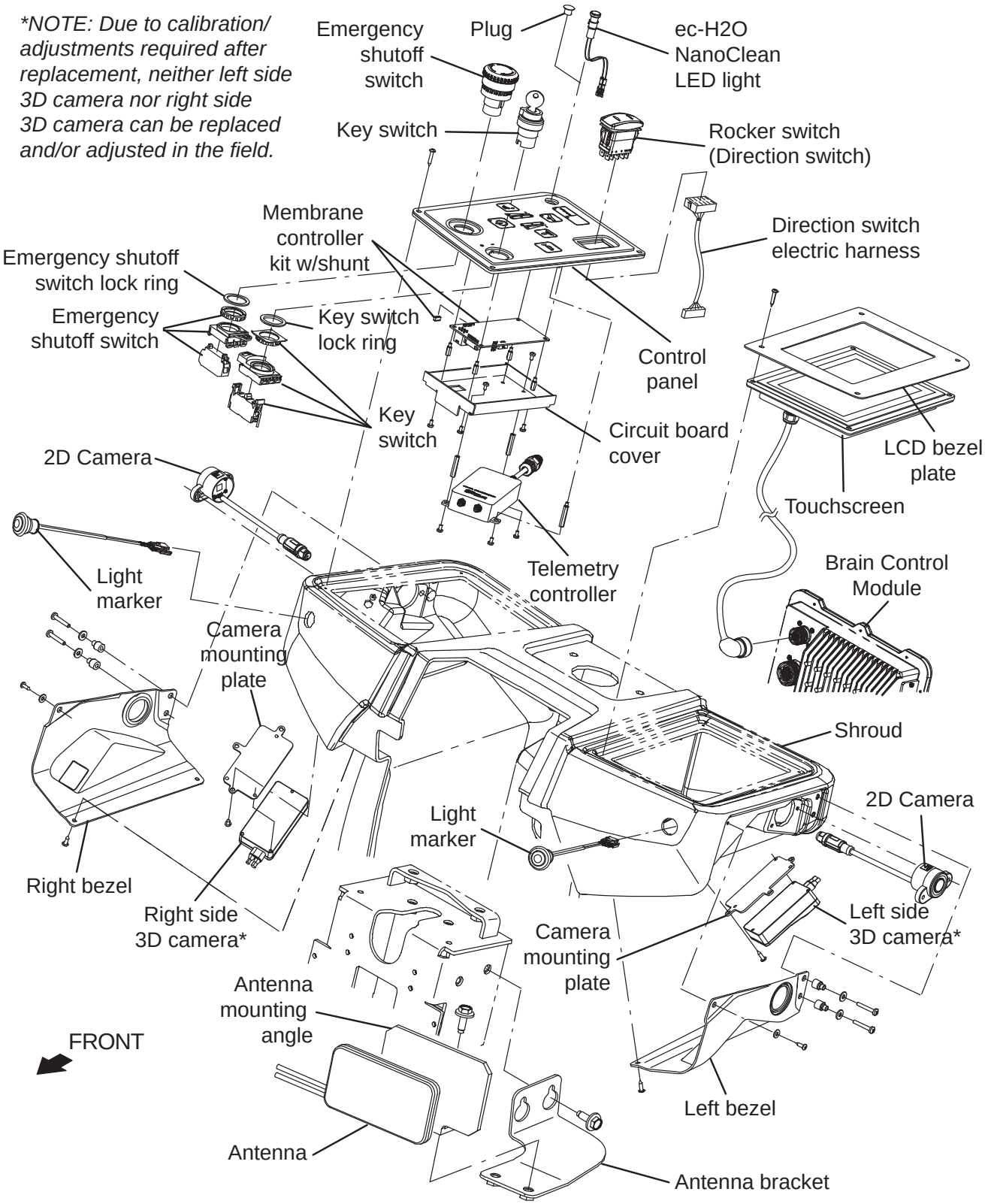
MAIN FRAME GROUP



CONTROLS/SENSORS/CAMERAS

INSTRUMENT PANEL GROUP

**NOTE: Due to calibration/ adjustments required after replacement, neither left side 3D camera nor right side 3D camera can be replaced and/or adjusted in the field.*



REMOVE/REINSTALL/REPLACE THE TOUCH-SCREEN

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

3. Remove the front cover from the steering column. See FRONT COVERS GROUP.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

4. Disconnect the touchscreen cable from the Brain Control Module.
5. Remove the hardware securing the touchscreen to the machine.
6. Carefully lift the touchscreen from the steering shroud. Do not break any wire or cable connections when lifting the touchscreen from the steering shroud.
7. If replacing the touchscreen or if the touchscreen must be completely removed to service or replace other components, disconnect all wire and cable connections from the touchscreen and set the touchscreen aside somewhere where it cannot be damaged.
8. Reinstall the touchscreen onto the steering shroud.
9. Connect the touchscreen cable to the Brain Control Module.

REMOVE/REINSTALL/REPLACE THE CONTROL PANEL

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the control panel to the machine.
4. Carefully lift the control panel from the steering shroud. Do not break any wire or cable connections when lifting the control panel from the steering shroud.
5. If replacing the control panel or if removing the control panel to access/remove/replace other components disconnect all wire and cable connections from the control panel.
6. If replacing the control panel, remove the on/off key switch, directional switch, and emergency shutoff button from the control panel.
7. If replacing the control panel, install the on/off key switch, directional switch, and emergency shutoff button removed from the control panel in the previous step onto the new control panel.
8. Connect wire and cable connections to the new control panel/previously removed control panel.
9. Reinstall the control panel onto the steering shroud.
10. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE ON/OFF KEY SWITCH, DIRECTIONAL SWITCH, ec-H2O LIGHT, AND E-STOP (EMERGENCY STOP) BUTTON

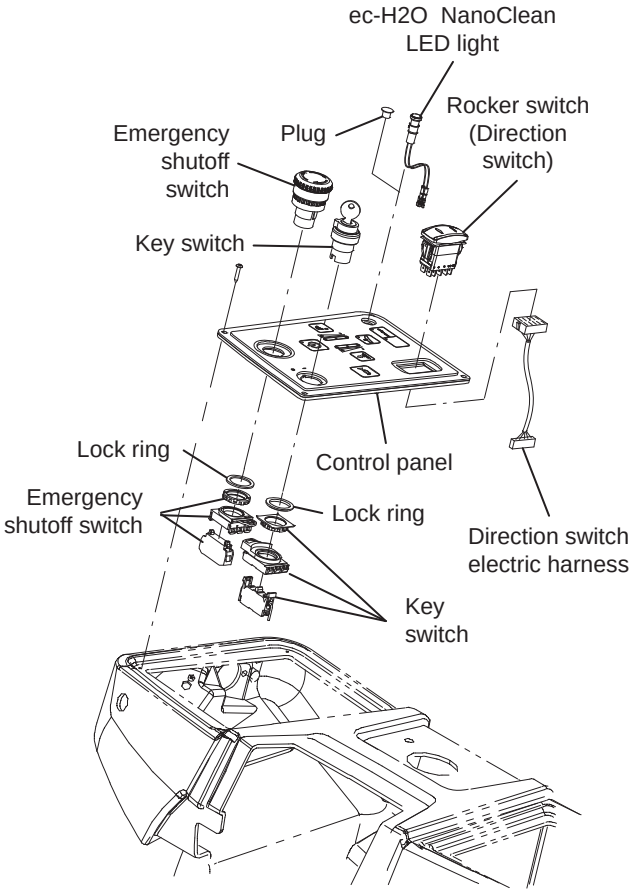
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the control panel from the steering shroud. See REMOVE/REINSTALL/REPLACE THE CONTROL PANEL for additional information.
4. Disconnect the main wire harness connections from the control panel control(s) being replaced.
5. Remove the control panel control(s) being replaced from the control panel.



6. Install the new control panel control(s) into the control panel.
7. Connect the main wire harness connections to the new control panel control(s).
8. Reinstall the control panel onto the shroud.

REMOVE/REINSTALL/REPLACE THE FRONT MARKER LIGHTS

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the control panel and/or touchscreen to the steering shroud and carefully lift the control panel and/or touchscreen from the shroud. See REMOVE/REINSTALL/REPLACE THE TOUCHSCREEN and/or REMOVE/REINSTALL/REPLACE THE TOUCH PANEL.
4. Disconnect the main wire harness from the marker light(s).
5. Remove the marker light(s) from the shroud.
6. Install the new marker light(s)/removed marker light(s) into the shroud.
7. Connect the main wire harness to the marker light(s).
8. Reinstall the control panel and/or touchscreen onto the shroud.

REMOVE/REINSTALL/REPLACE THE ANTENNA

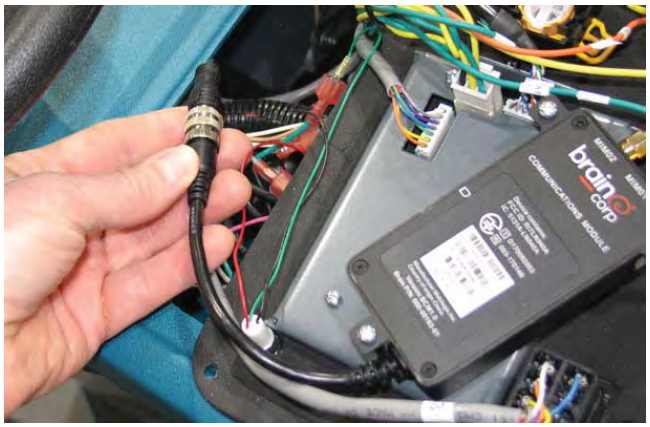
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

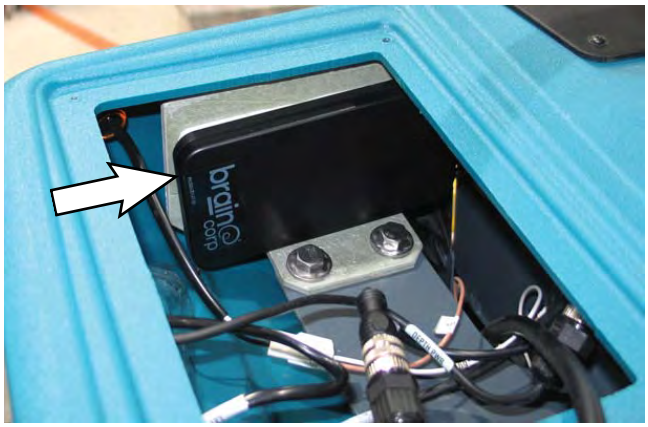
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the control panel to the steering shroud and carefully lift the control panel touchscreen from the shroud. See REMOVE/REINSTALL/REPLACE THE TOUCH PANEL.
4. Remove the hardware securing the touchscreen to the steering shroud and carefully lift the touchscreen from the shroud. See REMOVE/REINSTALL/REPLACE THE TOUCHSCREEN.
5. Disconnect the antenna cable from the telemetry controller.



6. Remove the antenna/antenna bracket from inside the steering shroud.



7. Remove the antenna from the antenna bracket.
8. Clean all remaining adhesive from the removed antenna from the antenna bracket.
9. Install the new antenna bracket onto the antenna bracket.
10. Install antenna/antenna bracket into the steering shroud.
11. Connect the antenna cable to the telemetry controller.
12. Reinstall components removed to access the antenna in reverse order of disassembly.
13. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE TELEMETRY CONTROLLER

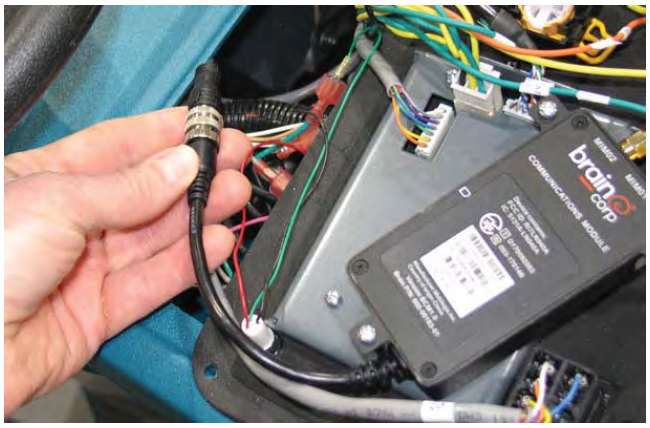
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

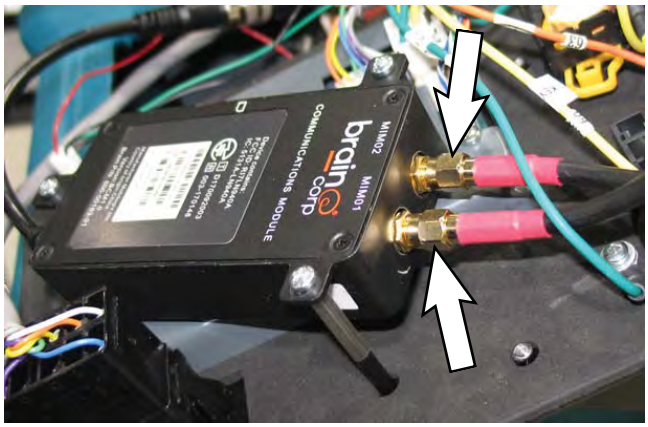
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the control panel to the steering shroud and carefully lift the control panel touchscreen from the shroud. See REMOVE/REINSTALL/REPLACE THE TOUCH PANEL.
4. Disconnect the antenna cable from the telemetry controller.



5. Disconnect the wire harness from the telemetry controller.



6. Remove the telemetry controller from the touch panel assembly.
7. Install the new telemetry controller/removed telemetry controller onto the touch panel assembly.
8. Connect the wire harness to the telemetry controller.
9. Connect the antenna cable to the telemetry controller.
10. Reinstall components removed to access the telemetry controller in reverse order of disassembly.
11. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE MEMBRANE CONTROLLER

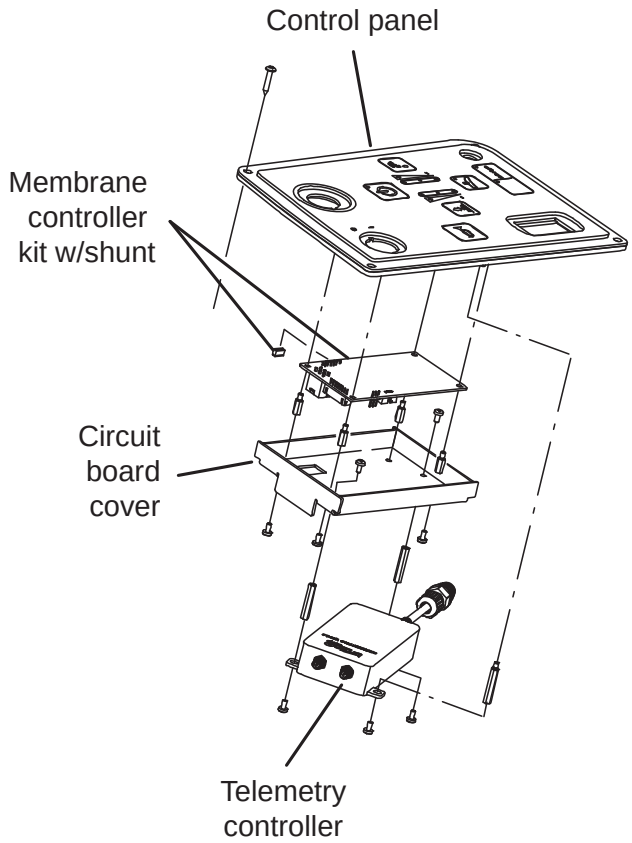
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

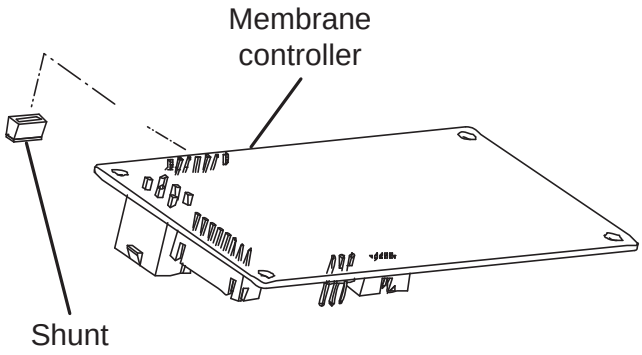
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

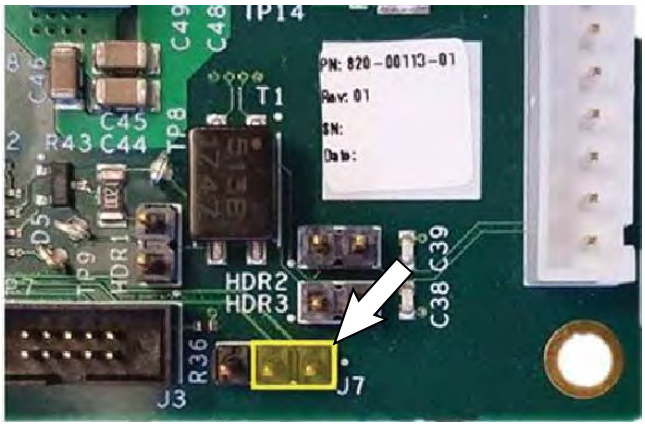
NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the control panel to the steering shroud and carefully lift the control panel touchscreen from the shroud. See REMOVE/REINSTALL/REPLACE THE TOUCH PANEL.
4. Remove the telemetry controller from the circuit board cover/control panel. See REMOVE/REINSTALL/REPLACE THE TELEMETRY CONTROLLER.



5. Disconnect the wire harness from the membrane controller assembly.
6. Remove the circuit board cover/membrane controller from the control panel.
7. Remove the membrane controller from the circuit board cover.
8. Machines equipped with ec-H2O option ONLY: Install the shunt onto the new membrane controller. Note position of the shunt in terminal J7 on the membrane controller terminal.





9. Install the new membrane controller onto the circuit board cover.
10. Install the circuit board cover/membrane controller onto the control panel.
11. Connect the wire harness to the membrane controller.
12. Reinstall components removed to access the membrane controller in reverse order of disassembly.

REMOVE/REINSTALL/REPLACE THE SIDE 2D CAMERAS

Clean the side 2D cameras after completing maintenance/service. Debris, streaks, or smudges could deliver false environmental information to the machine. Use a microfiber cloth to clean the cameras. Do not apply water to the cameras or the microfiber cloth.

NOTE: Do not scratch or damage the side 2D camera lenses. Robotic machine performance could be adversely affected if the camera lenses is scratched or damaged.

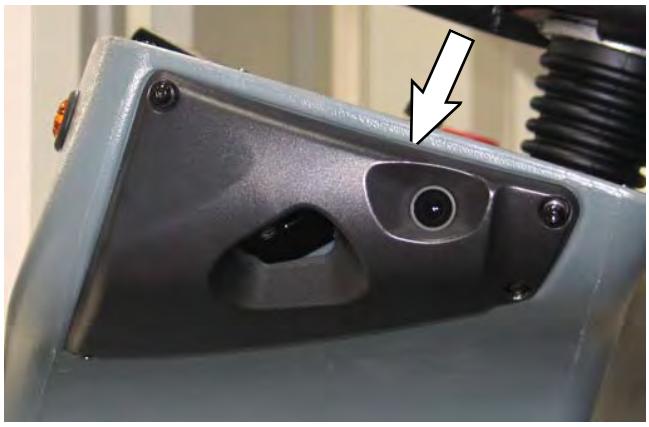
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the touchscreen and/or the control panel (depending on which camera(s) are being replaced) from the machine. See REMOVE/REINSTALL/REPLACE THE CONTROL PANEL and/or REMOVE/REINSTALL/REPLACE THE TOUCHSCREEN for additional information.
4. Remove the side cover from the steering shroud.



5. Disconnect the main wire harness from the camera.
6. Remove the 2D camera from the steering shroud.

7. Install the new 2D camera into the steering shroud.
8. Connect the main wire harness to the new 2D camera.
9. Reinstall components removed to access the 2D camera in reverse order of disassembly.
10. Repeat procedure if replacing the 2D camera located on the other side of the steering shroud.
11. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

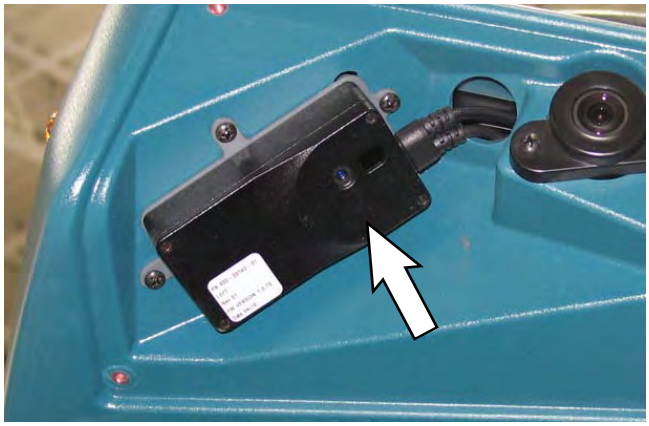
NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

MAINTAINING THE SIDE 3D CAMERAS

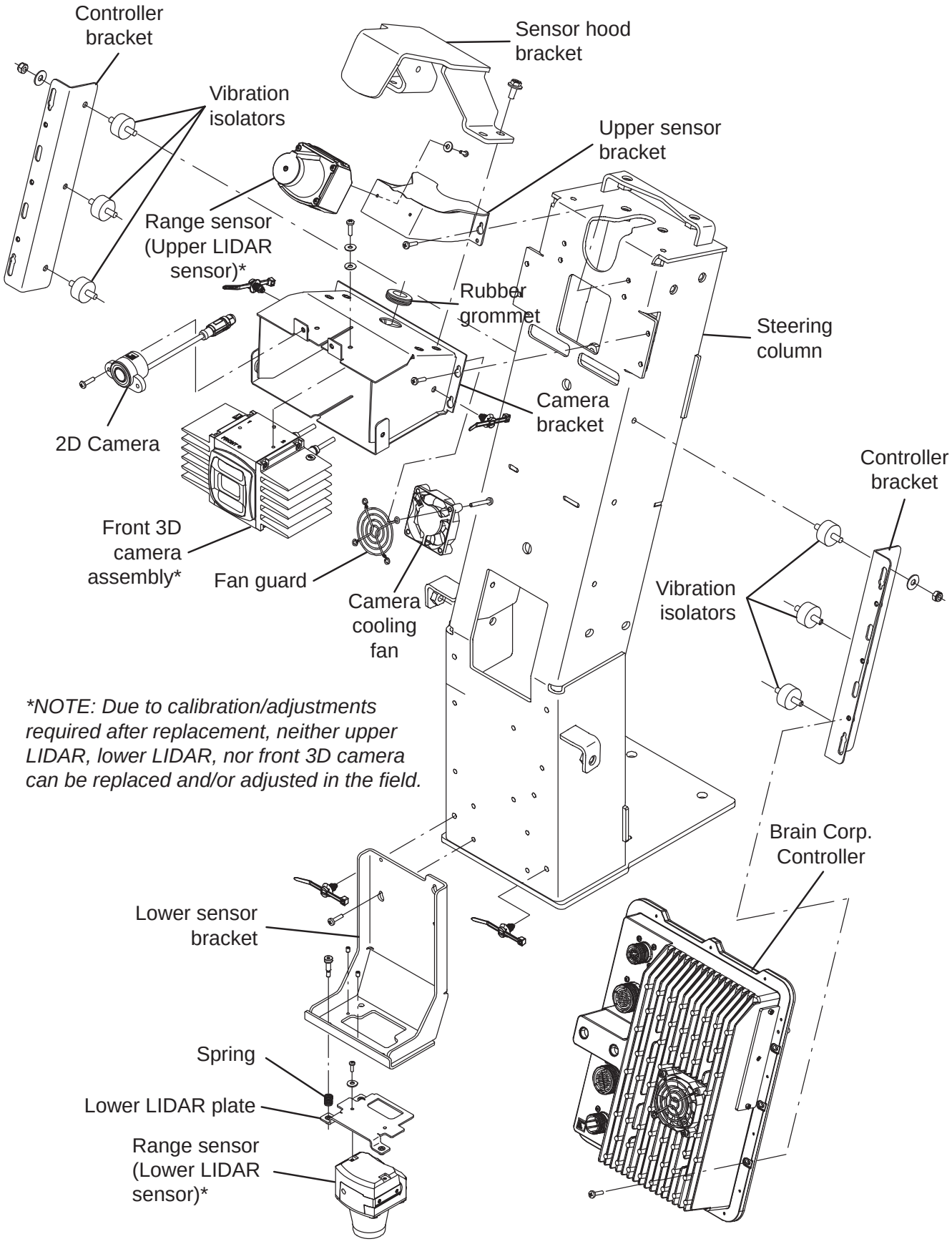
NOTE: Due to calibration/adjustments required after replacement, neither side 3D camera can be replaced/adjusted in the field. Contact Tennant Customer Service Department if either side 3D camera needs to be replaced/adjusted.

Clean the side 3D cameras after completing all maintenance/service. Debris, streaks, or smudges could deliver false environmental information to the machine. Use a microfiber cloth to clean the cameras. Do not apply water to the cameras or the microfiber cloth.

NOTE: Do not scratch or damage the side 3D camera lenses. Robotic machine performance could be adversely affected if the camera lenses are scratched or damaged.



FRONT CAMERAS AND SENSORS



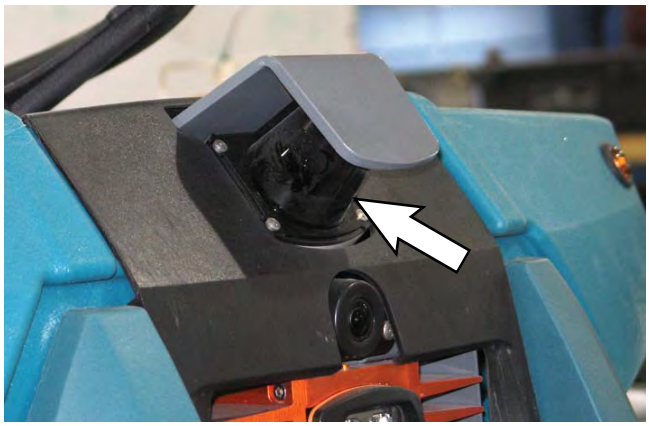
**NOTE: Due to calibration/adjustments required after replacement, neither upper LIDAR, lower LIDAR, nor front 3D camera can be replaced and/or adjusted in the field.*

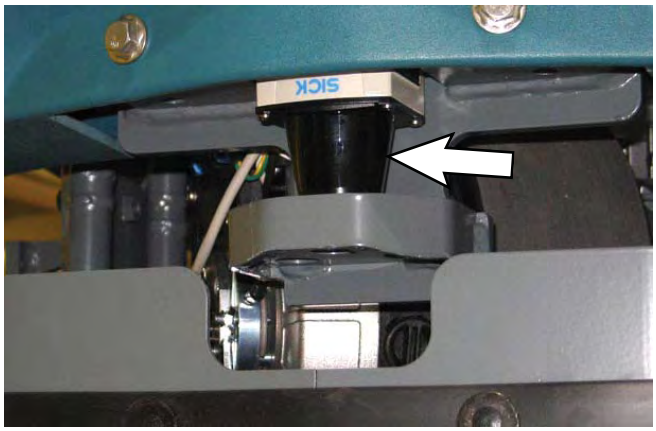
MAINTAINING THE UPPER LIDAR AND LOWER LIDAR

NOTE: Due to calibration/adjustments required after replacement, neither the front LIDAR nor the lower LIDAR can be replaced and/or adjusted in the field. Contact the Tennant Customer Service Department if either LIDAR needs to be replaced or adjusted.

Clean the upper LIDAR and lower LIDAR after completing maintenance/service. Debris, streaks, or smudges could deliver false environmental information to the machine. Use a microfiber cloth to clean the upper LIDAR and lower LIDAR. Do not apply water to the upper LIDAR/lower LIDAR or the microfiber cloth.

NOTE: Do not scratch or damage the upper LIDAR and lower LIDAR. Robotic machine performance could be adversely affected if the upper the LIDAR and/or lower LIDAR are scratched or damaged.



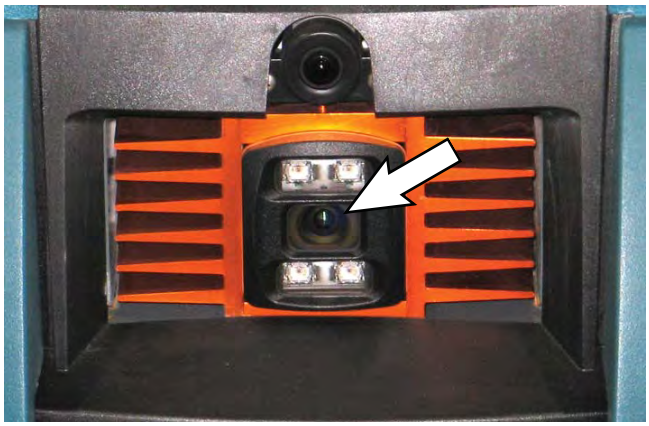


MAINTAINING THE FRONT 3D CAMERA

NOTE: Due to calibration/adjustments required after replacement, the front 3D camera cannot be replaced/adjusted in the field. Contact the Tennant Customer Service Department if the front 3D camera needs to be replaced/adjusted.

Clean the front 3D camera after completing maintenance/service. Debris, streaks, or smudges could deliver false environmental information to the machine. Use a microfiber cloth to clean the camera. Do not apply water to the camera or the microfiber cloth.

NOTE: Do not scratch or damage the front 3D camera lens. Robotic machine performance could be adversely affected if the camera lens is scratched or damaged.



REMOVE/REINSTALL/REPLACE THE FRONT 2D CAMERA

Clean the front 2D camera after completing maintenance/service. Debris, streaks, or smudges could deliver false environmental information to the machine. Use a microfiber cloth to clean the camera. Do not apply water to the camera or the microfiber cloth.

NOTE: Do not scratch or damage the 2D camera lens. Robotic machine performance could be adversely affected if the camera lens is scratched or damaged.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the front cover from the steering column. See FRONT COVERS GROUP.

4. Remove the front bezel from the machine.

5. Remove the front 2D camera from the camera bracket.

6. Disconnect the wire harness from the front 2D camera.
7. Install the new front 2D camera/removed front 2D camera onto the camera bracket.
8. Connect the wire harness to the front 2D camera.
9. Reinstall components removed to access the front 2D camera in reverse order of disassembly.
10. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE BRAIN CONTROLLER

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

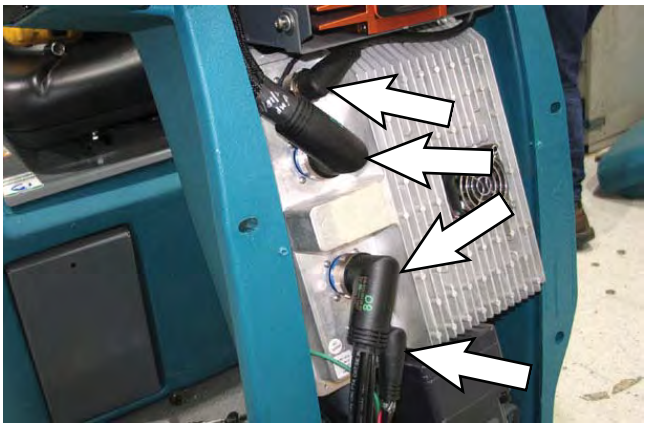
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the front cover from the steering column. See FRONT COVERS GROUP.

4. Remove the front bezel from the machine.

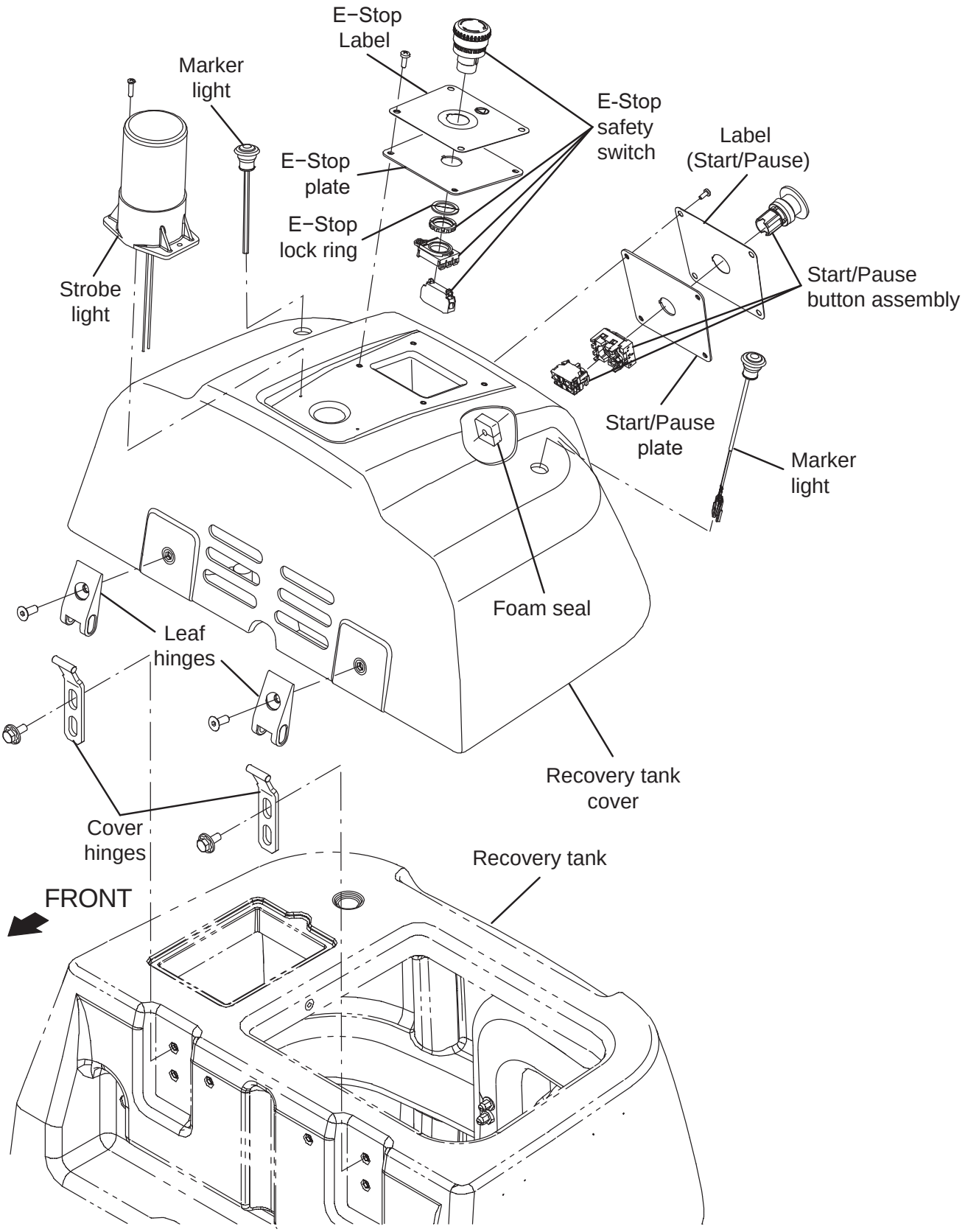
5. Disconnect all wire harness connections from the Brain controller.



6. Remove the Brain controller from the steering column.
7. Install the new Brain controller/removed Brain controller onto the steering column.
8. Connect the wire harness connections to the Brain controller.
9. Reinstall components removed to access the Brain controller in reverse order of disassembly.
10. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

RECOVERY TANK COVER CONTROLS/ COMPONENTS



REMOVE/REINSTALL/REPLACE THE START/ PAUSE BUTTON

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

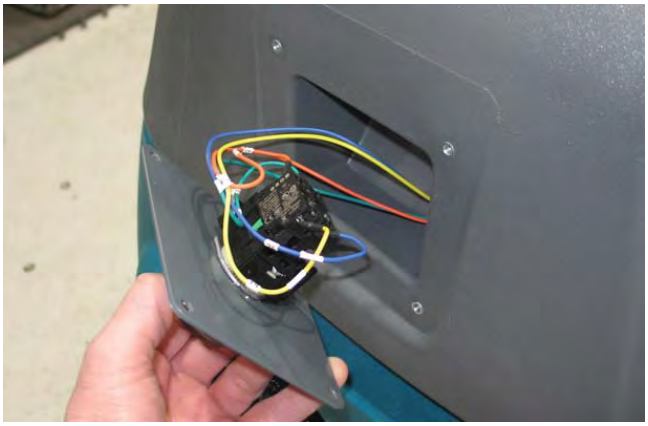
1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

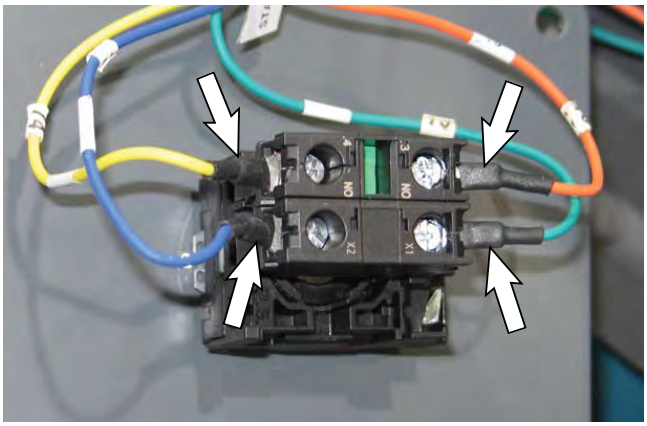
NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the start/pause button assembly to the recovery tank cover.

4. Carefully pull the blue start/pause button assembly from the recovery tank cover. Do Not break or damage wire/cable connections when pulling the blue start/pause button assembly from the recovery tank cover.

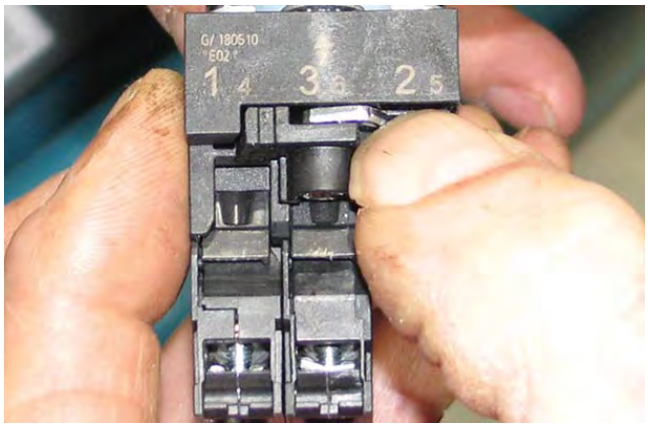


5. Disconnect the harness connections from the blue start/pause button assembly.



6. Loosen the retainer screw securing the start/pause button assembly to the start/pause plate.

7. Press the retainer lever and remove the start/pause button assembly from the start/pause button plate.

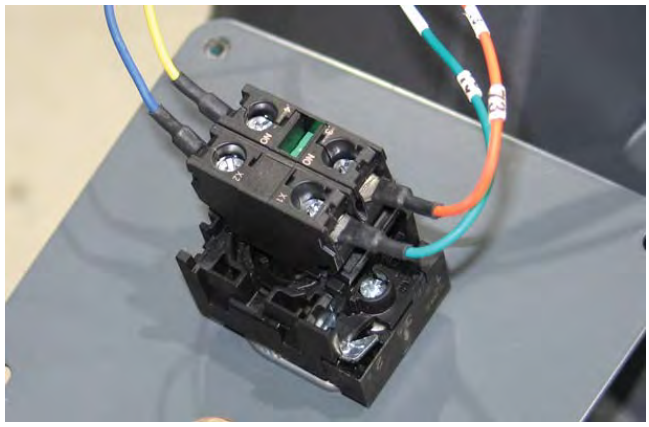


8. Press the retainer lever and remove the button from the start/pause button assembly.

9. Loosen the new retainer screw on the start/pause button body.

10. Install the new start/pause button assembly onto the start/pause button plate and tighten the retainer screw to secure the start/pause button assembly into place.

11. Connect the harness connections to the start/pause button assembly.



12. Install the start/pause button assembly onto the recovery tank cover.

13. Install the start/pause button assembly onto the recovery tank cover.

REMOVE/REINSTALL/REPLACE THE REAR E-STOP (EMERGENCY STOP) BUTTON

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

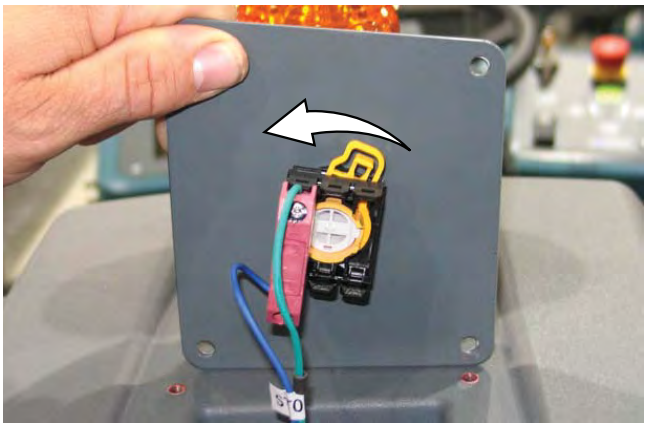
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

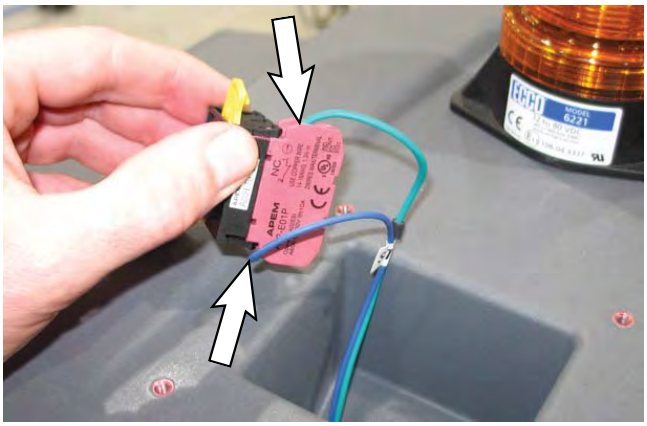
3. Remove the hardware securing the E-Stop button assembly to the recovery tank cover.

4. Carefully pull the E-Stop button assembly from the recovery tank cover. Do Not break or damage wire/cable connections when pulling the E-Stop button assembly from the recovery tank cover.

5. Push the lever to disconnect the E-Stop button connector from the E-Stop button.



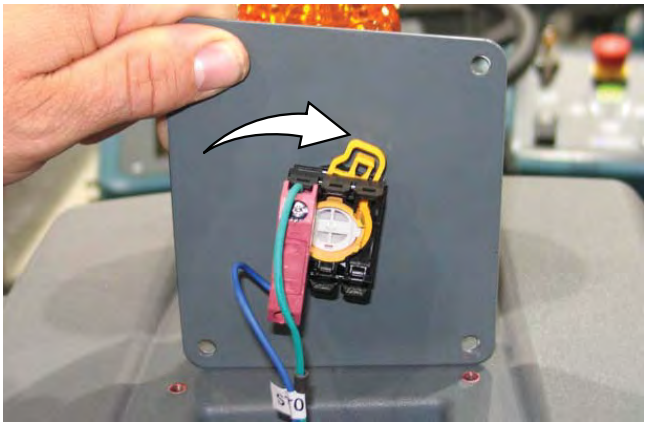
6. Disconnect the harness connections from the E-Stop button connector.



7. Remove the E-Stop button from the E-Stop mounting plate.

8. Connect the harness connections to the new E-Stop button connector.

9. Install the new E-Stop button/removed E-Stop button onto the E-Stop mounting plate.



10. Push the lever to connect the e E-Stop button to the E-Stop button connector.

11. Install the E-Stop button assembly onto the recovery tank cover.

REMOVE/REINSTALL/REPLACE THE REAR MARKER LIGHTS

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.

2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the recovery tank cover to the fan mounting plate.

4. Tilt the recovery tank cover from the fan mounting plate and toward the front of the machine.

NOTE: Do not completely remove the recovery tank cover from the machine. All components mounted to the recovery tank cover can be easily accessed with the recovery tank cover installed on the machine.

5. Disconnect the main wire harness from the marker light(s).

6. Pull the marker light(s) from the recovery tank cover.

7. Install the new marker light(s)/removed marker light(s) into the recovery tank cover.

8. Connect the main wire harness to the marker light(s).

9. Install the recovery tank cover onto the fan mounting plate.

REMOVE/REINSTALL/REPLACE THE STROBE LIGHT

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.

2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

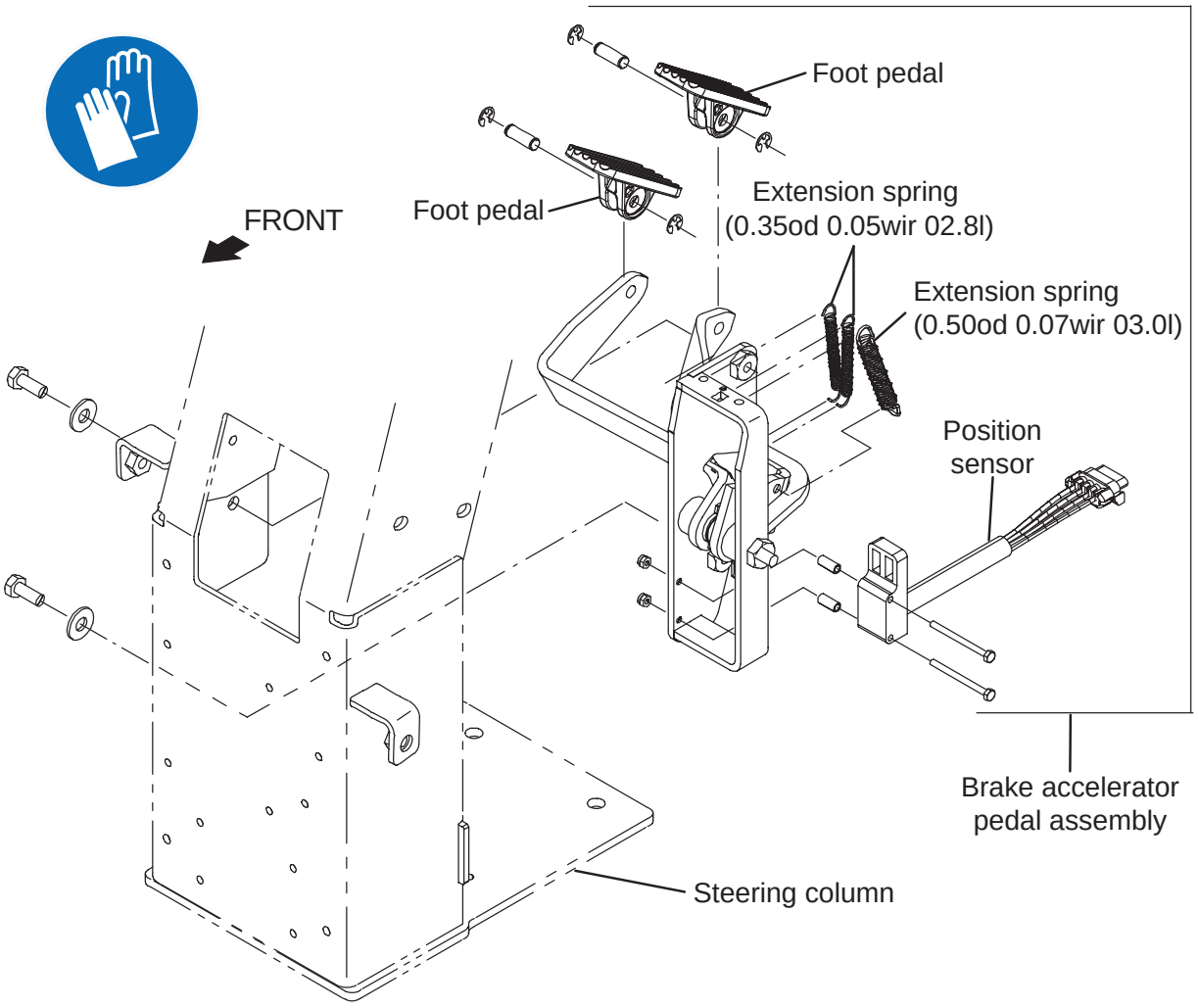
3. Remove the hardware securing the strobe light to the recovery tank cover and carefully lift the strobe light from the recovery tank cover.

4. Disconnect the wire harness from the strobe light.

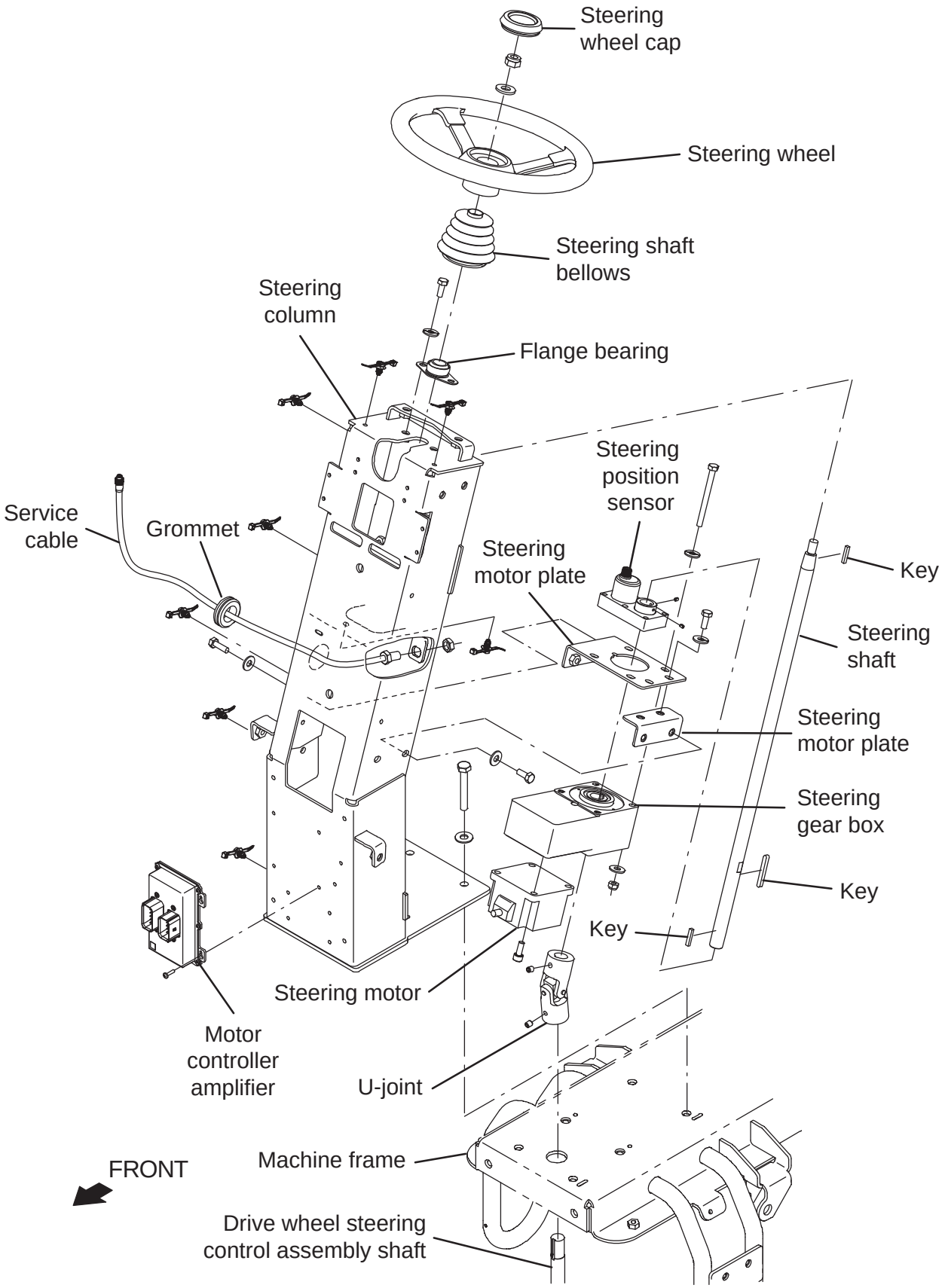
5. Connect the wire harness to the new strobe light/ removed strobe light.

6. Install the strobe light onto the recovery tank cover.

PEDALS GROUP



STEERING


Steering wheel cap
Steering wheel
Steering shaft bellows
Steering column
Flange bearing
Steering position sensor
Service cable
Grommet
Steering motor plate
Key
Steering shaft
Steering motor plate
Steering gear box
Key
Key
Steering motor
Motor controller amplifier
U-joint
Machine frame
FRONT
Drive wheel steering control assembly shaft

REMOVE/REINSTALL/REPLACE THE STEERING MOTOR/STEERING GEAR BOX/STEERING POSITION SENSOR

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electronic components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the front cover from the steering column. See FRONT COVERS GROUP.

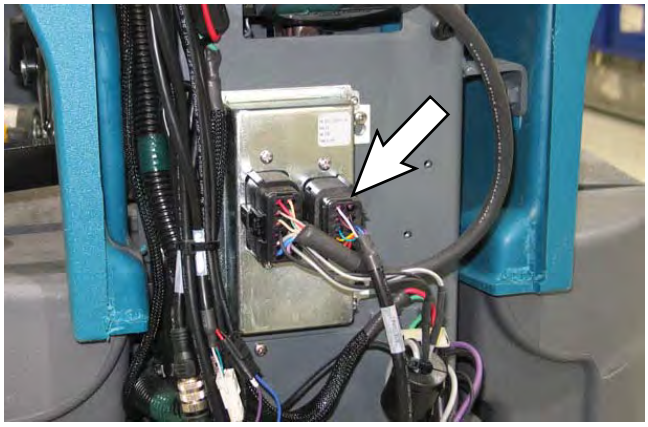
4. Remove the column access panel from the steering column. See FRONT COVERS GROUP.

5. Loosen the upper set screws securing the steering shaft into the u-joint.
6. Loosen both set screws securing the steering shaft in the steering position sensor.
7. Slide the steering wheel/steering shaft up, through the flange bearing enough to clear the steering gear box and the steering position sensor.

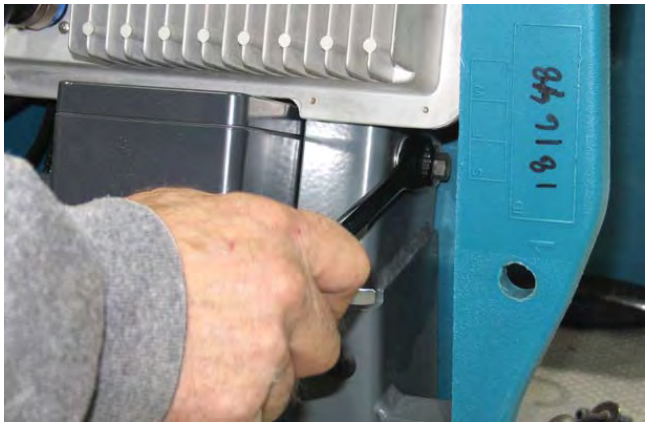
NOTE: Do Not lose either of the keys in the steering shaft when sliding the steering wheel/steering shaft from the u-joint and steering gear box.

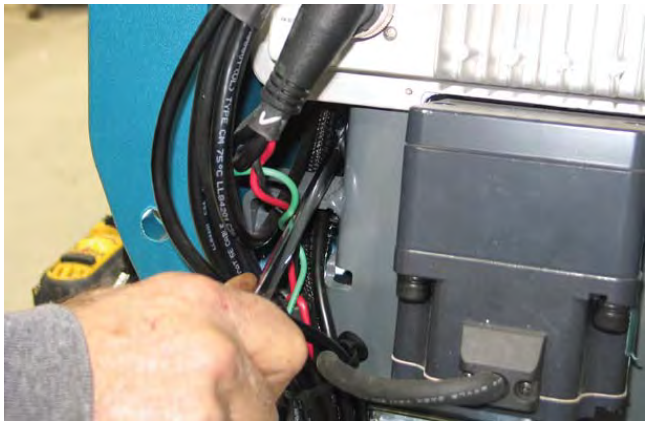
NOTE: If only replacing the steering position sensor, Do Not loosen the hardware securing the steering gear box to the steering motor plate.

8. **If replacing/removing the steering position sensor:** Disconnect the wire harness from the steering position sensor.
9. **If replacing/removing the steering position sensor:** Remove the steering position sensor from the machine.
10. **If replacing/removing the steering motor/ steering gear box:** Disconnect the steering motor cable from the motor control amplifier and wire harness.



11. **If replacing/removing the steering motor/ steering gear box:** Loosen the hardware securing the steering motor plates to the steering column. **Do Not** remove the hardware securing the steering motor plates to the steering column.





12. **If replacing/removing the steering motor/ steering gear box:** Remove the steering motor/ steering gear box from the steering motor plates.

13. Reinstall the steering position sensor and/or steering motor/steering gear box onto the machine.

14. Install the keys into the steering shaft and slide the steering wheel/steering shaft down through the steering position sensor, the steering gear box, and into the u-joint.

NOTE: The steering shaft must be properly aligned before set screws and hardware are tightened. Damage to u-joint may result if steering shaft is not properly aligned.

15. Tighten the upper set screws in the u-joint to secure the steering shaft into the u-joint.

16. Turn the steering wheel in the complete range of motion in both directions to allow the steering gear box and steering position sensor to self-align.

17. Tighten the hardware securing the steering motor plates to the steering column.

18. If the steering position sensor was replaced or removed, position the steering position sensor 2 mm (0.078 in.) above the steering gear box and tighten both steering position sensor set screws against the flat areas on the steering shaft to secure the steering position sensor onto the steering shaft.

19. Reassemble parts and components removed from the machine to access the steering system back onto the machine in reverse order of disassembly.

20. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE STEERING AMPLIFIER MODULE

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

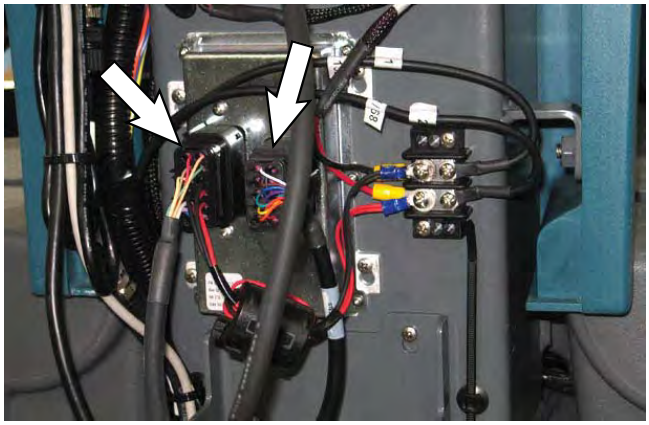
1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electronic components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the front cover from the steering column. See FRONT COVERS GROUP.

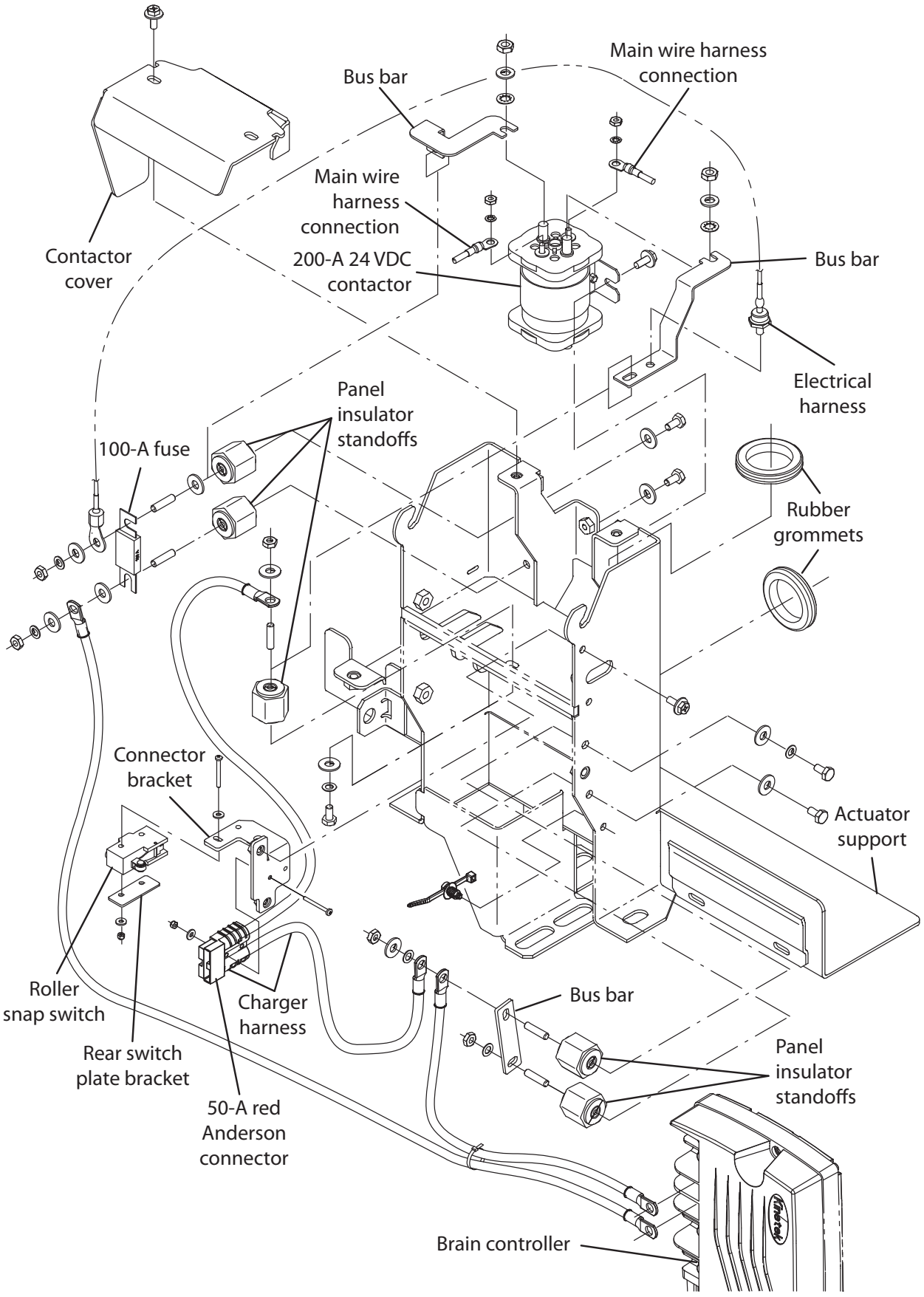
4. Disconnect the harness connector and steering motor from the steering amplifier module.



5. Remove the steering amplifier module from the steering column.
6. Reinstall the removed steering amplifier module/ install the new steering amplifier module onto the machine.
7. Connect the harness connections to the steering amplifier module.
8. Reassemble all items removed to access the steering amplifier module onto the machine in the reverse order of disassembly.
9. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

ELECTRICAL


Bus bar
Main wire harness connection
Main wire harness connection
Contactor cover
200-A 24 VDC contactor
Bus bar
Electrical harness
Panel insulator standoffs
100-A fuse
Rubber grommets
Connector bracket
Actuator support
Roller snap switch
Charger harness
Bus bar
Rear switch plate bracket
Panel insulator standoffs
50-A red Anderson connector
Brain controller

REMOVE/REINSTALL/REPLACE THE CONTACTOR

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

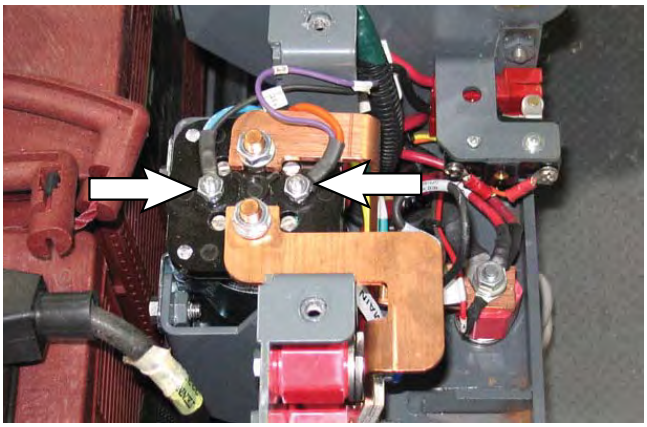
3. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/ REINSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
4. Confirm the machine battery cable is disconnected from the batteries.

ATTENTION: Potential electrical hazard if the battery cable is left connected to the batteries. The machine battery cable must be disconnected from the batteries before accessing/performing maintenance on the 200-A 24 VDC contactor.

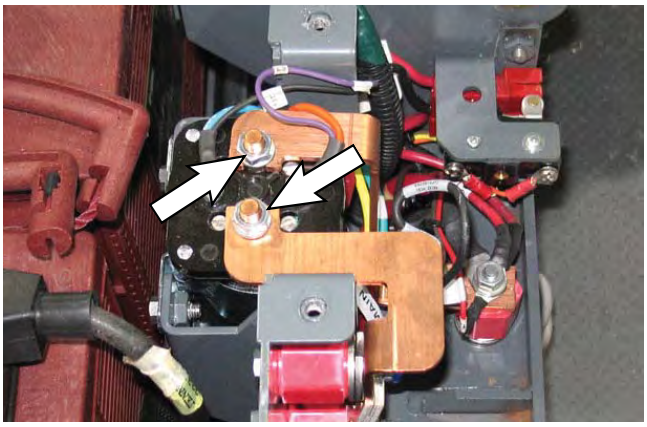
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

5. Remove the contactor cover from the actuator support.

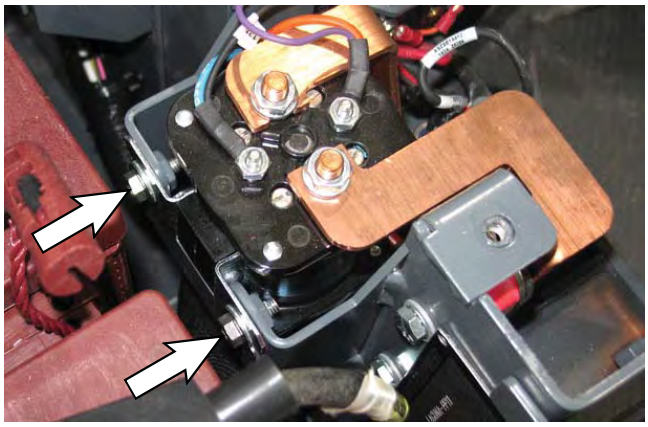
6. Disconnect wire harness connections from the top terminals of the contactor.



7. Remove both bus bars from the 200-A 24 VDC contactor and the corresponding panel insulator standoffs.



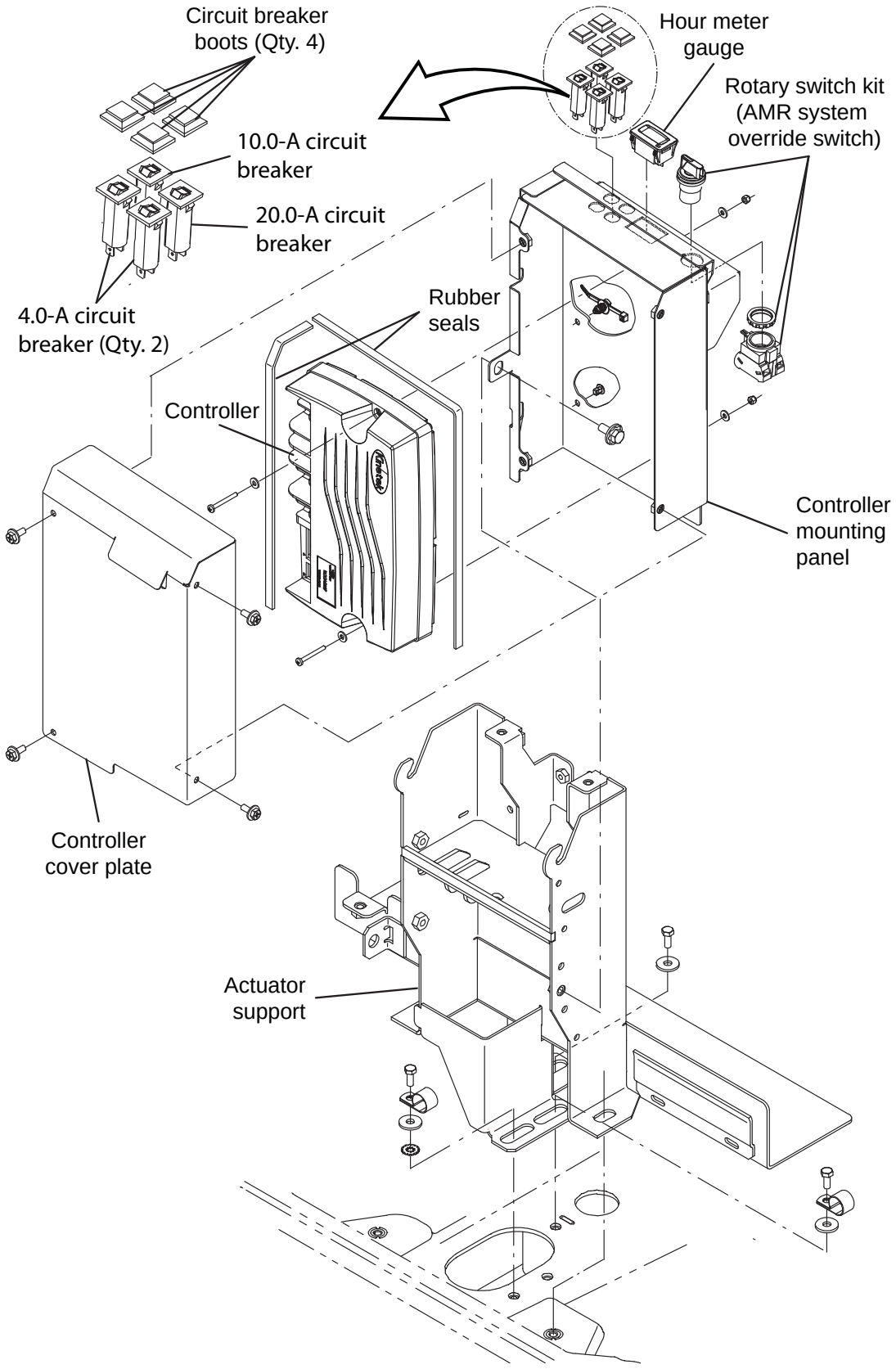
8. Loosen the hardware securing the 200-A 24 VDC contactor to the actuator support enough to be able to remove the contactor from the machine.



NOTE: If necessary, remove the batteries from the machine to make access to the hardware securing the 200-A 24 VDC contactor to the actuator support easier.

9. Carefully lift the 200-A 24 VDC contactor from the actuator support and disconnect the wire harness connections from the bottom terminals of the contactor.
10. Connect the wire harness to the terminals located on the bottom of the new 200-A 24 VDC contactor/ removed 200-A 24 VDC contactor.
11. Install the 200-A 24 VDC contactor onto the actuator support.
12. Install the bus bars, and all cable connections removed when the bus bars were removed, onto the 200-A 24 VDC contactor and panel insulator standoffs.
13. Connect the wire harness connections to the terminals located on the top of the 200-A 24 VDC contactor.
14. Install the contactor cover onto the actuator support.
15. Reconnect the battery cable to the batteries.
16. Reinstall the operator seat/seat plate and battery box cover onto the machine.

REMOVE/REINSTALL/REPLACE THE KINETEK CONTROLLER



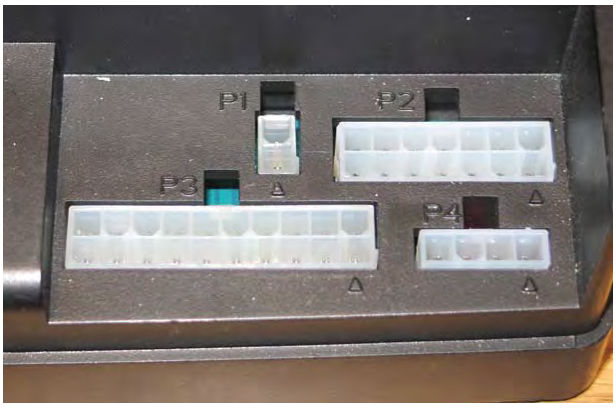
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Raise the seat and lock the seat into the fully raised position.
3. Disconnect the battery cable from the batteries.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

4. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/ INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
5. Remove the controller cover plate from the machine.

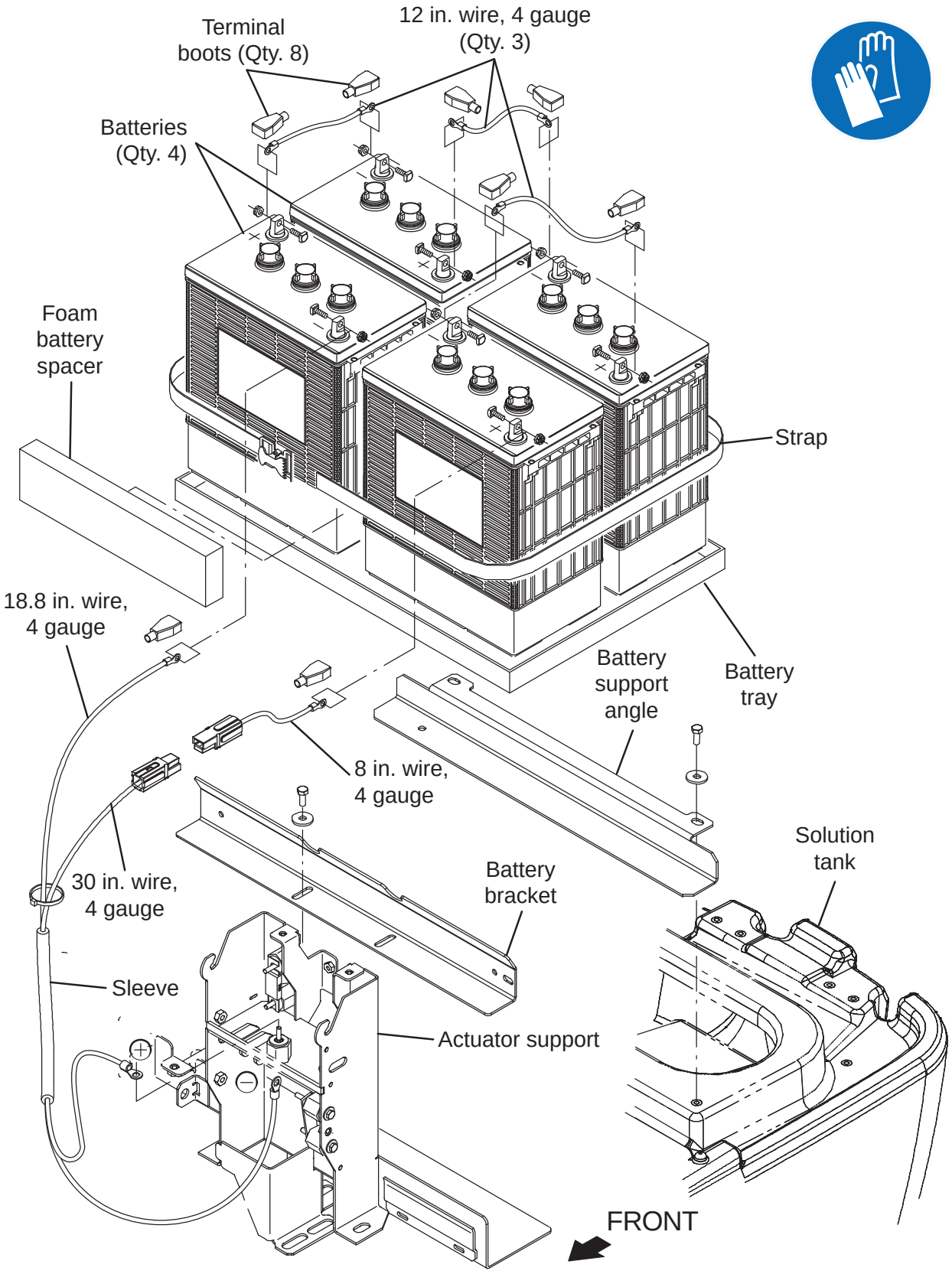
6. Disconnect all wire harness connections from the Kinetek controller.
7. Remove the Kinetek controller from the machine.
8. Install the new Kinetek controller/removed Kinetek controller onto the machine.
9. Connect wire harness connections to the Kinetek controller.



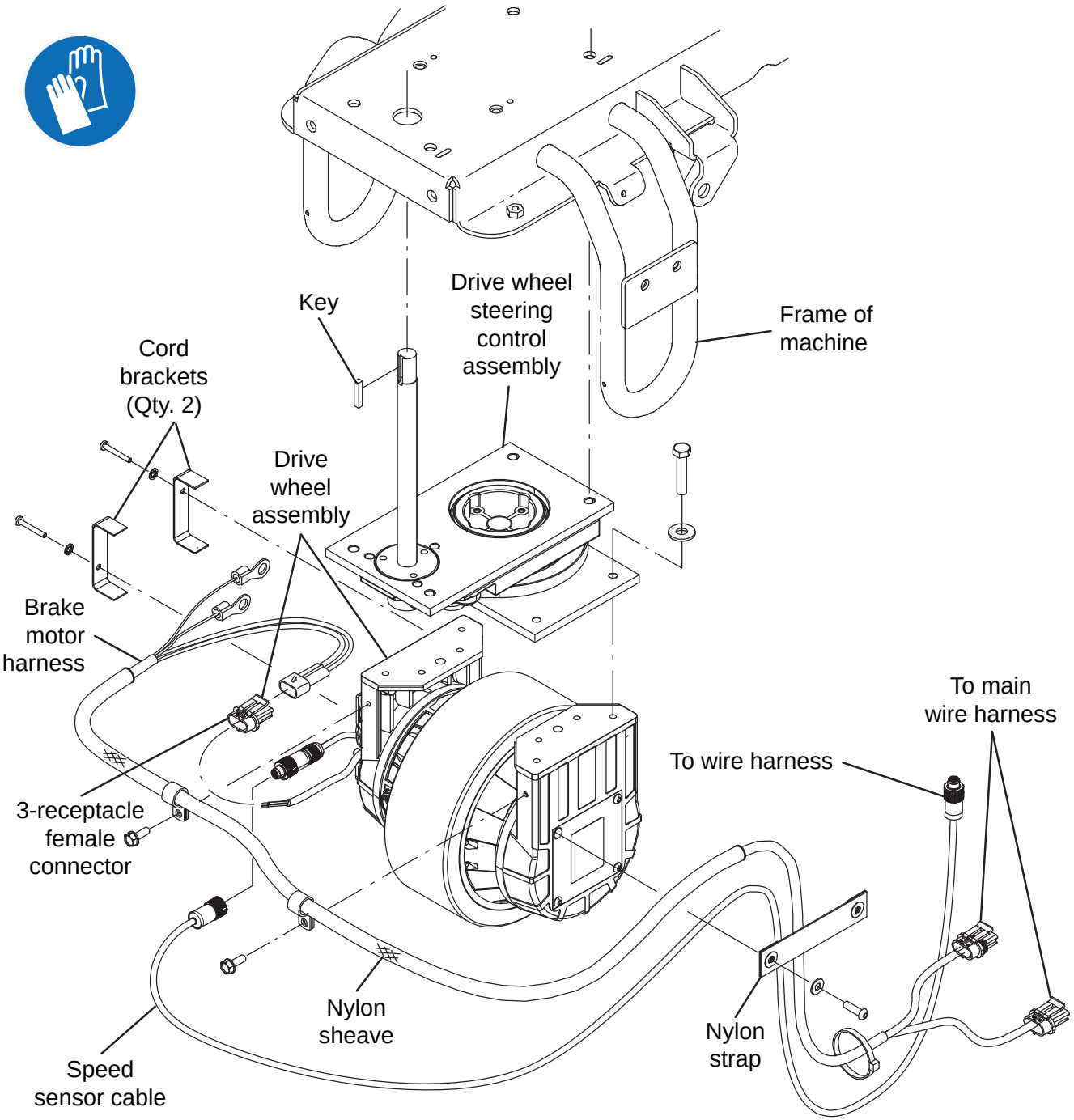
10. Reassemble all items back onto the machine in reverse order of removal.
11. Reconnect the battery cable to the batteries.
12. Start and test the machine to ensure the machine functions correctly. All machine functions should be fully operational when the corresponding buttons/ switches are activated.
13. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

BATTERY GROUP



DRIVE WHEEL GROUP



ATTENTION: DO NOT tip the machine onto its side to replace the drive wheel assembly. Sensitive robotic components could be damaged or bumped out of adjustment if the machine is tipped onto its side.

REMOVE/REINSTALL/REPLACE THE DRIVE WHEEL ASSEMBLY

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

ATTENTION: DO NOT tip the machine onto its side to replace the drive wheel assembly. Sensitive robotic components could be damaged or bumped out of adjustment if the machine is tipped onto its side.

1. Completely drain the solution tank and the recovery tank.
2. Turn the ON/OFF key switch OFF.
3. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

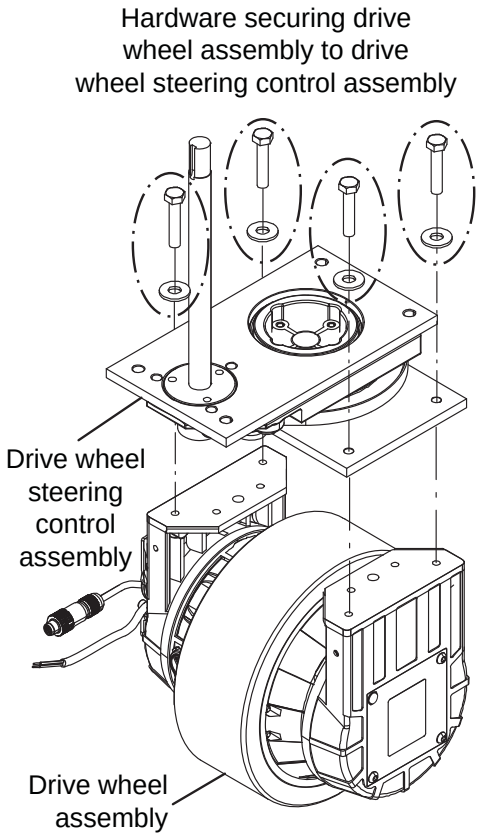
4. Remove the front guard from the front of the machine. See REMOVE/INSTALL THE FRONT GUARD.
5. Chock both rear tires.
6. Jack up the front end of the machine enough to access steering components/remove steering components from under the machine. Place jack stands under the machine and lower the machine onto the jack stands.

FOR SAFETY: When servicing machine, block machine tires before jacking machine up. Use a hoist or jack that will support the weight of the machine. Jack machine up at designated locations only. Support machine with jack stands.

7. Disconnect the speed sensor cable and all brake motor harness connections from the drive wheel assembly and encoder.

NOTE: Use care when removing the drive wheel assembly from the machine. The drive wheel weighs approximately 140 lbs (64 kg). If necessary, seek help to remove the drive wheel assembly from the machine.

8. Remove the hardware securing the drive wheel assembly to the drive wheel steering control assembly. Turn drive wheel assembly to the right and left as necessary to access/remove hardware.



9. Remove the drive wheel assembly from under the machine.
10. Reinstall drive motor/install new drive motor in reverse order of disassembly.

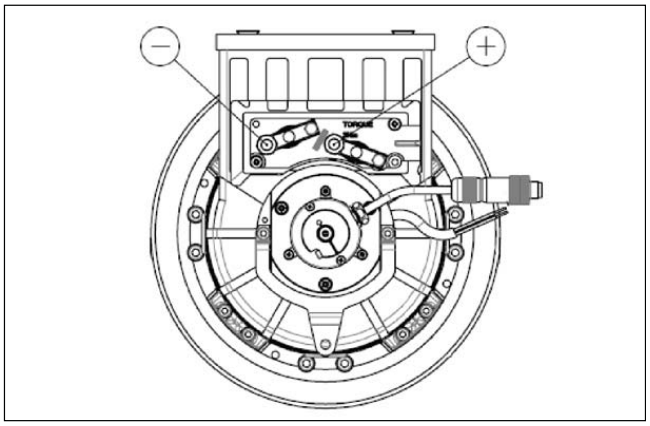
REMOVE/REINSTALL/REPLACE THE DRIVE MOTOR CARBON BRUSHES

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: Carbon brushes should be replaced as sets.

1. Remove the front guard from the machine. See REMOVE/INSTALL THE FRONT GUARD
2. Disconnect the Positive (+) and Negative (-) cable connections from the drive motor assembly.
3. Remove the connection box cover from the drive motor assembly connection box.
4. Loosen the clips from the carbon brushes located at the Positive (+) and Negative (-) connections and remove the carbon brushes from the drive motor assembly.



5. Inspect carbon brushes. Replace carbon brushes if they are stuck or are less than 10 mm (0.375 in) in length.
6. Use compressed air to clean any dust from inside the drive motor assembly.
7. Install the new carbon brushes/removed carbon brushes into the Positive (+) and Negative (-) connections and use clips to secure the carbon brushes inside the drive motor assembly.
8. Reinstall the connection box cover onto the drive motor assembly connection box
9. Reconnect the Positive (+) and Negative (-) cable connections to the drive motor assembly.
10. Reinstall the front perimeter guard onto the machine.

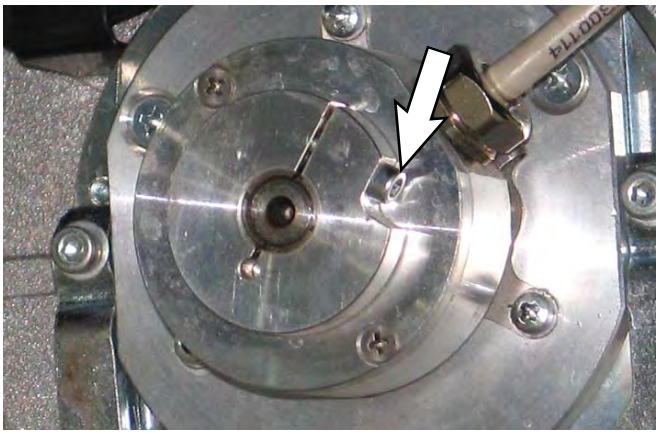
REMOVE/REINSTALL/REPLACE THE PARKING BRAKE AND ENCODER.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

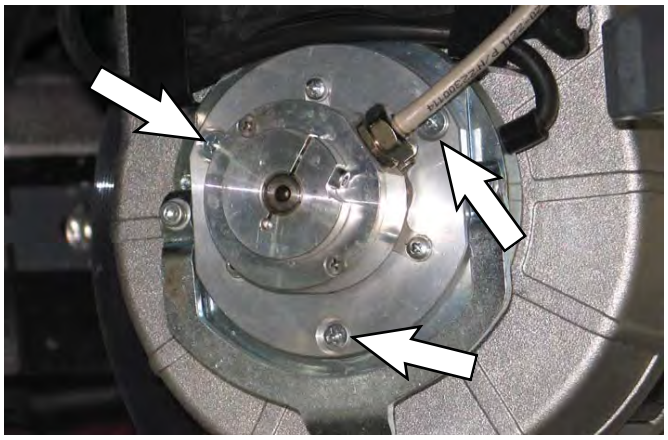
1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

3. Turn steering wheel so the encoder and brake assembly installed on the drive wheel assembly can be easily accessed.
4. Remove the hardware securing the encoder to the brake assembly. **Do Not** lose hardware securing the controller to the brake assembly. These parts will be needed to reinstall the encoder.

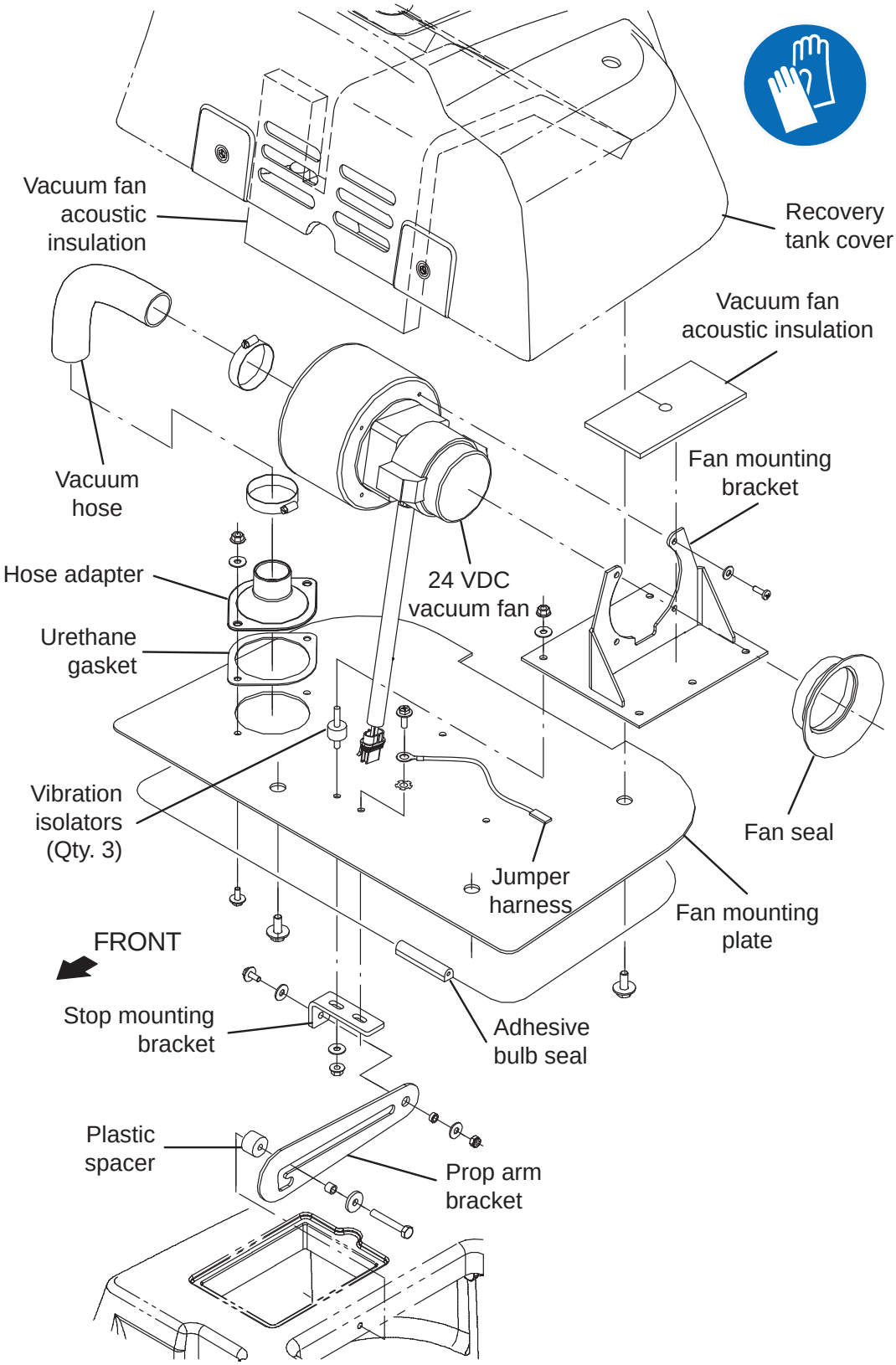


5. If only replacing the encoder: Disconnect the encoder cable from the wire harness.
6. If only replacing the encoder: Connect the new encoder cable to the wire harness and install the new encoder onto the brake assembly.
7. Remove the brake assembly from the drive wheel assembly.



8. Install the encoder onto the new brake assembly/ removed brake assembly.

SOLUTION SYSTEMS



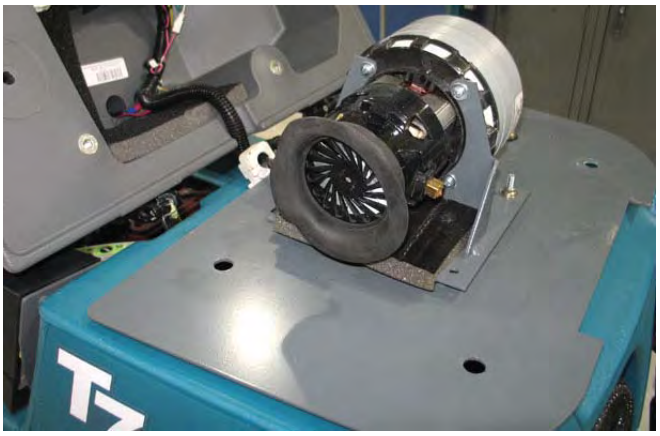
REMOVE/REINSTALL/REPLACE THE VACUUM FAN

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Completely drain the recovery tank.
2. Turn the ON/OFF key switch OFF.
3. Disconnect the battery cable from the machine.

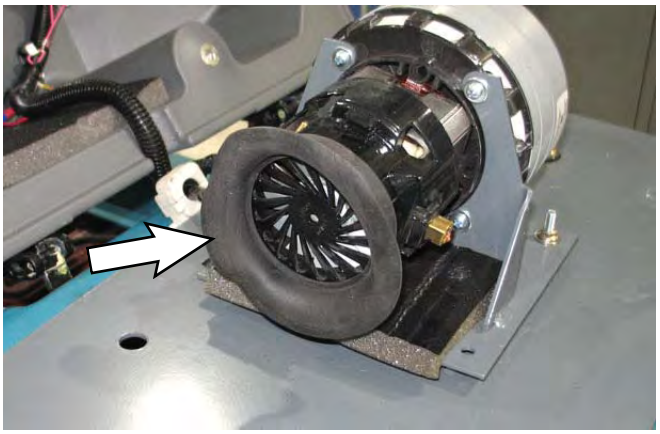
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

4. Remove the hardware securing the recovery tank cover to the fan mounting plate and lower the fan mounting plate onto the recovery tank opening, allowing access to the vacuum fan.



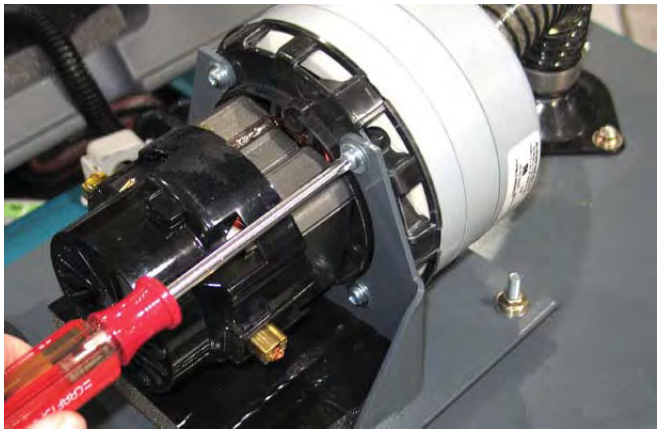
NOTE: Do not completely remove the recovery tank cover from the machine. All components mounted to the recovery tank cover can be easily accessed with the recovery tank cover installed on the machine.

5. Remove the fan seal from the vacuum fan.



6. Disconnect the main wire harness from the vacuum fan.
7. Disconnect the vacuum hose from the vacuum fan

8. Remove the vacuum fan from the fan mounting bracket.



9. Install the fan seal onto the new vacuum fan/ removed vacuum fan .
10. Install the new vacuum fan/removed vacuum fan onto the fan mounting bracket.

11. Connect the vacuum hose to the vacuum fan.
12. Reconnect the main wire harness to the vacuum fan.
13. Reinstall the vacuum fan cover onto the fan mounting plate.

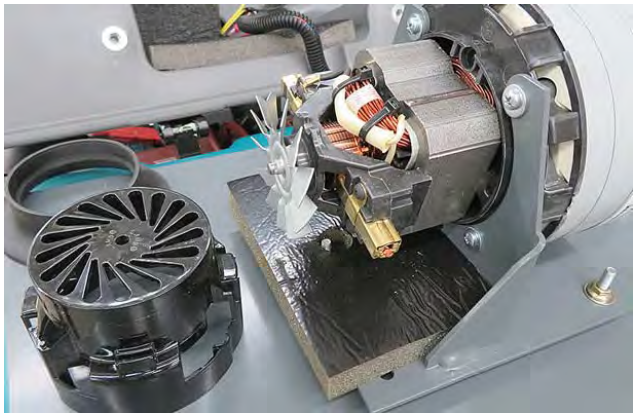
REMOVE/INSPECT/REPLACE THE RECOVERY TANK VACUUM FAN CARBON BRUSHES

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

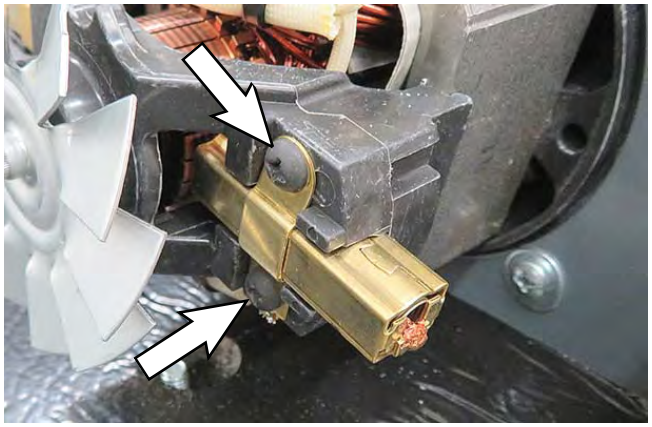
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: Carbon brushes should be replaced as sets.

1. Remove the fan seal from the vacuum fan.
2. Remove the vacuum fan cover from the vacuum fan.

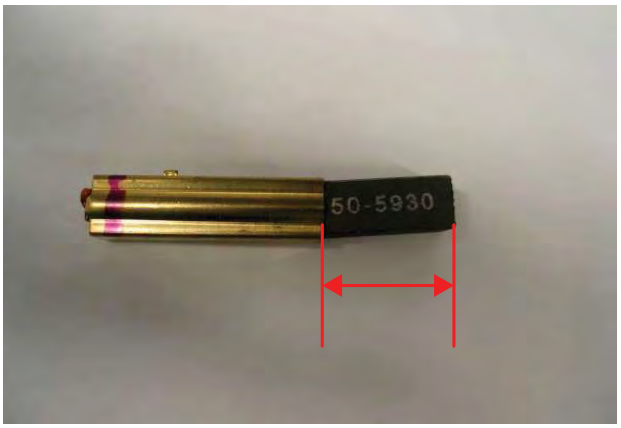


3. Loosen the carbon brush retainer mounting hardware.

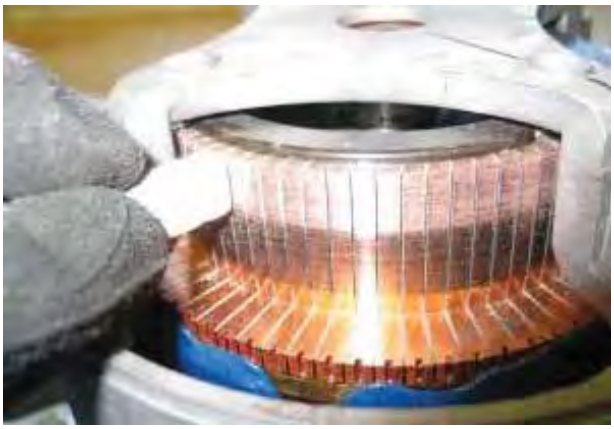


4. Remove the carbon brush from the vacuum fan motor.

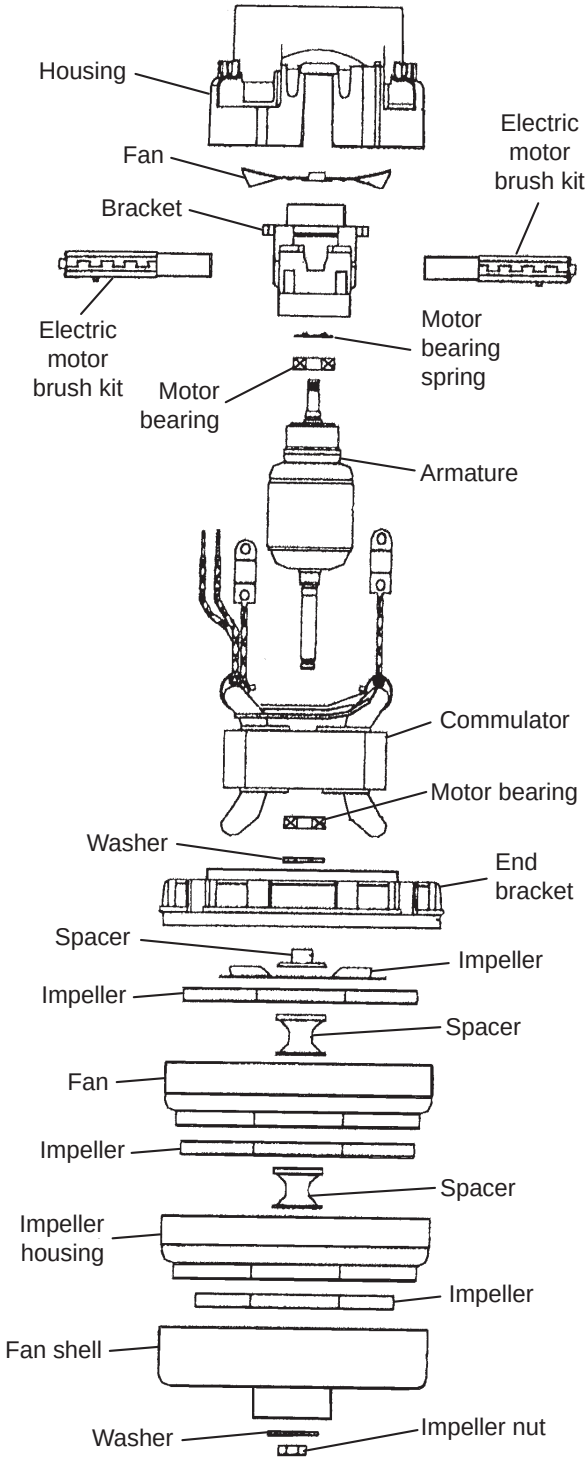
5. Inspect carbon brushes. Replace carbon brushes if they are stuck or are less than 10 mm (0.375 in) in length.



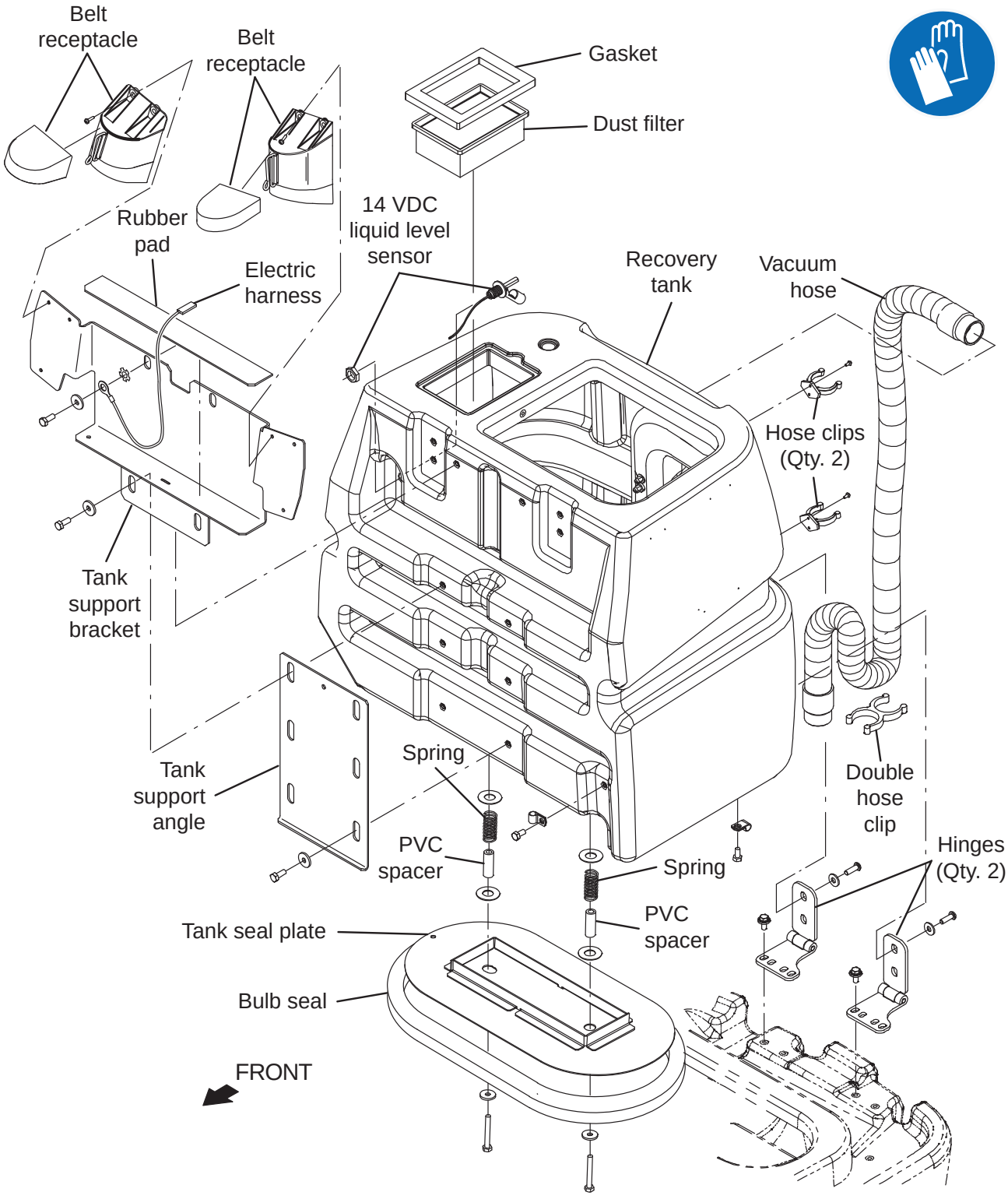
6. Use a stone to clean the commutator.



7. Use compressed air to clean dust from inside the vacuum fan motor.
8. Reinstall the removed vacuum fan brushes/install the new vacuum fan brushes in reverse order of disassembly.
9. Repeat procedure to remove or replace remaining vacuum fan carbon brushes.



RECOVERY TANK GROUP



REMOVE/REINSTALL/REPLACE THE RECOVERY TANK

1. Completely drain the recovery tank.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

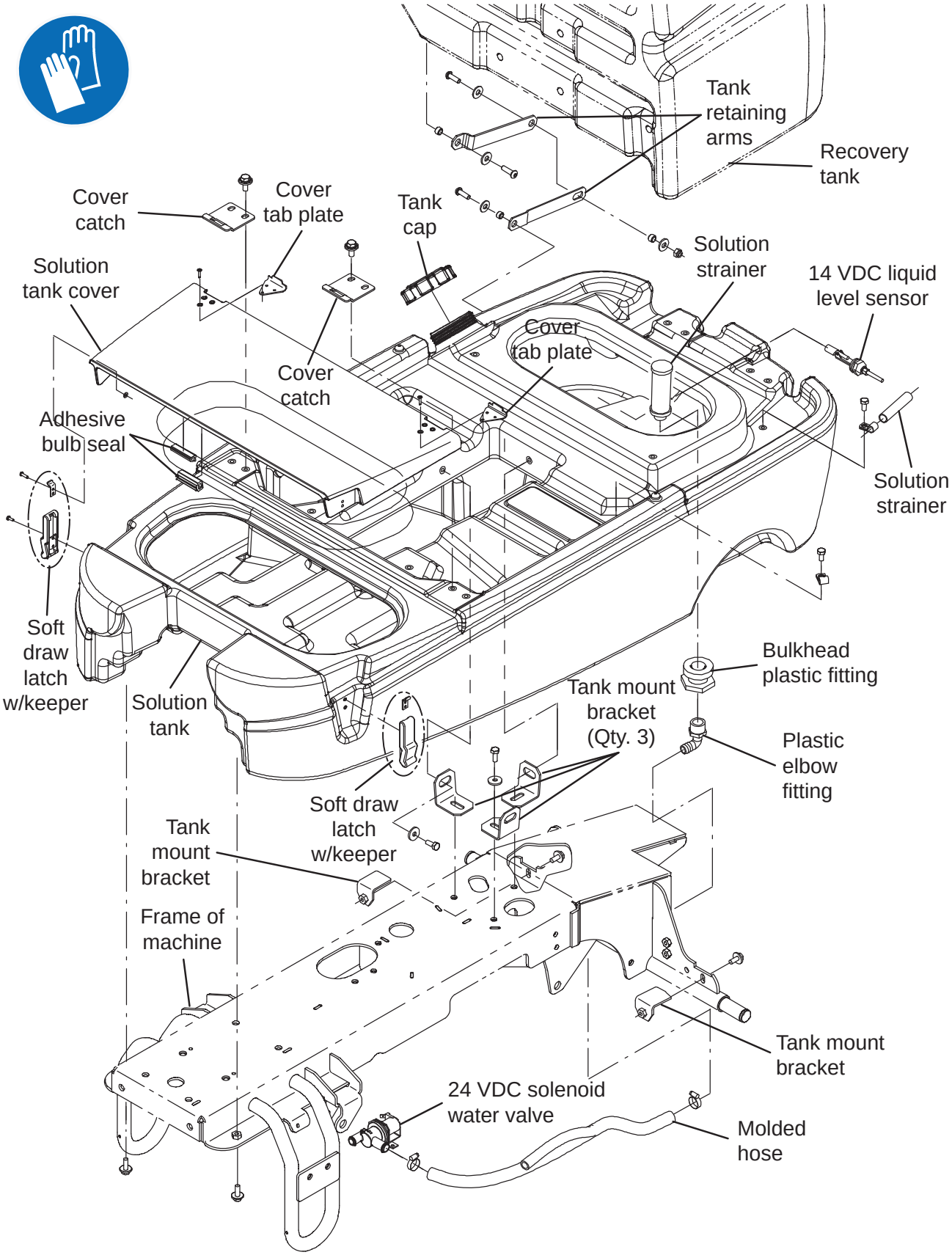
2. Turn the ON/OFF key switch OFF.
3. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

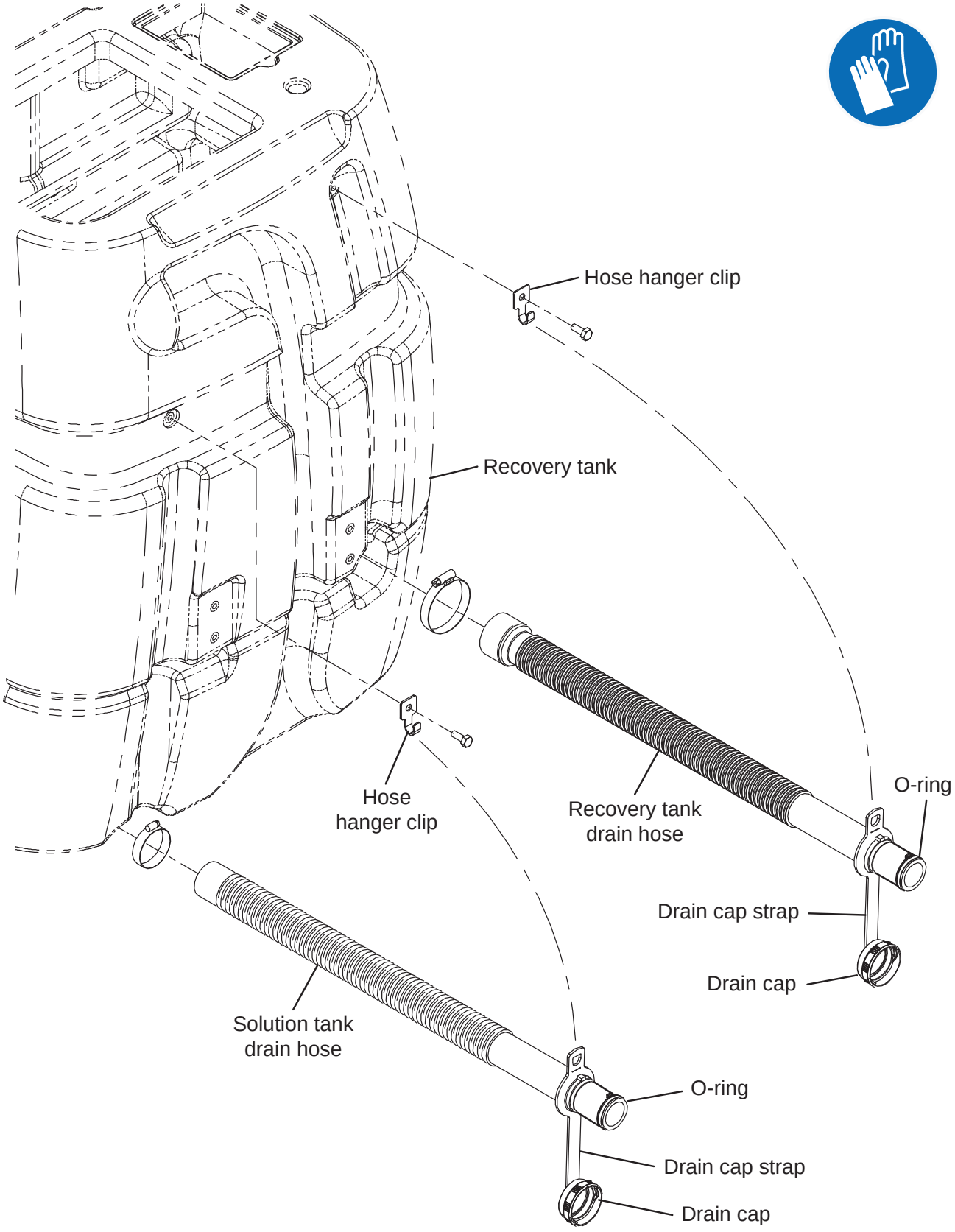
4. Remove the operator seat/seat plate from the machine. See REMOVE/INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
5. Tilt the recovery tank back. Ensure the recovery tank is empty before tilting.

6. Remove the tank support bracket and tank support angle from the machine.
7. Disconnect the main wire harness from the recovery tank cover assembly and the liquid level sensor.
8. Remove the gasket and dust filter from the recovery tank.
9. Remove all hose clips from the recovery tank.
10. Remove the belt receptacles from the recovery tank.
11. Remove the recovery tank cover assembly from the machine.
12. Remove the level sensor from the recovery tank.
13. Remove all hose clamps from the recovery tank.
14. Remove the hardware securing the recovery tank to the tank seal plate.
15. Remove the hardware securing the recovery tank to the hinges installed on the solution tank.
16. Install the new recovery tank onto the tank seal plate and solution tank.
17. Install the liquid level sensor into the recovery tank.
18. Install the recovery tank cover assembly onto the recovery tank.
19. Connect the main wire harness to the liquid level sensor and the recovery tank cover assembly.
20. Install all removed components onto the recovery tank in reverse order of disassembly.
21. Pour water into the recovery tank and observe around the are where the recovery tank is secured to the tank seal plate. There should be no leaks.
22. Reinstall the operator seat/seat plate onto the machine.

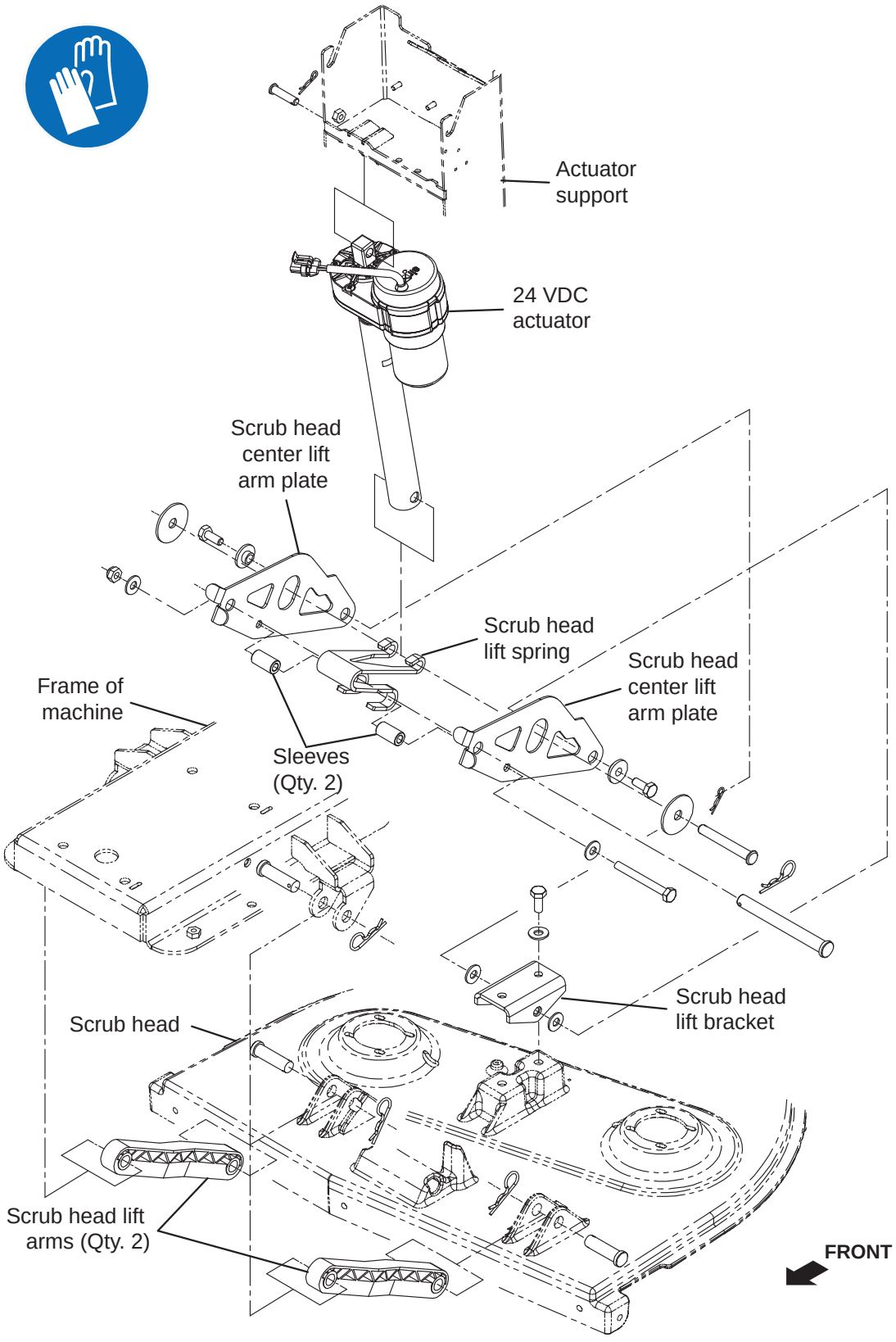
SOLUTION TANK GROUP



SOLUTION TANK/RECOVERY TANK DRAIN HOSES



SCRUBBING SYSTEMS



REMOVE/REINSTALL/REPLACE THE SCRUB HEAD

1. Completely empty the solution tank and recovery tank.
2. Turn the ON/OFF key switch OFF.
3. Remove the brushes from the scrub head.
4. Turn ON the machine, completely lower the scrub head to the floor, turn OFF the machine, and remove the key.

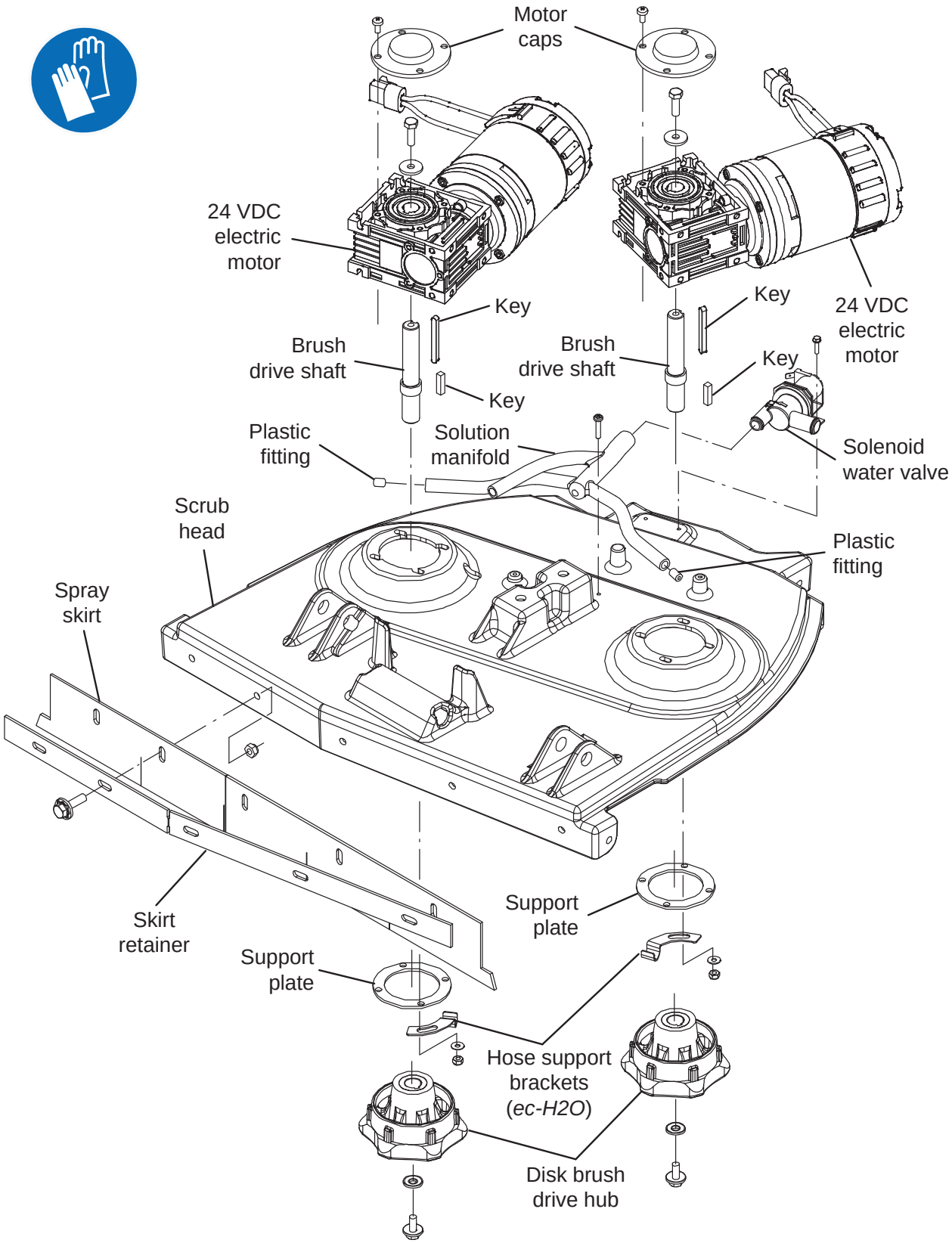
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

5. Remove the either the right rear guard or the left rear guard from the machine, depending on the side of the machine from which the scrub head is being removed. See MAIN FRAME GROUP for right rear guard/left rear guard.
6. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

7. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/ INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
8. Remove the clevis pin/cotter pin securing the scrub actuator to the actuator support.
9. Remove the clevis pins/cotter pins securing the scrub head lift arms to the frame of the machine and the scrub head.
10. Disconnect all wire and cable connections from the scrub head/scrub brush motors/solenoid water valve.
11. Disconnect the solution supply hose from the water solenoid valve located at the rear of the scrub head.
12. Remove the hardware securing the scrub actuator to the scrub head.
13. Remove the scrub head from under the machine.
14. If replacing the scrub brush motor carbon brushes, proceed to REMOVE/INSTALL/REPLACE THE SCRUB HEAD MOTOR CARBON BRUSHES.
15. If replacing scrub head motor(s), proceed to REMOVE/INSTALL/REPLACE THE SCRUB HEAD MOTORS.
16. Reinstall the scrub head onto the machine in reverse order of disassembly.

REMOVE/REINSTALL/REPLACE THE SCRUB HEAD MOTORS



FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, rand remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

3. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/ INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
4. Remove the scrub head from the machine. See REMOVE/INSTALL/REPLACE THE SCRUB HEAD.
5. Remove the disk brush drive hub from the removed scrub brush motor. Do Not lose/misplace the smaller key. This key is needed to install the disk drive hub onto the new scrub brush motor.
6. Remove the scrub brush motor from the scrub head.
7. Install the new scrub brush motor onto the scrub head.
8. Place the saved key into the notch in the brush drive shaft and install the disk brush drive hub onto the new scrub brush motor.
9. Repeat procedure if replacing the other scrub brush motor.
10. Reinstall the scrub head onto the machine in reverse order of disassembly.

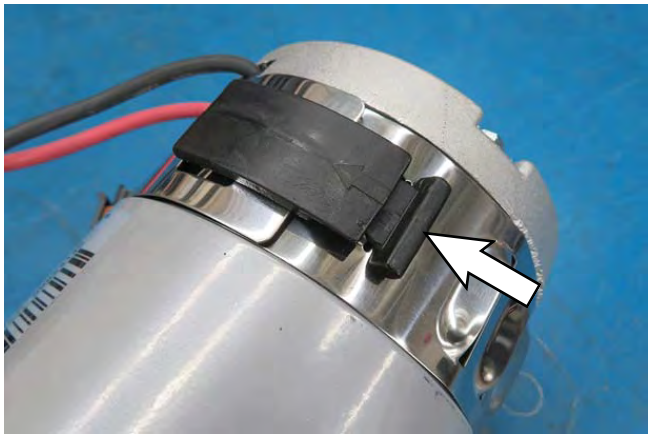
REMOVE/REINSTALL/REPLACE THE DISK SCRUB HEAD MOTOR CARBON BRUSHES

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

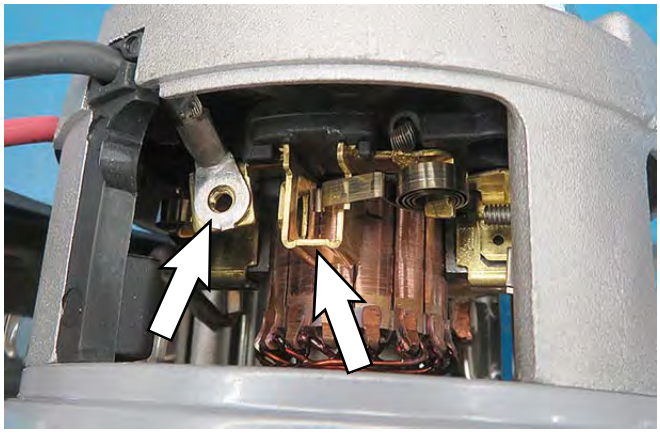
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

3. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
4. Remove the scrub head from the machine. See REMOVE/INSTALL/REPLACE THE SCRUB HEAD.
5. Remove the scrub brush motor(s) from the scrub head. See REMOVE/INSTALL/REPLACE THE SCRUB HEAD MOTORS.
6. Loosen and remove the band covering the carbon brushes from the scrub brush motor.



7. Lift the clip securing the carbon brush inside the scrub brush motor and pull the carbon brush from the retainer.

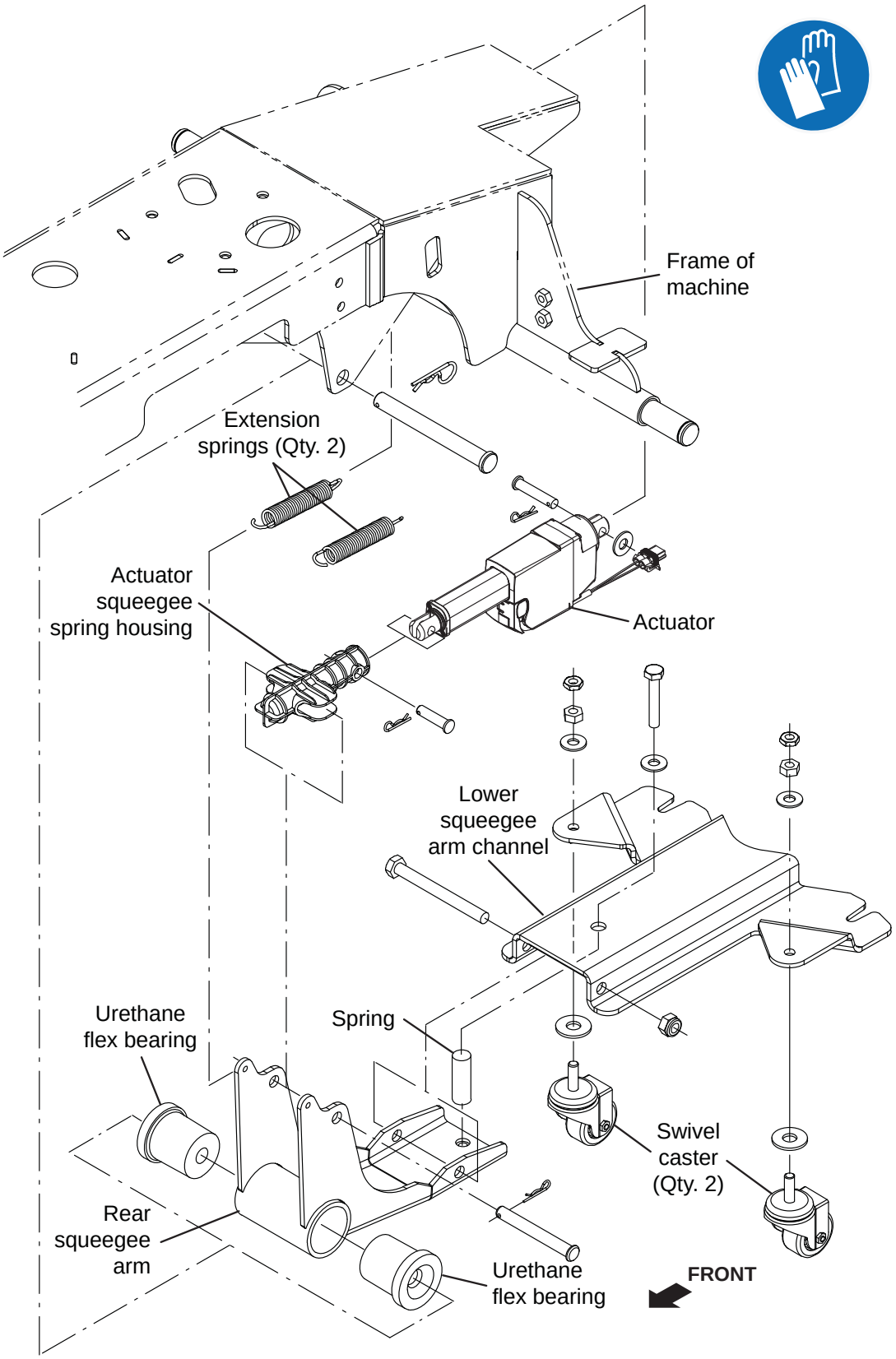
8. Remove the hardware securing the carbon brush cable to the scrub brush motor and remove the carbon brush from the motor.



9. Use compressed air to clean dust from inside the motor.

10. Install a new carbon brush/reinstall the removed carbon brush into the scrub brush motor in reverse order of disassembly.
11. Repeat procedure to remove or replace the remaining scrub brush motor carbon brushes.
12. Reinstall the retaining band onto the motor.
13. Reinstall the scrub brush motor onto the scrub head.
14. Reinstall the scrub head onto the machine.

REAR SQUEEGEE LIFT GROUP



ATTENTION: DO NOT tip the machine onto its side to replace the rear squeegee actuator. Sensitive robotic components could be damaged or bumped out of adjustment if the machine is tipped onto its side.

REMOVE/REINSTALL/REPLACE THE REAR SQUEEGEE ACTUATOR

1. Completely empty the solution tank and the recovery tank.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

2. Turn the ON/OFF key switch OFF

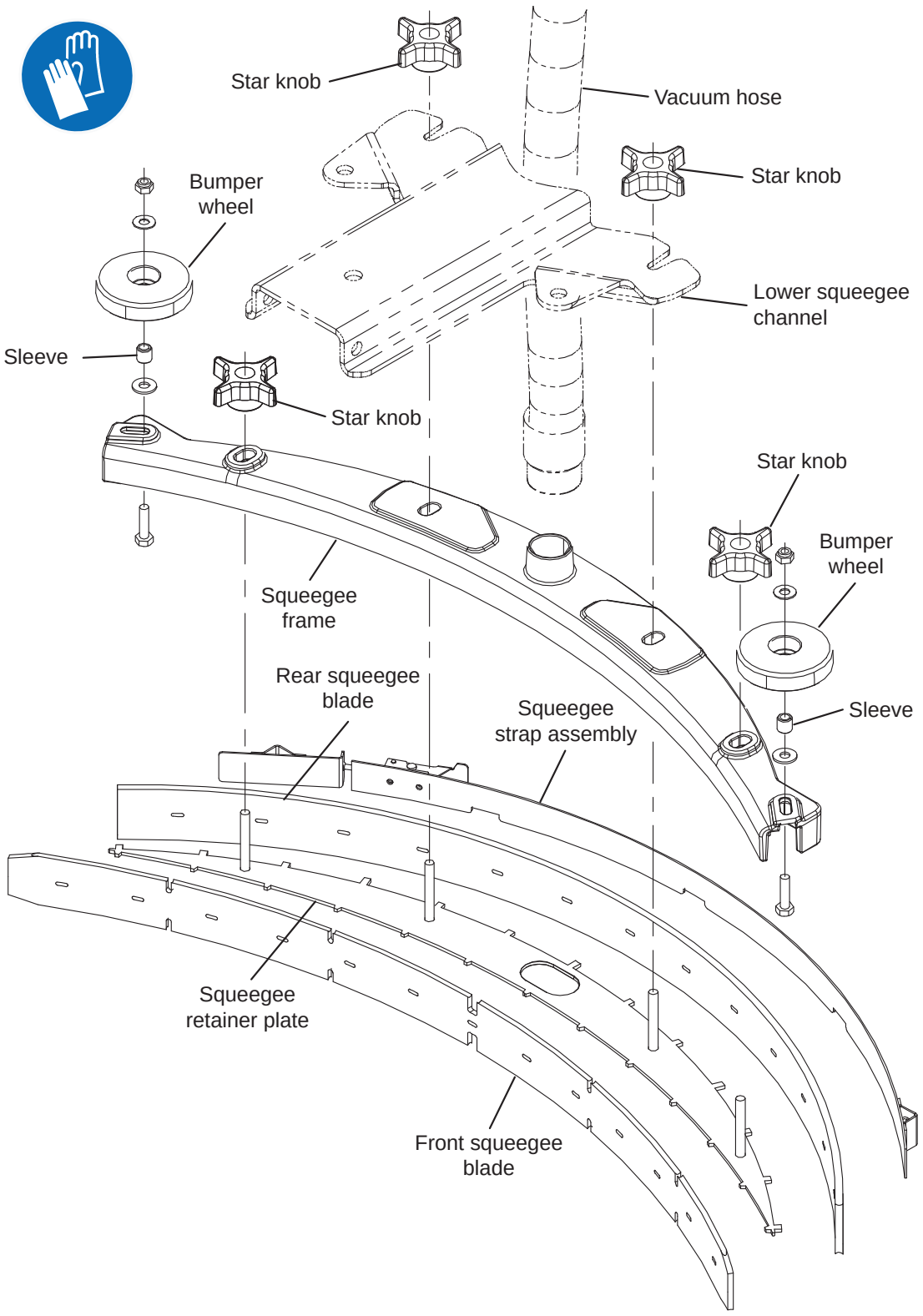
ATTENTION: DO NOT tip the machine onto its side to replace the rear squeegee actuator. Sensitive robotic components could be damaged or bumped out of adjustment if the machine is tipped onto its side.

3. Remove the front guard from the machine. See REMOVE/INSTALL THE FRONT GUARD
4. Disconnect the vacuum hose from the rear squeegee assembly and remove the rear squeegee assembly from the machine.
5. Place a chock in front of the drive wheel.
6. Jack up the rear end of the machine high enough to access/remove the squeegee actuator from the machine and place jack stands/blocks under both rear jacking locations.

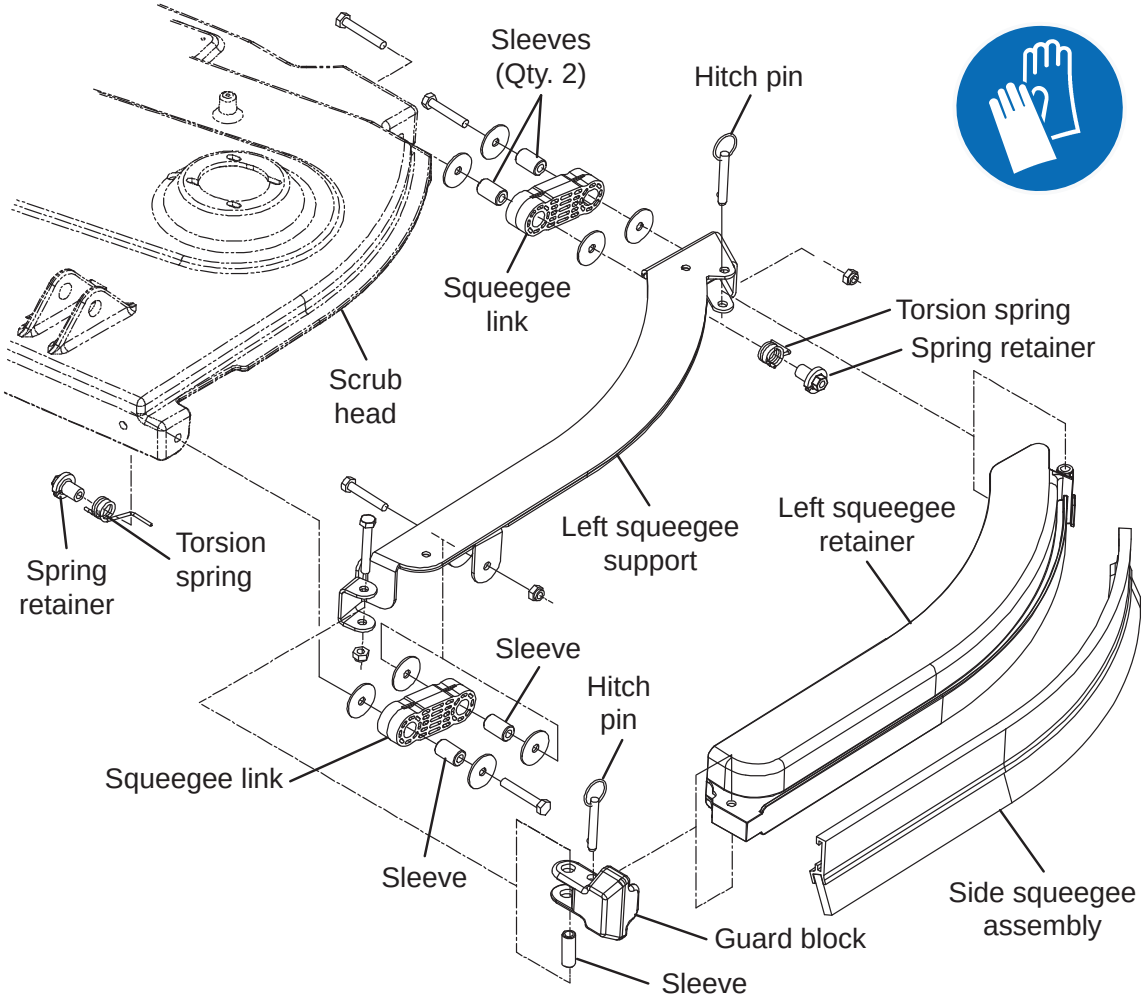
FOR SAFETY: When servicing machine, block machine tires before jacking machine up. Use a hoist or jack that will support the weight of the machine. Jack machine up at designated locations only. Block machine up with jack stands.

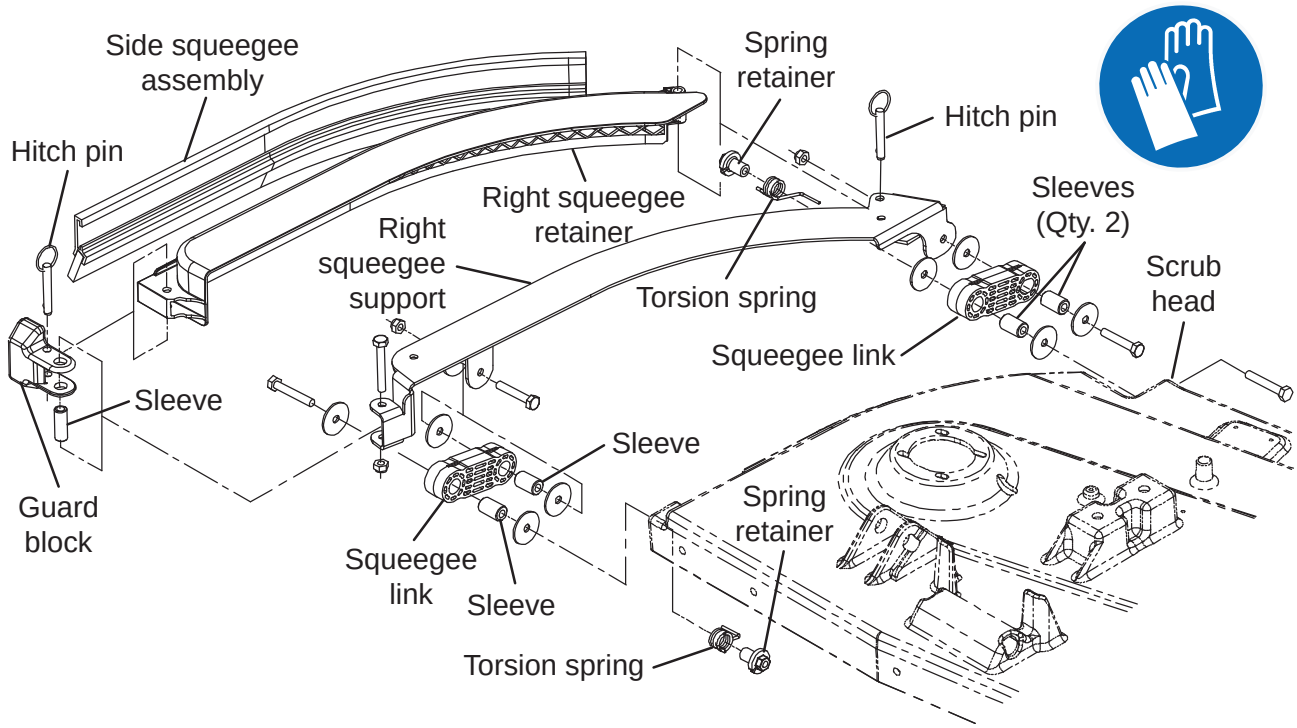
7. Turn the ON/OFF key switch ON.
8. Completely lower the squeegee so the actuator is fully extended.
9. Turn the ON/OFF key switch OFF.
10. Disconnect the battery cable from the machine.
11. Disconnect the main wire harness from the actuator.
12. Remove the cotter pin/clevis pin securing the rear squeegee arm to the actuator squeegee spring housing,
13. Disconnect the extension springs from the rear squeegee arm.
14. Remove the cotter pin/clevis pin securing the rear squeegee arm to the frame of the machine.
15. Remove the rear squeegee arm/lower squeegee arm channel from under the machine.
16. Remove the cotter pin/clevis pin securing the actuator to the frame of the machine.
17. Install the new actuator onto the frame of the machine.
18. Reinstall all rear squeegee components removed to remove the actuator in reverse order of disassembly.
19. Jack machine off from jack stands/blocks, remove jack stands/blocks from under the machine, and lower the machine to the floor.
20. Install the rear squeegee onto the machine.

REAR SQUEEGEE



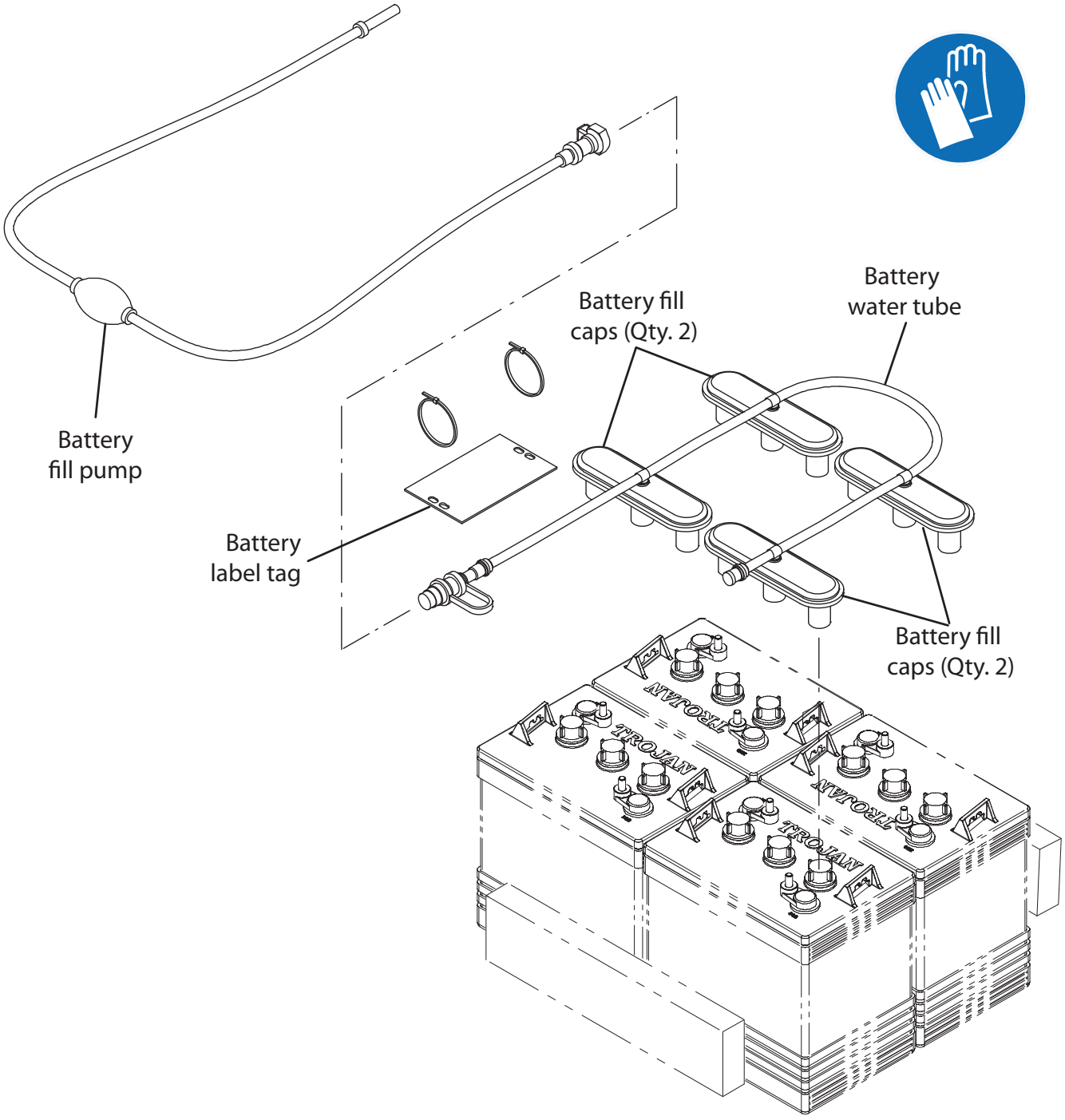
SIDE SQUEEGEES



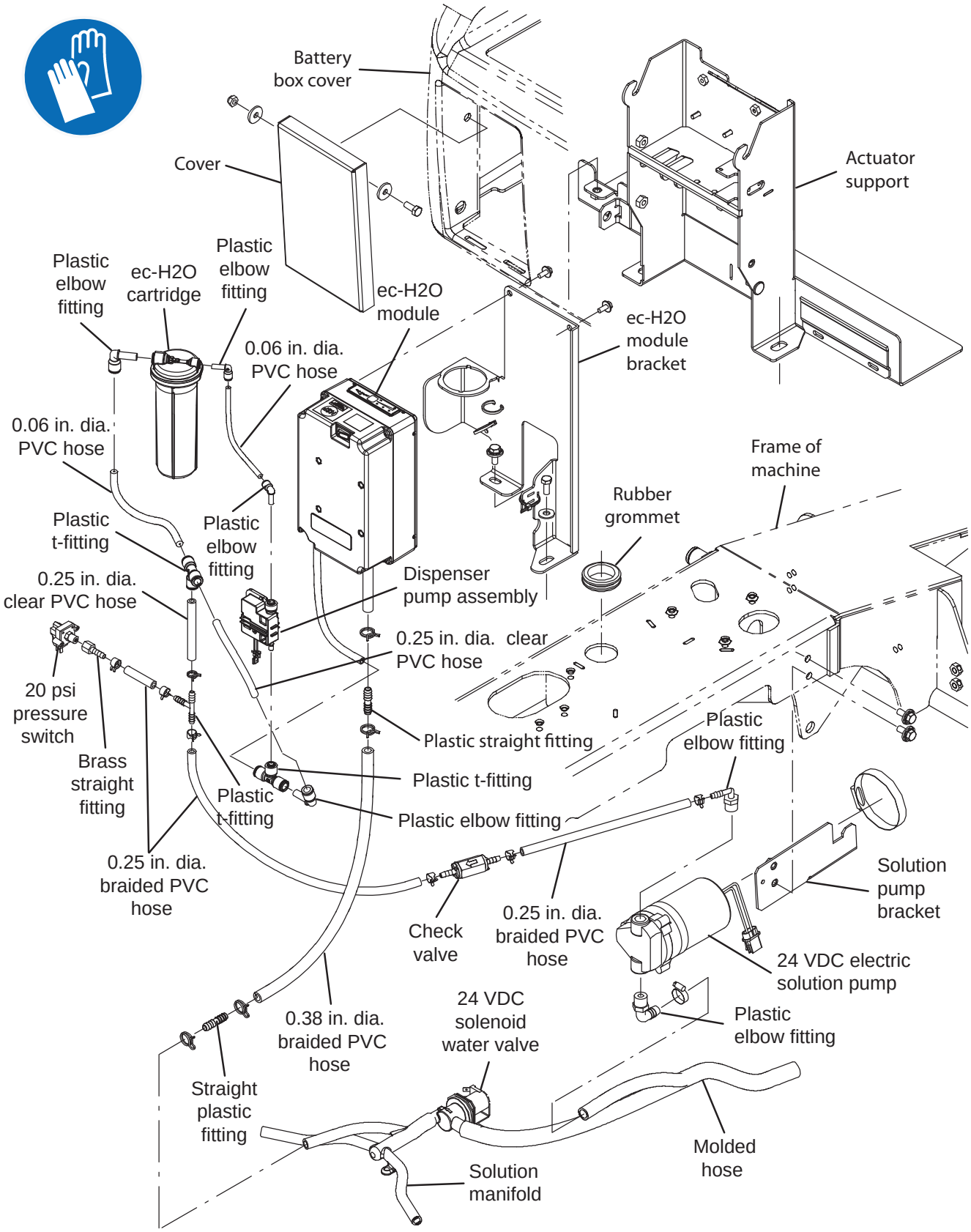


OPTIONS

BATTERY WATERING SYSTEM (OPTION)



ec-H2O NanoClean GROUP



REMOVE/REINSTALL/REPLACE THE ec-H2O SOLUTION PUMP (OPTION)

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Completely drain the solution tank and the recovery tank.
2. Completely lower the scrub head.
3. Turn the ON/OFF key switch OFF.
4. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

5. If necessary, jack up the back end of the machine to allow easier access to the ec-H2O solution pump.

FOR SAFETY: When servicing machine, jack machine up at designated locations only. Support machine with jack stands. Use jack or hoist that will support the weight of the machine.

6. If machine is jacked up off the floor, position jack stands under the back end of the machine and lower the machine onto the jack stands.
7. Loosen the hose clamp securing the ec-H2O pump to the pump mounting bracket and remove the ec-H2O pump from the pump mounting bracket.
8. Disconnect both solution hoses from the ec-H2O pump.
9. Disconnect the main wire harness from the ec-H2O pump.
10. Connect the solution hoses and main wire harness to the new/removed ec-H2O pump.
11. Reinstall the ec-H2O pump onto the pump mounting bracket.
12. Remove the jack stands from under the machine and lower the machine to the floor.

REMOVE/REINSTALL/REPLACE THE ec-H2O PRESSURE SWITCH (OPTION)

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Completely drain the solution tank and the recovery tank.
2. Turn the ON/OFF key switch OFF.
3. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

4. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/ INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
5. Disconnect the main wire harness from the pressure switch.
6. Remove the pressure switch from the brass straight fitting.
7. Install the new/removed pressure switch onto the brass straight fitting.
8. Connect the main wire harness to the pressure switch.
9. Reinstall all items removed from the machine to access the pressure switch.

REMOVE/REINSTALL/REPLACE THE ec-H2O MODULE (OPTION)

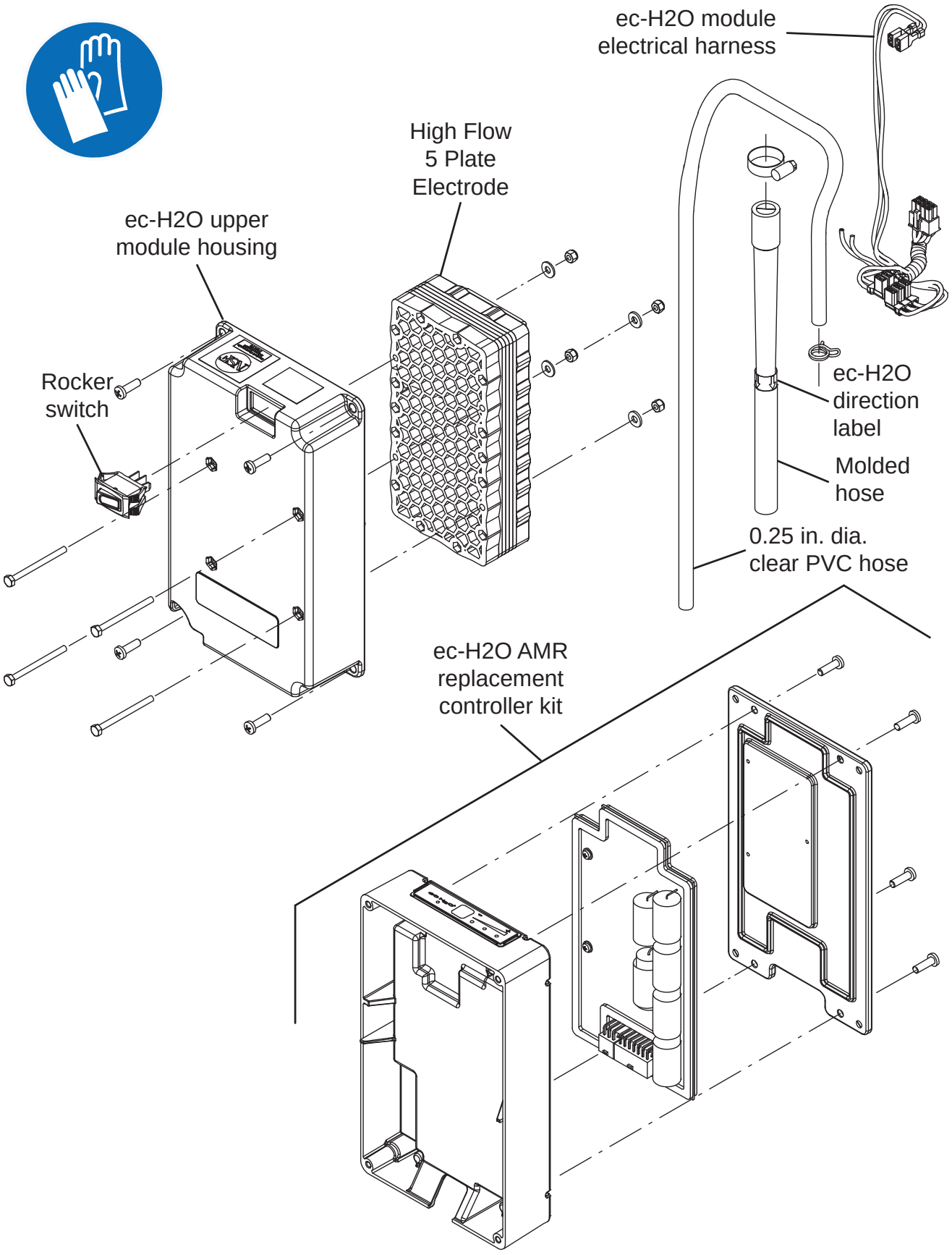
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Completely drain the solution tank and the recovery tank.
2. Turn the ON/OFF key switch OFF.
3. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

4. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/ INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
5. Remove the hardware securing the ec-H2O module to the ec-H2O module bracket.
6. Disconnect all main wire harness connections from the ec-H2O module.
7. Disconnect all solution hoses from the ec-H2O module.
8. Carefully remove the ec-H2O module from the machine.
9. Reinstall removed ec-H2O module/install new ec-H2O module in the reverse order of disassembly.
10. Install all items removed from the machine to access the ec-H2O module.

SERVICE THE ec-H2O MODULE (OPTION)



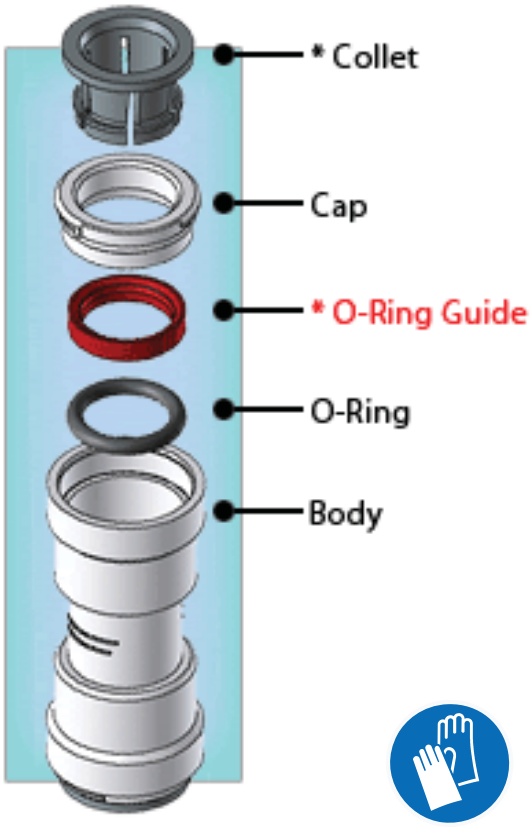
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key to the OFF position.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

3. Remove the ec-H2O module from the machine. See REMOVING/INSTALLING THE ec-H2O MODULE (OPTION).
4. Remove the ec-H2O upper module housing from the ec-H2O module.
5. Further disassemble the ec-H2O module as necessary to access and replace parts.
6. Reassemble the ec-H2O module in the reverse order of disassembly.
7. Reinstall the ec-H2O module onto the machine. See REMOVING/INSTALLING THE ec-H2O MODULE (OPTION).

CONNECT HOSES TO PTC (PUSH-TO-CONNECT) FITTINGS



1. Cut the tube square. The outer diameter of the tubing must be free of score marks, burrs, or sharp edges.

2. Insert tube into the fitting. The fitting will grip the hose before it seals.

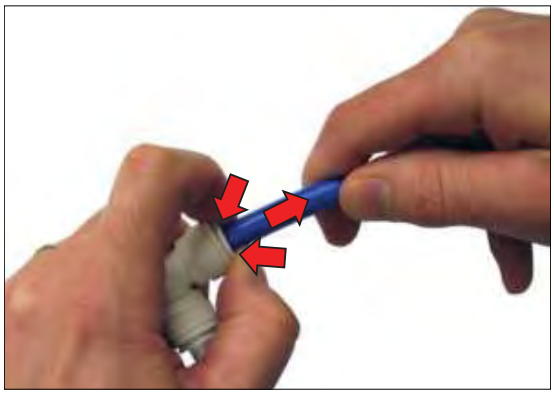
3. Push into the tube stop. The stainless steel teeth inside the collet firmly hold the tube in position and the o-ring provides a permanent leak-proof seal.

4. Pull on the fitting to ensure the hose connection is secure.

5. Test the fitting/hose connections for leaks prior to leaving the site.

DISCONNECT HOSES FROM PTC (PUSH-TO-CONNECT) FITTINGS

1. Push the hose into the fitting and push the collet squarely in against face of fitting to release the hose from the fitting. Continue to hold the collet held in against the fitting and pull the hose from the fitting.



NOTE: Be sure there is no pressure in the system and the system is emptied of all solution before disconnecting hose(s) from the fitting.