

INSTRUCTION TO SERVICE

ITS: 59024	
SECTION:	260 BATTERY COMPARTMENT
WRITTEN BY:	Curtis Matthews
SUBJECT:	MSD replacement – SR-2178, 2179, 2250

ITS59024

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▲ WARNING: Only trained personnel shall supervise and perform High Voltage system testing, checkout and troubleshooting. Two personnel (one called the Checker & the other called Monitor/Recorder) shall perform Checkout Procedures, together, to ensure safety of themselves, others nearby & for the protection of vehicle & property. Refresher training shall be provided to these personnel on a regular basis and when new systems are to be checked by them. The training of the personnel shall consist of:

1.0 SAFETY PROCEDURE: (Mandatory for all SRs)

- 1.1 Fill out and submit a Live Work Permit to the shop lead. See Appendix C for a Live Work Permit.
- 1.2 Turn the master run switch to the off position and wait 5 minutes before proceeding.
- 1.3 Turn the 12/24V battery disconnect and HV Interlock switch to the "OFF" position.
- 1.4 Lock and Tag the electrical system of the bus out and retain the key. See Figure 1.
- 1.5 Install a Lockout/Tagout Steering wheel cover as require
- INOTE: Refer to the Lockout/Tagout Procedure in section 1 of your Preventive Maintenance Manual or section 9 of your Service manual for additional information.
- In the second second
- INOTE: Refer to New Flyer High Voltage Safety Guidelines and Procedures Document 532295 (Appendix A) when completing installation or service work on high voltage power cables.



Figure 1: Lockout tagout location reference



WARNING: High Voltage PPE Category 2 is required. Please refer to Appendix B or the safety section of your Preventive Maintenance Manual and Service Manual for more information. There shall be no communication from observers with the 2 personnel performing HV work. If required all work must stop until communication has been completed.

- 1.6 Review the scope of work to be completed with the Monitor/Recorder.
- 1.7 Review/Rehearse the actions required in case of any possible accident scenarios.
- 1.8 Using an appropriate voltmeter as per appendix A, confirm that no voltage is present between HVPOS_VEH_FB & HVNEG_VEH_FB before proceeding. See Figure 2. These connections are located inside the HV Fuse box inside the inverter rack. See Figure 3 layout for location.



Figure 2: High voltage fuse box location reference



1.9 Identify the location(s) of the ESS compartments that will require work. See Figure 3. (Refer to your wiring schematic or schematics often located on the underside of the ESS enclosure lids)



Figure 3: Battery pack string location reference

- 1.10 Ensure the bus is not charging and gain access to the roof of the bus ESS enclosures and the other applicable ESS enclosure(s). Ensure the appropriate fall protection PPE is used and appropriate safety procedures are followed when applicable.
- 1.11 Determine and organize the required tools neatly before work begins.
- 1.12 Before removing any MSD(s), confirm voltage is present between the positive in terminal on the BDU and negative in terminal on the BDU. See Figure 5.



1.13 Confirm that **NO** voltage is present between the positive out terminal on the BDU contactor and negative out terminal on the BDU contactor. See Figure 4.



Figure 4: BDU and contactor location reference



2.0 Retrofit Procedure

2.1 Locate the rooftop ESS and open ESS battery panel. See figure 5.



Figure 5: Rooftop ESS

2.2 Locate MSDs x2. See figure 6.



Figure 6: Rooftop ESS MSD location



2.3 Remove and discard MSD plugs x2. Remove and keep high voltage barrier and mounting hardware x4. See figure 7.



Figure 7: Rooftop ESS MSDs and HV barrier

- 2.4 Remove and discard MSD brackets x2. See figure 8.
 - 2.4.1 Unfasten and keep bracket mounting hardware from rooftop ESS frame x8 bolts + washers + nuts.
 - 2.4.2 Unfasten and keep MSD receptacle mounting hardware x8 bolts + washers. Also, unfasten MSD stud nuts x4 that clamp down on HV busbars.



Figure 8: Rooftop ESS MSD receptacles and busbars exposed



- 2.5 Remove MSD receptacles and busbars. See figure 9.
 - 2.5.1 Remove and keep powerbar boots x4 to expose busbar hardware, remove and keep busbar hardware x4.
 - 2.5.2 Remove and keep stud nuts x4 connecting busbars to MSD receptacles.
 - 2.5.3 Remove and discard MSD receptacles x2 and busbars x4.



Figure 9: Rooftop ESS MSD receptacles and busbars exposed

- 2.6 Bench assemble new rooftop ESS MSD assemblies. See figure 10.
 - 2.6.1 Using original MSD mounting hardware x8, bench assemble MSD receptacle PN: (806450) x2 and plug PN: (805480) x2 onto bracket PN: (855541) x2.
 - 2.6.2 Torque all MSD mounting hardware bolts x8 to 14 ft-lbs (DRY).



Figure 10: Rooftop ESS MSD bench assembly



- 2.7 Install new MSD bench assembly onto bus. See figure 11.
 - 2.7.1 Fasten HV busbars PN: (852894) x4 and current sensing harness to new MSD receptacle PN: (806450) studs with nuts x4 kept from step 2.5, torque nuts to 80 in-lbs (DRY).
 - 2.7.2 Fasten rear ESS bench assembly to rooftop ESS frame with the bracket mounting hardware x8 kept from step 2.4. Torque all hardware to 14 ft-lbs (DRY).



Figure 11: Rooftop ESS MSD bench assembly

- 2.8 Re-install rooftop ESS high voltage barrier removed in step 2.3.
- 2.9 Remove all tools and debris and return the bus to service condition.
- 2.10 Remove all locks and tags from battery disconnect switches and steering wheel.
- 2.11 Turn low voltage, then high voltage disconnect switches into the "ON" position.



	Operation	Men	Hours	Labour Time M X HR
1	MSD remove and replace	2	2.67	5.34

PARTS REQUIRED					
			Qty.		
Item	Part Number	Description	per Coach	Units	Notes
1	806450	RCPT-MNL SVCE DISC 220 AMP	2	EA	
2	805480	PLUG-MNL SVCE DISC 250 AMP	2	EA	
3	853309	POWERBAR-ESS TO MSD	4	EA	
4	852861	BRACKET-DISCONNECT SWITCH MTG	2	EA	



<u>Appendix A – NFIL Spec 532295 - High</u> <u>Voltage Safety Guidelines & Procedures for</u> <u>New Flyer Battery Bus</u>

The following provides general guidelines in relation to safety and best practices when completing installation or servicing work on any New Flyer battery bus vehicle platform.

This document is not meant to supersede the actual released installation and assembly drawings and where conflicts arise, the released engineering drawings take precedence.



Introduction

The utmost concern, while working with High Voltage (HV) systems, is the safety of yourself, other personnel and the potential of damage to property. To minimize these risks, it is crucial to be properly trained and always maintain a very alert, questioning and disciplined attitude without fail. As soon as your guard is lowered, then the potential of an accident is probable that can hurt or kill yourself or someone else and possibly damage property.

What is High Voltage (HV)?

Any form of voltage that is greater than 50 volts if the person's skin at the electrical contact points is not compromised and not wet.



Equipment Required

The following equipment shall be required:

Digital Multimeter (DMM), 1000 volt Category III, 600 volt Category IV,
10Megohm impedance or greater with insulated case or rubber holster
Clamp-on current probe, 1000 volt Category III, 600 volt Category IV
High Pot Tester (Hi-Pot)
Phase rotation meter
Personal Protection Equipment (PPE) appropriate for 700volt DC & 230
volt AC with Class 00 or higher HV gloves with compatible leather over
gloves. Appropriate safety glasses as well as the face shield. The PPE
shall also meet the required Arc Flash & Arc Blast requirements. Before
use, inspect the PPE in accordance with this guideline.
Adequate lighting
HV insulated mat
Two fused HV clip leads 10 inches long
Safety barricade with warning lights & "Danger High Voltage" signs
Belt tool pouch (use only to carry small components up/down a ladder)
Torque Screwdriver set
Imperial torque nut driver set
Metric torque nut driver set
Imperial 1/4" torque drive socket set
Imperial 3/8" torque drive socket set
Insulated rescue hook
ABC Fire extinguisher, 5 lb minimum, at the activity areas
Spare HV and low voltage fuses

Equipment Calibration

All test equipment must be within their calibration interval and recorded such with the respective serial numbers. These records must be available to the Checker.

Personnel Requirement

Only trained personnel shall supervise and perform High Voltage system testing, checkout and troubleshooting. Two personnel (one called the Checker & the other called Monitor/Recorder) shall perform Checkout Procedures, together, to ensure safety of themselves, others nearby & for the protection of vehicle & property. Refresher training shall be provided to these personnel on a regular basis and when new systems are to be checked by them. The training of the personnel shall consist of:

HV & low voltage basics, intermediate & advanced electricity
HV & low voltage electrical systems of the vehicle
Shop safety practices & procedures
First aide including CPR & the use of the shop defibrillator
How to release a victim that can't let go HV
Quickest method of shutting down HV
Fire fighting and emergency procedures



To ensure effectiveness of training, exams of the trained material shall be required with a high passing mark of at least 80% and a retraining of the missed 20 % on a one to one basis.

Checker Function

(**Caution:** The Checker must not have any health conditions that can be exacerbated when startled and must not have any electronic implants.)

Directed by the Monitor/Recorder Performs all preparations & checks Wears PPE as specified by the Checkout Procedure Performs all restorations

Vehicle Inspection

It is necessary that the vehicle to be checked out, first be visually inspected of all systems, workmanship and with special attention to ensuring there is no HV cable or equipment damage or chafing.

High Voltage Checkout Preparation

- (1) The scope of the work must be accurately defined such as a Checkout Procedure that requires systematic steps with sign offs. Before a Checkout is performed, the Supervisor, Checker and Monitor/Recorder must conduct a briefing of what shall transpire, identify potential hazards, resist pressures of "is it done yet?", anticipate problems and question possible events. If an unexpected electrical hazard or fault occurs, during any time of the Checkout, it must be immediately reported to the supervisor. After the Checkout is completed the same group should review the results and processes and make proposed modifications to the procedures if required.
- (2) Install Safety barricade with warning lights & signs indicating "Danger High Voltage" around the vehicle perimeter and ensure no personnel are within the fenced perimeter during the checkout procedure.
- (3) It shall always be the goal to check the systems as much as possible with all HV power OFF and Locked Out/Tagged Out and proven as de-energized by voltage measurement using the DMM. The functionality of the DMM must be proved before and after the verification of no HV present. Then, if possible, the HV systems should be challenged by trying to energize them while checking that no HV appears.
- (4) When it is necessary to perform tests of HV systems with the power ON, then the Working Live procedure must be followed.
- (5) The test personnel shall always rehearse the actions required in case of any possible accident scenarios.



(6) Before beginning the Checkout Procedure, the test personnel shall remove all their jewelry (including pierced ones), watches and any electrically conductive objects on them.

PPE Requirements

The PPE voltage class, Arc Flash and Arc Blast rating shall be compatible with the voltage and Arc Flash capability of the systems being tested. Appropriate leather glove protectors shall be worn over the HV rubber gloves.

PPE Care & Testing

Rubber insulated PPE shall be periodically cleaned and tested in accordance with 29 CFR 1910.137 and the appropriate ANSI/ASTM standards. HV gloves, sleeves and mats shall be tested every 6 months. PPE apparel shall be cleaned and maintained in accordance with the manufacturer's instructions. A record of the PPE testing shall be maintained and available to the users.

PPE Inspection

Inspect PPE equipment, before use, for any degradation or damage and ensure that the HV gloves have been tested every 6 months. Also perform an air pressure test on the HV gloves before and after each use. If during PPE use a potential damaging incident occurred to the PPE, stop further testing and inspect the PPE. If at any time the PPE is defective, reject it, and obtain an accepted one.

PPE Storage

PPE apparel should be stored lying flat, undistorted, right-side out and not folded in protective containers. The HV mats can be rolled with an inside diameter greater than 2 inches. Rubber HV gloves should be stored in cool, dark, dry, and free from damaging chemicals or vapors. The glove cuffs should face downwards, without folding, in the appropriate glove bag and hung vertically.

Insulated Tools

Insulated tools should be visually inspected for insulation damage before and after each session of use.

Lockout/Tagout Procedure

The Lockout/Tagout procedure should be followed that is specified in the respective Checkout procedure. When removing the lock and tag:

- (1) The locks and tags shall be removed by the installer of them or under her/his supervision.
- (2) If the installer of the locks and tags is not available, then her/his supervisor:
 - (a) Ensures that the installer of the locks and tags in not in the facility
 - (b) Contacts the installer to inform her/him that the locks and tags will be removed
 - (c) Reminds the installer of the lock and tag removal when she/he resumes work



Stored Energy

Personnel must always remember the characteristics of stored energy devices such as capacitors and batteries and when energy is available from.

Working Live

To maximize safety, it is always important to perform the maximum amount of HV checkout in the de-energized state.

When it is necessary to work with HV equipment while energized or to verify whether HV is present, the utmost care and safety procedures must be utilized including:

- (1) Wearing appropriate PPE with protector gloves over top of the HV rubber gloves
- (2) Ensure all personnel, except the Checker and Monitor/Recorder, are clear of the vehicle
- (3) Kneeling or standing on HV insulated mat

Energizing & De-energizing Procedure

It is critical that before any HV system is energized that a visual check be performed to ensure that all possible HV compartments are closed and there is no debris, tools or test equipment lying on HV terminations. If there is a certain sequence of energizing and de-energizing the HV system, then all personnel involved must be trained in this sequence. (**CAUTION:** Never try to connect or disconnect circuit components such as cables, fuses, connectors, etc while there is current flowing in the circuit.)

Electrical Injuries

Electrical injuries should be immediately reported to the first aide personnel and the supervisor. Other than electrostatic shocks, even non-injurious electrical shocks should be reported to the supervisor. These should be immediately investigated and documented to determine the cause and prevent the occurrence in the future.



<u> Appendix B – NFIL PPE Categories</u>



PPE CATEGORIES					
CATEGORY 0	CATEGORY 1	CATEGORY 2			
1.2 cal/cm2	4 cal/cm2	8 cal/cm2			
	Arc Rated Clothing:				
Untreated cotton long sleeve shirt and pants	AR long sleeve shirt and pants or AR coverall	AR long sleeve shirt and pants or AR coverall			
	AR flash suit hood or AR face shield	AR flash suit hood or AR face shield and AR balaclava			
	AR jacket, parka, rainwear or hard hat liner (as needed)	AR jacket, parka, rainwear or hard hat liner (as needed)			
Other Equipment:					
Hard hat	Hard hat	Hard hat			
Safety glasses	Safety glasses or goggles	Safety glasses or goggles			
Hearing protection	Hearing protection (with inserts)	Hearing protection (with inserts)			
	Heavy duty leather gloves	Heavy duty leather gloves			



PPE CATEGORIES					
CATEGORY 0	CATEGORY 1	CATEGORY 2			
1.2 cal/cm2	4 cal/cm2	8 cal/cm2			
	Leather footwear (as needed)	Leather footwear (as needed)			
High Voltage Gloves rated Class 0 (0 to 1000 VAC/1500 VDC)	High Voltage Gloves rated Class 0 (0 to 1000 VAC/1500 VDC)	High Voltage Gloves rated Class 0 (0 to 1000 VAC/1500 VDC)			



Appendix C – Live Work Permit

Scope: Applies to New Flyer Transit Bus and Field Service employees and their temporary employees, contractors, sub-contractors, or contractor's agents.

FI-SAF-910-001 Rev. A

Issue Date: November 2019

ENERGIZED ELECTRICAL WORK PERMIT (ARC FLASH)					
PART I: TO BE COMPLETE	D BY REQUESTER		Job Work Order Number	:	
Description of circuit/equi	ipment/job location:				
Description of work to be	done:				
Justification of why the cir	rcuit/equipment cannot	t be de-energized:			
Requesters name/title:			Date:		
PART II: TO BE COMPLETE	ED BY THE ELECTRICALL	Y QUALIFIED PERSON PERFOR	MING WORK:		Check when complete
Detailed description of the	e job procedures to be	used in performing the reques	ted work:		
Description of the safe wo	ork practices to be emp	loyed:			
SHOCK/ARC FLASH RISK A	ASSESSMENT:				
Nominal Voltage to which	personnel will be expo	sed:			
Distance of limited approa	ach boundary: 4 feet (r	ninimum)			
Distance of restricted bou	ndary: 4 feet (minimu	m)			
Required Arc flash PPE cat	tegory for coach work a	ctivity: Category 2 (mandato	ry)		
Required Arc flash PPE cat	tegory for maintenance	work activity. Circle Categor	y: 1 2 3	4	
CONTAINMENTS, TOOLS	& EQUIPMENT: Check a	all that apply to planned work	activity below. Qualified I	Electricians	working
alone is strictly prohibited	d. Do not proceed with	work activity if <u>ALL</u> required	containments, tools and e	quipment a	re not
available. Failure to follow these requirements will result in disciplinary action up to and including termination.					
Emergency Response	Arc Flash	Fall Protection	Forklift,Aerial,Scissor	Bus Lift /	Jack Stand
Certified First Responder	Cat. 2 Arc Flash PPE	Arc Rated Fall Harness	Cert. forklift operator	Bus lift	
First Aid Kit	Cat. 3 Volt Meter	Fall Rescue Plan	Cert. genie operator	Stationary	y jacks
AED	Cat. 3 V. Meter Leads	Lock Out - Tag Out	Cert. scissor operator	Bump cap	,
Rescue Hook	Elect. Insulated Tools	Locks & Tags	Forklift		
Rescue Hook Attendant	Arc Flash Barricade	Lockout Procedure	Aerial lift		
	Qualified Electrician		Scissor lift		

BARRICADE PLAN (coach): Use block diagram of coach below to sketch barricade boundaries needed to maintain 4 feet (minimum) from exposed high voltage components. Take care to address access from any direction.

Rear	Front



BARRICADE PLAN (maintenance): Use block diagram section below to sketch barricade boundaries needed to maintain restricted approach distance from exposed high voltage components. See arc flash label on panel.

KEY PERSONNEL & EMERGENCY EQU	JIPMENT: List the nam	es of th	e qualified electricians and the lo	cation of first aid supplies,
ALD and emergency equipment belo	w. Locations can also	be mark	ed on parricade plan above.	
Qualified Electrician	Badge #		Emergency Equipment	Location
		┨││		
		1		
SAFETY PLAN REVIEW: Qualified Ele	ctrician(s)will review al	l steps o	of planned work activity. Affected	d employees will be briefed
on arc flash boundaries and relevant	safety precautions.			
Name	Badge #		Name	Badge #
		1 [
		1 1		
] [
		1 [
		1 [
Part III: APPROVAL(S) TO PERFORM 1	THE WORK WHILE ELEC	TRICALL	Y ENERGIZED:	
NFPA 70E requires the use of this ele	ectrical work permit for	all ener	gized work at or above 100 Volts	DC. In addition, New Flyer
of America requires using this electri	cal work permit as a pla	anning t	ool for non-energized work activ	ity to ensure that proper
safety precautions have been taken	Failure to do so may le	ead to s	erious injury or death.	
surety precoutions have been taken.	ranare to do so may n	200 20 3	crious injury of acadin	
			Padao #)ata:
			Dauge #	Jate.
New Flyer Qualified Electri	ician (mandatory)			

Date:

* Location Leadership

* By signing, the leadership of the affected area affirms that this plan has been communicated to all affected personnal under their supervision.