INSTRUCTION TO SERVICE ITS: 4947

SECTION:	MODEL:	TYPE:	WRITTEN BY:
260 Battery Compartment	☐30FT ☐35FT ☒40FT ☐ 60FT ☐DSL ☐CNG ☐ LNG ☒ XDE	☒ Xcelsior ☐ LOW FLOOR	Mike Pearson

OBJECTIVE/SUBJECT:

Provide instructions to upgrade the BAE Energy Storage System.

PROCEDURE:

1. Turn the main battery disconnect switch to the “OFF” position.
2. Follow as per appendix A: Equipment and Personnel Protection.
3. Remove Energy Storage System.
   a. Remove ESS Environmental access cover.

      Gain access to the ESS per Original Equipment Manufacturer (OEM) Service Manual instructions.

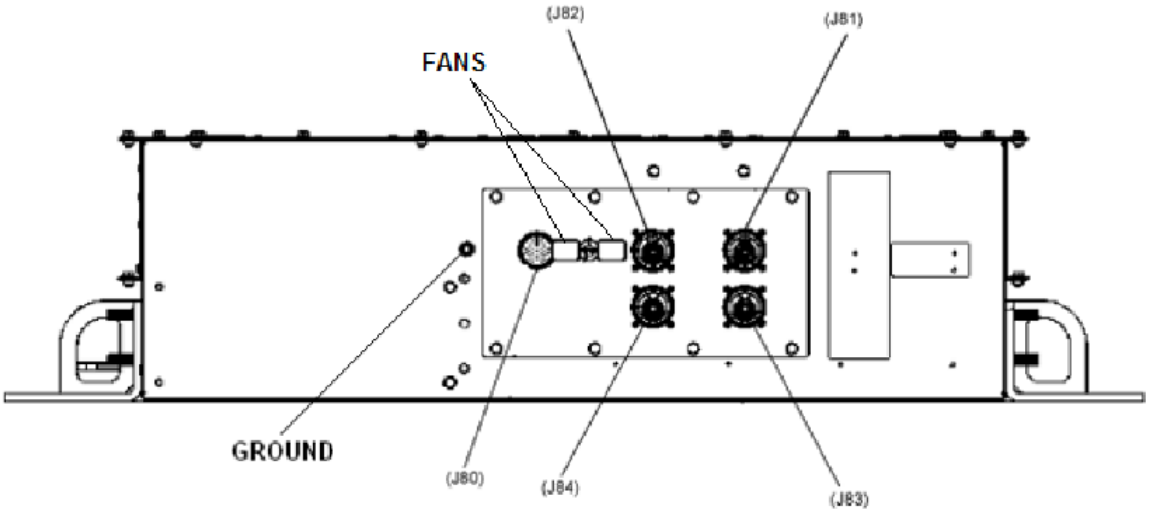
☞**NOTE: If performing the upgrade with the ESS installed on the bus, skip to Step 4.**

   b. Remove external cables:
      i. Disconnect the External Cable J80.
      ii. Disconnect the High-Voltage power source cable from the Black Veam connector J82 (PCS) and, if applicable, J84 (EAS/APS).

iii. Disconnect the High-Voltage power source cable from the Red Veam connector J81 (PCS) and, if applicable, J83 (EAS/APS).

iv. Disconnect the Fan Cables (Not shown).

v. Disconnect ground wire.



Disconnect ESS

c. Remove Energy Storage System:

1. Follow the OEM Service Manual section 7.3.2 to remove the ESS from the bus.

4. Upgrade Energy Storage System.

a. Remove the Top Cover:

1. Remove ¼” - 20 Fasteners and hardware from Top Cover.
2. Save removed hardware

b. Prepare opened Energy Storage System.

Removal of Top Cover

⚠ **DANGER: ALL PPE AND HIGH VOLTAGE TOOLS MUST BE USED FROM THIS POINT FORWARD.**

1. Perform DC Chassis Fault check.
   a. As soon as the external cover has been removed and before beginning any service or troubleshooting tasks, it is important to verify that any internal disconnects are properly opened and that there are no chassis-faults inside the ESS. The high-voltage system is normally electrically isolated from the vehicle chassis. A chassis fault occurs whenever some point on the high-voltage system becomes connected to the chassis.
   b. Carefully check for voltage between the Positive and Negative connections that exit the ESS after any internal contactors or disconnects. The voltage reading should be at or near 0 V DC. It is not abnormal to see some voltage reading from stray capacitance. But, this reading should quickly drop toward 0 V as the meter dissipates any capacitive energy. A steady reading of any significant voltage indicates a fault condition. If a fault exists, assume that all conductive parts inside the ESS are energized until the fault is isolated and cleared!

c. The Chassis Fault checks are made between live energy storage terminals and the ESS chassis. Caution must be exercised when making these measurements. These measurements should be made with the Stray Voltage Adapter attached to the meter. Carefully measure for voltage between the Positive battery connection and the ESS chassis. The battery connection can be any convenient junction on the battery side of the positive contactor or disconnect device. The chassis connection should be to clean bare metal. Next, measure between the Negative battery connection and the ESS chassis.

d. The Stray Voltage Adapter will dissipate any capacitive voltage charge and any high-impedance connections caused by dirt and ionic contaminants. Any steady reading above 4 V DC with the Stray Voltage Adapter indicates the presence of a Chassis Fault. If a Chassis Fault exists, assume that all conductive parts inside the ESS are energized, until the fault is isolated and cleared!

c. Perform a detailed inspection of the inside of the battery tub looking for loose, damaged, or missing hardware, damaged or loose wiring, and/or excessive debris.

⚠ **WARNING: Use PVC insulating blanket to cover any live parts and Bus Bars not being worked on.**

d. Remove Center Fuse.

1. Remove Side Louver Panel from the non-contactor side by removing five ¼” - 20 bolts, locks, and flats and disconnect solenoid.
2. Remove Safety Shield from the non-contactor side by removing seven ¼” - 20 bolts, locks, and flats and save hardware for replacement.
3. Remove Bus Bars and Clamps on the non-contactor side of **ALL** the Battery Modules.

⚠ **WARNING: ALLWAYS REMOVE THE NON-CONTACTOR SIDE BUS BARS FIRST THEN THE CONTACTOR SIDE OF THE BUS BAR OF ANY GIVEN MODULE TO MAKE THE LARGEST IMPACT ON VOLTAGE.**

☞ **NOTE: Bus Bars are used to connect the negative terminal (-) of a Battery Module to the positive terminal (+) of a second Battery Module. The non-contactor side of the Battery Modules are connected using Small-Standard Bus Bars. The contactor side of the Battery Modules are connected using Large-Standard, Terminal, and Mid-Pack Bus Bars.**

- Small-Standard Bus Bars connect the modules on the non-contactor side of the ESS.
- Large-Standard, Terminal, and Mid-pack Bus Bars connect the modules on the contactor side of the ESS.
- Battery Modules in slots 2-3, 6-7, 10-11, 14-15 are connected using a Large-Standard Bus Bar.
- Modules in slots 1 and 16 are connected using a Terminal Bus Bar.
- Battery Modules in slots 4-5, 8-9, and 12-13 are connected using Mid-Pack Bus Bars.
- Refer to Table 5-3 for various Bus Bar part numbers.

Table 5-3 Bus Bar Part Numbers

Part Number	Description
400244-001	Negative Terminal Bus Bar
400243-001	Short Bus Bar
400242-001	Long Bus Bar
400245-001	Positive Terminal Bus Bar
401075-001	Positive Midpack Fuse Bus Bar
401074-001	Negative Midpack Fuse Bus Bar
407220-001	Positive Center Contactor Bus Bar
407221-001	Negative Center Contactor Bus Bar

a. Remove the Bus Bar Clamp (P/N 400312-001) from the Bus Bar as follows:
    1. Loosen the bottom Captive Screw that secures the Bus Bar Clamp (P/N 400312-001).
    2. Hold the bottom Captive Screw and loosen the top Captive Screw(s). Holding the bottom Captive Screw prevents the Bus Bar Clamp (P/N 400312-001) from causing a short circuit.
    3. Remove the Bus Bar Clamp (P/N 400321-001).

b. Remove the Bus Bar as follows.
    1. Loosen the bottom Captive Screw that secures the Bus Bar.
    2. Hold the bottom Captive Screw and loosen the top Captive Screw(s). Holding the bottom Captive Screw prevents the Bus Bar from causing a short circuit.
    3. Remove the Bus Bar.
    4. Have **BOTH** technicians verify that all short Bus Bars are removed before proceeding.

4. Remove Side Louver Panel from the contactor side by removing five ¼" – 20 bolts, locks, and flats and disconnect solenoid.
5. Remove Safety Shield from the contactor side by removing seven ¼" – 20 bolts, locks, and flats and save hardware for replacement.
6. Remove Bus Bars and Clamps on the contactor side of **ALL** the battery Modules.
    a. Remove the Bus Bar Clamp (P/N 400312-001) from the Bus Bar as follows:
        1. Loosen the bottom Captive Screw that secures the Bus Bar Clamp (P/N 400312-001).
        2. Hold the bottom Captive Screw and loosen the top Captive Screw(s). Holding the bottom Captive Screw prevents the Bus Bar Clamp (P/N 400312-001) from causing a short circuit.
        3. Remove the Bus Bar Clamp (P/N 400312-001).
    b. Remove the Bus Bar as follows:
        1. Loosen the bottom Captive Screw that secures the Bus Bar.

2. Hold the bottom Captive Screw and loosen the top Captive Screw(s). Holding the bottom Captive Screw prevents the Bus Bar from causing a short circuit.

☞ **NOTE: The Terminal and Mid-Pack Bus Bars, loosen the two Hex Lock Nuts (PN 400969-005), Split (PN 400968-007) and Flat Washer (PN 400959-018) that secure the Fuse or Contactor and swing the Fuse and Contactor Bus Bars clear of the modules.**

3. Remove the Bus Bar.

☞ **NOTE: At this point in the process it is acceptable to remove High Voltage Personal Protection.**

e. Remove PVC Insulating Blankets.

f. Inspect the yellow sense wire in the area of the Positive Contactor for damage to make sure that it is not pinched between the contactor and the skin of the ESS.

g. Remove Center 250A Fuse.

1. Remove the two Lock Nuts (P/N 400969-005). Split (P/N 400968-007) and Flat Washers (PN 400959-018) that secure the Fuse (ITEM 1 P/N 400287-002) to the Bus Bar. Only remove the hardware that secures the Fuse (P/N 400287-002) to the Bus Bar.
2. Loosen the Captive Screws on the Midpack Bus Bars and remove them from the Tub. Be sure to hold them while loosening the captive hardware to prevent them from falling into the tub. Discard both center Fuse brackets.
3. Remove the Fuse (ITEM 1: P/N 400287-002) from Fuse Holder Posts & discard Fuse.
4. Remove the center fuse insulated standoffs and discard.

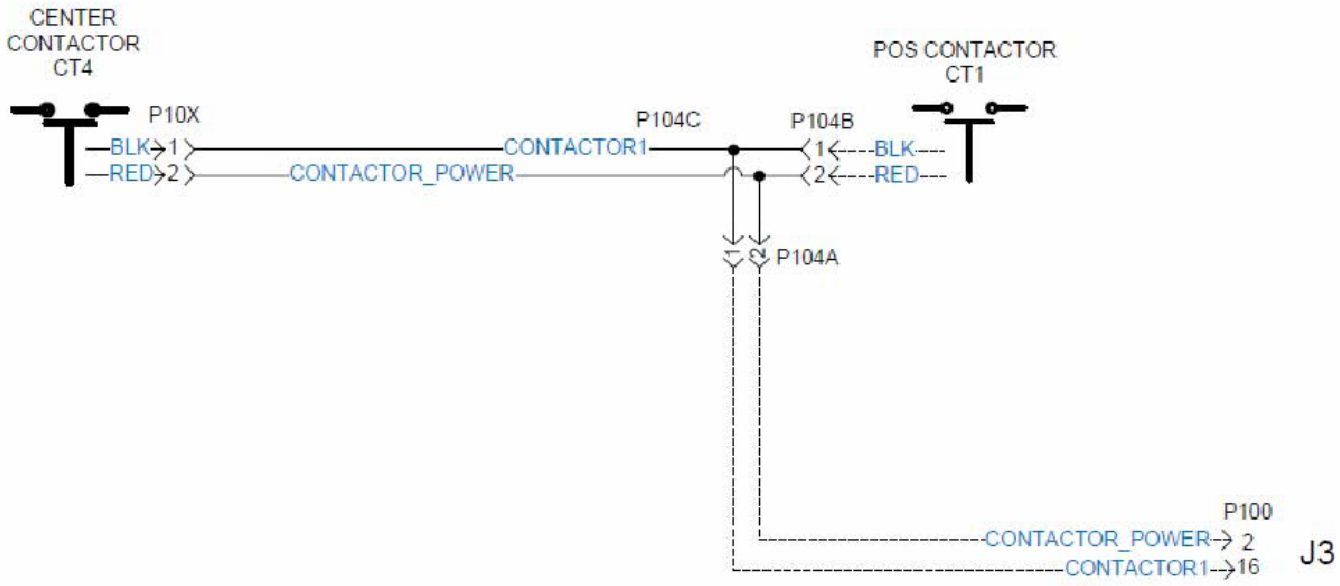
h. Replace Center 250A Fuse with Center Contactor.

☞ **NOTE: Contactor (P/N 400698-001) power terminals have a polarity (marked A1 & A2).**

1. Install Center Contactor Bracket (P/N 407219-001) with two Pan Head screws (P/N 900017-1053). Torque to 28-32 lb*in (3.16-3.61 N*m).
2. Line up the Contactor (P/N 400698-001) with the screw locations.
3. Use two Pan Head Screws (P/N 900017-1053) and two Flat Washers (P/N 900862-001) to secure contactor to the bracket. Torque screws to 28-32 lb*in (3.16-3.61N*m).

4. Use the two Hex Lock Nuts (P/N 400969-005), Split (P/N 400968-007) and Flat Washers (P/N 400959-018) to secure the Center Contactor Positive Bus Bar (P/N 407220-001) and Center Contactor Negative Bus Bar (P/N 407221-001) to the Center Contactor. Finger tighten the Lock nuts.
5. Disconnect the Positive Contactor wire harness.
6. Install new Wire Harness (P/N 407415-001) from Positive Contactor to Center Contactor. Route wire harness under steel tube.
7. Using two Tie Straps (P/N 403968-584) together, affix contactor harness to steel tubing.

Contactor Harness



Electrical Diagram of Center Pack Contactor Upgrade

⚠ **DANGER: ALL HIGH VOLTAGE PERSONAL PROTECTION MUST BE WORN AT THIS POINT.**

i. Replace Bus Bars and Clamps on the contactor side.

⚠ **WARNING: ALWAYS REMOVE THE NON CONTACTOR SIDE BUS BAR THEN THE CONTACTOR SIDE OF THE BUS BAR OF ANY GIVEN MODULE TO MAKE THE LARGEST IMPACT ON VOLTAGE.**

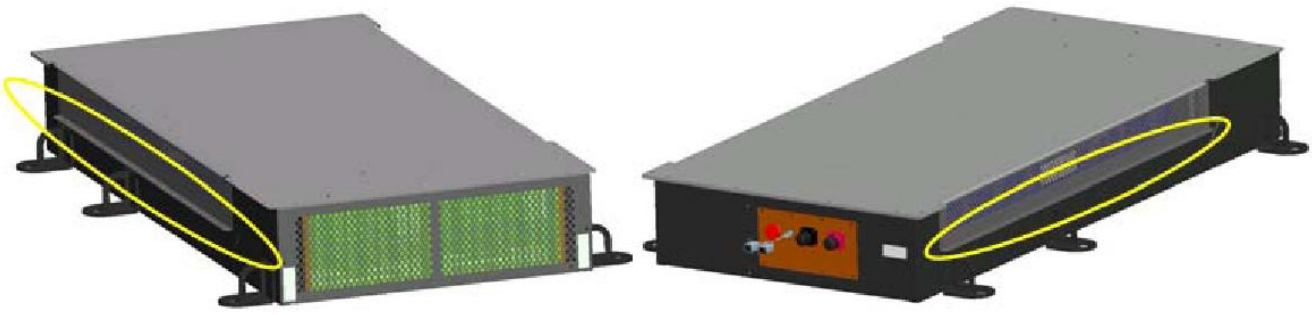
• Refer to Table 5-3 for various Bus Bar part numbers.

1. Replace the Bus Bar as follows.
   a. Line up the Bus Bar with the screw locations.
   b. Tighten the top Captive Screw. Torque to 22-24 lb*in (2.48-2.71 N*m).
   c. Hold the top Captive Screw and tighten the bottom Captive Screw(s). Torque to 22-24 lb*in (2.48-2.71 N*m). Holding the top Captive Screw prevents the Bus Bar from causing a short circuit.

2. Replace the Clamp (P/N 400312-001) to the Bus Bar as follows:
   a. Line up the Clamp with the screw locations.
   b. Tighten the top Captive Screw. Torque to 22-24 lb*in (2.48-2.71 N*m).
   c. Hold the top Captive Screw and tighten the bottom Captive Screw(s). Torque to 22-24 lb*in (2.48-2.71 N*m). Holding the top Captive Screw prevents the Clamp (P/N 400312-001) from causing a short circuit.

☞ **NOTE: For Terminal and Mid-Pack Bus Bars, install the two Hex Lock Nuts (P/N 400969-005), Split (P/N 400968-007) and Flat Washers (P/N 400959-018) that secure the Fuse or Contactor. Torque the Lock Nuts to 85-95 lb in (9.60-10.73 N*m).**

3. Replace Safety Shield on the Contactor side by re-installing seven ¼" – 20 bolts, locks, and flats and torque to 70± lb*in.
4. Replace the Side Louver Panel on the Contactor side.
   a. Position the side Louver Panel on the Contactor side and install five fasteners removed previously. Finger tighten only.
   b. Connect Solenoid to wire harness.



• Refer to Table 5-3 for various Bus Bar part numbers.

j. Replace Bus Bars and Clamps on the Non-Contactor side.
   1. Replace the Bus Bars as follows:
      a. Line up the Bus Bar with screw locations.
      b. Tighten the top Captive Screw. Torque to 22-24 lb*in (2.48-2.71 N*m).
      c. Hold the top Captive Screw and tighten the bottom Captive Screw(s). Torque to 22-24 lb*in (2.48-2.71 N*m). Holding the top Captive Screw prevents the Clamp (P/N 400312-001) from causing a short circuit.
   2. Replace the Clamp (P/N 400312-001) to the Bus Bar as follows:
      a. Line up the Bus Bar with screw locations.
      b. Tighten the top Captive Screw. Torque to 22-24 lb*in (2.48-2.71 N*m).
      c. Hold the top Captive Screw and tighten the bottom Captive Screw(s). Torque to 22-24 lb*in (2.48-2.71 N*m). Holding the top Captive Screw prevents the Clamp (P/N 400312-001) from causing a short circuit.

☞ **NOTE: For Terminal and Mid-Pack Bus Bars, install the two Hex Lock Nuts (P/N 400969-005), Split (P/N 400968-007) and Flat Washers (P/N 400959-018) that secure the Fuse or Contactor. Torque the Lock Nuts to 85-95 lb*in (9.60-10.73 N*m).**

   3. Replace the Safety Shield on the Non-Contactor side by reinstalling seven ¼" – 20 bolts, locks, and flats and torque to 70±2 lb*in.
   4. Replace the Side Louver Panel on the Non-Contactor side.
      a. Position the side Louver Panel on the Non-Contactor side and install five fasteners removed previously. Finger tighten only.
      b. Connect Solenoid to wire harness.

k. Prepare Energy Storage System for closure.
   1. Remove the High Voltage Vinyl Sheeting PVC insulating blanket(s).
   2. Perform a DC Chassis Fault Check to verify there are no chassis fault issues.

l. Install the Top Cover:
   1. Place the top cover in position.

☞ **NOTE: At this point in the process it is acceptable to remove High Voltage Personal Protection.**

2. Install the cover using previously removed fasteners. Finger tight only.
3. Using torque wrench and 3/8” socket, torque all 47 top cover and side louver fasteners to 70 ± lb in.

m. Change the ESS Label:

1. Determine the ESS part number by reading the factory label located on the connector end of the unit. Match the current part number on the factory label to column A and/or column B. Choose the appropriate new label supplied with this kit by matching New Label (column C) with column A and/or column B.

A	B	C	D
Old A123 P/N	Old BAE P/N	New Label	New A123 P/N
401200-004	36A9758G202	362A9758G203	401200-104

2. Clean the area directly under the ESS Configuration factory label with isopropyl alcohol. Affix the appropriate ESS Text Label under the factory label. Peel off the clear protective sticker from the release paper and cover the ESS Text Label.

5. Install Upgrades Energy Storage System:

☞**NOTE: If upgrade was performed to ESS with the ESS installed on the bus, skip to (5c).**

a. Follow the OEM Service Manual section 7.3.2 to install the ESS to the bus.
b. Connect the ESS external cables.
    1. Connect ground wire, torque hardware to 230 lb*in (25.986 N*m).
    2. Connect the fan cables.
    3. Connect the power source cable to BLACK VEAM connectors J82 (PCS) and, if applicable J84 (EAS/APS).
    4. Connect the power source cables to RED VEAM connectors J81 (PCS) and, if applicable J83(EAS/APS).
    5. Connect the Environmental Cover.
c. Close the ESS Environmental Cover.
    1. Close the ESS as follows:
        a. Close the ESS per Original Equipment Manufacturer (OEM) Service Manual Instructions, Section 7.3.2.
d. Software download:
    1. Download software
e. Functionality Test:
    1. Test drive the vehicle and use IDS to verify functionality.
f. Return bus to customer.

Appendix A: Equipment and Personnel Protection

DANGER

RISK OF ELECTRIC SHOCK. ONLY TRAINED SERVICE PERSONNEL SHOULD ACCESS COMPONENT OF THE HYBRIDRIVE® SYSTEM. FAILURE TO OBSERVE ALL HIGH VOLTAGE ELECTRICAL SAFETY PRECAUTIONS MAY RESULT IN PERSONNEL INJURY AND/OR DEATH. REVIEW THE JACKING AND HOISTING PROCEDURES AS DESCRIBED IN THE OEM SERVICE MANUAL PRIOR TO SERVICING THE VEHICLE. USE OF TEST MODE IN IDS IS PROHIBITED WHILE THE VEHICLE IS RAISED ON JACKS OR ON A HOIST. FAILURE TO COMPLY CAN RESULT IN PERSONNEL INJURY AND/OR DEATH AND SEVERE DAMAGE TO THE VEHICLE. EVEN WITH THE BATTERY ISOLATION/MASTER DISCONNECT SWITCH IN THE OFF POSITION, THE HYBRIDRIVE® BATTERY SYSTEM REMAINS A SEVERE SHOCK HAZARD BECAUSE THE BATTERY MODULES THEMSELVES ARE NOT DE-ENERGIZED BY THIS SWITCH. DURING SERVICE REMOVE JEWELRY, WEAR SAFETY GLASSES, AND SAFETY SHOES. WEAR LINESMAN'S HIGH VOLTAGE GLOVES (ASTM CLASS 00 MINIMUM), FIRE-RETARDANT CLOTHING WITH ARC RATING, AND HARD HAT) WHEN WORKING IN OR AROUND THE HYBRIDRIVE® TRACTION BATTERY ENCLOSURES.

WARNING

USE OF THE BATTERY ISOLATION/MASTER DISCONNECT SWITCH IS MANDATORY DURING HYBRIDRIVE® SYSTEM MAINTENANCE. IF THE HEV WAS RUNNING JUST PRIOR TO CONDUCTING MAINTENANCE, ALLOW FOUR MINUTES FOR PROPULSION SYSTEM COMPONENTS TO DISCHARGE ELECTRICITY BEFORE PROCEEDING. THE BATTERY ISOLATION/MASTER DISCONNECT SWITCH MUST BE LOCKED IN THE OFF POSITION WHILE MAINTENANCE IS PERFORMED ON ANY HYBRIDRIVE® COMPONENT. THIS WILL PREVENT ANY INADVERTENT REAPPLICATION OF POWER WHILE MAINTENANCE PERSONNEL MAY BE TOUCHING ANY OF THE HYBRIDRIVE® HIGH VOLTAGE ELECTRICAL CONNECTIONS. ALWAYS USE EXTREME CAUTION WHEN WORKING AROUND THE TRACTION BATTERY ENCLOSURES. ALWAYS VERIFY WITH A DIGITAL MULTI-METER (DMM) THAT AN ELECTRICAL CIRCUIT IS DE-ENERGIZED BEFORE TOUCHING ANY ELECTRICAL CONDUCTOR DURING HYBRIDRIVE® SYSTEM SERVICE.

LABOUR ESTIMATE

	Operation	Men	Hours	Labour Time M X HR
1	Provide instructions to upgrade the BAE Energy Storage System	2	2.0	4.0

PARTS REQUIRED

Item	Part Number	Description	Qty. per Coach	Units	Notes
1	400698-001	Center Contactor, Wired	1	EA	BAE Supplied
2	403968-584	Tie Straps-Newark 96F8060	2	EA	BAE Supplied
3	407220-001	Center Contactor Bus Bar MidPack (+)	1	EA	BAE Supplied
4	407221-001	Center Contactor Bus Bar MidPack (-)	1	EA	BAE Supplied
5	407219-001	Bracket-Contactor	1	EA	BAE Supplied
6	407415-001	Center Contactor Jumper Harness	1	EA	BAE Supplied
7	900862-001	Flat Washer-18-8 SST	2	EA	BAE Supplied
8	900017-1053	Screw-CRPH #10-32 w/ITW 18-8 SST	4	EA	BAE Supplied

SPECIAL TOOLS REQUIRED

Item	Part Number	Description	Qty. per Coach	Unit of Measure	Notes
1		Laptop with IDS, Kvaser	1	EA	
2		Fluke Multi-Meter	1	EA	
3		Stray Voltage Eliminator	1	EA	
4		High Voltage Gloves	1	Pair	
5		PVC Insulated Blankets	2	EA	36” square