NUMBER ONE PRIORITY

- PERSONAL SAFETY
<table>
<thead>
<tr>
<th><strong>NOTE</strong></th>
<th>RENDERS ADDED INFORMATION THAT WILL HELP COMPLETE, OFFER AN ALTERNATIVE, OR RATIONALIZE A PARTICULAR JOB OR PROCEDURE.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAUTION !</strong></td>
<td>ANY PREVENTATIVE ADVICE TO AVOID MAKING ERRORS THAT COULD DAMAGE THE PART, SYSTEM, VEHICLE, OR CAUSE PERSONAL INJURY.</td>
</tr>
<tr>
<td><strong>WARNING</strong></td>
<td>INDICATES THOSE AREAS WHERE INSUFFICIENT KNOWLEDGE OF A PROCEDURE, SKILL, OR LACK OF ATTENTION COULD RESULT IN PERSONAL INJURY OR LOSS OF LIFE.</td>
</tr>
<tr>
<td><strong>DANGER</strong></td>
<td>INDICATES AN IMMINENTLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS PERSONAL INJURY.</td>
</tr>
</tbody>
</table>
1274A/B HYBRID ELECTRICAL SYSTEMS

- ISOLATED VEHICLE FROM HYBRIDRIVE SYSTEMS
  » VEHICLE 24/12 VDC POWER DISTRIBUTION
  » HYBRIDRIVE OVERVIEW
  » HYBRIDRIVE TO VEHICLE INTERFACE
  » HYBRID SAFETY PRECAUTIONS
    - WELDING
    - ACCIDENTS
    - TOWING
  » SAFETY PROCEDURES
VEHICLE 24/12 VDC POWER DISTRIBUTION

- BATTERIES TO LOWER PDC
- LOWER PDC TO E ZONE
- E ZONE TO:
  - MAIN PANEL, DRIVER’S BARRIER AND RAMP
- E ZONE TO FRONT DOOR
LOWER PDC

TO ENGINE INTAKE HEATERS RELAY

TO UPC( E-ZONE OR REAR PANEL)
UPC (E-ZONE OR REAR PANEL)

DIAGNOSTIC CONNECTOR

GROUNDS
n **FRONT MECHANICAL BOX**
COMPARTMENTS & PANELS

DRIVER’S BARRIER

24V-12V DC-DC CONVERTERS

25 AMP & 40 AMP

12V

GND

24V

WARCO
CURBSIDE PANEL

C ZONE
ACCESS TO REAR DOOR MECHANICAL BOX

- LIMITED ACCESSIBILITY FOR CHECKS ONLY
- REPAIRS WILL REQUIRE LIGHT PANEL REMOVAL

44” VAPOR SWING OUT DOOR
COMPARTMENTS & PANELS

BATTERY COMPARTMENT

BATTERY SLIDE OUT TRAY

- TWO 12’S MAKE 24 VDC
- BATTERY SWITCH WILL SHUT DOWN ENGINE
- CUTS POWER TO BATTERY TUB CONTACTORS
n VOLTAGE CONVERTERS (3 EACH)
– PROVIDES REGULATED 12 VOLTS (APPROX. 13.8 VOLTS) FROM THE 24 VOLT BUS SYSTEM
  » 2 IN DRIVER’S BARRIER
  1 UNDER DASH
HybriDrive™ propulsion systems

Operating Advantages
- Up to 50% improved fuel economy
- Low emissions
  - Clean-fuel capability
- Turnkey system
  - Trouble-free performance
  - Fully integrated
  - In-depth support available to vehicle builders
- Superior drivability
- Intuitive driver interface
  - Drives like a conventional vehicle
  - Minimal operator training required
- Optimum battery management
  - Long life
  - Maintenance-free
- Advanced motor control
  - Smooth, shift-free
  - Superior energy efficiency
  - Highly reliable
- Integrated diagnostics & data logging
  - Maximizes vehicle availability
  - Useful for efficiency profiling

Maintenance Advantages
- Reduced brake wear
- No transmission
- No clutch
- No transfer case
- Reduced engine maintenance
  - HybriDrive systems operating cycle reduces engine wear; extends oil change intervals
- Control system limits willful abuse
- Integrated diagnostics
  - Serial interface provides access via PC-based equipment
  - Simple to use
  - Inexpensive
  - Clear, intuitive, graphic user interface

A cleaner, more efficient way to go!

BAE SYSTEMS Controls
600 Main Street
Johnson City, NY 13790 USA
1-800.576.3346
Fax 607.770.5751
www.na.baesystems.com/controls
ELECTRICAL LAYOUT VIEW

- ELECTRICAL POWER IS SUPPLIED FROM BATTERIES AND GENERATOR TO THE PCS
- PCS DIRECTS THE ELECTRICAL POWER ON DEMAND TO THE TRACTION MOTOR

» ELECTRICAL ENERGY IS CONVERTED TO MECHANICAL MOTION AND SUPPLIED TO THE REAR AXLE
ELECTRICAL LAYOUT VIEW

- BATTERY TUBS
- PCS
- GENERATOR
- TRACTION MOTOR
HIGH VOLTAGES

– MOTOR, THREE PHASE
  » MAX INPUT VOLTAGE 346 VOLTS AC, 500 HZ

– GENERATOR, THREE PHASE
  » 610 VOLTS AC, 400 HZ

– PROPULSION CONTROL SYSTEM (PCS)
  » TIES ALL HIGH VOLTAGE COMPONENTS TOGETHER

– BATTERIES, 46 EACH
  » 500 TO 700 VOLTS DC
n AC TRACTION GENERATOR

– 610V AC, 3 PHASE

– ISSUE - HIGH VOLTAGE TERMINALS EXPOSED DUE TO REMOVED COVER

– PROTECTIVE FEATURES (BATTERY CONDITIONER OFF)

» COVER SECURED WITH SCREWS

» TERMINALS NOT LIVE IF BUS IS OFF, AFTER 4 MIN WAITING PERIOD
TRACTION MOTOR

- 3 PHASE, 346 Vrms (line-line) at 500Hz
- ISSUE - HIGH VOLTAGE TERMINALS EXPOSED DUE TO REMOVED COVER
- PROTECTIVE FEATURES (BATTERY CONDITIONER OFF)
  - COVER SECURED WITH BOLTS
  - TERMINALS NOT LIVE IF BUS IS OFF, AFTER 4 MIN WAITING PERIOD
TRACTION BATTERY

- HAWKER ENERGY
  - MODEL XE70X
  - LEAD ACID

- CAPACITY - 70 AMP HOUR

- WEIGHT 59.8 POUNDS

- VIRTUALLY DRY WITH NO FREE ELECTROLYTE
  - NO LEAKS
  - NO MAINTENANCE
2 ROOF MOUNTED BATTERY TUBS

- 276V DC PER TUB
- TUBS ARE CONNECTED IN SERIES = 552 V DC
- "J" CONNECTORS-PCS TO BOSS CARD
DASH HYBRIDRIVE STATUS INDICATORS

- A SEVERE FAULT IS DETECTED IN THE HYBRIDRIVE SYSTEM
- A DASH WARNING BUZZER WILL ALSO SOUND
- REMOVE BUS FROM SERVICE IMMEDIATELY

THE HYBRIDRIVE SYSTEM IS OPERABLE IN A DEGRADED MODE AND NEEDS REPAIR
- VEHICLE MAY BE SAFELY DRIVEN TO RETURN TO THE DEPOT FOR REPAIR
DASH HYBRIDRIVE STATUS INDICATORS

- INDICATES THAT THE VEHICLE’S SPEED HAS EXCEEDED THE MAXIMUM LIMITS OF THE HYBRID PROPULSION SYSTEM
- APPLY BRAKES IMMEDIATELY TO SLOW DOWN THE BUS OR DAMAGE MAY RESULT
- THE HYBRIDRIVE SYSTEM MAY ALSO REDUCE TORQUE TO THE REAR WHEELS TO ZERO OR EVEN SHUTDOWN ALL POWER TO THE TRACTION MOTOR

- INDICATES ACTIVATION OF THE REGENERATIVE BRAKING OCCURING IN THE HYBRID PROPULSION SYSTEM
Module 7

© Orion Bus Industries, Inc. 2006. This material is supplied for training purposes only. Please refer to your Orion Service Manual for detailed maintenance procedures.
WHEN YOU WELD ON THE BUS

**CAUTION**

– ALWAYS CONNECT THE WELDERS GROUNDING CABLE AS CLOSE TO THE WORK AS POSSIBLE

**CAUTION**

– PLACE BATTERY ISOLATOR SWITCHES IN THE OFF POSITION

**CAUTION**

– DISCONNECT ALL SOLID STATE COMPONENTS
HYBRIDRIVE DISCONNECTS

Figure 20 Hybrid Welding Disconnections

- **Traction battery enclosure disconnections**: low voltage connection, positive and negative veam connectors.
- **Propulsion Control System disconnections**: J1, J2, J3, P52 (POS), and P53 (NEG).
Whenever any vehicle is involved in a motor vehicle accident, the vehicle structure and subsystem components are exposed to abnormal mechanical shocks and stresses. In the instance of most minor collisions, the propulsion system components should be well protected by the structure of the vehicle.

However, in the event of any motor vehicle accident, the following steps should be taken:

- The vehicle Master Switch and 24 Vdc Battery Isolator / Master Disconnect Switch should be turned off
- All propulsion system components and enclosures should be inspected for any external signs of physical damage
- All coolant lines and connections should be inspected for signs of leaks
- After verifying that all systems appear free from physical damage, the propulsion system may be re-energized
- If any faults are detected, or if the system performs any abnormal operations, shutdown the system and place the vehicle in the service facility for further diagnostics.

In the event of a MAJOR accident, or any accident where high voltage wiring has been exposed (or is arcing), the following additional steps should be taken:

- Immediately remove all passengers from the vehicle and remove any bystanders from the vicinity of the vehicle.

Contact the appropriate Service Personnel as soon as possible for support in securing and disconnecting high voltage components. **DO NOT** cut or disconnect any exposed high voltage cables unless supervised by authorized personnel.
HybriDrive™ Towing Instructions

Before towing vehicles equipped with a HybriDrive™ Propulsion System, remove both rear axles from the vehicle. Failure to comply will result in damage to the AC Traction Motor and subsequently void warranty coverage of the Traction Motor.
SAFETY EQUIPMENT

- USE PERSONAL PROTECTIVE EQUIPMENT AS A LAST LINE OF DEFENSE IN CASE SOMETHING GOES WRONG

- AVOID FALSE SENSE OF SECURITY GRANTED BY USE OF PROTECTIVE EQUIPMENT

- AVOID DETERMINING IF THE EQUIPMENT WORKS AS ADVERTISED
n HIGH VOLTAGE GLOVES SLEEVES, & APRON

– MUST BE RATED AT CLASS 0 (1000V DC) MINIMUM
– SHOULD BE WORN WHILE REMOVING INNER LID
– MUST BE WORN AT ALL TIMES WHILE INNER TUB LID IS REMOVED

n SLEEVES, & APRON (WORN FOR BENCH WORK)
n TERMINAL INSULATOR

- LOOSE CABLE ENDS CAN CONTACT THE TUB CHASSIS CREATING A SHORT CIRCUIT OR ELECTROCUTION HAZARD

- ALWAYS COVER LOOSE CABLE ENDS WITH TERMINAL INSULATORS
INSULATED THROW POLE - SAFETY HARNESS

- ALWAYS USE THE BUDDY SYSTEM WHILE SERVICING THE BATTERY TUB - CONSIDER IT A “NO LONE ZONE”

- IN CASE OF AN ACCIDENT, THIS POLE AND / OR A SAFETY HARNESS AND LANYARD MAY BE USED TO PULL PERSONNEL AWAY FROM THE HIGH VOLTAGE AREA, WHILE ISOLATING THE “BUDDY” FROM THE HIGH VOLTAGE HAZARD
ELECTRICAL INSULATOR BLANKETS

- CLEAR, NON-CONDUCTIVE RUBBER SHEETS
- PREVENTS INADVERTENT CONTACT WITH HIGH VOLTAGE COMPONENTS
- USE HALF-SIZED SHEETS TO COVER COMPARTMENT BEING WORKED ON
PLYWOOD WORKING PLATFORMS

- PROVIDES A SURFACE TO WORK ON WHILE SERVICING BATTERY TUB

- MUST BE USED OVERTOP OF INSULATOR BLANKETS

- USE HALF SIZED PLATFORM IF NECESSARY OVER COMPARTMENT BEING WORKED ON
PLYWOOD WORKING PLATFORMS

- PROVIDES A SURFACE TO WORK ON WHILE SERVICING BATTERY TUB

- MUST BE USED OVERTOP OF INSULATOR BLANKETS

- USE HALF SIZED PLATFORM IF NECESSARY OVER COMPARTMENT BEING WORKED ON
WORKING PLATFORM

- ALLOWS WORKERS TO ACCESS TUBS FROM THE SIDE OF THE BUS

- SHOULD BE 115” HIGH TO PROVIDE A GOOD WORKING LEVEL AT ROOF HEIGHT

- SHOULD BE 160” LONG TO GIVE ACCESS TO BOTH ENDS OF THE TUB
ADDITIONAL SAFETY EQUIPMENT

- INSULATED WRENCHES AND TOOLS FOR WORKING WITHIN BATTERY ENCLOSURE (1000 V, CLASS 0 MIN)
- FIRE EXTINGUISHER (DRY CHEMICAL)
- SAFETY GLASSES OR FACE SHIELD
- DIGITAL VOLTAGE METER AND TEST PROBES RATED FOR 1000V DC (USED TO CHECK FOR GROUND FAULTS)
GENERAL SAFETY PRECAUTIONS

- ALWAYS REFER TO THE SERVICE MANUAL BEFORE ATTEMPTING TO SERVICE TUBS

- INSULATED TOOLS AND EQUIPMENT MUST BE INSPECTED FOR DAMAGE OR WEAR PRIOR TO USE

- DO NOT ATTEMPT TO SERVICE THE BATTERY TUBS WHEN THE TRACTION BATTERY CONDITIONER IS CONNECTED

- WHEN WORKING ON THE ROOF OF THE BUS WEAR A SAFETY HARNESS
n **PRECAUTIONS (CONT’D)**

- REMOVE ALL METAL OBJECTS FROM YOU BODY THAT COULD MAKE CONTACT WITH THE COMPONENTS IN THE TUB - FALLING OBJECTS SUCH AS PENS AND METAL GLASSES CAN CREATE SHORT CIRCUITS BETWEEN THE BATTERY TERMINALS OR OTHER COMPONENTS

- ALWAYS CHECK FOR A GROUND FAULT WITHIN THE BATTERY TUB BEFORE YOU BEGIN WORKING ON IT - REFER TO THE SERVICE MANUAL FOR INSTRUCTIONS
PRECAUTIONS (CONT’D)

– ALL WIRING IN THE BATTERY TUB CARRIES A HIGH VOLTAGE, THIS INCLUDES THE SMALL SIGNAL WIRING TO THE BOSS AND EQUALIZATION CARDS- NEVER TOUCH ANY WIRES OR COMPONENTS IN THE TUB WITH YOUR BARE HANDS!

– USE CAUTION WHEN TOUCHING ANY WIRE ENDS ON ANY OF THE HARNESSSES IN THE TUB - FRAYED WIRE ENDS CAN PIERCE RUBBER GLOVES AND ENTER YOUR SKIN
PRECAUTIONS (CONT’D)

- DON'T ATTEMPT REPAIR WORK WHEN YOU ARE OVER TIRED OR SICK - NOT ONLY WILL YOU BE MORE CARELESS, BUT YOUR PRIMARY DIAGNOSTIC TOOL - DEDUCTIVE REASONING - WILL NOT BE OPERATING AT FULL CAPACITY

- FINALLY, NEVER ASSUME ANYTHING WITHOUT CHECKING IT OUT FOR YOURSELF! DON'T TAKE SHORTCUTS!
MASTER DISCONNECT SWITCH

- CUTS POWER TO ALL HYBRID SYSTEM ELECTRONICS
- DIRECTLY POWERS BATTERY TUB CONTACTORS
- WAIT 4 MINUTES AFTER SWITCHING THIS SWITCH BEFORE DISCONNECTING ANY HIGH VOLTAGE CONNECTORS
WORK SAFE

- USE OF BATTERY ISOLATOR SWITCH IS MANDATORY WHEN PERFORMING MAINTENANCE ON HYBRID SYSTEM
- MEASURE BEFORE TOUCHING
BASIC LAYOUT OF COMPONENTS

- Battery Tub #1: R/S
- Battery Tub #2: C/S
- Battery Conditioner Port
- AC/DC Converter
- Propulsion Control System
- DC/AC Inverter
- AC Generator
- AC Traction Motor
- Chassis Ground
**BATTERY TUB VEAM CONNECTOR**

- CUTS POWER BETWEEN BATTERY TUBS & BUS
- **DISCONNECTING THE VEAM CONNECTORS DOES NOT MAKE IT SAFE TO WORK INSIDE THE BATTERY TUBS**
n VEAM Connectors
- Fingerproofed Connectors
  » Locking Pin
- Between Battery Enclosures and PCS
- Never disconnect while bus is running
PROPULSION CONTROL SYSTEM - PCS

– NEVER DISCONNECT VEAM CONNECTORS WHILE BUS IS RUNNING OR MASTER DISCONNECT IS ENGAGED

– YOU COULD BE SERIOUSLY OR FATALLY INJURED BY ELECTRICAL SHOCK IF YOU ATTEMPT TO OPEN, DISCONNECT, REPAIR, TEST, INSPECT, OR ADJUST

– PROTECTIVE FEATURES (BATTERY CONDITIONER OFF)
  » VEAM CONNECTORS
  » CONNECTORS NOT LIVE IF BUS IS OFF, AFTER 4 MIN WAITING PERIOD
AC TRACTION GENERATOR

- VERIFY CIRCUIT IS DE-ENERGIZED, < 5 VDC
  » PHASE TO CHASSIS
  » PHASE TO PHASE

- ISSUE - HIGH VOLTAGE TERMINALS EXPOSED DUE TO REMOVED COVER

- PROTECTIVE FEATURES
  (BATTERY CONDITIONER OFF)
  » COVER SECURED WITH SCREWS
  » TERMINALS NOT LIVE IF BUS IS OFF, AFTER 4 MIN WAITING PERIOD
**TRACTION MOTOR**

- **VERIFY CIRCUIT IS DE-ENERGIZED, < 5 VDC**
  - PHASE TO CHASSIS
  - PHASE TO PHASE

- **ISSUE - HIGH VOLTAGE TERMINALS EXPOSED DUE TO REMOVED COVER**

- **PROTECTIVE FEATURES (BATTERY CONDITIONER OFF)**
  - COVER SECURED WITH BOLTS
  - TERMINALS NOT LIVE IF BUS IS OFF, AFTER 4 MIN WAITING PERIOD
TRACTION BATTERY CHARGER

– ISSUE - HIGH VOLTAGE TERMINALS - CONNECTED DIRECTLY TO BATTERY TUBS

– PROTECTIVE FEATURES

» CONNECTORS NOT LIVE IF BUS IS OFF, MASTER DISCONNECT OFF
TRACTION BATTERY SYSTEM (BATTERY ENCLOSURE)

- NOT DE-ENERGIZED BY BATTERY ISOLATOR SWITCH-ENERGIZED WHETHER THE BUS IS RUNNING OR NOT
- CHARGING VOLTAGE IS 350 VDC PER ENCLOSURE
- BATTERY VOLTAGE PER ENCLOSURE IS 276 VDC
- CONTACTORS IN EACH ENCLOSURE
  » ONE EACH FOR NEGATIVE AND POSITIVE CONNECTIONS
HIGH VOLTAGE (276 VOLTS PER TUB)

- DEVELOPED AS THE RESULT OF CONNECTING TWENTY-THREE 12VDC BATTERIES IN SERIES
- WHEN CONNECTED, HIGH VOLTAGE POTENTIAL EXISTS ON ANY BATTERY OR LEAD IN THE TUB
- CHECK FOR GROUND FAULTS
HIGH VOLTAGE (276 VOLTS PER TUB)

– LIMITED VOLTAGE WHEN BATTERIES ARE ISOLATED - IE.

» BATT.#1 TO GROUND CONTACTOR = 12VDC
» BATT.#5 TO GROUND CONTACTOR = 60VDC
» BATT.#23 TO GROUND CONTACTOR = 276VDC
» BATT.#20 TO BATT.#23 = 48VDC
NO LONE ZONE - HIGH VOLTAGE

DANGER!

USE EXTREME CAUTION IN THESE AREAS TO PREVENT SHORT CIRCUITS.
BATTERY TUB BUILD-UP

- Connect battery as per numbered sequence, torque to 60 in LBS
- Connect flying leads in correct sequence
CHECK FOR GROUND FAULTS

- BATTERY TUB(S) TO GROUND
- PCS TO ACTM 3 PHASE TO GROUND
- PCS TO ACTG 3 PHASE TO GROUND

STOP HEV INDICATOR AND BUS SHUTDOWN WITH NO OVERRIDE WHEN THE PCS DETECTS A GROUND FAULT

- IDS WILL INDICATE A CODE A043 OR A045 WHEN THIS OCCURS

» USE OF BOTH BAE’S AND ORION SERVICE MANUALS MAY BE REQUIRED TO IDENTIFY AND REPAIR THE GROUND FAULT
CHECK FOR GROUND FAULTS, < 1 VOLT

- BATTERY #23 POSITIVE TERMINAL TO CHASSIS
  BATTERY #1 NEGATIVE TERMINAL TO CHASSIS

- IF THIS TEST FAILS - TROUBLESHOOT AND REPAIR THE GROUND FAULT BEFORE PROCEEDING
WORK SAFE

— ALLOW 4 MINUTES TO DISCHARGE CONTACTORS
  » TWO PER BATTERY ENCLOSURE
  » ONE IN PCS

— WORKING WITHIN BATTERY ENCLOSURE WHILE ON THE ROOF
  » EXTREME VOLTAGES ARE EXPOSED
  » CARE WITH TOOLS & HARDWARE

— MEASURE BEFORE TOUCHING

— DURING BATTERY CONDITIONING
  » TREAT SYSTEM AS ENGINE RUNNING
WORK SAFE (CONT’D)

- INSTALL SAFETY PINS IN PRIMARY COVER
- USE TWO PEOPLE TO REMOVE BATTERY TUB INTERIOR COVER
- DISCONNECT VEAM CONNECTORS AT TUBS TO FURTHER ISOLATE BATTERY TUBS
- CHECK FOR GROUND FAULTS
- USE DIELECTRIC COVERS/PLATFORMS WHEN WORKING INSIDE THE BATTERY TUBS
- WEAR GLOVES AND FACE SHIELD
- ESTABLISH PERSON REMOVAL PROCEDURE
REMEMBER, HIGH VOLTAGE IS ALWAYS ON THE ROOF

HIGH VOLTAGE AT THE MOTOR, GENERATOR, AND PCS WHEN ENGINE IS RUNNING

MEASURE BEFORE YOU TOUCH
## PART NUMBERS - ORION VII

- 070775123  INSULATOR-TERMINAL
- 070775124  INSULATOR-BAT TUB SVC.1
- 070775125  INSULATOR-BAT TUB SVC.2
- 070775126  INSULATOR-BAT.TUB SVC.3
- 070775128  TOOL-BAT.TUB.WRK.PLTFRM
- 070775172  TOOL.BATTERY WRK.PLTFRM
QUESTIONS? GIVE US A CALL!
SERVICE USA & WARRANTY
800-716-7466
PARTS NORTH AMERICA
800-786-8099