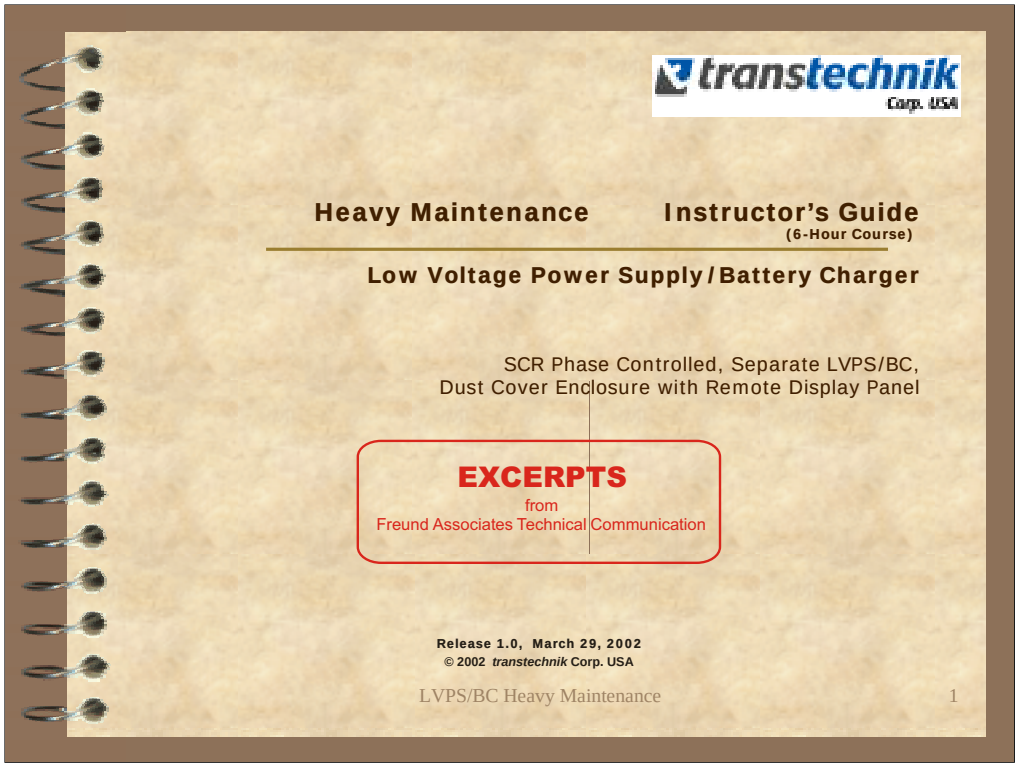


[To the Instructor]

Class size: 12 trainees.

Facilities required: classroom/workshop with screen for slide projection, laptop computer, and spare parts for the unit, if available.

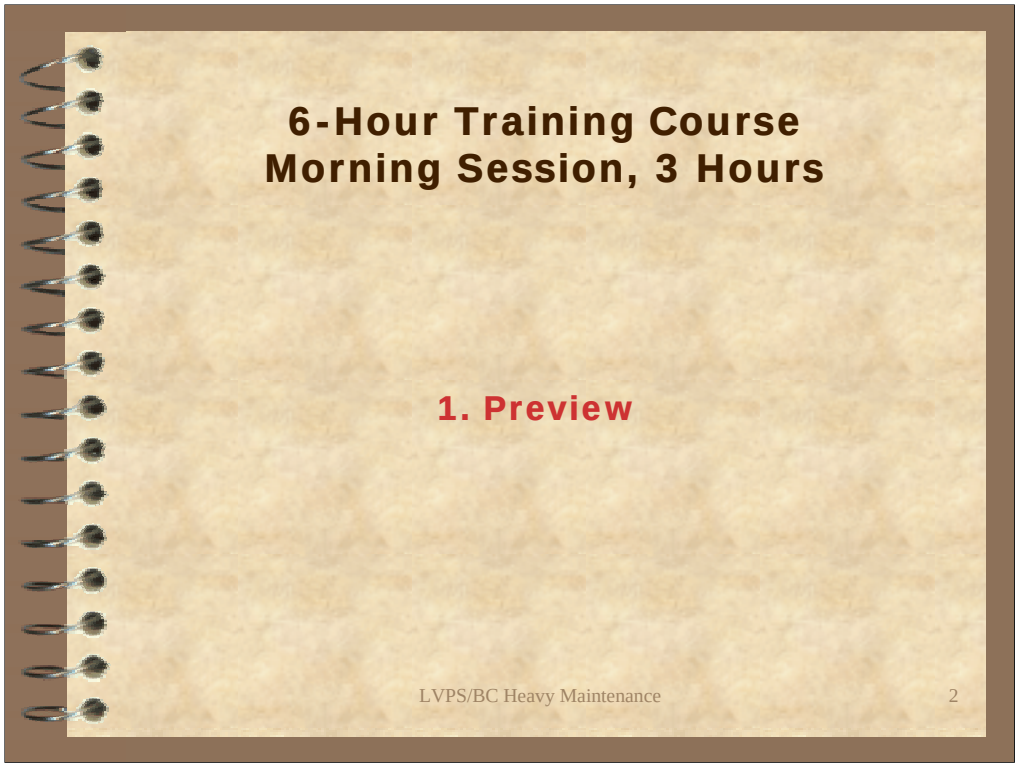
[Refer trainees to Student Workbook, Table of Contents]

This training course consists of two parts:

3-Hour Overview presents an overview of the Low Voltage Power Supply/Battery Charger (LVPS/BC) functionality, location, access and safety.

2.5-Hour Diagnostics and Repair provides basic instructions for technician troubleshooting, module/board replacement, repair, and maintenance for the Low Voltage Power Supply/Battery Charger.

In addition, time is allocated for discussion and testing



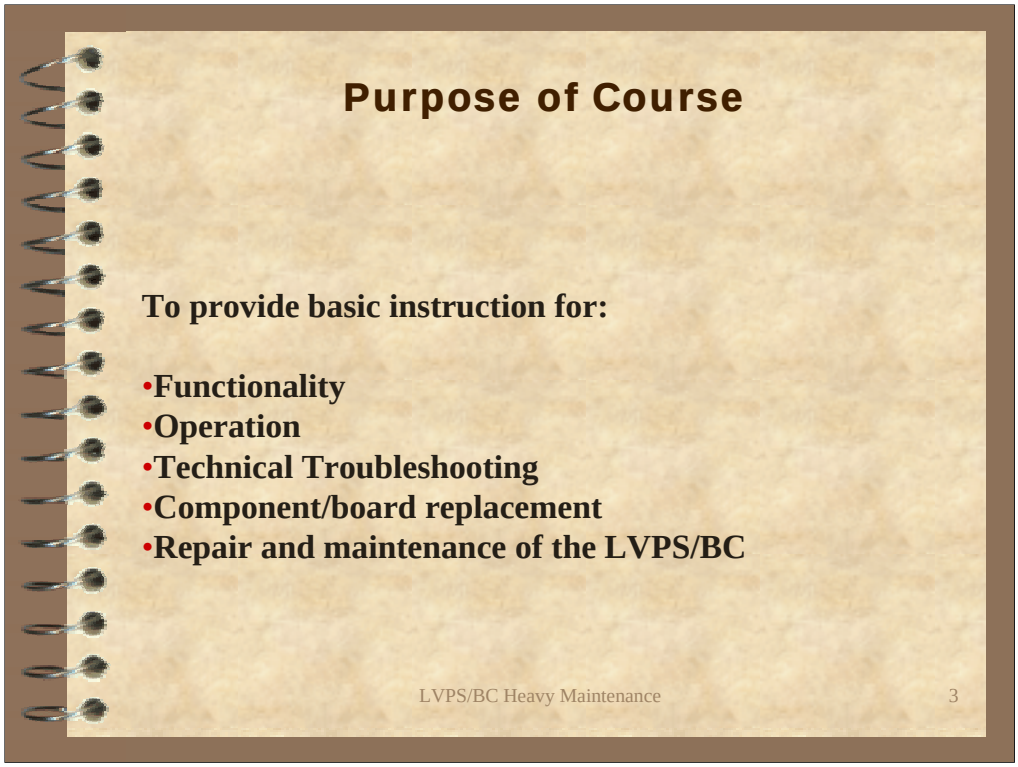
[Refer to Workbook, Table of Contents]

This six-hour course will cover 7 topics:

- *Functional Description* (1.5 hours)
- *RSDU Functionality* (30 minutes)
- Location & Access (30 minutes)
- Safety (30 minutes)

Lunch Break

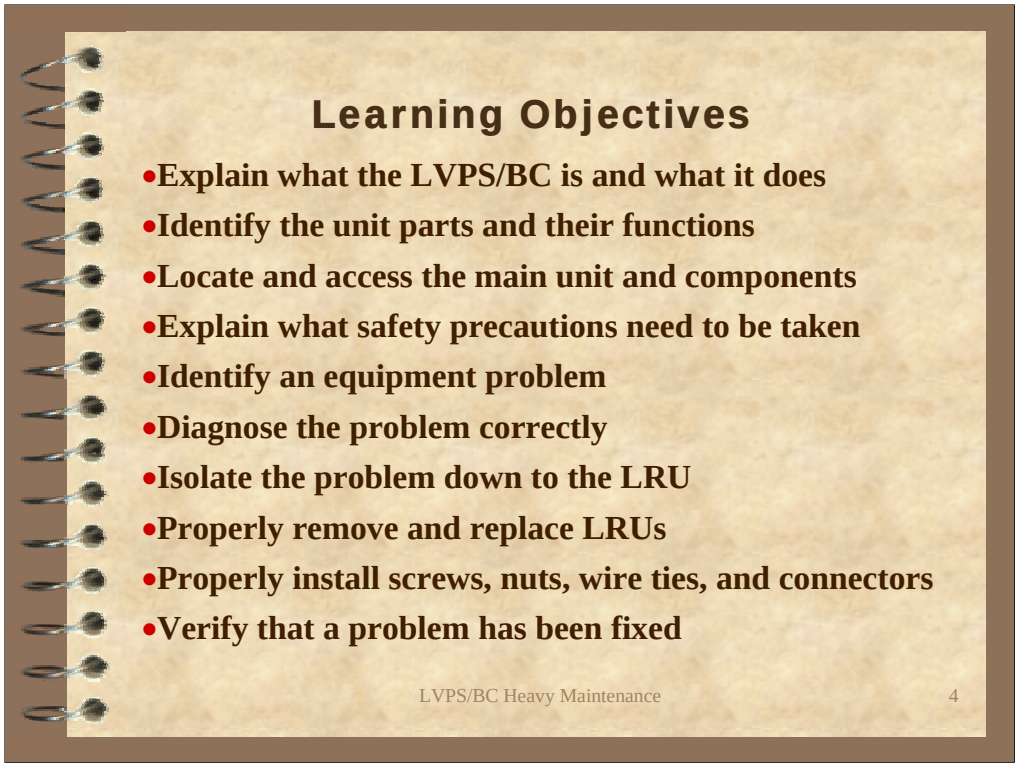
- Diagnostic Tables(20 Minutes)
- Diagnostic Functional Tests (30 minutes)
- Diagnosis & Repair Scenarios (1.25 hours)
- Achievement Test (30 minutes)



[Refer to Workbook, page 1.]

This Training Course provides an explanation of what the Low Voltage Power Supply and Battery Charger (LVPS/BC) is, what it does, and what can be expected during normal operation.

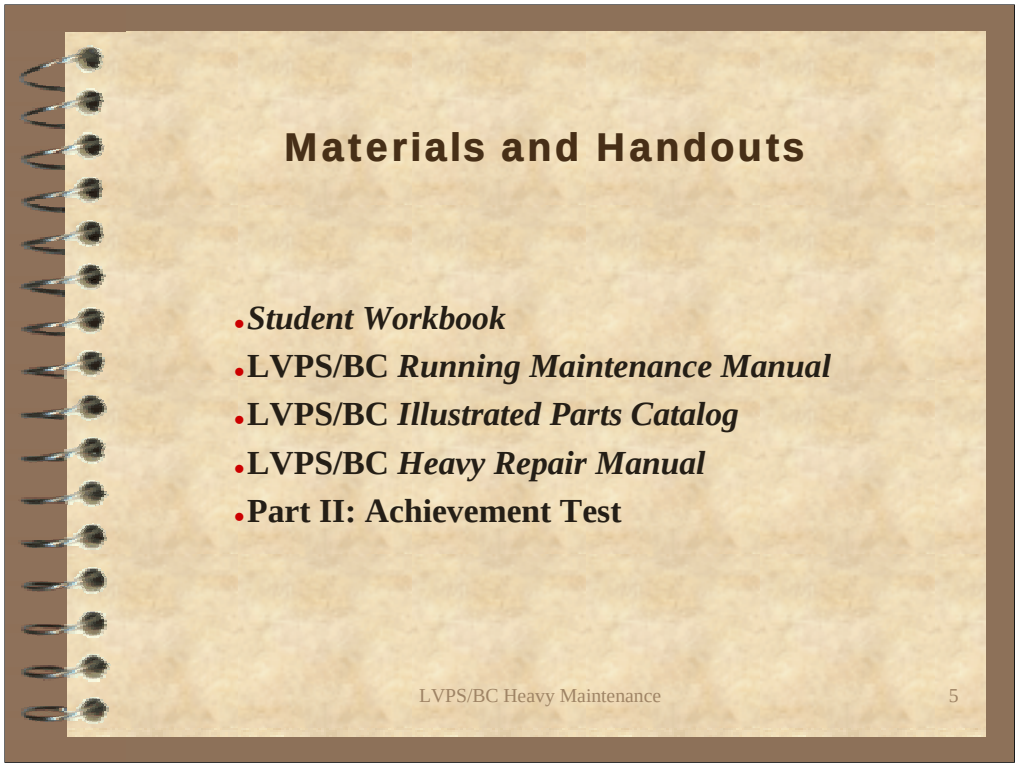
In addition, basic instruction is provided for technical troubleshooting, component/board replacement, repair, and maintenance of the Low Voltage Power Supply/Battery Charger (LVPS/BC). The student will learn to use the tables in the tables in the Heavy Repair Manual (HRM) to diagnose problems and to replace the faulty component.



[Refer to Workbook, page 1.]

At the end of this module, you should be be able to:

- Explain what the LVPS/BC is and what it does
- Identify the unit parts and their functions
- Locate and access the main unit and components
- Explain what safety precautions need to be taken
- Identify an equipment problem
- Use HRM Tables to diagnose the problem correctly and to isolate the problem down to the LRU
- Use HRM Tables to properly remove and replace LRUs, including the proper installation of screws, nuts, wire ties, and connectors
- Verify that a problem has been fixed



[Refer to Workbook, page 1. At this time, you should distribute 1 copy of each of the manuals to each person in the class. The test is a separate handout, distributed at the end of the module.]

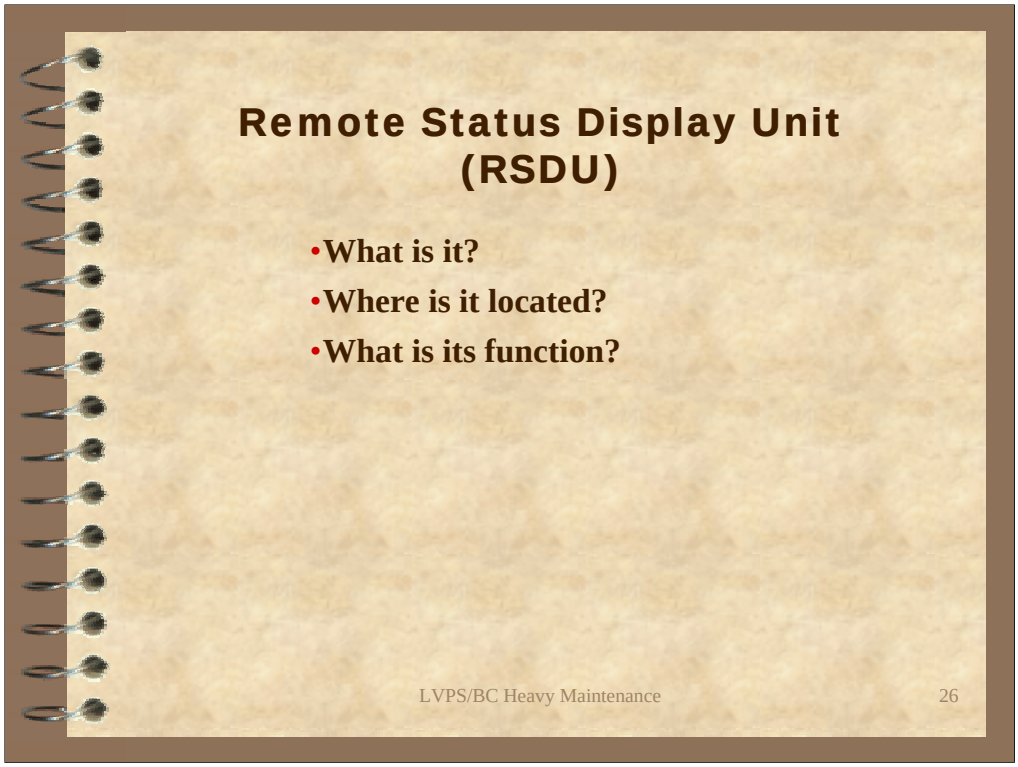
In addition to the *Student Workbook*, trainees will need the following written materials:

•LVPS/BC *Running Maintenance Manual (RMM)*

•LVPS/BC *Illustrated Parts Catalog*

•LVPS/BC *Heavy Repair Manual (HRM)*

•Part II: Achievement Test



[Refer to Workbook, page 13.]
[Refer to RMM or HRM, page 8 and Figure 4 page 11.]

•The Remote Status Display Unit (RSDU), shown in the next slide, contains a number of indicator lights that are useful for trouble shooting. The information being displayed comes from the controller boards by way of circuits on the interface board (see Figure 4). The RSDU also contains a Battery Capacity Level (BCL) meter.

•The RSDU is mounted separately from the main unit in an accessible location, such as behind the electrical panel in the car.

•The function of the RSDU is to provide status information about the LVPS/BC and to indicate the charge level of the backup batteries. The status information is used when troubleshooting the unit.

Remote Status Display Unit
(RSDU)

[Refer to Workbook, page 13.]

[Refer to RMM Manual, page 15, Figure 5.]

This photograph shows the RSDU with the Battery Capacity Level meter on the right and the indicator lights on the left.

There’s also a reset switch that will be explained in the next section.

[Refer to Workbook, page 14.]

Question 1
If one of your colleagues asked you, "What is this unit for?" what would you say?
Answer: Its main function is to provide power to a car at 72 VDC, while simultaneously charging the backup batteries. It will automatically switch between normal power and battery power.

Question 2
If they wanted to see the unit, how would you describe its location?
Answer: The unit is at the A-end of the bi-level car and is located in a compartment at the upper level.

Question 3
Give an overview of the unit's operation.
Answer: The unit has two basic circuits. One (the LVPS) converts electrical power from 480 VAC to 72 VDC and supplies up to 50 amps of current to the rail car. The other (the BC) does the same, but this is used to charge the battery and keep it ready. The unit monitors conditions, and will automatically switch the car's electrical load to the battery if the LVPS cannot supply power. When LVPS power is restored, it automatically switches back. The unit's status is displayed on the RSDU which can be used for troubleshooting.

[Refer to Workbook, page 15.]

Question
4. Where do you check the unit's status? What is its location?
Answer: You need to go to the RSDU (behind the electrical panel).

Question
5. What is CVCL?
Answer: CVCL stands for Constant Voltage Current Limit. It is the mode in which both the LVPS and BC operate. The output voltage will be held at a constant 72 VDC for all current loads up to the maximum, which is 50 amps for the LVPS and 27 amps for the BC.

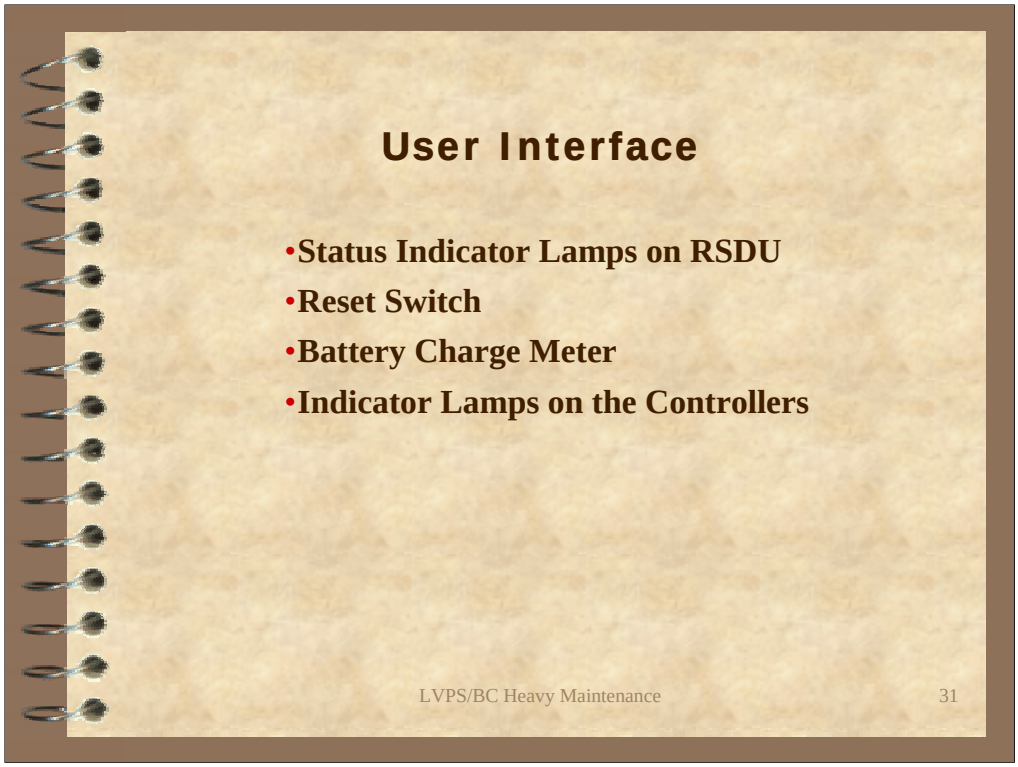
Question
6. Why is it important that the BC operate in the CVCL mode?
Answer: This circuit cannot overcharge the battery as the current is automatically regulated.

Question
7. How does the RSDU indicate unit status?
Answer: It has a set of indicator lamps which will either be green or red to show system status. In addition, an analog meter indicates the percent of battery charge.

[Refer to Workbook, page 16.]
[Refer to RMM Manual, pages 15-17 and 20-22.]

To understand the functionality of the Remote Status Display Unit, we need to answer several key questions:

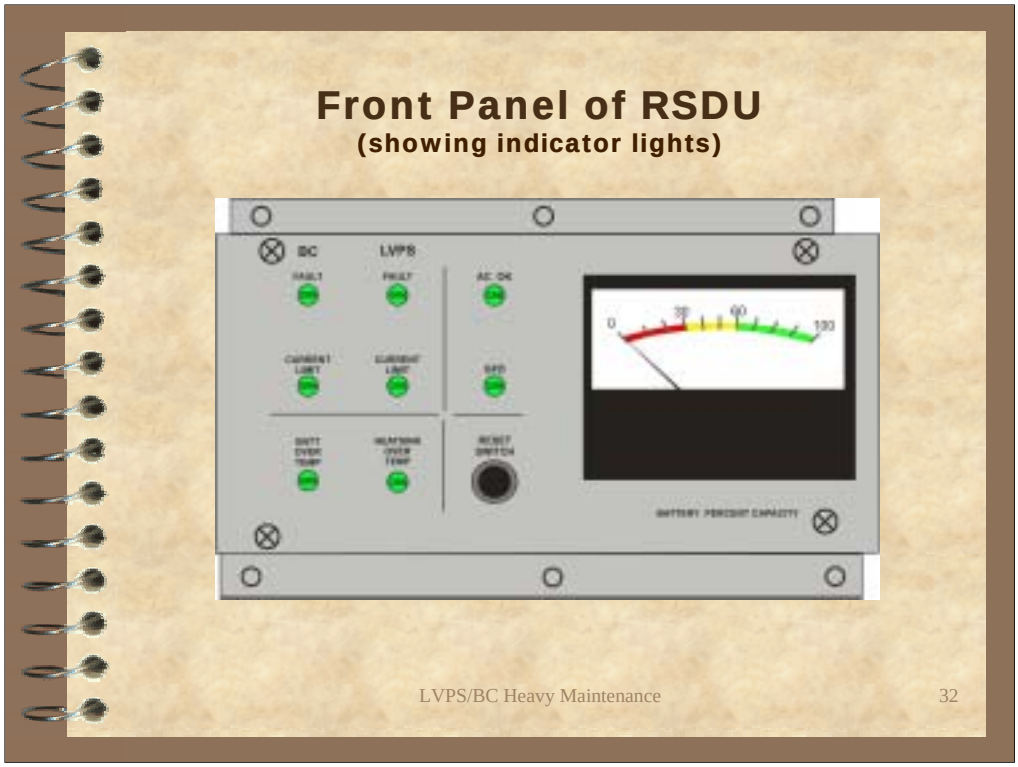
•What is the user interface?
•Where are the indicator lights and what do they mean?
•How do you read the battery meter?
•What do you see day-to-day?
•When do you push the reset button?



[Refer to Workbook, pages 16 and 17.]
[Refer to RMM, pages 15-22.]

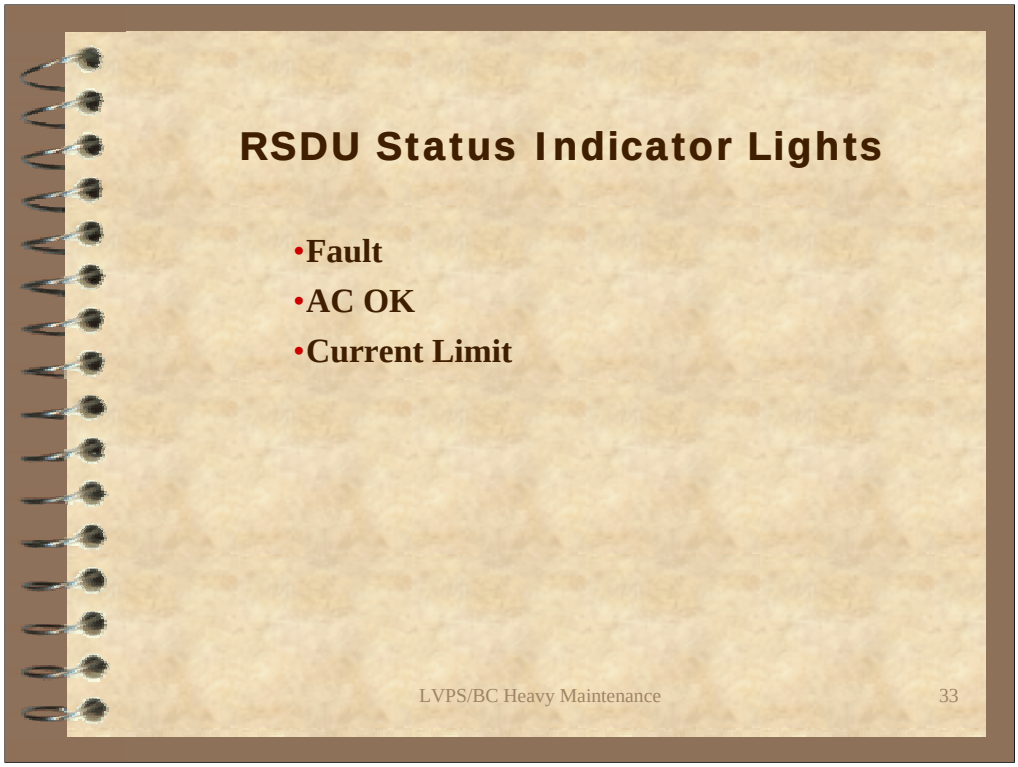
The user interface for the LVPS/BC system consists of the following elements:

•Status indicator lamps located on the RSDU
•The Reset Switch
•The Battery Charge Meter
•Indicator Lamps on the Controllers



[Refer to Workbook, page 16.]
[Refer to RMM Manual, page 15.]

Here we see a close up photograph of the RSDU showing the Status Indicator Lights and the Reset Switch. All lamps green indicates that the unit is operating normally and that the battery is most likely at least 80% charged.



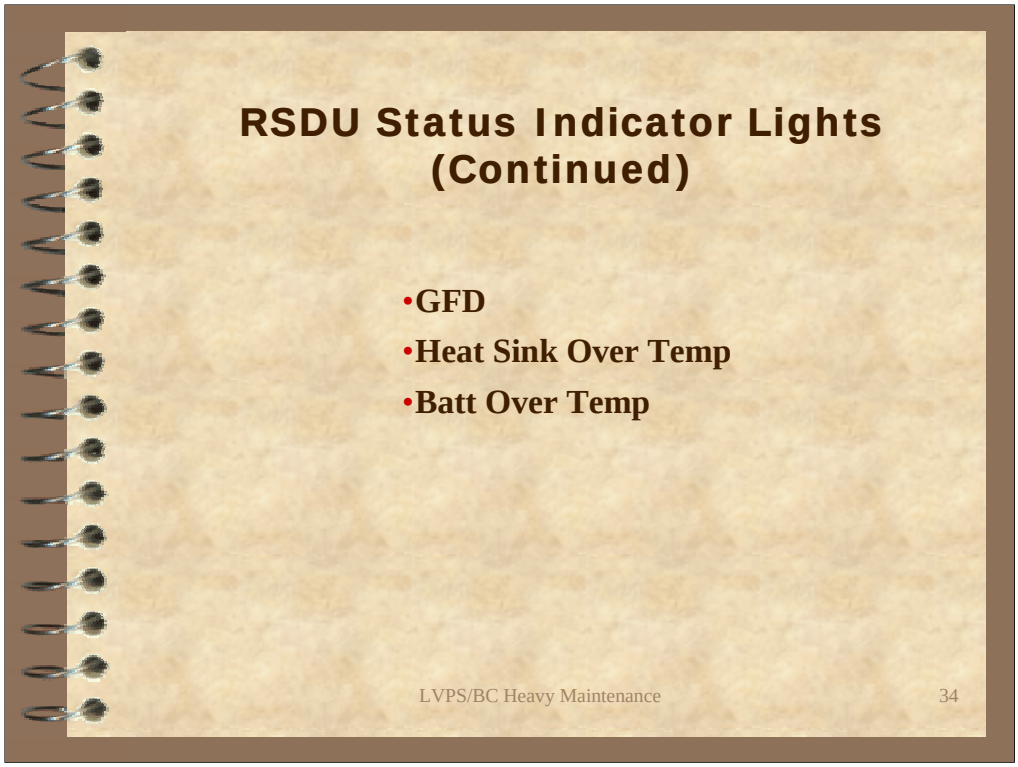
[Refer to Workbook, page 16.]
[Refer to RMM, pages 15-17 and 22 including Tables 2 and 5.]

Under normal operation all lamps will be green.

•There are two Fault lamps, one for the BC and one for the LVPS. If the Fault lamp is red, then the LVPS or the BC has shut down. If the BC lamp alone is red, then the BC has been shut down. If the LVPS lamp is red, then the BC lamp should also be red, with both the BC and LVPS shut down. In this case the car has been switched to the batteries.

•The AC OK lamp will be red if there's a problem with the AC input. In most cases, this is a problem with the external power and most likely not a problem within the LVPS/BC unit. If the external power has failed, both the LVPS and BC fault lamps will be red. Both will have shut down, and the load will have been switched over to the battery. First, check the circuit breakers. Be aware that this is 3-phase power, and it is possible that a breaker on only one phase has tripped.

•There are also two Current Limit lamps: one for the BC and one for the LVPS. When these lamps are red, they indicate that the circuit is operating at its current limit. This isn't a fault condition that will cause an automatic shut down on the LVPS or the BC. When the battery has been discharged significantly (below 80%), it is normal for the BC Current Limit to be red. As the battery reaches full charge, the BC Current Limit lamp should turn green. For the LPVS, a red Current Limit lamp indicates a very high load, far above normal. It could indicate a problem in the rail car's electrical system.



[Refer to Workbook, page 16.]
[Refer to RMM, pages 15-17 and 22 including Tables 2 and 5.]

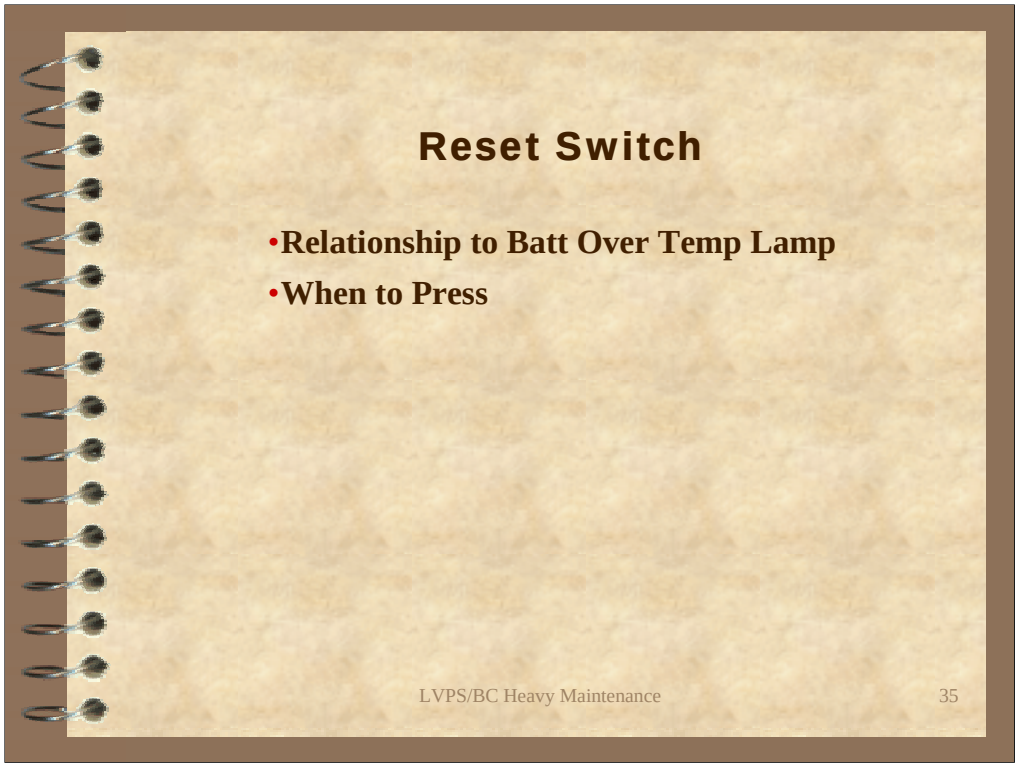
Under normal operation all lamps will be green.

•The GFD lamp is for operator information only. A red GFD lamp indicates a problem, but it does not cause the system to shut down. The red light indicates a ground fault leakage of 10mA (or more) between the LVPS/BC circuitry and the chassis.

•The Heat Sink Over Temp lamp will light if either one or both of the Heat Sinks for the BC and LVPS is over 85° C. If the LVPS Heat Sink is over 85° C, then both of the Fault lamps will be lit. Remember, an LVPS shut down causes the BC to shut down. If only the BC is over temperature, the BC Fault lamp will be lit and the BC alone will be shut down.

A high temperature in the Heat Sink is definitely an indication of a serious problem in the LPVS/BC unit. It could possibly be a fire. Once the temperature drops below 85° C, the affected modules will return to normal operation, and the light will return to green.

•The Batt Over Temp lamp will turn red if the temperature of the battery exceeds 65° C. This will shut down the BC and latch in this state. The BC will remain shut down, and the lamp will remain lit even after the battery temperature returns to normal. If this has occurred, then there is most likely a problem in the battery pack, and it should be checked as soon as possible.



[Refer to Workbook, page 17.]
[Refer to RMM, pages 15-17 and 22 including Tables 2 and 5.]

•The Batt Over Temp lamp will latch in the red state and the battery charger will remain shut down if the battery temperature ever exceeds 65° C. This is to ensure that the operator and the maintenance crew are aware of the problem.

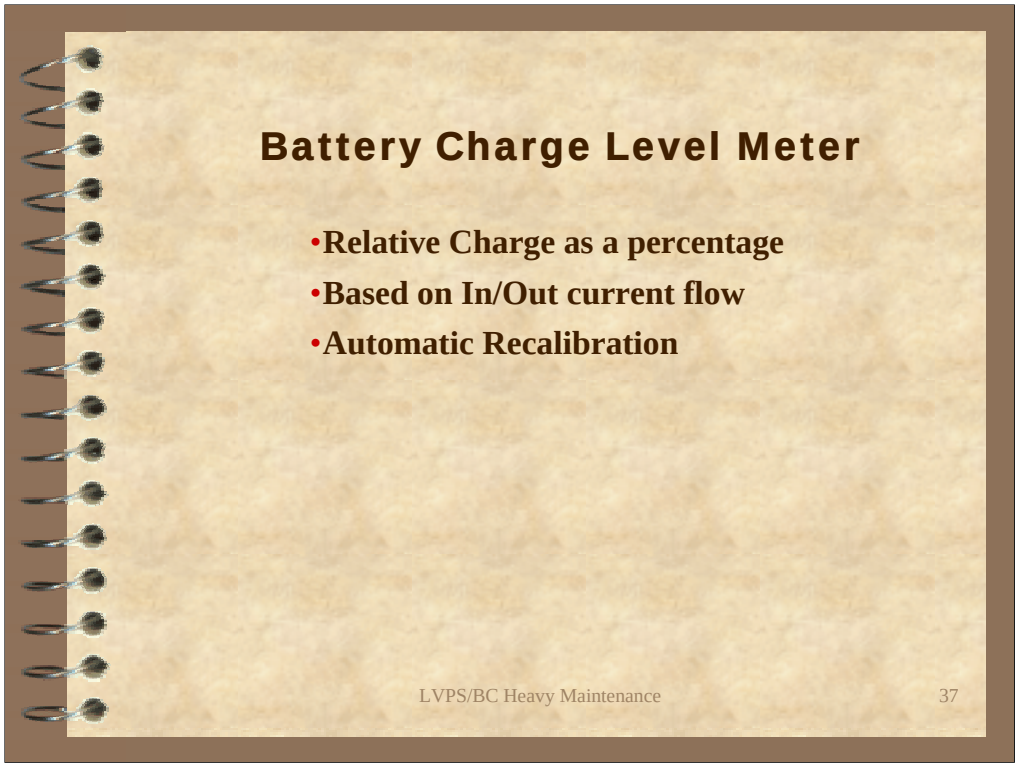
•The reset switch will have to be pressed in order to clear the lamp to green and to restart the battery charger. After you do this, you should observe the lamps for indications of other problems. If other problems are observed or the batteries overheat again, further diagnosis will be necessary.

Front Panel of RSDU

(showing reset button and battery meter)

[Refer to Workbook, page 17.]
[Refer to RMM Manual, page 15.]

Here's a close-up of the BCL portion of the RSDU, showing the reset button and battery meter. The meter in the picture is indicating a fully discharged battery.



[Refer to Workbook, page 17.] [Refer to RMM, page 20-21.]

The Battery Charge Level Meter is located in the right hand portion of the RSDU.

•It indicates the relative charge of the backup batteries as a percentage of full charge at 0, 20, 40, 60, 80, and 100%.

•It does this by monitoring the charge flowing *into* the battery during charging *out* when the electrical load is switched to the battery. The meter circuitry calculates the level based upon the known capacity of the battery. Like a full glass of water (if you continuously measure how much drains out and how much is refilled), you can calculate the level. Batteries also lose some of their charge over time, like water evaporating. This, too, can be calculated to make the meter more accurate.

•The meter automatically calibrates after a full battery discharge and charge cycle. Again, like the glass of water, you can easily tell when the glass is full and when it is empty. If you measure the flow and how long it takes from empty to full, you know exactly how much is in the tank.

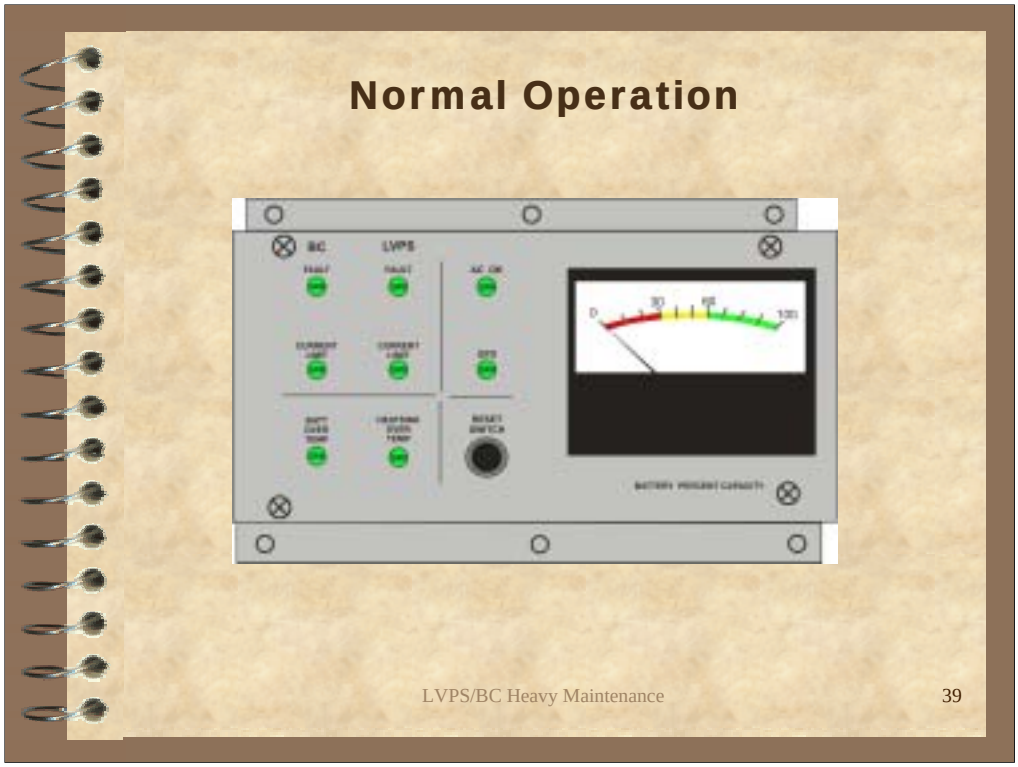
From a fully discharged state, it will take the batteries at least 5 hours to approach full charge. During this charging period, it is normal for the BC Current Limit Lamp to be red. This simply indicates that the BC is operating in the “Current Limit” mode.

For some period, once the meter has reached 100%, the BC Current Limit indicator may still be red. However, once the battery has reached full capacity, the indicator should return to green.

[Refer to Student Workbook, page 18.]

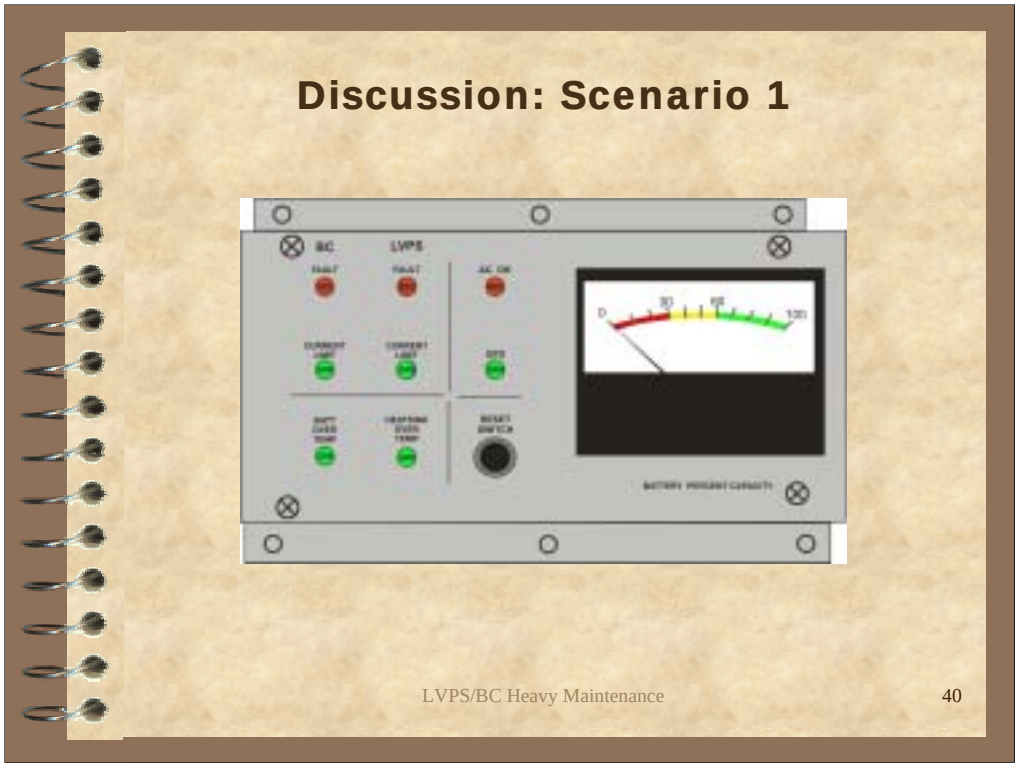
The Indicator Lights on the unit are the keys to identifying operating problems. Let's discuss several possible scenarios. These scenarios give an overview of how the RSDU indicator lamps are used to begin to understand the problem. A complete approach to diagnosing problems which includes using controller lamp status and test equipment will be covered in the afternoon session.

Now let us examine a few examples . . .



[Refer to Student Workbook, page 18.]

Normally, all indicator lights should be green.



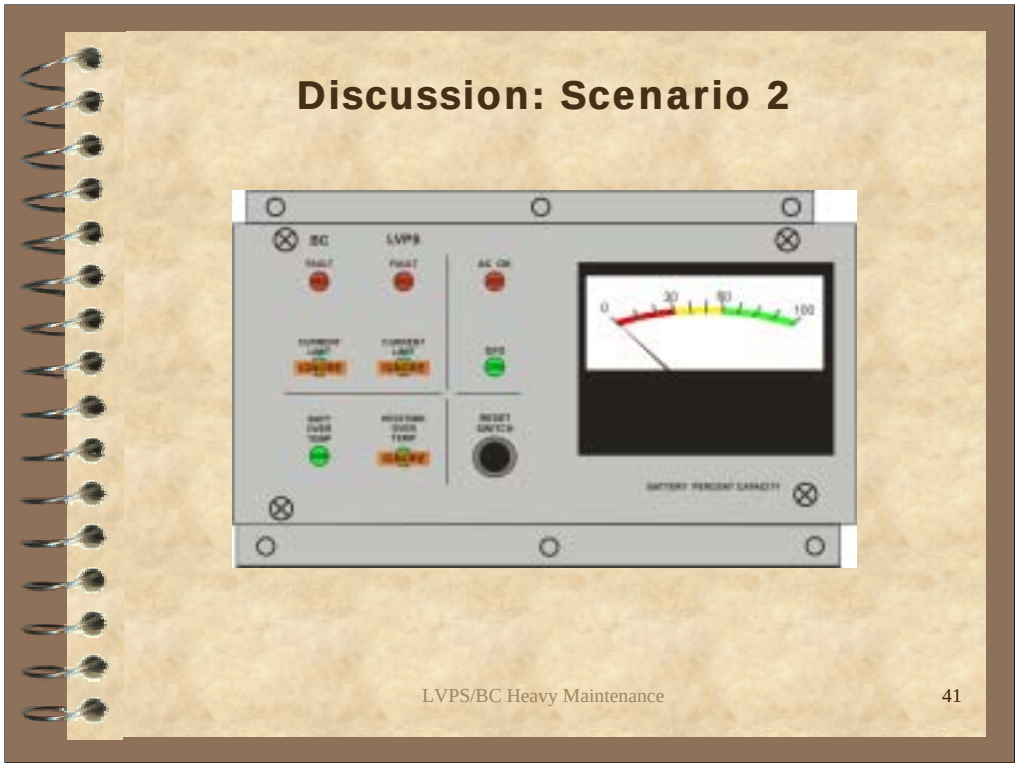
[Refer to Workbook, page 19.]

[Refer to RMM Table 2 on pages 16 and 17.]

Description:
AC OK is red (but there is still AC)

What is the problem?

This will cause the LVPS and BC Faults lamps to indicate red since both circuits will shutdown. This is most likely an external AC power problem. Check the circuit breakers first. There are 3 phases coming into the unit. It's possible that a breaker has tripped on only one phase. This condition could also be caused by high or low input AC voltage. It is possible that this is a problem inside the unit. However, this would be the result of some seriously damaged components.



[Refer to Student Workbook, page 20.]

[Refer to RMM page 20]

Description:

AC OK is red (Complete loss of AC Input power but battery power is available.)

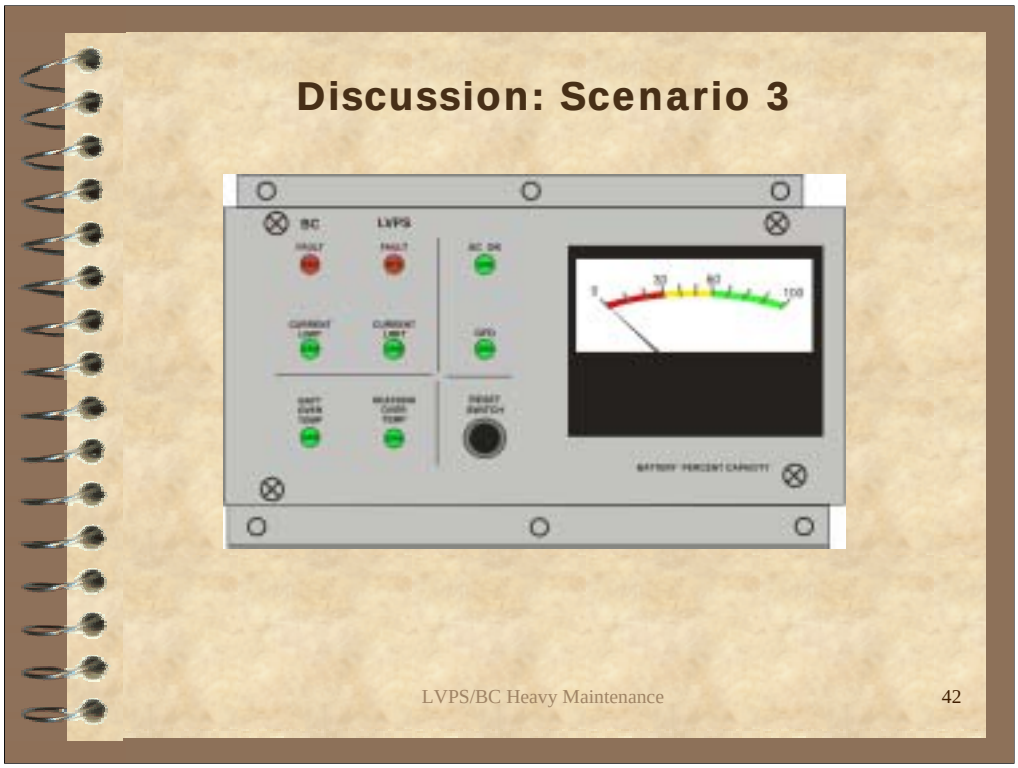
What's the problem?

If the LVPS/BC unit loses ALL AC power, only "GFD" and "Batt Over Temp" continue to respond to the situation that they are monitoring.

"AC OK," "LVPS Fault," and "BC Fault" will default to red.

The status of other lamps is meaningless and should be ignored. Those fault circuits require AC power to function.

Again, the first thing to check are the circuit breakers. This situation is also unlikely to have been caused by an internal fault.



[Refer to Student Workbook, page 21]

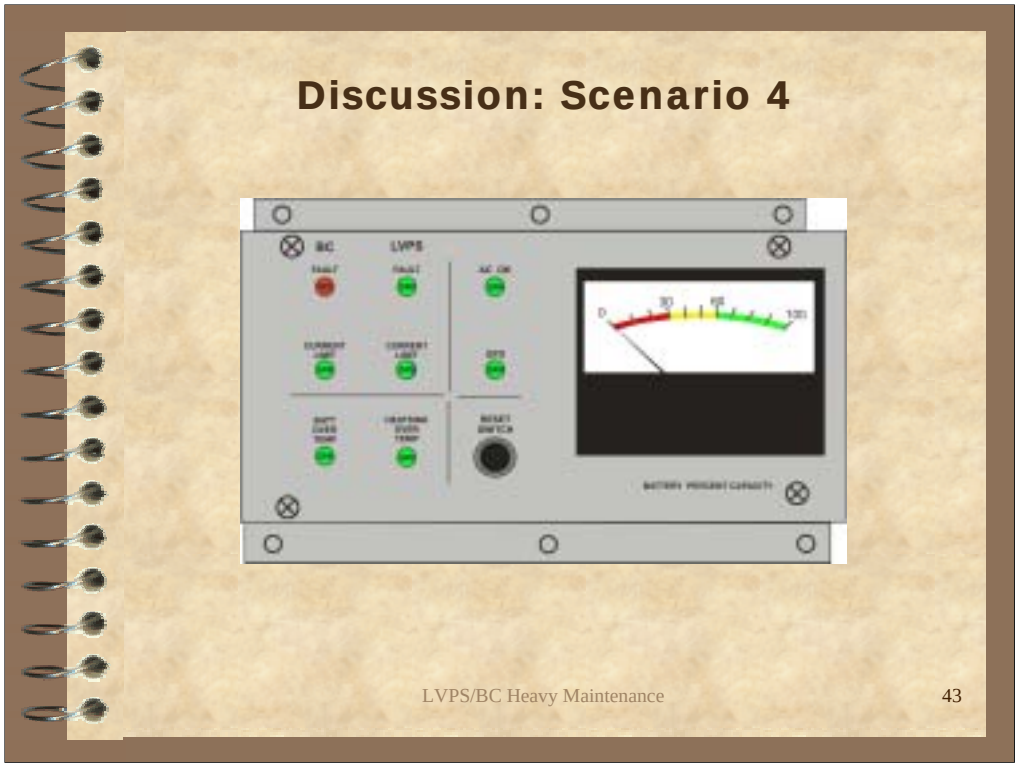
[Refer to RMM Table 2 on pages 16 and 17.]

Description:

LVPS Fault is red, (AC OK is green)

What's the problem?

Again, this would cause the BC to fault as well, but we know it is not caused by a problem with the input power. Without a "Heat Sink Over Temp" problem, this indicates that the output voltage on the LVPS is out of range. With a current limit light, this could indicate a very high load on the LVPS. This status scenario is probably a problem within the LVPS/BC unit.



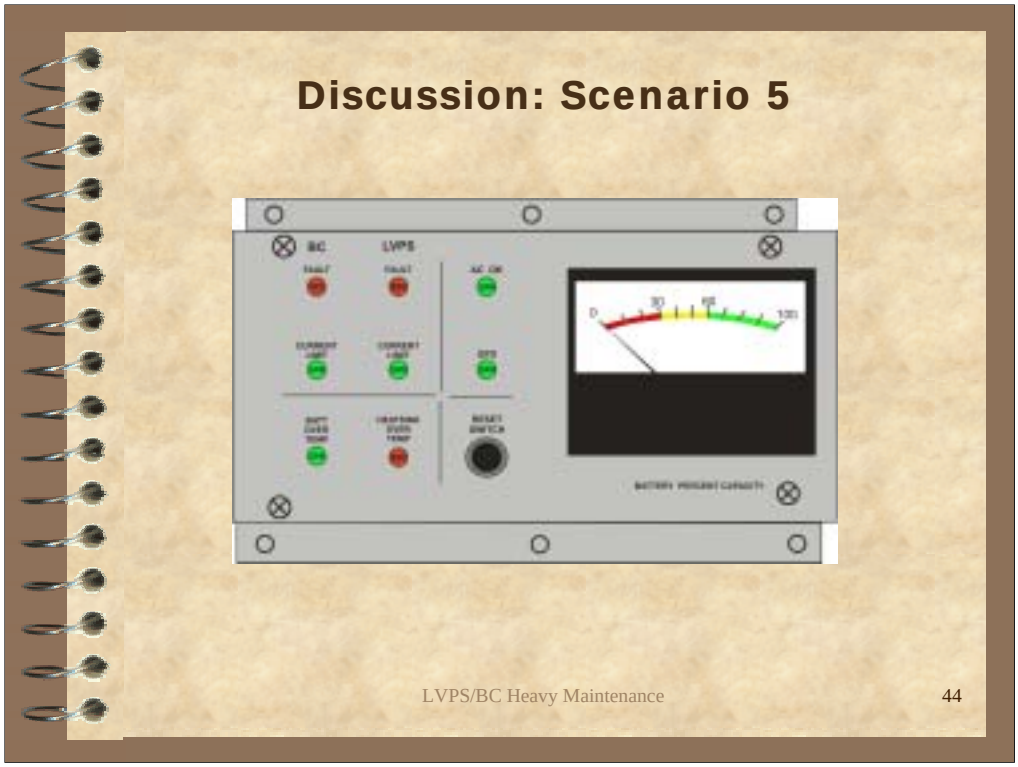
[Refer to Student Workbook, page 22]

[Refer to RMM Table 2 on pages 16 and 17.]

Description:

BC Fault is red (AC OK is green, and LVPS Fault is green)

What's the problem? Since there is no LVPS fault, the LVPS circuit continues to function normally. We know it is not caused by a problem with the input power. Also, without a "Heat Sink Over Temp" problem, this indicates that the output voltage on the BC is out of range (>79V dc). Since the load on the circuit cannot drastically change because it's connected to the battery, this status scenario will probably not occur unless the breaker has been thrown to disconnect the unit from the battery. It is most likely that there is a problem in the BC portion of the unit if this scenario occurs.



[Refer to Student Workbook, page 23]

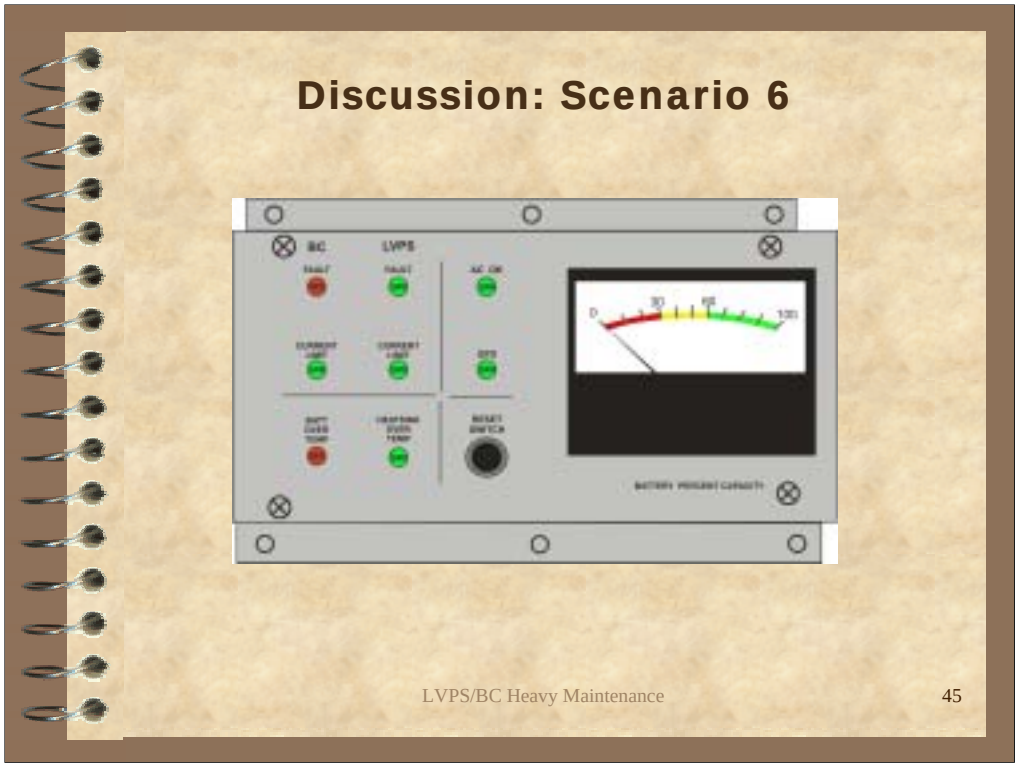
[Refer to RMM Table 2 on pages 16 and 17.]

Description:

Heat Sink Fault is red

What's the problem?

A Heat Sink Over Temp condition could be caused by either the LVSP or the BC and, in turn, cause the BC or both to indicate a fault and shutdown. This was caused by a high (85° C) temperature at the heat sinks. The unit is designed to dissipate heat through natural convection without assistance. Very likely there is a problem with an internal component. It is likely that this problem will cause a slow cycling of the unit. Once the BC or entire unit is shut down, the heat sink will cool. Once it cools sufficiently, the unit will restart and again overheat if due to a component failure.



[Refer to Student Workbook, page 24]

[Refer to RMM Table 2 on pages 16 and 17.]

Description:

Battery Over Temp is red (BC Fault is also red)

What's the problem?

This condition will cause the BC to fault and shut down to protect the battery. As we mentioned earlier, the BC won't restart until the LVPS/BC is reset by pressing the Reset button on the RSDU. This is most likely an external problem with the battery. However, it's possible that there is a problem with the BHTD/Battery Temperature Sensor.