The intent of this guide is to provide a basic understanding of the electrical system components of this airplane (exclusive of the magneto ignition system) to assist Flight Engineers in trouble shooting and correcting electrical malfunctions during mission operations. Detailed guidance should be obtained by referring to the Boeing B-17G Erection and Maintenance manual AN 01-20EG-2 or equivalence.

Note there are several electrical devices on TR that have been de-activated which significantly reduces the demand on the electrical system. These are the gun turrets, the electric heated flight suit system, the 1945 vacuum tube radios / radar, de-icing system and the auto pilot system.

**BATTERIES:**
The reserve and engine starting power is provided by three 24 volt batteries located in the leading edge of each inboard wing root. Each battery is connected in parallel to one common power bus by its individual switch located on the pilot's control panel located low on the left fuselage wall. Since each battery is individually connected to the bus, all THREE must be turned OFF to de-energize the aircraft. Very little maintenance issues will arise from the batteries unless a generator over-voltage occurs in service.

**GENERATORS:**
Four engine driven 24 volt, 200 amp DC generators, each driven by its corresponding engine, are connected in parallel. Each generator output is regulated by its dedicated adjustable carbon pile voltage regulator to share electrical loads equally among all generators.

**VOLTAGE REGULATORS:**
Four regulators are located in a ventilated shielded box in the lower passageway, below the flight deck, aft of the forward entrance door – one regulator for each generator. The voltage regulators are not field serviceable, except for adjusting, but are easily replaced by unsnapping each one from its base. A spare regulator should be carried on missions.
Regulators must be adjusted to insure equal load sharing, and load sharing can be monitored in flight by comparing each generator load meter for an imbalance. Load meters are located on the pilot's control panel.

**STABILIZING SYSTEM:**
An equalizing circuit and stabilizing transformer incorporated in the voltage regulator compartment maintain a steady voltage as loads change or if a voltage regulator adjustment should drift. These are not field repairable or adjustable.

**REVERSE CURRENT RELAYS (RCR):**
The Reverse Current Relay prevents battery voltage being shunted to ground through the generator armature whenever the generator is not turning fast enough to produce a positive voltage. There are four (4) RCR – one for each generator. RCR's are located on the rear of the firewall on engines #1 & #4, and on the inside of the wheel well of engines #2 & #3.

The RCR is only closed (i.e. allows electric power to flow) when the Generator Field Switch is in the "ON" position AND the engine RPM high enough to generate at least 20 volts. For all other conditions, they are normally open (i.e. not allow electric power to flow) to prevent back-feeding the generator. RCRs operate automatically.

The Generator Field Switches are located on the pilot's control panel. To avoid frequent activation of the Reverse Current Relay while taxiing, the Generator Field Switches are kept on the "OFF" position until takeoff. This should be considered a "Before take-off" item on the checklist. A test procedure is outlined in the manual.

**INVERTERS:**
Inverters are devices that convert direct current to alternating current. They are a 24 VDC motor powered by the aircraft DC bus which turns an AC generator. In Texas Raiders they produce 29 and 115 volts, 400 Hz AC.

Texas Raiders has two Inverters - a main and the reserve. Both are located under the flight deck below the copilot's seat. TWO operating Inverters are necessary, since they are critical to flight. Switching from the main to spare Inverter occurs automatically if the main Inverter fails, and an annunciator light illuminates in the event of a main Inverter failure. If both Inverters fail, an annunciator light reports both Inverters failed. AC power is distributed to the Station 4 breaker panel (Flight Engineer Panel).

The only present day function for the Inverters is to power up some of the instruments, namely these are:
1. oil pressure gauges
2. flap position indicator
3. fuel pressure gauges
4. annunciator lights
5. prop auto synchronize indicator

All of these are powered by the 29 VAC circuit. (All the other instruments do not rely upon the Inverters).

A loss of both Inverters will cause these instruments to not operate. Of these instruments, the most significant is the Oil Pressure Gauges. It becomes a pilot option to continue to fly should these gauges not operate.

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**POTENTIAL MALFUNCTIONS AND CORRECTIONS**

**BATTERIES:**
Batteries are inspected at 30 hour intervals, and will rarely require attention. If a generator overvoltage occurs, battery damage will not be noticeable due to their remote location relative to the aircraft cabin, (i.e. odor). Inspect all batteries for boil-over. Add distilled water (never acid) to appropriate level, and clean the battery compartment with a water/baking soda solution.

If a battery fails to come online, it might be relay or switch related and not the battery. Check the master switch by listening for the master relay sound (a noticeable ‘click’ when activated).

**GENERATORS:**
Generators either work or they don’t - partial generating doesn’t happen. A failed generator is replaced – not field repaired. Each generator output is monitored by a dedicated load meter located in the pilot’s panel. Texas Raiders has a very small electrical load, but each load meter should show some demand. If a load meter shows no load, the corresponding generator has failed. A failed generator in flight should be taken off-line (by the pilot) to avoid further internal damage.

If a disagreement of more than one graduation among load meters is noted, it indicates that particular generator is slightly over-volting and carrying the entire electrical load of
the plane. With as small a load as Texas Raiders carries, that is not a problem, but should be addressed back at base. With pilot concurrence, the appropriate voltage regulator can be carefully adjusted in-flight to equalize the load.

VOLTAGE REGULATORS:
The most common reason for a voltage error is a Voltage Regulator. If an error is noted and is of a level to produce concern, identifying the overvoltage generator should be done by the pilot and taken off-line. It can be addressed later, usually by replacing the Voltage Regulator upon landing. A failed Voltage Regulator will produce an obnoxious electrical odor in the cockpit due to their location just below the flight deck.

REVERSE CURRENT RELAYS (RCR):
A "stuck" RCR occasionally occurs. That will result in depleted batteries, or a damaged generator, or a fire - unless the protective current limiter properly blows first.

Our pilot's taxi with all generators "off-line". This reduces the make/break action in the RCR and concomitant arcing/sticking. A pilot option is to maintain a high enough engine RPM, without engine overheating, to keep the RCR on-line. Once an RCR sticks closed, the only remedy is to shut off all master switches and address the situation. Traveling with a spare RCR should be considered.

INVERTERS:
The inverters are identifiable by their noise. Two sources of failure can occur with the inverters--either the driving motor circuit or the output circuit. If the output voltage declines below 70 volts, it will automatically shut down and transfer to the spare inverter. The pilot will get an annunciator light if this occurs. If the pilot wishes to return to the main inverter, at least 90 seconds must elapse for the internal auto-switch circuit to cool down in the main inverter. A failure in the driving motor such as bearing failure, brush failure, etc., will require the inverter circuit breaker to be pulled. Electrical odor, or smoke, or flames will identify a failing inverter.

Inverters are essential components since they power engine gauges, esp. fuel pressure, oil pressure, flap, position and annunciator lights.

ELECTRICAL FIRE:
Consult Emergency Checklist.

FE OPERATIONAL AWARENESS summary regarding the Electrical System:

TR’s electrical system has a power generation side and a power consumption side. The power generation is the four (4) generators (each
with a Voltage Regulator and RCR) and the (3) batteries (seven total). The power consumption is all the electrical motors, lights, solenoids, relays, nav/com and the like.

Once TR has attained cruise flight the following status exists:

1. On the power generation side, IF any ONE of the seven (7) components remains functioning, the electrical system remains viable.

2. On the power consumption side, major items have a mechanical override in the event of motor failure (i.e. landing gear, flaps, hydraulic system, bomb bay doors). Alternate procedures are also available for nav/com loss.

3. The engines have no dependency upon the Electrical system – with exception of prop feathering following an engine in-flight shutdown.

The conclusion is that TR can continue to fly and safely land even with a total loss of the electrical system.