## ATTACHMENT #2C

## Procedure for Installation, RF Processing and Operation of the BURLE 7835 High Power Triode

### EXCLUSIVE FOR FERMI NATIONAL LABORATORY

This Application Guide includes general information useful in the care and maintenance, installation and operation of BURLE Tube Type 7835.

### A. UNPACKING THE TUBE:

Upon receipt of the 7835 tube, the recipient should visually inspect the shipping crate for damage or other indications of mishandling during shipment. If visual damage is evident, contact BURLE Application Engineering immediately.

After inspecting the crate and contents, cut and remove the metal seals that secure the hasps for the top of the crate. Open the top. Cut and remove the wire threaded through the four wing nuts. Remove the wing nuts.

Connect the lifting hook through the eyebolt provided with the tube. Never lift the tube by any other means than by the lifting device provided. Carefully lift the tube from the crate. When not in use the tube should be stored in the shipping crate only. Store the shipping crate for future use. Lifting the tube requires a crane or hoist having at least a 1,000 lb. rating.

### B. TUBE VACUUM TEST:

1. If the tube is supplied with an ion pump, the Purchaser must operate the ion pump at sixty (60) day intervals for as long as necessary to maintain vacuum conditions of less than 20 microamperes of ion pump current.

2. If the tube is not supplied with an ion pump, then a vacuum test should be performed on the tube within thirty (30) days after receipt at the customer's location or sixty (60) days after shipment, whichever occurs first. To perform the Vacuum Test, put a spot knocking supply between grid and cathode and raise the voltage to 2kV. A leakage current of less than 10 microamperes is considered acceptable.

### C. TUBE INSTALLATION

1. Make sure all circuit contact areas and ceramic insulators on the tube are clean. All areas of the cavity that make electrical contact to the tube should be checked. If spring finger contact surfaces are dirty or arced, they should be cleaned or replaced before a new tube is installed.

2. Both the upper and lower surfaces of the anode ceramic insulators need to be covered with a mylar protective band before sliding the anode connector assembly over them. The tube ceramic insulators are particularly vulnerable at this time. Never let the connector assembly contacts rub across the ceramic surface. This incidental contact will deposit metal on the ceramic and may cause voltage breakdown problems. The tube ceramics should also be kept free of dust, moisture and other foreign matter.

3. Using the appropriate wrenches make sure the filament connectors on the tube are tight, and that the mating surfaces to the spring rings are clean.

4. Make all the installation measurements of the tube (unless already done since the tube has been received) and of the socket. Record these measurements on the "7835 Installation Data Sheet" and complete the necessary calculations. Adjust the socket dimensions, if required, before installing the tube in the socket.

5. Never force the fit between the cavity mating connectors and the tube terminals when installing the tube. Avoid excessive mechanical stress, particularly on the plate ceramic and filament connectors. If it does not fit properly, stop and determine why.

6. Rotate the tube in a clockwise direction (looking down on the tube) when lowering the tube over the spring rings that make the filament connection. Rotate the tube in the same direction when removing it.

## D. PRELIMINARY OPERATING PROCEDURES

In accordance with the Tube Bulletin, make sure that the coolant system is supplying the proper flow of high purity water to all areas and that no leaks exist. The cavity must be pressurized to the recommended pressure, and all protection devices must be checked to insure that they are functioning properly.

## E. TUBE OPERATION - BREAK-IN AND SEASONING PROCEDURE

CAUTION: If installed, the ion pump must be turned off only during Step 1 of this procedure and should be operated at all times thereafter. If at anytime the ion pump current exceeds 100 microamperes, stop the procedure and allow the pump to operate until the current is reduced to less than 20 microamperes.

1. Filament Break-In Procedure:

   a. Connect the 7835 in the Gas Test configuration and measure the water leakage current.

   b. Slowly raise the filament current to about 2,000 amps. Allow approximately 5 minutes to elapse before raising the current above the 2,000 amp level.

   c. Raise the filament current in 1,000 amp steps every 2 or 3 minutes until the typical operating level (6,800 amps) is reached.

   d. Allow the filament to operate at this level for about 15 to 30 minutes without anode voltage or drive power to allow time for the getter to pump any released gas.

   <The time for Step 1 is about 30 to 45 minutes.>

2. Perform a Gas Test on the Tube:

   a. After the filaments have been operating at full value for 5 minutes, apply the -45 volt anode voltage.

   b. Turn on the grid supply and adjust for a grid current of 50 amps dc.

   c. Record the initial value of the anode current. After 5 minutes record the final value of the anode current and calculate the final gas current reading which is the anode current minus the water leakage current.

   d. A final gas current value of less than 20 microamperes is acceptable.

   <Typical time for Step 2 is about 15 minutes.>

3. Precaution to be Observed During the Entire Break-In:

   a. During the application of RF drive and plate voltage pulses, observations of the cathode and plate current pulses, the mod block indicator and the ion pump current (if available) are used to judge the progress of vacuum tube clean-up.

   The cathode and plate current pulses and the mod block indicator can be used to judge the frequency of internal tube arcs. Internal tube arcs may increase as the power or voltage applied to the tube is increased. If the tube is operated for a period of time at a constant level of power, the frequency of internal tube arcs will increase, indicating that the normal clean-up is taking place and the power input can be increased to a higher level. An increasing frequency of internal arcs or a burst of internal arcs should be countered by decreasing the power and running at a lower level before again increasing the power.

   If an ion pump is available, it should be used as an indicator of vacuum clean-up. Internal arcs usually show up as a short burst or increase in ion pump current. The absence of internal arcs will be accompanied by a decrease in ion pump current.

   Normal outgassing of tube elements after an increase in power will be indicated by a gradual increase in ion pump current. The current will then go through a peak and begin to decrease if normal clean-up is taking place.

If the ion pump current increases rapidly or continues to increase without peaking out, the power should be decreased and break-in completed at a lower level before again increasing power.

4. RF Drive Aging:

a. No plate voltage should be applied to the tube during this portion of the break-in procedure.

b. If at any time during the application of RF drive the driver reverse power becomes unstable or untuneable, reduce the RF drive to a level where the reverse power is stable. This instability is due to a release of gas within the tube as a result of the RF drive.

If the driver reverse power is unstable even at very low levels (less than 2 kW), turn the pulse off and let the tube sit with filaments on for at least four hours before trying again.

c. Apply RF drive at about 10 percent of the normal value (15 kW) for about 30 minutes. If the tube has an ion pump attached, make sure the ion pump current remains below 100 microamps. Increase the drive in 10 percent steps approximately every 15 to 30 minutes until full power is reached.

| STEP | POWER | TIME |
|---|---|---|
| 1. | 15 kW | 30 minutes |
| 2. | 35 | 15 |
| 3. | 55 | 15 |
| 4. | 75 | 15 |
| 5. | 95 | 15 |
| 6. | 115 | 15 |
| 7. | 125 | 15 |
| 8. | 145 | 15 |
| 9. | 165 | 15 |
| 10. | 175 | 15 |

<Typical time for Step 4 is about 3 hours and 15 minutes.>

5. Power RF Operation Break-In Procedure:

a. If at any time during this procedure excessive blocking, crowbarring or arcing should occur, one should reduce the anode voltage until the tube operation is once again stable.

b. Raise the anode voltage slowly until about 10 amperes of peak anode current is reached. Operate at this level for about one hour.

c. Increase the anode current in 10 ampere (peak) steps allowing the tube to operate at each level for about 45 to 60 minutes. Continue this until full power output is obtained. One must periodically check to see if the filament current is set properly for the power being generated.

<Typical time for Step 5 is about 20 hours.>

6. Full Power Seasoning:

a. Allow the tube to operate at full power (3.5 to 5.0 megawatts) for at least 48 hours.

b. Make the final log book entry for the operating parameters of the tube at the conclusion of the break-in period. At the least the following should be recorded.

Filament Current
Forward Power
Reverse Power
Anode Voltage (peak)
Anode Current (peak)
Drive Power

<Typical time for Step 6 is about 48 hours.>

7. The Break-in Procedure Approximate Times:

a.

| | |
|---|---|
| Filament Break-In | 30 minutes |
| Gas Test | 15 minutes |
| RF Drive Break-In.... | 3 hours, 15 minutes |
| Power RF Operation Break-In | 20 hours |
| Full Power Operation | 48 hours |
| Total Break-In Time | 72 hours |

F. **PROBLEMS:**

If at any time the tube exhibits a serious problem that makes proceeding difficult or impossible, or it appears the tube will not meet specifications, then BURLE Applications Engineering should be contacted for further advice.

G. **FERMILAB TUBE TESTING PROCEDURES:**

These procedures are those followed by Fermi National Accelerator Laboratory for the testing of a new or rebuilt 7835 vacuum tube. They are acceptable to BURLE, and are appended to the negotiated contract between BURLE and the DOE contracting agencies approving the contract.