RCA-6146B/8298A 

**BEAM POWER TUBE**

**Controlled Zero-Bias**
- Plate Current
- Controlled Power Output at Reduced Heater Voltage

85 Watts CW Output (ICAS) at 60 Mc
50 Watts CW Output (ICAS) at 175 Mc

RCA "Dark Heater" with 5- to 8-volt Range

3-13/16" Max. Length
1-21/32" Max. Diameter
Octal 8-Pin Base
Small, Sturdy Structure

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RCA-6146B/8298A is a small, sturdy, beam power tube having high efficiency and high power sensitivity for use in mobile and stationary equipment. It is rated as an af power amplifier and modulator, a linear rf power amplifier, and a Class C rf power amplifier and oscillator.

The 6146B features a heater designed to operate over a voltage range of 6.0 to 7.5 volts and which will take excursions from 5 to 8 volts in battery operation. The heater design insures dependable performance in mobile equipment under operating conditions during battery charging and discharging. See Special Performance Data on page 4 for information covering heater overvoltage and undervoltage operation.

Controlled zero-bias plate current is offered in the 6146B to insure more dependable performance as a Class AB1 linear rf amplifier for single-sideband suppressed-carrier service. See Test No.3 of Characteristics Range Values.

Also featured in the design of the 6146B is the new RCA "Dark Heater", which functions efficiently at operating temperatures 350° K below those of the heaters in conventional tube types. The dark surface of the new heater radiates heat more efficiently and improves the transfer of heat to the cathode so that optimum cathode temperature may be attained with the heater operating at approximately 1350° K.

The low operating temperature of the "Dark Heater" results in (1) lower internal stresses in the heater wire and smaller thermal change during heater warmup, (2) cooler operation of the heater which minimizes changes in heater shape and reduces the possibility of heater damage and heater shorts, (3) extremely stable heater current characteristics throughout life, and (4) significant reduction in effects of ac heater leakage.

Small in size for its power-output capability, the 6146B has a rugged button-stem construction with short internal leads, a T12 bulb, triple base-pin connections for grid No.3 and cathode (both joined to internal shield inside the tube) to permit effective rf grounding, and an octal base with short metal sleeve having its own base-pin terminal. The sleeve shields the input to the tube and isolates it from the output circuit so completely that no other external shielding is required. Separation of input and output circuits is accomplished by bringing the plate lead out of the bulb to a cap opposite the base.

The 6146B/8298A is unilaterally interchangeable with the 6146, 6146A, and 8298.

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**GENERAL DATA**

**Electrical:**

- **Heater, for Unipotential Cathode:**
  - Voltage (AC or DC): 6.3 volts
  - Current at 6.3 volts: 1.125 amp
  - Minimum heating time: 60 sec

  *See Special Performance Data on page 4 for heater operation in stationary equipment and in mobile equipment.*

- **Transconductance,** for plate voltage = 200, grid- No. 2 volts = 200, and plate ma. = 100: 7000 \( \mu \)hos

- **Mu-Factor,** Grid No. 2 to Grid No. 1 for plate voltage = 200, grid-No.2 volts = 200, and plate ma. = 100: 4.5

- **Direct Interelectrode Capacitances (Approx.):**
  - Grid No. 1 to plate: 0.22 max. pf
  - Grid No. 1 to cathode & grid No. 3 & internal shield, base sleeve, grid No. 2, and heater: 13 pf
  - Plate to cathode & grid No. 3 & internal shield, base sleeve, grid No. 2, and heater: 8.5 pf

**Mechanical:**

- **Operating Position:** Any
- **Maximum Overall Length:** 3-13/16"
- **Seated Length:** 3-1/8" = 1/8"
- **Maximum Diameter:** 1-21/32"
- **Bulb:** T12
- **Cap:** Small (JEDEC No. CL-1)
- **Base:** Small-Wafer Octal 8-Pin with Sleeve (JEDEC Group 1, No. BB-150), or Small-Wafer Octal 8-Pin with External Barriers and Sleeve (JEDEC Group 1, No. BB-159)
- **Bulb Temperature (At hottest point):** 260 max. °C
- **Weight (Approx.):** 2.3 oz

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**AF POWER AMPLIFIER & MODULATOR — Class AB1**

**CCE** | **ICAS**
---|---
**Maximum Ratings, Absolute-Maximum Values:**
- **DC PLATE VOLTAGE:** 600 max. | 750 max. volts
- **DC GRID-No. 2 VOLTAGE:** 250 max. | 250 max. volts
- **MAX.-SIGNAL DC PLATE CURRENT:** 175 max. | 220 max. ma
- **MAX.-SIGNAL PLATE INPUT:** 90 max. | 120 max. watts

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Marca(s) Registrada(s)

6146B/8298A 2-64
Printed in U.S.A.
### AF Power Amplifier & Modulator – Class AB₂

**Maximum Ratings, Absolute-Maximum Values:**

<table>
<thead>
<tr>
<th>CCS</th>
<th>ICAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Plate Voltage..</td>
<td>600 max. 750 max. volts</td>
</tr>
<tr>
<td>DC Grid-No. 2 Voltage</td>
<td>250 max. 250 max. volts</td>
</tr>
<tr>
<td>MAX.- SIGNAL DC PLATE CURRENT b.</td>
<td>175 max. 220 max. ma</td>
</tr>
<tr>
<td>MAX.- SIGNAL PLATE INPUT b.</td>
<td>90 max. 120 max. watts</td>
</tr>
<tr>
<td>MAX.- SIGNAL GRID-No. 2 INPUT b.</td>
<td>3 max. 3 max. watts</td>
</tr>
<tr>
<td>PLATE DISSIPATION b.</td>
<td>27 max. 35 max. watts</td>
</tr>
<tr>
<td>PEAK HEATER-CATHODE VOLTAGE: Heater negative with respect to cathode</td>
<td>135 max. 135 max. volts</td>
</tr>
<tr>
<td>Heater positive with respect to cathode</td>
<td>135 max. 135 max. volts</td>
</tr>
</tbody>
</table>

**Typical CCS Operation:**

<table>
<thead>
<tr>
<th>Values are for 2 tubes</th>
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</thead>
<tbody>
<tr>
<td>DC Plate Voltage..</td>
</tr>
<tr>
<td>DC Grid-No. 2 Voltage</td>
</tr>
<tr>
<td>DC Grid-No. 1 Voltage: From fixed-bias source</td>
</tr>
<tr>
<td>Peak AF Grid-No. 1-to-Grid-No. 1 Voltage</td>
</tr>
<tr>
<td>Zero-Signal DC Plate Current</td>
</tr>
<tr>
<td>Max.-Signal DC Plate Current</td>
</tr>
<tr>
<td>Max.-Signal DC Grid-No. 2 Current</td>
</tr>
</tbody>
</table>

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**Linear RF Power Amplifier, Class AB₁ Single-Sideband Suppressed-Carrier Service**

Peak envelope conditions for a signal having a minimum peak-to-average power ratio of 2

<table>
<thead>
<tr>
<th>CCS</th>
<th>ICAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC PLATE VOLTAGE,..</td>
<td>600 max. 750 max. volts</td>
</tr>
<tr>
<td>DC Grid-No. 2 VOLTAGE,..</td>
<td>250 max. 250 max. volts</td>
</tr>
<tr>
<td>Plate Current</td>
<td>150 max. 220 max. ma</td>
</tr>
<tr>
<td>PLATE DISSIPATION,..</td>
<td>27 max. 35 max. watts</td>
</tr>
<tr>
<td>PEAK HEATER-CATHODE VOLTAGE: Heater negative with respect to cathode</td>
<td>135 max. 135 max. volts</td>
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<td>DC Grid-No. 1 Voltage: From fixed-bias source</td>
</tr>
<tr>
<td>Peak AF Grid-No. 1-to-Grid-No. 1 Voltage</td>
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<tr>
<td>Zero-Signal DC Plate Current</td>
</tr>
<tr>
<td>Max.-Signal DC Plate Current</td>
</tr>
<tr>
<td>Max.-Signal DC Grid-No. 2 Current</td>
</tr>
<tr>
<td>Max.-Signal DC Grid-No. 1 Current</td>
</tr>
<tr>
<td>Effective Load Resistance (Plate to plate)</td>
</tr>
<tr>
<td>Max.-Signal DC Driving Power (Approx.)</td>
</tr>
<tr>
<td>Max.-Signal DC Power Output (Approx.)</td>
</tr>
</tbody>
</table>

**Maximum Circuit Values (CCS or ICAS):**

<table>
<thead>
<tr>
<th>Grid-No. 1-Circuit Resistance under Any Condition: g</th>
</tr>
</thead>
<tbody>
<tr>
<td>With fixed bias</td>
</tr>
<tr>
<td>With cathode bias</td>
</tr>
</tbody>
</table>

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**Notes:**

- a
- b
- c
- d
- e
- f
- g
- h
- i
- j
- k
- l
- m
- n
- o
- p
- q
- r
- s
- t
- u
- v
- w
- x
- y
- z
PLATE-MODULATED RF POWER AMPLIFIER —
Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0; at frequencies up to 60 Mc.

PLATE MODULATION RATING:

| DC Plate Vol. | 480 max. | 600 max. volts |
| DC Grid-No. 3 Voltage | 250 max. | 250 max. volts |
| DC Grid-No. 1 Voltage | -150 max. | -150 max. volts |
| DC Plate Current | 145 max. | 180 max. ma |
| DC Grid-No. 1 Current | 3.5 max. | 4.0 ma |
| PLATE INPUT | 60 max. | 85 max. watts |
| GRID-No. 2 INPUT | 2 max. | 2 max. watts |
| PLATE DISSIPATION | 18 max. | 23 max. watts |
| PEAK HEATER-CATHODE VOLTAGE: |
| Heater negative with respect to cathode. | 135 max. | 135 max. volts |
| Heater positive with respect to cathode. | 135 max. | 135 max. volts |

Typical Operation:

| DC Plate Voltage | 475 | 600 volts |
| DC Grid-No. 2 Voltage | 165 | 175 volts |
| DC Grid-No. 1 Voltage | -86 | -92 volts |
| Peak RF Grid-No. 1 Voltage | 106 | 114 volts |
| DC Plate Current | 125 | 140 ma |
| DC Grid-No. 2 Current | 8.5 | 9.5 ma |
| DC Grid-No. 1 Current | 3.3 | 3.4 ma |
| Driving Power | 0.4 | 0.5 watt |
| Power Output (Approx.) | 42 | 62 watts |

Maximum Circuit Values (CCS or ICAS):

Grid-No. 1 Circuit Resistance | 30,000 max. ohms |

RF POWER AMPLIFIER & OSC. — Class C Telegraphy

RF POWER AMPLIFIER — Class C FM Telephony

Maximum Ratings, Absolute-Maximum Values up to 60 Mc:

| DC Plate Voltage | 600 max. | 750 max. volts |
| DC Grid-No. 2 Voltage | 250 max. | 250 max. volts |
| DC Grid-No. 1 Voltage | -150 max. | -150 max. volts |
| DC Plate Current | 175 max. | 220 max. ma |
| DC Grid-No. 1 Current | 3.5 max. | 4.0 max. ma |

Note: Specifications subject to change without notice.

CHARACTERISTICS RANGE VALUES

1. Direct Inter-electrode Capacitances:
   Grid-No. 1 to plate: 1 0.22 pf
   Grid-No. 1 to cathode & grid No. 2: 1 12.0 15.0 pf
   Plate to cathode & grid No. 3: 1 7.3 9.5 pf
2. Plate Current: 2 46 94 ma
3. Zero-Bias Plate Current: 3 330 ma
4. Grid-No. 2 Current: 2 -5.5 ma

Note 1: With no external shield.
Note 2: With heater voltage of 6.75 volts, dc plate voltage of 400 volts, dc grid-No. 2 voltage of 200 volts, and dc grid-No. 1 voltage of -34 volts.
Note 3: With heater voltage of 6.75 volts, dc plate voltage of 100 volts, dc grid-No. 2 voltage of 200 volts, and dc grid-No. 1 voltage of -100 volts. Grid No. 1 is square-wave pulsed at 1000 kc to zero volts. Limit value is peak-pulse current.
SPECIAL PERFORMANCE DATA ON HEATER OPERATION

Stationary Equipment Operation:
Heater, for Unipotential Cathode:

<table>
<thead>
<tr>
<th></th>
<th>Design Min.</th>
<th>Center</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (AC or DC)</td>
<td>6.3 volts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current at 6.3 volts</td>
<td>1.000 amp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic Grid-No.2 Current</td>
<td>15 ma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Useful Power Output b</td>
<td>59 watts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a It is recommended that the design-center heater voltage be 6.3 volts; the heater power supply should not fluctuate more than 10% to insure long life.

b In a single-tube, self-excited oscillator circuit, and with ac heater voltage of 6.3 volts, dc plate voltage of 600 volts, dc grid-No.2 voltage of 200 volts, grid-No.1 resistor of 24,000 ± 10% ohms, dc plate current of 150 max. ma., dc grid-No.1 current of 2.5 to 3 ma., and frequency of 15 Mc.

Mobile Equipment Operation:
Heater, for Unipotential Cathode:

<table>
<thead>
<tr>
<th></th>
<th>Design Min.</th>
<th>Range Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (AC or DC)</td>
<td>6.0-7.5 volts</td>
<td></td>
</tr>
<tr>
<td>Current at 6.75 volts</td>
<td>1.100 amp</td>
<td>1.220 amp</td>
</tr>
<tr>
<td>Dynamic Grid-No.2 Current</td>
<td>15 ma</td>
<td></td>
</tr>
<tr>
<td>Useful Power Output I b</td>
<td>59 watts</td>
<td></td>
</tr>
<tr>
<td>Useful Power Output II</td>
<td>See Note c</td>
<td></td>
</tr>
</tbody>
</table>

Overvoltage Heater Life Tests:
Continuous heater life tests are performed periodically on sample lots of tubes with 6 volts on the heater, all other electrodes "floating". Intermittent heater life tests are performed periodically on sample lots of tubes with 11 volts on the heater, a cycle of 1 minute "ON" and 4 minutes "OFF". After 1000 hours of the continuous heater life test and after 48 hours of the intermittent heater life test, the following tests are performed:

With heater voltage of 6.75 volts and ± 100 dc volts between cathode and heater, the heater-cathode leakage current will not exceed 100 microamperes.

With ac or dc heater voltage of 6.75 volts, grid-No.1 volts = -200 and cathode, grid-No.2, and plate grounded, the minimum grid-No.1 leakage resistance will be 10 megohms.

With ac or dc heater voltage of 6.75 volts, plate volts = -200, and cathode grid No.1 and grid No.2 grounded, the minimum plate leakage resistance will be 10 megohms.

a It is recommended that the heater voltage operate within the range of 6.0 to 7.5 volts and within excursions from 5 to 8 volts in battery operation. See Useless Power Output Test II and Overvoltage Tests.

b In a single-tube, self-excited oscillator circuit, and with ac heater voltage of 6.9 volts, dc plate voltage of 600 volts, dc grid-No.2 voltage of 200 volts, grid-No.1 resistor of 24,000 ± 10% ohms, dc plate current of 150 max. ma., dc grid-No.1 current of 2.5 to 3 ma., and frequency of 15 Mc.

c With conditions in note b above, reduce heater voltage to 5 volts. Useful power output will be at least 90% of the power output at heater voltage of 6.3 volts.

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With no external shield.

Averaged over any audio-frequency cycle of sine-wave form.

Obtained preferably from a separate source or from the plate voltage supply with a voltage divider.

The driver stage should be capable of supplying the No. 1 grids of the class AB1 stage with the specified driving voltage at low distortion.

The type of input coupling network used should not introduce too much resistance in the grid-No. 1 circuit. Transformer or impedance coupling devices are recommended.

Driver stage should be capable of supplying the specified driving power at low distortion to the No. 1 grids of the AB2 stage.

To minimize distortion, the effective resistance per grid-No. 1 circuit of the AB2 stage should be held at a low value. For this purpose the use of transformer coupling is recommended. In no case, however, should the total dc grid-No. 1 circuit resistance exceed 30,000 ohms when the tube is operated at maximum ratings. For operation at less than maximum ratings, the dc grid-No. 1 circuit resistance may be as high as 100,000 ohms.

Obtained preferably from a separate, well-regulated source.

Referenced to either of the two tones and without the use of feedback to enhance linearity.

Obtained preferably from a separate source modulated with the plate supply, or from the modulated plate supply through a series resistor.

Obtained from grid-No. 1 resistor or from a combination of grid-No. 1 resistor with either fixed supply or cathode resistor.

Obtained preferably from separate source, or from the plate-supply voltage with a voltage divider, or through a series resistor. A series grid-No. 2 resistor should be used only when the tube is used in a circuit which is not keyed. Grid-No. 2 voltage must not exceed 435 volts under key-up conditions.

Obtained from fixed supply, by grid-No. 1 resistor, by cathode resistor, or by combination methods.

When grid No. 1 is driven positive and the tube is operated at maximum ratings, the total dc grid-No. 1 circuit resistance should not exceed the specified value of 30,000 ohms. If this value is insufficient to provide adequate bias, the additional required bias must be supplied by a cathode resistor or fixed supply. For operation at less than maximum ratings, the dc grid-No. 1 circuit resistance may be as high as 100,000 ohms.

**Definitions**

AB1 - The subscript 1 indicates that grid-No. 1 current does not flow during any part of the input cycle.

AB2 - The subscript 2 indicates that grid-No. 1 current flows during some part of the input cycle.

CCS - Continuous Commercial Service.

ICAS - Intermittent Commercial and Amateur Service.

Ratings System - The maximum ratings in the tabulated data are established in accordance with the following definition of the Absolute-Maximum Rating System for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

**Two-Tone Modulation** - Two-Tone Modulation operation refers to that class of amplifier service in which the input consists of two monofrequency rf signals having equal peak amplitude.

**Maximum Ratings vs. Operating Frequency**

In Class C Telegraphy Service

![Fig.1A](925S-12243)

**Maximum Ratings vs. Operating Frequency**

In Class C Telephony Service

![Fig.1B](925S-12244)
GENERAL CONSIDERATIONS

Temperature

The maximum bulb temperature of 260° C is a tube rating and is to be observed in the same manner as other ratings. The temperature may be measured with temperature-sensitive paint, such as Tempilaq. The latter is made by the Tempil Corporation, 132 W. 22nd Street, New York 11, N.Y.

MECHANICAL CONSIDERATIONS

Plate Circuit

Heavy leads and conductors together with suitable insulation should be used in all parts of the rf plate tank circuit so that losses due to rf voltages and currents may be kept at a minimum. At the higher frequencies, it is essential that short, heavy leads be used for circuit connections in order to minimize lead inductance and losses.

Connections to the plate should be made with a flexible lead to prevent any strain on the seal at the cap.

ELECTRICAL CONSIDERATIONS

Plate and Grid No.2

When a new circuit is tried or when adjustments are made, it is advisable to reduce the
plate voltage and grid-No.2 voltage. If the 6146B is operated at maximum ratings and grid-No.2 voltage is obtained through a series dropping resistor, the use of a 2500-ohm protective resistor in the high-voltage supply lead is recommended. When a separate grid-No.2 voltage supply is used, a 10,000-ohm protective resistor should be connected in the grid-No.2 supply lead.

TYPICAL PLATE CHARACTERISTICS

The grid-No.2 current is a very sensitive indication of plate-circuit loading and grid-No.2 current rises excessively (often to the point of damaging the tube) when the amplifier is operated without load. Therefore, care should be taken when tuning a 6146B under no-load conditions in order to prevent exceeding the grid-No.2 input rating of the tube.

TYPICAL CHARACTERISTICS

The plate voltage should be applied before or simultaneously with the grid-No.2 voltage; otherwise, with voltage on grid No.2 only, its current may be large enough to cause excessive grid-No.2 dissipation. A dc milliammeter should be used in the grid-No.2 circuit so that its current may be measured and the dc power input determined.

Driver

The driver stage for the 6146B in either class C telephony or telegraphy service should have considerably more output capability than the typical driving power shown in the tabulated data in order to permit considerable range of adjustment, and also to provide for losses in the grid-No.1 circuit and the coupling circuits.
This recommendation is particularly important near the maximum-rated frequency where there are other losses of driving power, such as circuit losses, radiation losses, and transit-time losses.

**Efficiency**

Highest operating efficiency in high-frequency service, and therefore maximum power output, will be obtained when the 6146B is operated under load conditions such that the maximum rated plate current flows at the plate voltage which will give maximum rated input.

**Class C Telephony**

In plate-modulated class C amplifier service, the 6146B can be modulated 100 per cent. The grid-No.2 voltage must be modulated simultaneously with the plate voltage so that the ratio of grid-No.2 voltage to plate voltage remains constant. Modulation of the grid-No.2 voltage can be accomplished either by connecting grid No.2 through a separate winding on the modulation transformer to the fixed grid-No.2 voltage supply, or by connecting grid No.2 through an audio-frequency choke of suitable impedance for low audio frequencies to the fixed grid-No.2 supply voltage. The supply end of the choke should be well bypassed to ground.

**Circuit Arrangements**

Push-pull or parallel circuit arrangements can be used when more radio-frequency power is required than can be obtained from a single 6146B. Two 6146B's in parallel or push-pull will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage necessary to drive a single tube.

With either connection, the driving power required is approximately twice that for a single tube. The push-pull arrangement has the advantage of simplifying the balancing of high-frequency circuits.

When two or more tubes are used in the circuit, precautions should be taken to insure that each tube draws the same plate current.

**Standby Operation**

During standby periods in intermittent operation, the heater voltage may be maintained at normal operating value for most applications.

In those applications which require maximum reliability, it is recommended that the heater voltage be maintained at normal operating value when the period is less than 15 minutes; that it be reduced to 80 per cent of normal when the period is between 15 minutes and 2 hours; and that for longer periods, the heater voltage should be turned off.

**Protective Devices**

Protective devices should be used to protect not only the plate but also grid No.2 against overload. In order to prevent excessive plate current flow and resultant overheating of the tube, the common ground lead of the plate circuit should be connected in series with the coil of an instantaneous overload relay. This relay should be adjusted to remove the dc plate and grid-No.2 voltage when the average value of plate current reaches a value slightly higher than normal plate current. A protective device in the grid-No.2 supply should remove the grid-No.2 voltage when the dc grid-No.2 current reaches a value slightly higher than normal.

**Precautions**

The rated plate and grid-No.2 voltages of this tube are extremely dangerous. Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel cannot possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies when any gate or door on the protective housing is opened, and should prevent the closing of the primary circuit until the door is again locked.