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AN ELECTRON-BOMBARDMENT-HEATED SODIUM EXPERIMENT

by

Robert E. Holtz

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Robert E. Holtz

Reactor Engineering Division

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September 1967

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NOMENCLATURE

<u>Symbol</u>	<u>Definition</u>	<u>Units</u>
A	Constant in Richardson's Equation	Amps/cm ² -°K ²
A _c	Cross-sectional area of cathode	cm ²
b	Constant in Richardson's Equation	°K
d _c	Cathode diameter	cm
d _a	Anode diameter	cm
e	Napierian base	-
I	Electron-emission current	Amps/cm ²
I ₁	Electron-emission current at d _c /d _a = 1	Amps/cm ²
i	Cathode-heating current	Amps
i _e	Emission current	Amps
P _{EBH}	Total EBH power	Watts
P _H	Cathode-heating power	Watts
T _a	Temperature of anode	°K
T _c	Temperature of cathode	°K
V _a	Accelerating voltage	Volts
<u>Greek Letters</u>		
ε _a	Emissivity of anode	-
ε _c	Emissivity of cathode	-
σ	Stefan Boltzmann constant	Watts/cm ² °K ⁴
ρ	Electrical resistivity of cathode	Ohm-cm

AN ELECTRON-BOMBARDMENT-HEATED SODIUM EXPERIMENT

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ABSTRACT

This report presents experimental electron-bombardment-heating (EBH) data pertinent to the construction of a high-heat-flux, transient electron-bombardment heater. Testing with both pure tungsten and uncarburized-thoriated-tungsten, 0.030-in.-diam cathodes supplied heat fluxes of up to 371,000 Btu/hr-ft² to the inside surface of a 3/4-in.-diam, Schedule 160 pipe (anode). Plots are presented showing the effects of geometry, accelerating voltage, cathode temperature, diode vacuum, and cathode material upon the electron-emission current. Curves showing the EBH behavior during transient testing are also shown.

I. INTRODUCTION

Much effort is presently being expended to study the boiling-heat transfer and fluid-flow characteristics of liquid metals, especially the alkali metals and mercury. This effort is due to the large potential that the liquid metals have for use in various power-producing reactor applications and to the safety considerations associated with these liquid-metal-cooled, fast breeder reactors. Despite the efforts expended, the coolant-dynamics behavior in liquid-metal-cooled reactors is not sufficiently predictable.

The ultimate goal of the fast-reactor safety program is to develop the techniques of predicting reactor system dynamics during various reactor accidents. A general analytical treatment of a fast-reactor accident involves the coupling of hydrodynamics, heat transfer, structural mechanics, and neutronics equations. Coolant dynamics during various reactor accidents is pertinent input to a reactor safety analysis. Some of the effects that must be explored in order to glean the necessary reactor safety analysis input are:

1. Coolant expulsion mechanism.
2. Degree of liquid superheat.
3. Two-phase critical-flow phenomena.
4. Parallel-channel flow stability.
5. Structural-hydrodynamics interactions.

Associated with obtaining the pertinent experimental heat-transfer and fluid-flow information are the design and construction of a heater capable of supplying high, relatively uniform heat fluxes to flowing liquid metals. Temperatures up to 2100°F and heat fluxes beyond 10^6 Btu/hr-ft² (possibly up to 10^7 Btu/hr-ft²) must be anticipated. Both steady-state and transient tests must be conducted to obtain the necessary information pertinent to both general reactor technology and reactor safety considerations. Also, the tests that initially use one heater, such as studying fluid expulsion from a tube or annulus, must eventually be expanded to include the basic effects of clustering on coolant dynamics.

Techniques for supplying the high, relatively uniform heat fluxes required have been examined,^{1,2} and it has been theoretically shown that electron-bombardment heating is capable of supplying high, uniform heat fluxes to high-temperature liquid metals during both steady-state and transient testing. To augment this theoretical investigation of electron-bombardment heating, to gain experience with electron-bombardment heating, and to investigate mechanical and geometric factors involved in the construction of a high-heat-flux heater, an electron-bombardment-heating experiment was designed and built. Although the information obtained from this experiment was used primarily in the design of a high-temperature, high-heat-flux electron-bombardment heater, basic information pertaining to the more general behavior of electron-bombardment heaters was also gleaned.

II. ELECTRON-BOMBARDMENT-HEATING BACKGROUND

Electron-bombardment heating (EBH) may be used for heating various experiments being employed either to study the heat-transfer and fluid-flow phenomena of the liquid metals or to conduct various out-of-pile tests that simulate reactor coolant dynamics. Taylor and Steinhaus³ have shown, during EBH tests with water, that EBH is a satisfactory heating technique for both initially static and flowing systems. Petukhov, Kovalev, and Zhukov⁴ have used EBH in experiments studying boiling sodium.

Electron-bombardment heating may be used in a system studying annular flow, flow through a tube, or flow through clusters. The basic system for coolant-dynamics testing in annular flow consists of two concentric tubes with heat applied to the inside surface of the inner tube while the liquid metal flows in the annulus between the tubes. Figure 1 shows the electron-bombardment-heating arrangement of an annular-flow system. The heating is accomplished by placing an electron emitter (cathode) inside the evacuated inner tube, heating the cathode, and drawing the electrons to the inner tube (anode) with an accelerating voltage. The generated heat then flows through the tube wall to the liquid metal inside the annulus.

112-5618

Fig. 1. Electron-bombardment Heating Applied to Annular Flow

surrounded by radiation shields which are at the same potential as the cathode. Figure 2 is a cross section of this system.

When EBH is used to study coolant flow through clusters, a group of heaters similar to those for studying flow through an annular section may be employed. These heaters may be positioned to obtain the desired geometrical configurations.

The three most commonly used electron emitters are pure tungsten, thoriated tungsten, and oxide-coated cathodes. Because of the high liquid-metal temperatures involved in the pertinent liquid-metal experiments, pure tungsten and/or thoriated-tungsten emitters must be employed. Figure 3 shows the emission characteristics of both pure tungsten and carburized-thoriated tungsten as predicted by Richardson's Equation.¹ The electron emission per unit area increases with increasing temperature; thus a larger cathode area will require a lower cathode temperature for a given heat flux at constant potential difference between cathode and anode. Additional information concerning the application of EBH for boiling-liquid-metal experiments is contained in Ref. 1.

Initially, a small-scale EBH model was constructed at Argonne to verify the uniform heat fluxes expected. This model consisted of a 0.020-in.-diam, uncarburized-thoriated-tungsten cathode, surrounded by a 0.5-in.-OD, Type 316 stainless steel tubular anode of a 0.035-in. wall thickness. The heated length was 4 in. Chromel-Alumel thermocouples were attached to the outside tube wall 0.5 in. from each end of the heated length and in the center of the anode on the outside surface. All the thermocouples gave identical readings at given heat fluxes. Heat

The arrangement for using EBH to supply heat to a liquid metal flowing inside a circular tube consists of the electron-emitting surface (cathode) surrounding the flow tube (anode). The cathode may consist of many vertically positioned wires, equally spaced around the flow tube. The electrons are drawn from the emitter to the outside tube wall, and the heat generated at the outside tube wall is conducted through the tube to the liquid metal. This EBH arrangement must be

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Fig. 2. Electron-bombardment Heating Applied to Flow Through a Tube

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Fig. 3. Electron Emission of Pure Tungsten and Carburized-Thoriated Tungsten

fluxes up to approximately 8000 Btu/hr-ft² at the outside anode surface were obtained. Limitations of the available power supply caused termination of testing at these power levels.

Testing beyond the 8000-Btu/hr-ft² heat-flux level was required to gain information pertinent to the construction of a high-heat-flux electron-bombardment heater with transient capabilities; hence, the electron-bombardment heated sodium experiment was designed and built.

III. EXPERIMENTAL APPARATUS

The EBH experimental apparatus is shown schematically in Fig. 4. The cathode was placed inside the vertically positioned tube (anode), with the liquid sodium surrounding the tube. Heating of the cathode produced a flow of electrons (from the cathode) that were drawn to the anode by means of an accelerating voltage. The heat generated at the inside tube surface flowed through the tube wall to the sodium. Heat was removed from the sodium by means of cooling coils positioned above the liquid-sodium level. The apparatus was instrumented so that the heat flux, anode wall temperature, sodium temperature, and system pressure could be obtained. The apparatus is described in detail in the following paragraphs.

A. Electron-bombardment Heater

The electron-bombardment heater section consisted of a 16-in.-long heated filament (cathode)

112-4909

Fig. 4. Schematic Diagram of EBH Experiment

112-6608

Fig. 5. EBH Boiler

centered inside a 3/4-in.-diam, Schedule 160 pipe (anode). The anode was surrounded by liquid sodium, which was contained between the anode and an 8-in.-diam, Schedule 40 pipe. The entire EBH boiler section, other than the cathode and the cathode support pieces, was constructed from Type 304 stainless steel. Figure 5 is a photograph of the EBH boiler surrounded by insulation.

Filaments of 0.020 in. and 0.030 in. in diameter of both pure tungsten and uncarburized-thoriated tungsten were used in the heater. Alumina (Al_2O_3) insulators were used for electrical and thermal insulation between the high-temperature, high (negative)-potential cathode and the lower-temperature, grounded

anode. These alumina insulators also positioned the cathode. Tantalum connectors supported the emitter. The lower tantalum connector was free to move vertically inside the alumina insulation to take up the difference in thermal expansion between the cathode and anode. Tension was applied to the filaments to keep them from buckling. This was accomplished by means of a weight and a flexible lead positioned at the bottom of the heated section.

A cooling coil was located above the sodium level in the test vessel. This coil, used for condensing the sodium vapors, removed 10 kW from the system when the sodium vapor was at 1500°F. The facility to pass either an inert gas or air through the cooling coil was available. The coil was constructed of 0.5-in.-OD, 0.035-in.-wall, Type 304 stainless steel tubing.

B. Electrical Components

The major electrical components, other than the previously described EBH section, employed in this experiment consisted of a

high-voltage power supply for supplying power to the heater and filament transformers for heating the cathode. Figure 4 shows a simplified electrical diagram of the major components of the system. Other electrical components used in the experiment were several high-voltage feedthroughs, heating wire, etc. Figure 6 is a photograph of the high-voltage power supply, Ther Rectifier Model No. T200-4 Si 200VNQR. This power supply had been built to the following specifications:

1. AC input: Main and control 460 V, 3-phase, 60-cycle.
2. DC output: Variable from 500 to 20,000 V dc, 10 Amp, 200 kW.
3. Rectifying agent: Silicon diodes.
4. Control: By saturable reactors.
5. Voltage regulation: $\pm 1\%$ at any voltage setting.
6. Protection for:
 - a. Insufficient cooling
 - b. Overtemperature
 - c. AC overcurrent
 - d. DC overcurrent.

112-3771

Fig. 6. Overall View of Original High-voltage Power Supply

Since experimental testing was conducted at power levels below 20 kW, the power supply was modified to enable finer voltage control at these power levels by replacing the saturable reactors by two banks of

112-6614

Fig. 7. Overall View of Modified High-voltage Power Supply

powerstats. Figure 7 is an overall view of the modified high-voltage power supply. This arrangement limited the maximum available voltage to 7700 V and the maximum available power to 23.7 kW.

Figure 8 shows the filament transformers used to supply power for direct heating of the cathode (see Fig. 4 for electrical diagram). Power was supplied to the filament transformers by a powerstat.

Figure 9 is an overall view of the EBH section, the high-voltage power supply, the filament transformers, the vacuum system, the system piping, and the wiring.

The test vessel was wrapped with clamshell heaters and heating wire. This enabled the outgassing of the evacuated EBH region at suf-

112-6615

Fig. 8. Filament Transformers

112-6609

Fig. 9. Overall View of EBH Experiment

C. Vacuum and Gas Systems

Vacuum and gas systems controlled both the environment in the EBH unit and the pressure in the sodium pool.

The vacuum system used to evacuate the electron-bombardment heater consisted of the Veeco VP-9 high-vacuum pumping system, shown in Fig. 10, and a Welch Duo Seal vacuum pump (Model 1402). These units were mounted in the framework shown in Fig. 11. The high-vacuum piping from the vacuum system to the EBH experiment is shown in Fig. 9. The vacuum system was capable of pumping the EBH unit to a vacuum in the 10^{-5} - to 10^{-6} -Torr range.

112-6613

Fig. 10. Vacuum-pumping Station

The high-vacuum pumping system employed for removing gas from the sodium pool was the roughing pump and piping shown in Fig. 5. This pump was capable of pumping the sodium-system pressure to a vacuum of approximately 10^{-2} Torr.

A gas system was also available for supplying purified argon gas to either the EBH system or the sodium system. The argon gas was purified by using a magnesium-perchlorate moisture trap, a NaK bubbler

for removing oxygen, and a vapor trap for removing any NaK vapors that might be carried out of the NaK bubbler. This argon-gas supply system was used primarily for controlling the pressure in the sodium.

D. Instrumentation

The instrumentation for the experiment consisted primarily of Chromel-Alumel thermocouples, thermocouple readout equipment, instruments for controlling and measuring power to and from the high-voltage power supply and the filament transformers, and vacuum and pressure

control-and-readout equipment. Much of this instrumentation is shown in Fig. 11. These instruments will be discussed individually in the rest of this section.

112-6612

Fig. 11. EBH Experiment Control Panel

Chromel-Alumel thermocouples were used for measuring temperatures throughout the system. Figure 12 shows the locations of these thermocouples. Four sheathed, Chromel-Alumel thermocouples were located in the anode wall to measure the wall temperature. These thermocouple assemblies consisted of 0.012-in.-diam wires, sheathed in a 0.060-in.-OD Inconel sheath and insulated from the sheath. The remaining Chromel-Alumel thermocouples were constructed from 18-gauge wire.

The readout equipment for these thermocouples consisted of two two-pen recorders and a 24-point strip-chart recorder. The outputs of the four thermocouples in the anode wall were read out on the two two-pen recorders, and the other thermocouple outputs were read out on the multi-point strip-chart recorder.

The high-voltage power supply control panel and an additional voltmeter and ammeter are shown in Fig. 11. The additional voltmeter and ammeter served as a check on the voltmeter and ammeter in the high-voltage power supply control panel.

THERMOCOUPLE NO. LOCATION	TEMPERATURE MEASUREMENT
(1-4)	ANNULUS WALL
(5-9)	SODIUM
(10,11)	SODIUM VAPOR
(12,13)	TOP FLANGE
(14,15)	BOTTOM FLANGE

Fig. 12. EBH Experiment Thermocouple Locations

pure-tungsten and uncarburized-thoriated-tungsten filaments were also achieved. Heat fluxes up to 371,000 Btu/hr-ft² were supplied to the anode during both steady-state and transient testing with both the pure-tungsten and the uncarburized-thoriated-tungsten filaments. Peak sodium temperatures beyond 1600°F were obtained. The maximum power supplied to the sodium was 23.7 kW, which corresponds to a heat flux of 371,000 Btu/hr-ft² at the inside anode surface. This includes an emission current range to 5.2 Amp and a cathode-to-anode voltage of 7700 V.

The cooling coil for removing heat from the system was designed to remove a maximum of 10 kW with a 1500°F sodium temperature. Hence,

Variacs controlled the cathode heating power. These variacs and the instrumentation used to measure the power into the variacs are also shown in Fig. 11. The meters used to measure the power for heating the cathode are shown in Fig. 9.

The vacuum- and pressure-measuring instruments are shown in Fig. 5. Pressure gauges measured the sodium system pressure and the rough pressure in the electron-bombardment heater. An ionization gauge tube for obtaining the vacuum in the electron-bombardment heater is also shown in Fig. 5, and the readout equipment for the electron-bombardment heater is shown in Fig. 11.

IV. ELECTRON-BOMBARDMENT-HEATING EXPERIMENT

A. Operation and Performance

The EBH experiment was operated from April 1, 1965, to November 18, 1966. During this period, steady-state and transient testing was conducted for 900 hr. Approximately 500 hr of testing with a 0.030-in.-diam uncarburized-thoriated-tungsten filament and 400 hr of testing with a 0.030-in.-diam pure-tungsten filament were accomplished. Additional hours of operation with both 0.020-in.-diam

the system was operated well above the design condition. A short, high-powered energy burst was planned for the final test; however, a sodium leak at the outside wall of the vessel at a thermocouple well caused an early shutdown of the experiment.

During the first year of operation, the system was plagued with operational difficulties. Some of the difficulties were:

1. Sputtering of silvered joints.
2. Breakdown of a relay in the power supply.
3. Breakdown of alumina insulators.
4. Leak in the vacuum system.
5. Difficulties involving cathode support.
6. Melting of flexible leads.
7. Mismatch between EBH circuit and high-voltage power supply.
8. High-voltage arcing in power supply.

After the above difficulties were resolved, the EBH experiment was operated for approximately 8 months without further difficulties.

More elaborate descriptions of these difficulties and the techniques used to resolve them are contained in Refs. 5-26.

B. Experimental Results

Data from the operation of the uncarburized-thoriated-tungsten and pure-tungsten cathodes are in Appendix A and B, respectively. Both 0.020- and 0.030-in. diameters of both type cathodes were used during the experiment; however, the data presented are for the 0.030-in.-diam cathodes. Larger emission currents were obtained with the 0.030-in.-diam cathodes than with the 0.020-in.-diam cathodes because of a better match between the filament transformers and the 0.030-in.-diam cathodes. Figure 13 shows the effects of geometry when the cathode and anode are coaxial cylinders.²⁷ The variation of emission current with diameter ratio is less than 15%.

Fig. 13. Effect of Geometry upon Emission Current

Fig. 14. Emission Current vs Accelerating Voltage for Uncarburized-Thoriated Tungsten

Although cathode-heating power is the primary method of controlling cathode temperature, the anode temperature also influences the cathode temperature. The relationship between the heat generated in the cathode and the heat radiated from the cathode may be approximated by

$$\frac{i^2 \rho}{A_c} = \frac{\pi d_c \sigma (T_c^4 - T_a^4)}{\frac{1}{\epsilon_c} + \frac{d_c}{d_a} \left(\frac{1}{\epsilon_a} - 1 \right)} \quad (1)$$

Hence, a lower anode temperature will require a larger heat-generation rate in the cathode to maintain a constant cathode temperature. Reference 1 contains a more detailed treatment of this effect.

Figure 15 shows typical plots of emission current versus accelerating voltage for a pure-tungsten cathode with constant cathode-heating currents and constant diode vacuum. The shape of these plots is similar to the shape of the plots for uncarburized-thoriated-tungsten; however, for the same diode vacuum and cathode-heating current, the emission currents for uncarburized-thoriated tungsten are higher than the emission currents for pure tungsten.

Fig. 15. Emission Current vs Accelerating Voltage for Pure Tungsten

Figure 16 shows the measured electron-emission current of

both pure tungsten and uncarburized-thoriated tungsten plotted against the cathode-heating current. Both curves are for a diode vacuum of 1.5×10^{-5} Torr.

Fig. 16. Measured Electron Emission of Pure Tungsten and Uncarburized-Thoriated Tungsten

experimentally measured emission from pure tungsten was higher than the published electron emission for pure tungsten, and the experimentally measured electron emission from uncarburized-thoriated tungsten was lower than the published electron-emission values for carburized-thoriated tungsten. Published and experimentally measured values for the constants, A and b , in Richardson's Equation are shown in Table I.

The electron-bombardment-heater was operated in a vacuum of 8×10^{-5} to 1×10^{-5} Torr. Figures 18 and 19 show the effect of the vacuum upon the electron-emission current for both uncarburized-thoriated tungsten and pure tungsten, respectively. These plots show that an increased amount of gas in the heater increases the electron emission for both uncarburized-thoriated-tungsten and pure-tungsten cathodes.

The transient-test results of the EBH experiment were very predictable

from uncarburized-thoriated tungsten is higher than the electron emission from pure tungsten at any given cathode-heating power (cathode temperature) and diode vacuum.

Figure 17 shows published emission characteristics of pure tungsten and carburized-thoriated tungsten²⁸ and the experimentally observed emission characteristics of pure tungsten and uncarburized-thoriated tungsten. The emission characteristics are correlated by Richardson's Equation,

$$I = AT_c^2 e^{b/T_c}, \quad (2)$$

for the electron emission in the emission-limited region. The experi-

Fig. 17. Emission Characteristics of Pure Tungsten and Thoriated Tungsten.

and reproducible. Figures 20 and 21 show typical plots of the EBH power versus the potential difference between cathode and anode (accelerating voltage) for transient testing with uncarburized-thoriated-tungsten and pure-tungsten cathodes, respectively. The plots are at constant diode vacuum and constant cathode-heating power. The straight lines on these plots are an indication of the reliability of obtaining a preset power level with electron-bombardment heaters.

TABLE I. Published and Experimentally Measured Values of A and b in Richardson's Equation

Element	A	b
Pure tungsten (published)	60.2	52,400
Pure tungsten (experimental)	74.4	45,810
Carburized-thoriated tungsten (published)	3.0	30,500
Uncarburized-thoriated tungsten (experimental)	11.9	39,902

Fig. 18. Effect of Vacuum upon Emission Current for Uncarburized-Thoriated Tungsten

Fig. 19. Effect of Vacuum upon Emission Current for Pure Tungsten

Fig. 20. Transient EBH Powers vs Accelerating Voltage for Uncarburized-Thoriated Tungsten

Fig. 21. Transient EBH Power vs Accelerating Voltage for Pure Tungsten

Fig. 22. Transient-test Emission Current vs Accelerating Voltage for Uncarburized-Thoriated Tungsten

Figures 22 and 23 show typical plots of emission current versus accelerating voltage during transient testing with uncarburized-thoriated-tungsten and pure-tungsten emitters, respectively. These plots are for constant diode vacuum and constant diode-heating power. Very stable and predictable emission currents are obtainable during transient heating with both uncarburized-thoriated-tungsten and pure-tungsten cathodes.

Fig. 23. Transient-test Emission Current vs Accelerating Voltage for Pure Tungsten

Figure 24 shows plots of electron-emission current versus accelerating voltage for uncarburized-thoriated-tungsten cathodes that were heated well above their normal operating temperature before the cathode temperature was lowered and the accelerating voltage was applied. These plots are at constant cathode-heating current and constant diode vacuum. Before an accelerating voltage was applied, the cathodes were heated to approximately 2800°K; the temperature was then reduced to the normal operating temperature. This excessive heating resulted in an excess of thorium electrons at the cathode surface. Upon application of the accelerating voltage, the electron-emission current was above the normal emission current until the excess of electrons at the cathode surface was drawn to the anode. Figure 24 does not indicate the length of time that these higher emission currents were

Fig. 24. Emission Current vs Accelerating Voltage for Uncarburized-Thoriated Tungsten

sustained. Usually these excessive emission currents were available for approximately 15 min. This behavior was not observed in the operation with the pure-tungsten cathodes.

V. DISCUSSION OF RESULTS

The objectives of this experiment were to augment the theoretical investigation of electron-bombardment heating, to gain experience with electron-bombardment heating, and to investigate mechanical and geometric factors involved in the construction of a high-heat-flux heater. The experimental results have augmented the theoretical behavior of electron-bombardment heaters, confirmed the expected EBH operation for both steady-state and transient tests, and yielded pertinent information concerning the design of a high-heat-flux electron-bombardment heater.

Some of the difficulties that were resolved before the successful operation of this experiment point out difficulties that may be expected in the construction and operation of a high-heat-flux electron-bombardment heater. Knowledge of what difficulties to expect and methods of resolving these difficulties will aid in the construction of a working, high-heat-flux electron-bombardment heater.

The EBH tests were conducted in both the space-charge-limited and emission-limited regions. Most of the testing was conducted in the emission-limited region, where the emission current is relatively unaffected by the potential difference between cathode and anode. Figure 13 indicates that, in the emission-limited region, the geometry has only a small effect upon emission current. Hence, the two variables of prime importance in the operation of an electron-bombardment heater in the emission-limited region are the cathode temperature and the diode vacuum.

The primary control of the emission current is obtained by regulating the cathode temperature. In this experiment, the cathode was heated directly, and the cathode-heating current was always much larger than the emission current. The ability to control the cathode temperature by directly heating the cathode is demonstrated in Figs. 14 and 15 for both uncarbided-thoriated-tungsten and pure-tungsten emitters. End effects for directly heated cathodes have been calculated in Ref. 1.

Operation in the emission-limited region is especially advantageous for EBH transient tests. A desired emission current can be obtained by heating the cathode at a preset power. The accelerating potential can also be preset and can then be instantaneously applied by pressing the power supply START button. Thus, the emission current and the accelerating potential can be independently controlled to obtain an accurate preset power level.

Although cathode-heating power is the primary method of controlling the emission current, the diode vacuum also influences the emission current. Figures 18 and 19 show the effect of diode vacuum upon the emission current for both uncarburized-thoriated-tungsten and pure-tungsten cathodes operating in the emission-limited region. In this experiment, a vacuum higher than 8×10^5 Torr was required to obtain constant-power, steady-state EBH operation.

APPENDIX A

Tabulation of EBH Data for 0.030-in.-diam
Uncarburized-thoriated-tungsten Cathodes

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EC -1	0	0	0	0	1.0	-	0	0
-2	0	0	0	56.0	1.15	-	0	0
-3	0	0	0	84.4	1.2	-	0	0
-4	0	0	0	123.9	1.3	-	0	0
-5	0	0	0	159.6	1.6	-	0	0
-6	0	0	0	203.8	1.9	-	0	0
-7	0	0	0	255.4	2.1	-	0	0
-8	0	0	0	255.4	1.8	-	0	0
-9	43	0.02	0.001	255.4	6.3	230	0	14
-10	144	0.07	0.010	255.4	3.2	-	0.2	160
-11	144	0.03	0.004	255.4	1.5	-	0.1	61
-12	432	0.03	0.012	255.4	1.5	230	0.3	193
-13	972	0.02	0.019	255.4	1.5	-	0.5	306
-14	1800	0.02	0.036	255.4	1.5	-	0.9	580
-15	2335	0.02	0.046	255.4	1.5	232	1.1	740
-16	2710	0.02	0.054	255.4	1.45	-	1.3	867
-17	3125	0.02	0.062	255.4	1.4	-	1.5	999
-18	3100	0.07	0.217	325.5	1.6	235	5.1	3,491
-19	3100	0.07	0.217	325.5	1.3	-	5.1	3,491
-20	3050	0.22	0.671	399.3	1.6	-	15.7	10,790
-21	3050	0.20	0.610	399.3	1.4	259	14.3	9,810
-22	3000	0.37	1.110	446.0	1.6	-	26.0	17,848
-23	2950	0.53	1.563	477.3	1.7	-	36.6	25,138
-24	2980	0.52	1.549	477.3	1.5	302	36.3	24,911
-25	2925	0.77	2.252	508.8	1.7	-	52.2	36,215
-26	2925	0.74	2.164	508.8	1.6	-	49.6	34,801
-27	0	0	0	508.8	1.35	331	0	0
-28	0	0	0	508.8	1.3	-	0	0
-29	259	0.53	0.137	508.8	1.5	-	3.1	2,205
-30	259	0.60	0.155	508.8	1.1	327	3.5	2,493
-31	878	0.62	0.544	508.8	1.3	-	12.3	8,750
-32	1640	0.63	1.033	508.8	1.4	-	23.4	16,614
-33	2160	0.63	1.360	508.8	1.4	343	30.9	21,872
-34	2560	0.64	1.638	508.8	1.4	-	36.8	26,337
-35	2925	0.65	1.901	508.8	1.4	-	42.7	30,570
-36	2950	0.66	1.947	508.8	1.25	408	43.3	31,310
-37	2880	0.92	2.649	546.0	1.35	-	58.3	42,600
-38	2880	0.92	2.649	546.0	1.4	-	57.7	42,600
-39	2850	1.12	3.192	580.9	1.4	471	69.6	51,330
-40	2850	1.11	3.163	580.9	1.45	-	67.6	50,864
-41	2800	1.30	3.640	602.7	1.5	-	77.8	58,535
-42	2820	1.30	3.666	602.7	1.5	599	76.1	58,954
-43	2765	1.52	4.202	627.8	1.55	-	87.3	67,572
-44	2765	1.48	4.092	627.8	1.55	-	82.6	65,805
-45	2735	1.68	4.594	643.8	1.6	716	92.8	73,877
-46	2735	1.68	4.594	643.8	1.6	-	91.1	73,877
-47	2680	1.92	5.145	660.0	1.7	-	101.1	82,739
-48	2710	1.83	4.959	660.0	1.9	864	95.8	79,747
-49	2720	1.75	4.760	660.0	2.1	-	88.7	76,548
-50	2735	1.70	4.649	660.0	2.35	-	85.3	74,762
-51	2650	2.07	5.485	679.4	2.55	1044	99.8	88,205
-52	2590	2.40	6.216	696.0	2.9	-	113.1	99,961
-53	2590	2.39	6.190	696.0	3.3	-	111.7	99,542

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10^{-5} Torr	Max Sodium Temp, °F	Wall Temp, Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EC -54	2590	2.40	6.216	696.0	3.7	1157	111.2	99,961
-55	0	0	0	696.0	2.9	-	0	0
-56	0	0	0	696.0	2.0	-	0	0
-57	103	0.70	0.072	696.0	1.9	819	1.4	1,159
-58	331	1.93	0.638	696.0	1.8	-	12.3	10,258
-59	605	1.95	1.179	696.0	1.8	-	22.8	18,960
-60	832	2.00	1.664	696.0	1.85	822	32.1	26,758
-61	1210	2.03	2.456	696.0	1.9	-	47.4	39,494
-62	1585	2.03	3.217	696.0	1.95	-	62.1	51,736
-63	1900	2.04	3.876	696.0	2.0	846	74.8	63,333
-64	2270	2.10	4.767	696.0	2.1	-	91.3	76,661
-65	2650	2.11	5.591	696.0	2.2	-	107.0	89,911
-66	2880	2.13	6.134	696.0	2.2	900	116.4	98,642
-67	2865	2.18	6.245	696.0	2.3	-	117.5	100,428
-68	2865	2.20	6.303	696.0	2.45	-	116.6	101,361
-69	2865	2.18	6.245	696.0	2.75	1083	113.6	100,428
-70	2865	2.20	6.303	696.0	3.5	-	112.8	101,361
-71	2850	2.23	6.355	685.4	3.9	-	112.8	102,199
-72	2850	2.28	6.498	685.4	4.3	1193	114.4	104,499
-73	2840	2.32	6.588	685.4	5.1	-	116.0	105,945
-74	0	0	0	685.4	3.2	-	0	0
-75	0	0	0	685.4	2.9	-	0	0
-76	720	1.73	1.245	685.4	2.5	1062	22.5	20,020
-77	1500	1.80	2.700	685.4	2.7	-	48.7	43,419
-78	1915	1.87	3.581	685.4	2.8	-	64.6	57,588
-79	2305	1.93	4.448	685.4	2.9	1078	80.3	72,530
-80	2640	1.97	5.200	685.4	3.0	-	93.1	83,625
-81	2910	2.00	5.820	685.4	3.1	-	104.2	93,595
-82	2890	2.12	6.126	685.4	3.3	1125	109.6	98,515
-83	2870	2.16	6.199	685.4	3.8	-	110.1	99,688
-84	2860	2.21	6.320	685.4	4.4	-	111.3	101,634
-85	2850	2.26	6.441	685.4	4.9	1218	113.4	103,580
-86	2850	2.30	6.555	685.4	5.4	-	114.5	105,413
-87	0	0	0	685.4	3.5	-	0	0
-88	0	0	0	685.4	3.1	-	0	0
-89	0	0	0	685.4	3.15	-	0	0
-90	130	1.27	0.165	685.4	2.6	1069	3.0	2,653
-91	0	0	0	685.4	3.15	-	0	0
-92	0	0	0	0	4.0	-	0	0
-93	0	0	0	0	3.2	-	0	0
-94	230	0	0	0	2.75	-	0	0
-95	201	0.07	0.014	462.6	2.85	1040	0.3	226
-96	965	0.08	0.077	462.6	2.85	-	1.4	1,239
-97	1760	0.09	0.158	462.6	2.9	-	2.9	2,540
-98	2710	0.10	0.271	462.6	3.1	1013	5.0	4,358
-99	3080	0.10	0.308	462.6	2.9	-	5.7	4,952
-100	2925	0.79	2.310	617.7	2.85	-	42.4	37,148
-101	2765	1.59	4.396	671.2	2.85	1020	80.6	70,696
-102	2665	2.00	5.330	685.4	2.9	-	97.0	85,713
-103	2880	2.03	5.846	685.4	2.9	-	106.4	94,010
-104	2870	2.09	5.998	685.4	2.95	1080	108.2	96,456
-105	2860	2.20	6.292	685.4	3.15	-	112.6	101,186
-106	2850	2.28	6.498	685.4	3.0	-	115.4	104,499
-107	2810	2.40	6.744	685.4	4.0	1191	118.8	108,452
-108	2800	2.43	6.804	685.4	4.5	-	119.8	109,418
-109	2770	2.55	7.063	685.4	5.4	1234	123.4	113,583
-110	0	0	0	685.4	3.3	-	0	0
-111	0	0	0	685.4	3.1	-	0	0
-112	0	0	0	685.4	3.1	-	0	0
-113	0	0	0	685.4	3.05	-	0	0

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10^{-5} Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EC-114	750	1.80	1.350	685.4	2.7	1027	24.8	21,712
-115	1480	1.85	2.738	685.4	2.8	-	49.8	44,032
-116	1930	1.89	3.647	685.4	2.9	-	66.3	58,698
-117	2305	1.91	4.402	685.4	2.95	1047	80.1	70,790
-118	2680	1.92	5.145	685.4	3.0	-	93.6	82,739
-119	2880	2.06	5.932	685.4	3.1	-	107.0	95,395
-120	2860	2.21	6.320	685.4	3.2	1117	113.1	101,634
-121	2850	2.28	6.498	685.4	3.35	-	116.3	104,499
-122	2820	2.33	6.570	685.4	3.7	-	116.6	105,658
-123	2790	2.42	6.751	685.4	4.2	1175	118.9	108,565
-124	2700	2.47	6.866	685.4	4.8	-	120.9	110,417
-125	2765	2.50	6.912	685.4	5.5	-	120.8	111,156
-126	0	0	0	685.4	3.5	1243	0	0
-127	0	0	0	685.4	2.9	-	0	0
-128	735	1.83	1.345	685.4	2.6	-	25.1	21,627
-129	1470	1.89	2.778	685.4	2.8	934	51.8	44,673
-130	1945	1.91	3.714	685.4	2.9	-	69.3	59,727
-131	2665	1.94	5.170	685.4	3.0	-	95.6	83,140
-132	2910	1.97	5.790	685.4	3.05	977	107.1	93,110
-133	2880	2.10	6.048	685.4	3.0	-	111.0	97,261
-134	2860	2.15	6.149	685.4	3.1	-	111.0	98,887
-135	2835	2.25	6.378	685.4	3.4	1152	114.1	102,567
-136	2810	2.32	6.519	685.4	3.7	-	115.7	104,833
-137	2810	2.35	6.603	685.4	4.0	-	116.3	106,185
-138	2795	2.39	6.680	685.4	4.4	1220	117.6	107,425
-139	2780	2.46	6.838	685.4	5.1	-	119.5	109,964
-140	2765	2.50	6.912	685.4	5.5	-	120.8	111,156
-141	2420	2.48	6.001	685.4	5.1	1260	104.8	96,503
-142	2420	2.51	6.074	685.4	5.4	-	106.1	97,681
-143	2160	2.45	5.292	685.4	4.9	-	92.5	85,105
-144	2145	2.48	5.319	685.4	5.1	1274	92.2	85,538
-145	1775	2.42	4.295	685.4	4.6	-	74.4	69,070
-146	1800	2.42	4.356	685.4	4.7	-	75.5	70,051
-147	1800	2.42	4.356	685.4	4.8	1279	75.5	70,051
-148	1800	2.42	4.356	685.4	5.0	-	75.5	70,051
-149	1800	2.42	4.356	685.4	5.15	-	75.5	70,051
-150	1485	2.40	3.564	685.4	4.6	1288	61.8	57,314
-151	1485	2.40	3.564	685.4	4.6	-	61.8	57,314
-152	1475	2.42	3.569	685.4	4.7	-	61.9	57,395
-153	1475	2.42	3.569	685.4	4.8	1283	61.9	57,395
-154	0	0	0	685.4	4.6	-	0	0
-155	0	0	0	0	5.3	-	0	0
-156	0	0	0	0	4.1	-	0	0
ED -1	0	0	0	0	9.1	-	0	0
-2	0	0	0	56.5	1.0	-	0	0
-3	0	0	0	118.5	1.3	-	0	0
-4	0	0	0	203.8	1.7	-	0	0
-5	0	0	0	315.2	2.1	-	0	0
-6	0	0	0	315.2	1.7	-	0	0
-7	0	0	0	315.2	1.5	-	0	0
-8	173	0.03	0.005	315.2	2.4	248	0.1	80
-9	792	0.03	0.023	315.2	1.8	-	0.5	368
-10	1770	0.03	0.053	315.2	1.6	-	1.2	853
-11	2330	0.03	0.069	315.2	1.4	250	1.6	1,107
-12	2735	0.03	0.082	315.2	1.25	-	1.9	1,319
-13	3110	0.03	0.093	315.2	1.2	-	2.2	1,494
-14	3480	0.03	0.104	315.2	1.3	253	2.5	1,673
-15	3480	0.03	0.104	315.2	1.1	-	2.4	1,673
-16	3425	0.22	0.753	396.0	1.5	-	17.6	12,109
-17	3425	0.21	0.719	396.0	1.2	273	16.8	11,563

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
ED-18	3440	0.20	0.688	396.0	1.2	-	15.9	11,063
-19	0	0	0	396.0	1.1	-	0	0
-20	935	0.17	0.158	396.0	1.2	289	3.6	2,540
-21	2275	0.18	0.409	396.0	1.15	-	9.5	6,578
-22	3050	0.20	0.610	396.0	1.15	-	14.1	9,810
-23	3450	0.19	0.655	396.0	1.15	298	15.2	10,536
-24	3410	0.54	1.841	475.4	1.4	-	41.8	29,604
-25	3410	0.50	1.705	475.4	1.35	-	38.3	27,418
-26	3350	0.77	2.579	516.7	1.5	387	57.3	41,473
-27	3350	0.75	2.512	516.7	1.4	-	55.3	40,394
-28	3350	0.74	2.479	516.7	1.4	-	54.0	39,867
-29	0	0	0	516.7	1.2	435	0	0
-30	980	0.53	0.519	516.7	1.3	-	11.3	8,345
-31	0	0	0	516.7	1.1	-	0	0
-32*	980	0.50	0.490	516.7	1.4	435	10.8	7,878
-33	2270	0.53	1.203	516.7	1.15	-	26.2	19,347
-34	3025	0.55	1.663	516.7	1.25	-	36.2	26,744
-35	3430	0.60	2.058	516.7	1.2	455	44.8	33,096
-36	3330	1.03	3.429	574.7	1.25	-	74.0	55,142
-37	3210	1.53	4.911	633.6	1.4	-	106.0	78,975
-38	3130	2.01	6.291	657.8	1.5	549	133.2	101,167
-39	3130	2.01	6.291	657.8	Off Scale	-	127.4	101,167
-40	0	0	0	657.8	1.4	-	0	0
-41	720	1.89	1.360	657.8	1.0	621	28.2	21,872
-42	1500	1.93	2.895	657.8	1.0	-	59.6	46,557
-43	1930	2.07	3.995	657.8	1.15	-	82.2	64,246
-44	2335	2.09	4.880	657.8	1.25	649	99.5	78,475
-45	2635	2.05	5.401	657.8	1.3	-	110.1	86,857
-46	3050	2.08	6.344	657.8	1.3	-	128.1	102,020
-47	3285	2.08	6.832	657.8	1.4	712	136.7	109,870
-48	3285	2.07	6.799	657.8	1.5	-	133.6	109,338
-49	3300	1.95	6.435	657.8	1.5	-	125.4	103,486
-50	3300	1.92	6.336	657.8	1.5	873	122.3	101,893
-51	3310	1.88	6.222	657.8	1.5	-	118.1	100,060
-52	3310	1.92	6.355	657.8	1.6	-	118.5	102,199
-53	3300	1.93	6.369	657.8	1.7	1036	116.8	102,421
-54	3290	2.00	6.580	657.8	1.9	-	118.7	105,818
-55	3285	2.03	6.668	657.8	2.1	-	118.4	107,231
-56	3270	2.10	6.867	657.8	2.4	1175	120.9	110,431
-57	3265	2.13	6.954	657.8	3.1	-	121.5	111,830
-58	3250	2.15	6.987	657.8	4.5	-	121.1	112,363
-59	3250	2.15	6.987	657.8	6.0	1292	121.1	112,363
-60	0	0	0	657.8	2.7	-	0	0
-61	0	0	0	657.8	1.55	-	0	0
-62	865	1.40	1.211	657.8	1.5	806	23.4	19,474
-63	2015	1.46	2.941	657.8	1.5	-	56.8	47,297
-64	2780	1.48	4.114	657.8	1.6	-	78.7	66,159
-65	3170	1.51	4.786	657.8	1.6	847	91.6	76,967
-66	3570	1.51	5.390	657.8	1.7	-	103.2	86,679
-67	3570	1.53	5.462	644.6	1.7	-	103.6	87,838
-68	3450	2.09	7.210	677.1	1.8	914	135.6	115,948
-69	3430	2.18	7.477	677.1	1.8	-	139.5	120,241
-70	3420	2.25	7.695	677.1	1.85	-	142.3	123,746
-71	3405	2.32	7.899	677.1	1.9	1044	144.9	127,026
-72	3385	2.40	8.124	677.1	1.95	-	147.5	130,644
-73	3350	2.46	8.241	677.1	2.1	-	148.7	132,529
-74	3350	2.49	8.341	677.1	2.6	1166	148.1	134,136

*Indicates a transient test.

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
ED -75	3330	2.51	8.358	677.1	2.9	-	147.2	134,409
-76	3320	2.58	8.565	677.1	3.7	-	150.8	137,736
-77	3320	2.60	8.632	677.1	4.6	-	150.8	138,815
-78	3300	2.70	8.910	677.1	6.0	1265	155.7	143,286
-79	0	0	0	677.1	2.4	-	0	0
-80	0	0	0	677.1	2.3	-	0	0
-81	0	0	0	677.1	2.15	-	0	0
-82	575	1.82	1.046	677.1	1.8	970	19.5	16,821
-83	1555	1.97	3.063	677.1	1.9	-	56.7	49,257
-84	2800	?	-	677.1	9.0	-	-	-
-85	0	0	0	677.1	2.3	-	0	0
-86	280	1.80	0.504	677.1	1.8	968	9.4	8,104
-87	835	1.90	1.586	677.1	1.9	-	29.6	25,505
-88	1440	1.93	2.779	677.1	1.95	-	51.8	44,692
-89	1900	2.02	3.838	677.1	2.0	970	71.0	61,720
-90	2260	2.03	4.587	677.1	2.1	-	84.8	73,763
-91	2630	2.10	5.523	677.1	2.1	-	101.3	88,818
-92	3020	2.17	6.553	677.1	2.2	1018	120.2	105,380
-93	3390	2.20	7.458	677.1	2.25	-	135.7	119,934
-94	3800	2.30	8.740	677.1	2.4	-	159.0	140,553
-95	3780	2.45	9.261	677.1	2.6	1121	167.1	148,931
-96	3770	2.53	9.538	677.1	3.1	-	170.7	153,384
-97	3755	2.60	9.763	677.1	3.7	-	173.3	157,002
-98	3740	2.65	9.911	677.1	4.6	-	174.5	159,382
-99	3735	2.70	10.084	677.1	6.0	1233	177.6	162,166
-100	0	0	0	677.1	2.4	-	0	0
-101	0	0	0	677.1	2.3	-	0	0
-102	360	1.73	0.622	677.1	1.9	941	11.7	10,003
-103	1580	1.88	2.970	677.1	2.1	-	55.4	47,764
-104	1915	1.93	3.695	677.1	2.1	-	68.9	59,421
-105	2275	2.00	4.550	677.1	2.1	959	84.9	73,170
-106	2635	2.08	5.480	677.1	2.15	-	101.4	88,125
-107	3000	2.12	6.360	677.1	2.2	991	117.6	102,279
-108	3410	2.20	7.502	677.1	2.3	-	137.6	120,641
-109	3810	2.30	8.763	677.1	2.4	-	159.4	140,921
-110	4140	2.40	9.936	677.1	2.5	1074	180.8	159,787
-111	4110	2.50	10.275	677.1	2.7	-	185.4	165,239
-112	4100	2.55	10.455	677.1	3.0	-	187.1	168,132
-113	4080	2.62	10.689	677.1	3.6	1170	191.3	171,896
-114	4070	2.70	10.989	677.1	4.3	-	195.1	176,717
-115	4060	2.75	11.165	677.1	5.4	1207	198.2	179,548
-116	0	0	0	677.1	2.4	-	0	0
-117	0	0	0	677.1	2.2	-	0	0
-118	288	1.75	0.504	677.1	1.9	977	9.3	8,104
-119	907	1.92	1.741	677.1	2.0	-	32.2	27,998
-120	1555	2.00	3.110	677.1	2.1	-	57.0	50,011
-121	2270	2.08	4.721	677.1	2.2	990	86.6	75,921
-122	2630	2.13	5.601	677.1	2.2	-	102.7	90,071
-123	3020	2.16	6.523	677.1	2.3	-	118.7	104,899
-124	3425	2.23	7.637	677.1	2.35	1042	138.9	122,813
-125	3870	2.30	8.901	677.1	2.5	-	160.6	143,140
-126	4270	2.43	10.376	677.1	2.8	-	188.8	166,859
-127	4500	2.51	11.295	677.1	3.3	1124	202.1	181,640
-128	4470	2.58	11.532	677.1	4.3	-	206.4	185,452
-129	4430	2.70	11.961	677.1	6.0	1195	212.3	192,350
-130	0	0	0	677.1	2.5	-	0	0
-131	0	0	0	677.1	2.0	-	0	0
-132	144	1.30	0.187	677.1	1.8	896	3.5	3,006
-133	806	1.88	1.515	677.1	1.9	-	28.5	24,365
-134	1610	1.93	3.107	677.1	2.1	-	58.4	49,964

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10^{-5} Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
ED-135	2275	2.01	4.572	677.1	2.1	914	85.3	73,523
-136	2660	2.05	5.453	677.1	2.1	-	101.7	87,692
-137	3060	2.10	6.426	677.1	2.1	-	118.6	103,339
-138	3450	2.18	7.521	677.1	2.2	973	139.1	120,948
-139	3890	2.28	8.869	677.1	2.3	-	162.7	142,627
-140	4280	2.38	10.186	677.1	2.4	-	186.9	163,806
-141	4630	2.51	11.621	677.1	2.7	-	211.4	186,880
-142	4630	2.60	12.038	677.1	Off Scale	-	-	193,590
-143	0	0	0	677.1	2.8	1083	0	0
-144	0	0	0	677.1	3.2	-	0	0
-145	0	0	0	0	2.6	-	0	0
-146	0	0	0	0	2.2	-	0	0
EE -1	0	0	0	0	11.0	-	0	0
-2	0	0	0	58.1	17.0	-	0	0
-3	0	0	0	115.5	17.0	-	0	0
-4	0	0	0	201.9	20.0	-	0	0
-5	0	0	0	312.2	22.0	-	0	0
-6	0	0	0	467.7	24.0	-	0	0
-7	0	0	0	685.4	29.0	-	0	0
-8	0	0	0	685.4	16.0	-	0	0
-9	0	0	0	685.4	9.5	-	0	0
-10	0	0	0	485.0	12.0	-	0	0
-11	0	0	0	485.0	16.0	-	0	0
-12	115	1.25	0.143	485.0	16.0	394	3.1	2,299
-13	187	2.60	0.486	485.0	16.0	-	10.7	7,817
-14	259	1.52	0.393	485.0	16.0	-	8.6	6,319
-15	302	0.90	0.271	485.0	15.5	403	6.0	4,358
-16	317	0.69	0.218	485.0	15.5	-	4.8	3,506
-17	763	0.67	0.511	485.0	16.0	-	11.2	8,217
-18	806	0.48	0.386	485.0	15.5	439	8.5	6,205
-19	806	0.48	0.386	485.0	12.0	-	8.2	6,205
-20	1110	0.48	0.532	485.0	13.0	-	11.4	8,557
-21	1120	0.47	0.526	485.0	-	624	10.9	8,458
-22	1125	0.47	0.528	485.0	5.0	-	11.0	8,491
-23	1125	0.47	0.528	485.0	9.0	-	10.9	8,491
-24	0	0	0	485.0	8.7	685	0	0
-25	0	0	0	485.0	6.5	-	0	0
-26	0	0	0	485.0	6.5	-	0	0
-27	0	0	0	485.0	5.8	-	0	0
-28	115	0.88	0.101	485.0	5.0	891	1.9	1,626
-29	245	3.20	0.784	485.0	4.0	-	15.1	12,609
-30	288	2.40	0.691	485.0	5.0	-	13.3	11,110
-31	396	0.88	0.348	485.0	7.0	901	6.7	5,598
-32	412	0.58	0.238	485.0	6.5	-	4.6	3,826
-33	906	0.53	0.480	485.0	6.5	-	9.3	7,718
-34	1830	0.48	0.878	485.0	6.5	907	16.9	14,121
-35	1840	0.47	0.864	485.0	5.8	-	16.7	13,895
-36	2200	0.47	1.034	480.5	5.5	-	20.0	16,628
-37	2160	0.68	1.468	519.4	5.5	948	28.1	23,606
-38	2160	0.63	1.360	519.4	5.5	-	26.0	21,872
-39	2100	0.99	2.079	551.4	5.5	-	39.8	33,435
-40	2100	0.98	2.058	611.3	5.2	1026	38.7	33,096
-41	1990	1.53	3.044	611.3	5.2	-	57.3	48,951
-42	2015	1.49	3.002	611.3	5.2	-	55.5	48,277
-43	2010	1.53	3.075	611.3	6.5	1137	55.9	49,450
-44	1970	1.65	3.250	611.3	7.6	-	58.6	52,263
-45	1915	1.79	3.427	611.3	8.5	-	61.3	55,109
-46	1915	1.80	3.447	611.3	9.2	1256	61.7	55,434
-47	2030	1.50	3.045	561.0	8.4	-	-	48,970
-48	2015	1.52	3.062	561.0	8.8	-	54.4	49,243

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10^{-5} Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EE-49	1670	1.49	2.488	561.0	8.2	1263	44.2	40,013
-50	1685	1.28	2.156	561.0	8.2	-	38.3	34,670
-51	1685	1.24	2.089	561.0	8.2	-	36.8	33,595
-52	1690	1.22	2.061	561.0	8.3	1294	36.3	33,143
-53	0	0	0	561.0	7.9	-	0	0
-54	0	0	0	561.0	6.9	-	0	0
-55	115	0.95	0.109	561.0	5.5	1150	2.0	1,753
-56	259	2.00	0.518	561.0	5.4	-	9.3	8,330
-57	880	1.20	1.056	561.0	6.1	-	19.0	16,981
-58	892	1.02	0.909	561.0	6.1	1152	16.4	14,616
-59	1750	1.07	1.072	561.0	6.4	-	33.8	30,104
-60	1725	1.12	1.932	561.0	6.2	-	34.9	31,070
-61	1725	1.12	1.932	561.0	6.2	1202	34.6	31,070
-62	1725	1.19	2.052	561.0	6.2	-	36.7	32,997
-63	1725	1.20	2.070	561.0	6.3	-	36.7	33,289
-64	1725	1.20	2.070	561.0	6.3	1229	36.7	33,289
-65	2000	0.02	0.040	0	5.5	-	0.7	646
-66	0	0.01	0	0	5.3	-	0	0
EF -1	0	0	0	0	1.1	-	0	0
-2	0	0	0	56.5	1.7	-	0	0
-3	0	0	0	118.5	2.0	-	0	0
-4	0	0	0	201.9	2.3	-	0	0
-5	0	0	0	318.8	2.3	-	0	0
-6	0	0	0	467.7	2.7	-	0	0
-7	0	0	0	684.7	3.6	-	0	0
-8	0	0	0	684.7	2.5	-	0	0
-9	0	0	0	330.0	1.8	-	0	0
-10	0	0	0	330.0	1.6	-	0	0
-11	43	0.18	0.007	330.0	2.7	244	0.2	113
-12	100	0.60	0.060	330.0	2.3	-	1.4	966
-13	100	0.60	0.060	330.0	1.35	-	1.4	966
-14	140	0.80	0.112	330.0	1.45	248	2.6	1,800
-15	140	0.80	0.112	330.0	1.3	-	2.6	1,800
-16	230	0.93	0.213	330.0	1.4	-	5.0	3,425
-17	252	0.78	0.196	330.0	1.3	252	4.6	3,152
-18	266	0.67	0.178	330.0	1.3	-	4.2	2,865
-19	280	0.43	0.120	330.0	1.3	-	2.8	1,932
-20	288	0.40	0.115	330.0	1.3	257	2.7	1,847
-21	965	0.38	0.366	330.0	1.4	-	8.6	5,885
-22	1850	0.35	0.647	330.0	1.5	-	15.1	10,404
-23	1885	0.28	0.527	330.0	1.4	266	12.3	8,477
-24	2275	0.28	0.637	330.0	1.4	-	14.9	10,243
-25	2185	0.51	1.114	414.8	1.7	-	26.1	17,914
-26	2230	0.43	0.958	414.8	1.5	286	22.4	15,408
-27	2185	0.50	1.092	453.6	1.5	-	25.3	17,561
-28	2185	0.45	0.983	453.6	1.5	-	22.5	15,808
-29	2065	1.06	2.188	536.0	1.9	320	50.2	35,188
-30	2100	1.01	2.121	536.0	1.6	-	47.2	34,109
-31	2450	1.01	2.474	536.0	1.9	-	54.5	39,787
-32	2835	1.01	2.863	536.0	1.9	442	63.0	46,039
-33	0	0	0	536.0	1.5	-	0	0
-34	0	0	0	536.0	1.4	-	0	0
-35	72	0.52	0.037	536.0	2.0	414	0.8	594
-36	72	0.52	0.037	528.6	1.4	-	0.8	594
-37	173	2.08	0.359	528.6	1.5	-	7.9	5,772
-38	288	2.80	0.806	528.6	1.5	419	17.7	12,962
-39	503	2.73	1.373	528.6	1.5	-	29.9	22,080
-40	605	1.60	0.968	528.6	1.3	-	21.1	15,568
-41	627	1.25	0.783	528.6	1.3	432	24.2	12,590
-42	1700	1.19	2.023	528.6	1.6	-	44.1	32,530

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power kW	Cathode-heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EF -43	2060	1.10	2.266	528.6	1.6	-	49.4	36,441
-44	2460	1.10	2.706	528.6	1.6	455	58.4	43,518
-45	2850	1.10	3.135	528.6	1.7	-	67.7	50,416
-46	2865	1.00	2.865	528.6	1.8	-	61.8	46,072
-47	2865	1.00	2.865	528.6	1.65	500	61.8	46,072
-48	3270	1.00	3.270	528.6	1.8	-	69.9	52,589
-49	3200	1.30	4.160	566.5	1.9	-	88.0	66,898
-50	3130	1.62	5.070	606.3	2.1	550	107.3	81,533
-51	3020	2.10	6.342	644.6	2.3	-	131.7	101,987
-52	2950	2.48	7.316	663.7	2.3	-	150.5	117,654
-53	3170	2.50	7.925	663.7	2.3	707	160.0	127,445
-54	3270	2.52	8.240	663.7	2.3	-	163.4	132,510
-55	3270	2.52	8.240	663.7	Pulsed	779	163.4	132,510
-56	0	0	0	663.7	1.8	-	0	0
-57	0	0	0	663.7	1.6	-	0	0
-58	100	0.61	0.061	663.7	1.5	689	1.2	980
-59	575	3.70	2.127	663.7	1.7	-	42.2	34,203
-60	690	2.70	1.863	663.7	1.3	-	36.9	29,958
-61	720	2.58	1.857	663.7	1.3	689	36.8	29,863
-62	1468	2.50	3.670	663.7	1.5	-	72.8	59,020
-63	1770	2.47	4.371	663.7	1.55	-	85.9	70,291
-64	2160	2.48	5.356	663.7	1.6	725	105.3	86,132
-65	2550	2.48	6.324	663.7	1.7	-	123.2	101,700
-66	2910	2.48	7.216	663.7	1.9	-	139.3	116,043
-67	3200	2.42	7.744	663.7	2.0	808	149.5	124,533
-68	3200	2.48	7.936	663.7	1.9	-	151.9	127,624
-69	3200	2.51	8.032	663.7	2.1	-	151.1	129,165
-70	3210	2.42	7.768	663.7	2.1	946	146.1	124,920
-71	3200	2.48	7.936	663.7	2.2	-	146.8	127,624
-72	3200	2.43	7.776	663.7	2.4	-	141.5	125,047
-73	3200	2.45	7.840	663.7	2.9	1107	140.3	126,079
-74	3185	2.50	7.962	663.7	3.5	-	141.3	128,039
-75	3185	2.52	8.026	663.7	4.4	-	142.5	129,071
-76	3170	2.57	8.146	663.7	6.0	-	143.4	130,998
-77	3150	2.68	8.442	663.7	7.0	1233	148.7	135,761
-78	0	0	0	663.7	2.6	-	0	0
-79	0	0	0	663.7	2.4	-	0	0
-80	144	1.40	0.201	663.7	1.9	756	3.9	3,232
-81	400	3.10	1.240	663.7	1.9	-	24.1	19,940
-82	447	2.57	1.148	663.7	1.7	-	22.4	18,461
-83	460	2.40	1.104	663.7	1.7	756	21.5	17,754
-84	1480	2.40	3.552	663.7	2.0	-	68.6	57,121
-85	1845	2.41	4.446	663.7	2.0	-	85.8	71,497
-86	2200	2.42	5.324	663.7	2.1	864	102.8	85,618
-87	2560	2.42	6.195	663.7	2.1	-	118.6	99,627
-88	2950	2.42	7.139	663.7	2.2	-	129.9	114,803
-89	3340	2.42	8.082	663.7	2.3	869	153.4	129,971
-90	3770	2.42	9.123	663.7	Off Scale	-	171.6	146,712
-91	0	0	0	663.7	2.5	-	0	0
-92*	1440	2.60	3.744	663.7	2.3	-	71.0	60,208
-93	1485	2.40	3.564	663.7	1.9	869	67.6	57,314
-94	0	0	0	663.7	2.3	-	0	0
-95	0	0	0	663.7	2.3	-	0	0
-96	245	2.47	0.605	663.7	1.8	691	12.1	9,730
-97	662	3.03	2.005	663.7	1.9	-	39.4	32,243
-98	720	2.42	1.742	663.7	1.7	-	34.5	28,012
-99	1470	2.42	3.557	663.7	1.9	707	69.9	57,201
-100	0	0	0	663.7	2.0	-	0	0

*Indicates a transient test.

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EF-101*	1760	2.70	4.752	663.7	2.2	-	95.1	76,421
-102	1835	2.42	4.440	663.7	1.9	729	87.3	71,403
-103	0	0	0	663.7	2.1	-	0	0
-104*	2090	2.80	5.852	663.7	2.4	-	117.1	94,109
-105	2190	2.42	5.299	663.7	2.0	752	103.2	85,213
-106	0	0	0	663.7	1.6	-	0	0
-107*	2475	2.80	6.930	663.7	2.1	-	137.4	111,444
-108	2560	2.42	6.195	663.7	1.7	772	119.6	99,627
-109	0	0	0	663.7	1.6	-	0	0
-110*	2880	2.70	7.776	663.7	2.6	-	154.2	125,047
-111	2930	2.42	7.090	663.7	1.7	799	135.7	114,016
-112	0	0	0	663.7	1.6	-	0	0
-113*	3130	2.65	8.294	663.7	2.0	-	163.0	133,377
-114	3170	2.42	7.671	663.7	1.8	828	145.6	123,360
-115	0	0	0	663.7	1.7	-	0	0
-116*	3355	2.70	9.058	663.7	2.3	-	176.5	145,666
-117	3430	2.45	8.403	663.7	1.8	855	159.5	135,130
-118	0	0	0	663.7	1.7	-	0	0
-119*	3630	2.70	9.801	663.7	2.3	-	190.9	157,615
-120	3700	2.46	9.102	663.7	1.9	874	171.2	146,372
-121	0	0	0	663.7	1.7	-	0	0
-122*	3915	2.70	10.570	663.7	Off Scale	-	200.6	169,979
-123	0	0	0	663.7	1.8	851	0	0
-124	505	2.42	1.222	663.7	1.5	-	23.4	19,653
-125	1485	2.40	3.564	663.7	1.6	-	67.6	57,314
-126	2190	2.41	5.277	663.7	1.7	860	100.1	84,860
-127	2950	2.42	7.139	663.7	1.8	-	134.3	114,803
-128	3350	2.42	8.107	663.7	2.0	-	151.2	130,371
-129	3630	2.42	8.784	663.7	2.2	927	163.9	141,260
-130	3600	2.47	8.892	663.7	2.3	-	161.8	142,994
-131	3610	2.50	9.025	663.7	2.8	-	162.8	145,133
-132	3600	2.52	9.072	663.7	3.5	1148	162.4	145,892
-133	3600	2.55	9.180	663.7	4.1	-	163.0	147,626
-134	3570	2.70	9.639	663.7	6.0	1215	169.7	155,009
-135	0	0	0	663.7	2.4	-	0	0
-136	0	0	0	663.7	2.2	-	0	0
-137	0	0	0	663.7	1.9	-	0	0
-138	100	0.75	0.075	663.7	1.7	734	1.5	1,206
-139	290	2.20	0.638	663.7	1.6	-	12.6	10,258
-140	720	2.43	1.749	663.7	1.6	-	34.3	28,125
-141	750	2.16	1.620	663.7	1.9	743	31.8	26,052
-142	1555	2.28	3.545	663.7	2.1	-	69.7	57,008
-143	2190	2.32	5.080	663.7	2.2	-	99.0	81,693
-144	2580	2.38	6.140	663.7	2.2	795	118.6	98,741
-145	3000	2.42	7.260	663.7	2.3	-	140.2	116,749
-146	3485	2.47	8.607	663.7	2.4	-	164.8	138,414
-147	3770	2.51	9.462	663.7	2.5	873	179.6	152,163
-148	3770	2.57	9.688	663.7	2.5	-	180.7	155,796
-149	3750	2.62	9.825	663.7	2.7	-	180.2	158,001
-150	3740	2.68	10.023	663.7	3.1	1067	182.3	161,182
-151	3790	2.75	10.422	663.7	4.3	-	186.5	167,599
-152	3320	2.71	8.997	663.7	3.9	-	161.0	144,686
-153	3310	2.75	9.102	663.7	4.7	1193	161.6	146,372
-154	2910	2.67	7.769	663.7	3.9	-	137.9	124,938
-155	2910	2.69	7.827	663.7	4.7	-	137.8	125,871
-156	2520	2.62	6.602	663.7	3.9	1229	116.3	106,171
-157	2505	2.68	6.713	663.7	4.9	-	117.3	107,952
-158	2490	2.72	6.772	663.7	6.5	-	117.4	108,904

*Indicates a transient test.

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EF-159	2160	2.66	5.745	663.7	5.3	1281	99.6	92,389
-160	1845	2.57	4.741	663.7	4.5	-	82.2	76,242
-161	1845	2.60	4.797	663.7	4.8	-	82.5	77,142
-162	1845	2.57	4.741	663.7	5.1	1294	81.5	76,242
-163	0	0	0	663.7	3.5	-	0	0
-164	0	0	0	663.7	3.3	-	0	0
-165	0	0	0	663.7	3.3	-	0	0
-166	0	0	0	663.7	2.7	-	0	0
EG -1	0	0	0	0	1.1	218	0	0
-2	0	0	0	58.1	1.5	-	0	0
-3	0	0	0	85.8	1.7	-	0	0
-4	0	0	0	163.0	2.4	217	0	0
-5	0	0	0	256.2	2.5	-	0	0
-6	0	0	0	391.2	2.8	-	0	0
-7	0	0	0	567.8	3.5	221	0	0
-8	0	0	0	685.4	3.8	-	0	0
-9	0	0	0	685.4	2.0	-	0	0
-10	0	0	0	332.2	1.7	235	0	0
-11	95	0.31	0.029	332.2	6.0	-	0.7	466
-12	95	0.32	0.030	332.2	1.5	-	0.7	481
-13	403	0.52	0.209	332.2	1.9	235	4.9	3,360
-14	462	0.29	0.133	332.2	1.3	-	3.1	2,139
-15	1000	0.29	0.290	332.2	1.3	-	6.9	4,665
-16	1875	0.29	0.543	332.2	1.4	243	12.7	8,731
-17	2275	0.28	0.637	332.2	1.4	-	14.9	10,243
-18	2665	0.28	0.746	332.2	1.4	-	17.5	11,996
-19	3050	0.18	0.549	332.2	1.4	250	12.8	8,830
-20	3460	0.16	0.553	332.2	1.4	-	12.9	8,891
-21	3870	0.16	0.619	332.2	1.4	-	14.5	9,956
-22	4250	0.15	0.637	332.2	1.4	257	14.9	10,243
-23	4220	0.25	1.055	391.0	1.6	-	24.7	16,967
-24	4190	0.42	1.759	439.6	1.7	-	40.7	28,285
-25	4190	0.41	1.717	439.6	1.5	307	39.7	27,611
-26	4150	0.65	2.697	485.7	1.75	-	61.8	43,372
-27	4150	0.62	2.573	485.7	1.6	-	57.7	41,379
-28	4070	0.89	3.622	524.7	1.85	387	80.5	58,247
-29	4080	0.85	3.468	524.7	1.7	-	76.3	55,769
-30	4030	1.15	4.634	562.3	1.9	-	101.0	74,522
-31	4030	1.15	4.634	562.3	1.7	531	99.0	74,522
-32	3920	1.62	6.350	619.2	1.9	-	133.1	102,119
-33	3820	2.19	8.365	658.5	2.3	-	167.4	134,522
-34	3760	2.52	9.475	674.8	2.3	712	189.6	152,371
-35	3760	2.57	9.663	674.8	2.1	-	191.6	155,396
-36	3920	2.60	10.192	674.8	2.1	-	198.5	163,900
-37	3920	2.60	10.192	674.8	7.5	856	196.8	163,900
-38	0	0	0	674.8	1.7	-	0	0
-39	0	0	0	674.8	1.7	-	0	0
EH -1	0	0	0	0	1.4	-	0	0
-2	0	0	0	206.8	3.7	-	0	0
-3	0	0	0	470.3	5.6	-	0	0
-4	0	0	0	685.4	7.7	-	0	0
-5	0	0	0	678.5	1.7	-	0	0
-6	0	0	0	336.0	1.6	-	0	0
-7	158	0.12	0.018	336.0	5.9	268	0.4	287
-8	1000	0.13	0.130	336.0	3.2	-	3.0	2,092
-9	1895	0.13	0.246	336.0	2.2	-	5.7	3,958
-10	2305	0.13	0.299	336.0	2.0	271	6.9	4,806
-11	2700	0.13	0.351	336.0	1.95	-	8.1	5,645
-12	3050	0.13	0.396	336.0	1.95	-	9.2	6,370
-13	3460	0.14	0.484	336.0	2.0	280	11.2	7,784

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10^{-5} Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EH-14	3840	0.14	0.537	336.0	1.9	-	12.4	8,637
-15	4270	0.14	0.597	336.0	1.95	-	13.8	9,603
-16	4615	0.14	0.646	336.0	2.1	284	15.0	10,390
-17	4620	0.13	0.600	336.0	1.9	-	13.8	9,650
-18	4610	0.24	1.106	336.0	2.1	-	25.4	17,787
-19	4610	0.23	1.060	336.0	2.0	302	24.3	17,047
-20	4580	0.42	1.923	446.4	2.1	-	43.6	30,924
-21	4580	0.40	1.832	446.4	2.0	-	41.1	29,463
-22	4510	0.63	2.841	446.4	2.2	340	63.8	45,686
-23	4530	0.61	2.763	446.4	2.1	-	61.4	44,432
24	4480	0.82	3.673	446.4	2.4	-	58.8	42,986
-25	4480	0.81	3.628	446.4	2.2	399	79.9	58,342
-26	4430	1.15	5.094	446.4	2.5	-	111.0	81,920
-27	4430	1.18	5.227	446.4	2.2	-	112.8	84,059
-28	4370	1.61	7.035	446.4	2.6	502	148.9	113,131
-29	4370	1.62	7.079	446.4	2.4	-	148.4	113,842
-30	4310	2.02	8.706	446.4	2.8	-	179.1	140,007
-31	4310	2.06	8.878	446.4	2.8	671	179.3	142,773
-32	4210	2.57	10.819	446.4	3.2	-	216.5	173,984
-33	4210	2.57	10.819	446.4	2.8	-	212.6	173,984
-34	4210	2.55	10.735	446.4	2.8	829	207.3	172,636
-35	4450	2.58	11.481	446.4	2.8	-	219.7	184,632
-36	4450	2.58	11.481	446.4	2.9	-	216.0	184,632
-37	4430	2.65	11.739	446.4	3.5	1011	217.1	188,779
-38	4420	2.72	12.022	446.4	4.3	-	218.7	193,330
-39	4400	2.90	12.760	446.4	Off Scale	1078	230.2	205,199
-40	0	0	0	446.4	2.2	-	0	0
-41	0	0	0	446.4	1.9	-	0	0
-42	0	0	0	658.5	2.1	-	0	0
-43	0	0	0	480.5	1.9	-	0	0
-44	150	0.30	0.045	480.5	2.0	608	0.9	726
-45	935	0.39	0.364	480.5	1.9	-	7.4	5,852
-46	1855	0.39	0.723	480.5	1.8	-	14.9	11,629
-47	2610	0.38	0.991	480.5	1.7	605	20.4	15,935
-48	3350	0.38	1.273	480.5	1.7	-	25.9	20,473
-49	3790	0.38	1.440	480.5	1.7	-	29.3	23,159
-50	4190	0.39	1.634	480.5	1.7	613	33.3	26,278
-51	4570	0.39	1.782	480.5	1.7	-	36.3	28,657
-52	4950	0.39	1.930	480.5	1.9	-	39.3	31,037
-53	4870	0.93	4.529	567.8	1.9	640	91.5	72,830
-54	4770	1.65	7.870	642.4	2.2	-	156.1	126,559
-55	4650	2.52	11.718	689.0	2.6	-	228.3	188,444
-56	4650	2.62	12.183	689.0	2.5	806	235.3	195,922
-57	4620	2.77	12.797	689.0	2.8	-	245.0	205,793
-58	4610	2.85	13.138	689.0	2.6	-	251.5	211,278
-59	4600	2.90	13.340	689.0	2.6	921	253.1	214,524
-60	4600	2.95	13.570	689.0	2.9	-	255.3	218,223
-61	4600	3.00	13.800	689.0	3.2	1015	255.3	221,922
-62	0	0	0	689.0	2.1	-	0	0
-63	0	0	0	689.0	2.0	-	0	0
-64	0	0	0	487.6	1.9	-	0	0
-65	0	0	0	487.6	1.9	-	0	0
-66	150	0.25	0.037	487.6	2.1	547	0.7	594
-67	978	0.32	0.312	487.6	2.0	-	6.5	5,018
-68	1900	0.32	0.608	487.6	1.9	-	12.6	9,777
-69	2650	0.31	0.821	487.6	1.9	547	17.0	13,203
-70	3530	0.32	1.129	487.6	1.9	-	23.4	18,155
-71	4250	0.32	1.360	487.6	1.9	-	28.2	21,872
-72	4630	0.32	1.481	487.6	1.9	561	30.7	23,818
-73	5030	0.32	1.609	487.6	1.9	-	33.4	25,877

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10^{-5} Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EH -74	5440	0.38	2.067	487.6	2.0	-	42.9	33,242
-75	5380	0.77	4.142	553.5	2.1	590	85.2	66,611
-76	5325	1.22	6.496	617.0	2.2	-	131.2	104,466
-77	5250	1.79	9.397	664.4	2.8	-	186.4	151,117
-78	5180	2.38	12.328	697.3	3.0	775	240.2	198,250
-79	5165	2.55	13.170	697.3	3.2	-	254.3	211,791
-80	5155	2.63	13.557	697.3	3.0	-	264.4	218,016
-81	5150	2.77	14.265	697.3	3.0	883	273.1	229,399
-82	5120	2.87	14.694	697.3	3.3	-	278.8	236,302
-83	5115	2.95	15.089	697.3	3.6	-	286.3	242,654
-84	5110	3.00	15.300	697.3	3.6	955	287.9	246,046
-85	0	0	0	697.3	2.1	-	0	0
-86	0	0	0	697.3	1.9	-	0	0
-87	0	0	0	697.3	2.1	-	0	0
-88	0	0	0	483.1	2.0	-	0	0
-89	145	0.25	0.036	483.1	2.1	694	0.7	580
-90	980	0.30	0.294	483.1	1.9	-	5.9	4,726
-91	2275	0.30	0.682	483.1	1.9	-	13.6	10,969
-92	3040	0.30	0.912	483.1	1.9	689	18.2	14,668
-93	3860	0.30	1.158	483.1	1.9	-	23.2	18,621
-94	4650	0.31	1.441	483.1	1.9	-	28.8	23,173
-95	5070	0.32	1.622	483.1	1.9	696	32.5	26,085
-96	5450	0.32	1.744	483.1	2.1	-	34.6	28,045
-97	5880	0.32	1.881	483.1	2.1	711	37.3	30,250
-98	0	0	0	483.1	2.2	-	0	0
-99	0	0	0	483.1	2.0	-	0	0
-100	403	0.26	0.104	483.1	2.1	621	2.1	1,673
-101	1900	0.29	0.551	483.1	2.0	-	10.3	8,863
-102	2710	0.30	0.813	483.1	2.0	-	16.6	13,075
-103	3450	0.31	1.069	483.1	2.0	622	21.8	17,189
-104	4285	0.32	1.371	483.1	2.0	-	27.9	22,047
-105	4650	0.32	1.488	483.1	1.9	-	30.3	23,931
-106	5070	0.32	1.622	483.1	1.9	637	33.1	26,085
-107	5470	0.32	1.750	483.1	1.9	-	35.7	28,144
-108	5720	0.32	1.830	483.1	2.0	-	37.3	29,430
-109	-	-	-	505.6	Off Scale	646	-	-
-110	0	0	0	505.6	1.9	-	0	0
-111	432	0.32	0.138	505.6	1.8	639	2.8	2,219
-112	0	0	0	686.0	2.0	-	0	0
-113*	1900	2.03	3.857	686.0	2.2	-	77.9	62,026
-114	1865	2.42	4.513	686.0	2.0	655	91.1	72,576
-115	0	0	0	686.0	1.8	-	0	0
-116*	2275	2.13	4.845	686.0	2.2	-	97.8	77,915
-117	2205	2.45	5.402	686.0	2.1	675	108.1	86,872
-118	0	0	0	686.0	1.7	-	0	0
-119*	2635	2.15	5.665	686.0	2.4	-	113.4	91,103
-120	2590	2.42	6.267	686.0	2.1	703	124.3	100,781
-121	0	0	0	686.0	1.9	-	0	0
-122*	3030	2.15	6.514	686.0	2.4	-	130.4	104,753
-123	3000	2.40	7.200	686.0	2.1	741	141.5	115,788
-124	0	0	0	686.0	1.7	-	0	0
-125*	3430	2.20	7.546	686.0	2.5	-	149.6	121,348
-126	3400	2.40	8.160	686.0	2.2	774	159.0	131,224
-127	0	0	0	686.0	1.9	-	0	0
-128*	3885	2.22	8.624	686.0	2.5	-	168.0	138,688
-129	3870	2.48	9.597	686.0	2.4	813	183.7	154,335
-130	0	0	0	686.0	1.9	-	0	0
-131*	4320	2.25	9.720	686.0	2.2	-	191.0	156,310

*Indicates a transient test.

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EH-132	0	0	0	686.0	2.0	-	0	0
-133	0	0	0	0	2.4	-	0	0
-134	0	0	0	0	1.7	-	0	0
EI -1	0	0	0	0	2.0	-	0	0
-2	0	0	0	207.9	4.0	-	0	0
-3	0	0	0	682.4	5.1	-	0	0
-4	0	0	0	682.4	3.5	-	0	0
-5	0	0	0	682.4	2.4	-	0	0
-6	0	0	0	682.4	1.5	-	0	0
-7	0	0	0	682.4	1.6	-	0	0
-8	0	0	0	485.7	1.5	338	0	0
-9	144	0.40	0.058	485.7	3.6	-	-	933
-10	144	0.50	0.072	485.7	1.7	-	-	1,159
-11	144	0.50	0.072	485.7	1.7	-	-	1,159
-12	880	0.58	0.510	485.7	2.3	343	11.4	8,203
-13	880	0.57	0.502	485.7	1.9	-	-	8,071
-14	1820	0.57	1.037	485.7	1.9	-	-	16,675
-15	2580	0.57	1.471	485.7	2.0	-	-	25,658
-16	3340	0.57	1.904	485.7	2.0	369	42.3	30,617
-17	4170	0.58	2.419	485.7	2.1	-	-	38,901
-18	4570	0.57	2.605	485.7	2.0	-	-	41,893
-19	4965	0.57	2.830	485.7	2.1	-	-	45,511
-20	5350	0.55	2.943	485.7	2.0	419	64.1	47,325
-21	5350	0.55	2.943	485.7	1.9	-	-	47,325
-22	5770	0.54	3.156	485.7	2.1	455	68.1	50,751
-23	0	0	0	485.7	1.4	437	0	0
-24	970	0.38	0.369	485.7	1.5	-	-	5,932
-25	1855	0.42	0.779	485.7	1.55	-	-	12,527
-26	2600	0.46	1.196	485.7	1.6	-	-	19,234
-27	3350	0.48	1.608	485.7	1.6	439	34.7	25,858
-28	4175	0.49	2.046	485.7	1.6	-	-	32,903
-29	4970	0.49	2.435	485.7	1.7	-	-	39,160
-30	5370	0.49	2.631	485.7	1.7	-	-	42,312
-31	5780	0.49	2.832	485.7	1.9	473	60.5	45,544
-32	5780	0.48	2.774	485.7	1.9	-	-	44,611
-33	5720	0.95	5.434	578.8	2.3	529	113.9	87,385
-34	5720	1.02	5.834	578.8	2.1	572	121.1	93,817
-35	5670	1.55	8.789	643.8	2.5	615	179.1	141,340
-36	5670	1.60	9.072	643.8	2.4	660	183.2	145,892
-37	5580	1.98	11.048	668.0	2.8	709	219.1	177,668
-38	5580	2.50	13.950	698.0	3.4	815	271.7	224,334
-39	5560	2.59	14.400	698.0	3.6	858	275.6	231,571
-40	5550	2.68	14.874	698.0	3.4	903	284.7	239,195
-41	5530	2.77	15.318	698.0	4.0	968	290.6	246,334
-42	5520	2.82	15.566	698.0	4.5	1013	292.8	250,324
-43	5510	3.00	16.530	698.0	6.2	1035	308.3	265,826
-44	0	0	0	698.0	2.1	1044	0	0
-45	0	0	0	698.0	1.7	-	0	0
-46	0	0	0	698.0	2.0	-	0	0
-47	0	0	0	483.2	1.9	568	0	0
-48	150	0.28	0.042	483.2	2.0	-	-	674
-49	980	0.33	0.323	483.2	2.0	-	-	5,192
-50	1885	0.33	0.622	483.2	1.9	-	-	10,003
-51	2640	0.34	0.898	483.2	1.9	563	18.6	14,442
-52	3400	0.35	1.190	483.2	1.9	-	-	19,135
-53	3850	0.38	1.463	483.2	1.9	-	-	23,526
-54	4600	0.39	1.794	483.2	1.9	-	-	28,850
-55	5410	0.39	2.110	483.2	2.1	581	43.4	33,930
-56	5800	0.39	2.262	483.2	2.0	-	-	36,375
-57	6190	0.40	2.476	483.2	2.3	-	-	39,820

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH, Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EI-58	6190	0.39	2.414	483.2	2.0	610	49.6	38,821
-59	6120	1.03	6.304	592.1	2.3	639	127.3	101,379
-60	6070	1.52	9.226	646.0	2.5	689	182.9	148,366
-61	6000	2.40	14.400	700.9	-	797	280.5	231,571
-62	0	0	0	700.9	2.0	793	0	0
-63	0	0	0	700.9	1.9	-	0	0
-64	0	0	0	0	2.2	-	0	0
-65	0	0	0	0	1.5	-	0	0
EK -1	0	0	0	0	1.0	-	0	0
-2	0	0	0	58.7	2.0	-	0	0
-3	0	0	0	123.0	2.1	-	0	0
-4	0	0	0	206.8	3.2	-	0	0
-5	0	0	0	330.0	3.0	-	0	0
-6	0	0	0	475.4	3.6	-	0	0
-7	0	0	0	691.3	4.6	-	0	0
-8	0	0	0	689.0	4.8	-	0	0
-9	0	0	0	686.7	2.6	-	0	0
-10	0	0	0	686.7	2.2	-	0	0
-11	0	0	0	488.3	1.8	-	0	0
-12	86	0.63	0.054	488.3	4.1	244	1.3	867
-13	86	0.62	0.053	488.3	1.6	-	1.2	853
-14	115	0.80	0.092	488.3	1.5	-	2.2	1,480
-15	130	0.93	0.120	488.3	1.5	248	2.8	1,932
-16	173	1.00	0.173	488.3	1.6	-	4.0	2,780
-17	187	0.82	0.153	488.3	1.5	-	3.6	2,460
-18	195	0.75	0.146	488.3	1.6	257	3.4	2,346
-19	907	0.80	0.725	488.3	2.1	-	17.0	11,657
-20	1800	0.70	1.260	488.3	2.5	-	29.5	20,261
-21	2565	0.68	1.744	488.3	2.4	271	40.8	28,045
-22	3340	0.70	2.338	488.3	2.4	-	54.8	37,600
-23	4170	0.70	2.919	488.3	2.5	-	67.6	46,944
-24	4580	0.70	3.206	488.3	2.5	306	74.3	51,557
-25	4970	0.70	3.479	488.3	2.2	-	80.6	55,948
-26	5000	0.69	3.450	488.3	2.0	-	79.1	55,482
-27	5375	0.68	3.655	488.3	2.0	361	83.8	58,780
-28	5800	0.62	3.596	488.3	1.9	-	81.6	57,828
-29	5800	0.60	3.480	488.3	1.8	-	78.2	55,962
-30	5800	0.53	3.074	488.3	1.7	433	68.4	49,456
-31	5800	0.52	3.016	488.3	1.6	-	65.7	48,503
-32	6130	0.50	3.065	488.3	1.7	-	66.8	49,290
-33	6200	0.43	2.666	488.3	1.7	500	57.5	42,873
-34	0	0	0	488.3	1.4	-	0	0
-35	0	0	0	709.2	1.6	-	0	0
-36	0	0	0	706.2	1.4	-	0	0
-37	0	0	0	488.3	1.3	-	0	0
-38	1000	0.23	0.230	488.3	1.4	434	5.0	3,699
-39	1870	0.25	0.467	488.3	1.3	-	10.2	7,511
-40	2700	0.28	0.756	488.3	1.4	-	16.5	12,156
-41	3460	0.28	0.968	488.3	1.4	434	21.1	15,568
-42	4220	0.28	1.181	488.3	1.4	-	25.7	18,993
-43	5010	0.29	1.452	488.3	1.4	-	31.6	23,352
-44	5430	0.30	1.629	488.3	1.4	451	35.5	26,198
-45	5820	0.30	1.746	488.3	1.4	-	37.7	28,078
-46	6230	0.30	1.869	488.3	1.4	-	40.3	30,057
-47	6200	0.68	4.216	523.9	1.6	487	91.0	67,798
-48	6150	1.08	6.642	637.1	1.9	-	140.6	106,812
-49	6100	1.58	9.638	678.5	2.5	-	200.2	154,990
-50	6050	2.15	13.007	692.0	4.0	-	267.6	209,172
-51	6030	2.25	13.567	692.0	6.2	671	276.5	218,176
-52	0	0	0	692.0	1.4	-	0	0

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EK -53	0	0	0	490.2	1.3	-	0	0
-54*	3025	0.30	0.907	490.2	1.5	622	19.0	14,588
-55*	2930	0.72	2.109	563.0	1.4	-	43.8	33,916
-56*	2850	1.08	3.078	618.4	1.5	-	63.9	49,498
-57	2810	1.30	3.653	618.4	1.4	606	75.9	58,747
-58	0	0	0	618.4	1.3	-	0	0
-59*	3640	1.07	3.894	618.4	1.6	-	80.9	62,620
-60	3600	1.28	4.608	618.4	1.5	613	115.4	90,184
-61	0	0	0	618.4	1.3	-	0	0
-62*	4470	1.07	4.782	618.4	1.6	-	98.4	76,901
-63	4425	1.29	5.708	618.4	1.5	633	116.3	91,791
-64	0	0	0	618.4	1.3	-	0	0
-65*	5410	1.05	5.680	618.4	1.6	-	116.9	91,343
-66	5300	1.28	6.784	618.4	1.5	662	137.0	109,097
-67	5730	1.28	7.334	618.4	1.6	-	148.1	117,941
-68	6120	1.23	7.527	618.4	1.7	-	152.0	121,046
-69	6070	2.00	12.140	715.2	2.4	738	240.8	195,229
-70	6050	2.13	13.886	715.2	2.2	-	253.3	207,226
-71	6050	2.18	13.189	715.2	2.4	-	256.9	212,098
-72	6050	2.22	13.431	715.2	2.7	901	259.4	215,990
-73	6030	2.30	13.869	715.2	3.0	-	265.4	223,034
-74	6020	2.42	14.568	715.2	4.1	-	276.4	234,276
-75	6000	2.60	15.600	715.2	6.2	1031	293.5	250,871
-76	0	0	0	715.2	1.9	-	0	0
-77	0	0	0	715.2	1.6	-	0	0
-78	0	0	0	565.1	1.6	-	0	0
-79*	2980	0.47	1.400	565.1	2.2	556	29.1	22,513
-80	3775	0.58	2.189	565.1	1.6	-	45.4	35,202
-81	4575	0.60	2.745	565.1	1.6	-	52.0	44,145
-82	5370	0.60	3.222	565.1	1.9	586	66.9	51,816
-83	5800	0.62	3.596	565.1	1.7	-	73.9	57,828
-84	6160	0.62	3.819	565.1	2.5	612	78.5	61,414
-85	0	0	0	565.1	1.6	-	0	0
-86	1000	0.49	0.490	565.1	1.6	-	10.1	7,878
-87	2200	0.53	1.166	565.1	1.6	581	24.2	18,753
-88	3770	0.58	2.186	565.1	1.6	-	45.3	35,155
-89	5370	0.60	3.222	565.1	1.7	-	66.2	51,816
-90	5820	0.62	3.608	565.1	1.7	615	74.2	58,021
-91	6180	0.62	3.831	565.1	2.9	-	78.8	61,607
-92	0	0	0	565.1	1.6	-	0	0
-93	720	0.48	0.345	565.1	1.6	558	7.1	5,546
-94	2200	0.52	1.144	565.1	1.7	-	23.7	18,395
-95	3760	0.58	2.180	565.1	1.7	-	45.2	35,056
-96	4530	0.60	2.718	565.1	1.7	574	56.4	43,711
-97	5370	0.62	3.329	565.1	1.7	-	69.1	53,536
-98	5300	1.10	5.830	659.2	2.0	-	119.9	93,756
-99	5230	1.68	8.786	709.2	2.1	664	177.4	141,293
-100	5500	1.72	9.460	709.2	2.2	-	189.3	152,130
-101	5500	1.73	9.515	709.2	2.2	-	185.3	153,016
-102	5760	1.72	9.907	709.2	2.2	864	193.0	159,321
-103	5910	1.77	10.460	709.2	2.6	-	200.2	168,212
-104	5900	1.91	11.269	709.2	3.0	-	210.2	181,221
-105	-	-	-	-	-	-	-	-
-106	5880	2.00	11.760	709.2	Off Scale	1069	217.5	189,118
-107	0	0	0	709.2	2.2	-	0	0
-108	993	0.23	0.228	520.7	2.0	-	4.3	3,666
-109	2275	0.23	0.523	520.7	2.1	891	9.9	8,411
-110	4630	0.25	1.157	520.7	2.2	-	21.9	18,607

*Indicates a transient test.

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EK-111	4350	1.85	8.047	700.3	2.5	-	152.7	129,405
-112	4325	2.02	8.736	700.3	2.8	1018	161.6	140,487
-113	4300	2.13	9.159	700.3	4.1	-	166.6	147,291
-114	4280	2.35	10.058	700.3	7.0	-	181.4	161,747
-115	3350	2.48	8.308	700.3	5.1	1177	149.9	133,603
-116	3340	2.53	8.450	700.3	6.2	-	151.2	135,889
-117	2925	2.55	7.458	700.3	5.7	-	133.4	119,934
-118	2900	2.60	7.540	700.3	6.4	1213	134.9	121,254
-119	2890	2.69	7.774	700.3	8.5	-	138.0	125,019
-120	2480	2.69	6.671	700.3	6.2	-	118.4	107,279
-121	2470	2.75	6.792	700.3	8.8	1261	119.6	109,225
-122	2635	2.00	5.270	675.5	6.2	-	-	84,709
-123	2635	1.98	5.217	675.5	7.5	-	91.8	83,899
-124	2620	2.00	5.240	675.5	8.8	1297	91.5	84,266
-125	2700	1.08	4.536	656.3	7.5	-	79.2	72,944
-126	2700	1.65	4.455	656.3	7.5	-	77.8	71,643
-127	2720	1.60	4.352	656.3	7.5	1308	76.0	69,985
-128	2785	1.28	3.564	630.7	6.2	-	62.2	57,314
-129	2815	1.20	3.378	630.7	6.2	-	59.0	54,322
-130	2835	1.19	3.373	630.7	6.6	1292	58.9	54,242
-131	2835	1.18	3.345	630.7	6.2	-	58.4	53,790
-132	2835	1.18	3.345	630.7	5.5	1272	58.4	53,790
-133	0	0	0	630.7	5.0	-	0	0
-134	0	0	0	630.7	2.2	-	0	0
-135	0	0	0	0	3.2	-	0	0
-136	0	0	0	0	2.1	-	0	0
EL -1	0	0	0	0	1.7	-	0	0
-2	0	0	0	59.3	2.0	-	0	0
-3	0	0	0	205.7	2.6	-	0	0
-4	0	0	0	489.5	3.7	-	0	0
-5	0	0	0	714.0	4.5	-	0	0
-6	0	0	0	706.1	4.6	-	0	0
-7	0	0	0	706.1	2.6	-	0	0
-8	58	0.62	0.036	706.1	7.5	237	0.8	580
-9	72	0.53	0.038	706.1	2.6	-	0.8	613
-10	115	1.00	0.115	706.1	2.8	-	2.6	1,847
-11	144	1.92	0.276	706.1	2.8	-	6.4	4,439
-12	230	2.78	0.639	706.1	2.8	246	14.9	10,276
-13	252	2.62	0.660	706.1	2.5	-	15.4	10,616
-14	316	2.72	0.860	706.1	2.5	-	20.1	13,829
-15	490	2.78	1.362	706.1	2.6	-	31.9	21,905
-16	735	2.80	2.058	706.1	2.8	284	47.6	33,096
-17	735	2.78	2.043	706.1	2.4	-	47.3	32,855
-18	1000	2.78	2.780	706.1	2.4	-	64.4	44,706
-19	1440	2.77	3.989	706.1	2.9	327	92.4	64,147
-20	1755	2.72	4.774	706.1	3.0	-	109.4	76,774
-21	2130	2.67	5.687	706.1	3.0	-	130.4	91,456
-22	2490	2.62	6.524	706.1	3.3	387	148.0	104,913
-23	2880	2.60	7.488	706.1	6.2	423	168.2	120,420
-24	0	0	0	706.1	2.2	-	0	0
-25	0	0	0	616.9	1.9	-	0	0
-26	115	1.00	0.115	616.9	1.7	-	2.6	1,847
-27	230	1.38	0.317	616.9	1.7	396	7.1	5,098
-28	360	1.41	0.508	616.9	1.9	-	11.5	8,170
-29	620	1.42	0.880	616.9	1.9	-	19.7	14,150
-30	1680	1.42	2.368	616.9	2.1	401	53.5	38,368
-31	2375	1.43	3.373	616.9	2.2	-	75.0	54,242
-32	3150	1.47	4.631	616.9	2.4	-	101.9	74,475
-33	3960	1.47	5.821	616.9	2.5	451	128.1	93,610
-34	4800	1.42	6.816	616.9	2.9	-	148.5	109,611

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10^{-5} Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EL-35	5220	1.42	7.412	616.9	-	495	159.9	119,195
-36	0	0	0	616.9	1.7	-	0	0
-37	0	0	0	514.8	1.6	-	0	0
-38	201	0.48	0.096	514.8	1.5	468	2.1	1,545
-39	865	0.53	0.458	514.8	1.6	-	10.0	7,365
-40	1830	0.54	0.988	514.8	1.9	-	21.5	15,888
-41	2950	0.57	1.682	514.8	1.9	460	36.6	27,051
-42	4130	0.58	2.395	514.8	2.0	-	52.2	38,514
-43	4950	0.60	2.970	514.8	2.0	-	64.1	47,764
-44	5800	0.60	3.480	514.8	3.0	486	75.1	55,962
-45	0	0	0	0	1.9	-	0	0
-46	6210	0	0	0	1.9	-	0	0
-47	6210	-	-	0	4.9	-	-	-
-48	0	0	0	0	1.7	-	0	0
-49	0	0	0	0	1.1	-	0	0
-50	0	0	0	0	0.8	-	0	0
-51	0	0	0	482.5	1.9	-	0	0
-52	0	0	0	482.5	1.1	-	0	0
-53	0	0	0	447.8	1.1	-	0	0
-54	1000	0.13	0.130	447.8	1.4	-	-	2,092
-55	2320	0.13	0.302	447.8	1.4	-	-	4,858
-56	3860	0.18	0.695	447.8	1.4	-	-	11,176
-57	4630	0.20	0.926	447.8	1.4	-	-	14,889
-58	0	0	0	447.8	1.2	-	-	0
EM -1	0	0	0	0	0.8	-	0	0
-2	0	0	0	206.8	2.4	-	0	0
-3	0	0	0	485.0	3.4	-	0	0
-4	0	0	0	700.3	5.0	-	0	0
-5	0	0	0	700.3	1.5	-	0	0
-6	0	0	0	338.9	1.4	-	0	0
-7	0	0	0	338.9	1.4	-	0	0
-8	173	0.02	0.003	338.9	2.2	239	0.1	47
-9	173	0.02	0.003	338.9	1.5	-	0.1	47
-10	1000	0.02	0.020	338.9	1.5	-	0.5	320
-11	980	0.20	0.196	462.9	2.4	240	4.6	3,152
-12	980	0.25	0.245	462.9	1.5	-	5.7	3,939
-13	0	0	0	462.9	1.1	-	0	0
-14	187	0.20	0.037	462.9	1.4	259	0.8	594
-15	1000	0.20	0.200	462.9	1.4	-	4.6	3,218
-16	1890	0.22	0.415	462.9	1.5	-	9.7	6,672
-17	3050	0.22	0.671	462.9	1.6	266	15.7	10,790
-18	3830	0.22	0.842	462.9	1.6	-	19.7	13,542
-19	4610	0.23	1.060	462.9	1.6	-	24.8	17,047
-20	5010	0.23	1.152	462.9	1.5	306	26.6	18,527
-21	0	0	0	462.9	1.1	-	0	0
-22	173	0.13	0.022	462.9	1.1	-	0.5	353
-23	1000	0.13	0.130	462.9	1.2	315	2.9	2,092
-24	1885	0.16	0.301	462.9	1.2	-	6.9	4,839
-25	3040	0.18	0.547	462.9	1.2	-	12.5	8,797
-26	3860	0.18	0.694	462.9	1.4	320	15.9	11,162
-27	4610	0.18	0.829	462.9	1.4	-	18.8	13,330
-28	5025	0.19	0.594	462.9	1.4	-	13.4	9,551
-29	5420	0.19	1.029	462.9	1.4	333	23.3	16,548
-30	5780	0.19	1.098	462.9	1.4	-	24.9	17,655
-31	5780	0.21	1.213	462.9	1.4	-	27.2	19,507
-32	6190	0.21	1.299	462.9	1.2	396	28.8	20,887
-33	6190	0.21	1.299	462.9	1.1	-	28.8	20,887
-34	6170	0.27	1.665	498.5	1.2	-	36.6	26,777
-35	6170	0.28	1.727	498.5	1.1	441	37.6	27,771
-36	6170	0.40	2.468	524.0	1.4	-	53.7	39,688

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EM-37	6190	0.43	2.661	524.0	1.4	-	57.4	42,793
-38	6170	0.59	3.640	555.3	1.4	522	77.7	58,535
-39	6180	0.60	3.708	555.3	1.5	-	77.7	59,628
-40	6150	0.78	4.797	591.2	1.6	-	99.6	77,142
-41	6160	0.82	5.051	591.2	2.0	689	102.0	81,227
-42	6130	0.98	6.007	624.8	1.7	-	120.2	96,602
-43	6100	1.21	7.381	665.7	1.9	-	145.0	118,695
-44	6100	1.20	7.320	665.7	1.7	847	141.3	117,715
-45	6075	1.42	8.626	687.3	2.1	-	165.1	138,716
-46	6060	1.62	9.817	706.8	2.4	-	184.7	157,869
-47	6050	1.68	10.164	706.8	2.6	1004	189.6	163,453
-48	6060	1.78	10.786	706.8	3.3	-	199.5	173,456
-49	6050	1.90	11.495	706.8	3.6	-	210.8	184,854
-50	6035	2.12	12.794	706.8	5.9	-	232.7	205,746
-51	6000	3.00	18.000	706.8	2.6	1152	327.4	289,466
-52	0	0	0	706.8	2.4	-	0	0
-53	0	0	0	706.8	1.4	-	0	0
-54	0	0	0	532.0	1.4	-	0	0
-55	120	0.38	0.045	532.0	1.4	635	0.9	726
-56	980	0.40	0.392	532.0	1.5	-	7.9	6,304
-57	1870	0.43	0.804	532.0	1.4	-	16.3	12,929
-58	2980	0.46	1.370	532.0	1.5	635	27.9	22,032
-59	3760	0.49	1.842	532.0	1.5	-	37.5	29,623
-60	4570	0.50	2.285	532.0	1.5	-	46.5	36,747
-61	5360	0.50	2.680	532.0	1.4	649	54.6	43,099
-62	5370	0.50	2.685	532.0	1.5	-	54.2	43,179
-63	5790	0.51	2.952	532.0	1.5	-	59.6	47,472
-64	6180	0.50	3.090	532.0	1.5	702	62.4	49,691
-65	6530	0.50	3.265	532.0	1.5	-	65.3	52,504
-66	6500	0.70	4.550	591.2	1.6	-	90.2	73,170
-67	6470	1.05	6.793	652.5	1.6	802	132.3	109,243
-68	6450	1.42	9.159	687.3	1.9	-	175.3	147,291
-69	6450	1.52	9.804	687.3	2.0	-	186.0	157,662
-70	6435	1.64	10.553	687.3	2.1	963	198.5	169,705
-71	6420	1.73	11.106	705.0	2.2	-	208.9	178,601
-72	6400	1.87	11.968	705.0	2.5	-	223.2	192,463
-73	6370	2.00	12.740	705.0	3.6	1078	235.6	204,874
-74	6330	3.00	18.990	705.0	-	-	348.3	305,387
-75	0	0	0	705.0	1.9	-	0	0
-76	0	0	0	705.0	1.6	-	0	0
-77	0	0	0	520.7	1.5	-	0	0
-78	115	0.30	0.034	520.7	1.5	682	0.6	547
-79	950	0.33	0.313	520.7	1.6	-	6.3	5,032
-80	2450	0.32	0.784	520.7	1.5	-	15.8	12,609
-81	3780	0.40	1.548	520.7	1.5	680	31.2	24,893
-82	5400	0.40	2.160	520.7	1.5	-	43.6	34,735
-83	5800	0.42	2.436	520.7	1.5	-	48.7	39,174
-84	6200	0.43	2.666	520.7	1.6	705	53.3	42,873
-85	6580	0.42	2.763	520.7	1.6	-	55.2	44,432
-86	6940	0.41	2.845	520.7	1.5	-	56.9	45,752
-87	0	0	0	520.7	3.6	739	0	0
-88	0	0	0	520.7	1.5	-	0	0
-89	1000	0.30	0.300	520.7	1.5	-	6.0	4,825
-90	5420	0.39	2.113	520.7	1.5	718	42.2	33,982
-91	5830	0.39	2.273	520.7	1.5	-	45.4	36,554
-92	6220	0.40	2.488	520.7	1.5	-	49.7	40,013
-93	6610	0.39	2.577	520.7	1.6	747	51.1	41,440
-94	3790	0.33	1.250	520.7	1.4	-	25.0	20,101
-95	5400	0.38	2.052	520.7	1.5	-	40.6	32,997
-96	6220	0.39	2.425	520.7	1.5	738	48.0	39,000

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EM -97	6600	0.39	2.574	520.7	1.5	-	51.0	41,393
-98	6960	0.38	2.644	520.7	1.5	-	52.4	42,519
-99	6925	0.63	4.362	579.3	1.5	784	85.7	70,149
-100	6900	0.97	6.693	637.1	1.6	-	130.3	107,632
-101	6840	1.40	9.576	682.6	1.9	-	181.7	153,996
-102	6800	1.63	11.084	693.2	2.1	950	208.5	178,248
-103	6770	2.00	13.540	693.2	2.6	-	252.5	217,742
-104	6730	2.50	16.825	693.2	10.1	-	-	270,571
-105	6700	3.00	20.100	693.2	Off Scale	1112	371.8	323,235
-106	0	0	0	693.2	1.9	-	0	0
ER -1	0	0	0	0	1.4	221	0	0
-2	0	0	0	60.9	1.7	-	0	0
-3	0	0	0	205.7	2.1	-	0	0
-4	0	0	0	478.0	3.8	-	0	0
-5	0	0	0	700.3	4.0	230	0	0
-6	0	0	0	689.6	2.1	-	0	0
-7	58	0.48	0.027	689.6	2.1	-	0.6	433
-8	130	1.40	0.182	689.6	2.1	252	4.3	2,926
-9	135	1.38	0.186	689.6	2.4	-	4.3	2,987
-10	187	2.28	0.426	689.6	2.4	-	9.8	6,846
-11	0	0	0	689.6	2.1	279	0	0
-12	0	0	0	493.4	2.0	-	0	0
-13	925	0.43	0.397	493.4	2.0	-	9.3	6,380
-14	0	0	0	493.4	1.5	282	0	0
-15	965	0.32	0.308	493.4	1.9	-	7.1	4,952
-16	920	0.45	0.414	493.4	1.7	-	9.6	6,653
-17	0	0	0	576.0	1.6	289	0	0
-18	865	1.00	0.865	576.0	1.9	-	11.5	13,909
-19	865	1.07	0.925	576.0	1.9	-	21.4	14,875
-20	0	0	0	576.0	1.6	300	0	0
-21	1845	0.73	1.346	576.0	2.0	-	31.1	21,641
-22	1770	1.03	1.823	576.0	1.9	-	41.4	29,312
-23	0	0	0	576.0	1.6	325	0	0
-24	2500	0.88	2.200	576.0	2.0	-	50.4	35,376
-25	2470	1.03	2.544	576.0	1.8	-	57.1	40,908
-26	0	0	0	576.0	1.6	-	0	0
-27	3285	0.80	2.628	576.0	1.7	374	59.0	42,260
-28	3270	1.00	3.270	576.0	1.7	-	72.7	52,584
-29	0	0	0	576.0	1.6	-	0	0
-30	4100	0.82	3.362	576.0	1.7	408	74.7	54,063
-31	4070	0.93	3.785	576.0	1.7	-	83.3	60,867
-32	0	0	0	689.6	1.6	-	0	0
-33	0	0	0	689.6	1.2	419	0	0
-34	863	1.82	1.570	689.6	1.2	-	31.4	25,246
-35	1910	1.90	3.629	689.6	1.4	-	72.6	58,356
-36	1850	2.13	3.940	681.4	1.4	473	85.4	63,360
-37	2630	2.05	5.391	681.4	1.5	-	116.3	86,693
-38	3450	2.05	7.072	681.4	1.6	-	149.7	113,724
-39	3410	2.23	7.604	681.4	1.9	603	157.9	122,281
-40	4290	2.17	9.309	681.4	3.2	-	191.5	149,699
-41	4290	2.15	9.223	681.4	5.9	-	187.9	148,318
-42	4290	2.07	8.880	681.4	7.5	739	179.3	142,801
-43	4290	2.05	8.794	681.4	2.9	-	176.0	141,416
-44	4300	2.07	8.901	681.4	1.9	-	173.4	143,140
-45	5160	2.02	10.423	681.4	2.2	910	201.3	167,613
-46	5160	2.18	11.248	681.4	2.9	-	209.8	180,882
-47	5180	2.07	10.722	676.2	2.9	-	198.3	172,424
-48	5160	2.18	11.248	676.2	4.6	1130	206.3	180,882
-49	5180	2.00	10.360	665.7	4.9	-	188.5	166,600
-50	5160	2.18	11.248	665.7	8.2	-	201.3	180,882

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
ER -51	5200	1.93	10.036	645.1	6.2	1232	179.6	161,389
-52	5170	2.19	11.322	645.1	Off Scale	-	201.0	182,069
-53	5180	2.00	10.360	599.8	Off Scale	1278	183.9	166,600
-54	0	0	0	599.8	Off Scale	-	0	0
-55	0	0	0	706.8	4.4	-	0	0
-56	0	0	0	706.8	1.4	892	0	0
-57	0	0	0	706.8	1.2	-	0	0
-58	763	2.21	1.686	706.8	1.1	-	34.0	27,112
-59	2230	2.18	4.861	706.8	1.2	657	97.3	78,167
-60	3450	2.15	7.417	706.0	1.2	-	147.1	119,275
-61	4330	2.08	9.006	706.8	1.5	-	178.6	144,827
-62	5210	1.98	10.315	706.8	1.6	774	202.7	165,879
-63	5660	1.97	11.150	706.8	2.0	-	215.3	179,303
-64	5620	2.30	12.926	706.8	2.2	-	245.3	207,866
-65	5650	2.00	11.300	682.0	2.2	1018	212.6	181,716
-66	5620	2.30	12.926	682.0	2.8	-	239.1	207,866
-67	5650	2.00	11.300	662.8	2.9	-	207.3	181,716
-68	5630	2.20	12.386	662.8	5.9	1170	225.3	199,182
-69	5630	2.05	11.541	642.2	7.7	-	206.5	185,594
-70	5660	1.92	10.867	622.6	10.1	-	194.5	174,756
-71	-	-	-	622.6	Off Scale	1260	-	-
-72	0	0	0	468.0	1.7	-	0	0
-73	0	0	0	706.8	1.9	-	0	0
-74	0	0	0	706.8	1.4	658	0	0
-75	750	2.18	1.635	706.8	1.1	-	33.01	26,292
-76	3480	2.08	7.238	706.8	1.4	-	144.8	116,396
-77	4320	2.05	8.856	706.8	1.5	707	175.6	142,415
-78	5210	1.97	10.263	706.8	1.7	-	201.7	165,041
-79	5650	1.93	10.904	706.8	2.1	-	210.5	175,350
-80	6030	2.15	12.964	706.8	2.9	932	248.2	208,479
-81	6025	2.38	14.339	706.8	4.4	-	269.8	230,591
-82	6030	2.00	12.060	685.0	3.3	-	-	193,938
-83	6030	2.30	13.869	685.0	3.8	1042	258.7	223,029
-84	6050	2.00	12.100	665.7	3.6	-	225.7	194,584
-85	6030	2.20	13.266	665.7	6.2	-	243.3	213,332
-86	6040	2.00	12.080	640.0	7.5	1202	219.8	194,263
-87	6040	2.00	12.080	640.0	8.2	-	218.0	194,263
-88	0	0	0	146.7	2.0	-	0	0
-89	0	0	0	706.8	1.9	1157	0	0
-90	0	0	0	706.8	1.6	-	0	0
-91	0	0	0	587.2	1.4	-	0	0
-92	880	0.83	0.730	587.2	1.2	810	13.6	11,737
-93	3740	0.87	3.253	587.2	1.5	-	62.8	52,311
-94	4500	0.90	4.050	587.2	1.5	-	78.2	65,127
-95	5330	0.92	4.903	587.2	1.5	847	93.8	78,843
-96	5760	0.92	5.299	587.2	1.6	-	101.4	85,213
-97	6150	0.92	5.658	587.2	1.5	-	108.3	90,985
-98	6150	1.07	6.580	632.0	1.6	907	122.7	105,813
-99	6120	1.25	7.650	632.0	1.9	-	142.7	123,021
-100	6100	1.50	9.150	632.0	2.1	-	169.2	147,140
-101	6150	1.05	6.457	564.9	2.1	1112	118.4	103,834
-102	0	0	0	0	2.6	-	0	0
-103	0	0	0	0	3.3	-	0	0
-104	0	0	0	0	2.2	-	0	0
EV -1	0	0	0	0	1.2	-	0	0
-2	0	0	0	203.5	2.0	-	0	0
-3	0	0	0	709.2	3.4	-	0	0
-4	0	0	0	693.3	1.5	-	0	0
-5	0	0	0	508.9	1.5	-	0	0
-6	144	0.31	0.044	508.9	2.4	-	1.0	707

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux; Btu/hr-ft ²
EV -7	950	0.42	0.399	508.9	2.1	-	9.3	6,417
-8	2200	0.47	1.034	508.9	2.2	-	24.2	16,628
-9	3770	0.47	1.772	508.9	2.2	-	41.4	28,497
-10	4610	0.48	2.213	508.9	2.2	-	51.6	35,588
-11	4610	0.60	2.766	508.9	2.0	-	63.3	44,480
-12	4970	0.60	2.982	508.9	2.0	-	68.3	47,957
-13	4970	0.60	2.982	508.9	2.1	-	67.6	47,957
-14	0	0	0	508.9	1.7	-	0	0
-15	0	0	0	508.9	1.1	-	0	0
-16	0	0	0	508.9	0.7	-	0	0
-17	1000	0.38	0.380	508.9	0.8	-	8.6	6,111
-18	1845	0.43	0.793	508.9	0.8	-	17.9	13,756
-19	2985	0.48	1.433	508.9	0.8	-	32.1	23,045
-20	3770	0.48	1.810	508.9	0.8	-	40.6	29,110
-21	4570	0.49	2.239	508.9	1.0	-	50.2	36,008
-22	4570	0.52	2.376	508.9	1.0	-	52.7	38,208
-23	5375	0.52	2.795	508.9	1.1	-	61.4	44,946
-24	5800	0.52	3.016	508.9	1.1	-	65.7	48,503
-25	5800	0.52	3.016	508.9	1.1	-	-	48,503
-26	6200	0.52	3.224	508.9	1.1	601	67.5	51,849
-27	6200	0.48	2.976	508.9	1.1	-	61.2	47,858
-28	6580	0.48	3.158	508.9	1.2	649	64.9	50,784
-29	6580	0.48	3.158	508.9	1.1	-	64.3	50,784
-30	6960	0.48	3.341	508.9	1.2	693	68.1	53,729
-31	6970	0.40	2.788	508.9	1.7	-	56.3	44,833
-32	6970	0.43	2.997	508.9	1.2	-	60.5	48,197
-33	7300	0.42	3.066	508.9	1.4	727	61.9	49,304
-34	7300	0.42	3.066	508.9	1.2	-	61.3	49,304
-35	7560	0.42	3.175	508.9	-	747	64.1	51,057
-36	0	0	0	508.9	1.1	-	0	0
-37	0	0	0	721.7	1.2	-	0	0
-38	0	0	0	721.7	1.0	-	0	0
-39	260	2.47	0.642	721.7	0.8	-	13.5	10,324
-40	533	2.58	1.375	721.7	1.0	-	29.1	22,113
-41	820	2.63	2.157	721.7	1.0	-	45.2	34,688
-42	793	2.70	2.141	721.7	1.0	-	44.8	34,429
-43	1440	2.71	3.902	721.7	1.2	-	81.8	62,752
-44	2490	2.68	6.673	721.7	2.0	-	138.5	107,312
-45	3310	2.60	8.606	721.7	2.2	-	177.0	138,395
-46	4230	2.47	10.448	721.7	2.6	-	209.0	168,019
-47	4650	2.40	11.160	721.7	3.0	781	221.3	179,468
-48	5120	2.48	12.698	721.7	3.2	-	247.3	204,201
-49	5520	2.78	15.346	721.7	6.2	952	293.7	246,786
-50	5575	2.30	12.823	682.7	4.1	-	243.3	206,212
-51	6000	2.53	15.180	682.7	10.1	-	288.0	244,114
-52	5975	2.68	16.013	682.7	-	1099	301.2	257,510
-53	6020	2.40	14.448	667.0	7.5	-	269.5	232,344
-54	6380	2.20	14.036	641.3	-	-	259.6	225,719
-55	6625	3.00	19.875	641.3	-	1230	364.6	319,616
-56	0	0	0	641.3	1.7	-	0	0
-57	0	0	0	712.8	1.4	-	0	0
-58	0	0	0	712.8	1.1	-	0	0
-59	245	2.48	0.608	712.8	0.8	-	12.2	9,777
-60	1730	2.81	4.861	712.8	1.0	-	97.2	78,174
-61	2465	2.93	7.222	712.8	1.4	-	143.2	116,141
-62	3730	2.80	10.444	712.8	1.7	-	203.4	167,952
-63	5070	2.80	14.196	712.8	3.6	-	274.1	228,292
-64	5110	2.42	12.366	685.0	2.0	-	238.7	198,862
-65	5590	2.53	14.143	685.0	2.5	939	270.7	227,439
-66	5640	2.03	11.449	645.8	1.9	-	217.2	184,114

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10^{-5} Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
EV-67	6050	2.07	12.524	645.8	2.4	1009	235.6	201,402
-68	6490	-	-	645.8	-	-	-	-
-69	0	0	0	645.8	1.9	-	0	0
-70	0	0	0	645.8	1.1	-	0	0
-71	0	0	0	635.6	1.1	-	0	0
-72	835	1.38	1.152	635.6	1.0	-	23.4	18,527
-73	1685	1.50	2.528	635.6	1.0	-	51.0	40,654
-74	3570	1.59	5.676	635.6	1.1	-	113.5	91,277
-75	4900	1.60	7.840	635.6	1.6	-	156.8	126,079
-76	5730	1.58	9.053	635.6	1.4	-	179.5	145,586
-77	6170	1.58	9.749	635.6	1.6	-	191.6	156,776
-78	6150	1.61	9.902	635.6	1.6	885	192.9	159,240
-79	6510	1.62	10.546	635.6	2.0	-	201.8	169,592
-80	6480	1.76	11.405	635.6	2.1	-	216.4	183,407
-81	6820	1.90	12.958	635.6	2.9	1013	243.8	208,385
-82	0	0	0	635.6	3.0	-	0	0
-83	0	0	0	635.6	1.0	-	0	0
-84	0	0	0	635.6	1.0	-	0	0
-85	0	0	0	0	1.4	-	0	0
-86	0	0	0	0	1.1	-	0	0
FA -1	0	0	0	0	2.2	226	0	0
-2	0	0	0	209.7	4.5	-	0	0
-3	0	0	0	724.1	7.5	-	0	0
-4	534	3.00	1.602	724.1	5.7	234	37.5	25,764
-5	476	3.20	1.523	724.1	4.2	-	35.7	24,492
-6	1440	2.80	4.032	724.1	5.1	-	93.4	64,839
-7	2565	2.65	6.797	724.1	4.9	279	155.9	109,305
-8	2480	3.00	7.440	724.1	4.5	-	168.8	119,647
-9	2450	3.13	7.668	724.1	4.4	-	174.0	123,313
-10	3500	2.94	9.702	724.1	8.2	369	220.2	156,022
-11	3270	3.13	10.235	724.1	-	-	229.9	164,593
-12	4260	3.90	16.614	724.1	-	-	373.2	267,179
-13	0	0	0	724.1	3.0	405	0	0
-14	505	2.96	1.495	724.1	2.8	-	34.6	24,040
-15	1440	3.00	4.320	724.1	2.9	-	99.1	69,471
-16	2480	2.97	7.366	724.1	3.3	419	165.5	118,455
-17	3340	2.90	9.686	724.1	4.1	-	215.4	155,763
-18	4240	2.83	11.999	724.1	3.0	-	266.8	192,963
-19	-	4.20	-	724.1	-	487	-	-
-20	0	0	0	724.1	3.0	-	0	0
-21*	2600	2.58	6.708	724.1	3.0	-	150.7	107,872
-22	2490	2.95	7.345	724.1	2.9	477	160.1	118,116
-23	2480	3.00	7.440	724.1	3.0	-	162.2	119,647
-24	0	0	0	710.9	2.8	-	0	0
-25*	3390	2.53	8.577	710.9	3.0	482	186.9	137,929
-26	3330	2.87	9.557	710.9	3.2	-	204.2	153,690
-27	3330	2.87	9.557	710.9	5.5	-	204.2	153,690
-28	0	0	0	710.9	2.9	550	0	0
-29*	4280	2.52	10.786	710.9	3.2	-	235.1	173,456
-30	4250	2.71	11.517	710.9	6.2	-	241.5	185,212
-31	0	0	0	727.6	2.8	585	0	0
-32*	4630	2.98	13.797	727.6	3.6	-	294.9	221,875
-33	4630	3.10	14.353	727.6	4.4	-	295.3	230,818
-34	4630	3.10	14.353	727.6	8.0	680	292.6	230,818
-35	4625	3.12	14.430	727.6	8.8	-	291.4	232,057
-36	4700	2.75	12.925	725.0	5.0	-	258.7	207,852
-37	5130	2.79	14.313	725.0	5.1	869	281.3	230,172
-38	5160	2.49	12.848	703.2	4.6	-	250.3	206,613

*Indicates a transient test.

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10^{-5} Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
FA-39	5640	2.53	14.269	703.2	6.6	-	275.5	229,465
-40	6040		-	703.2	4.0	991	-	-
-41	0	0	0	703.2	3.2	-	0	0
-42	0	0	0	703.2	2.1	-	0	0
-43	0	0	0	703.2	1.6	504	0	0
-44	620	1.56	0.967	671.6	1.6	-	20.5	15,549
-45	2050	1.62	3.321	671.6	1.9	-	69.6	53,408
-46	3570	1.68	5.998	671.6	2.0	554	124.6	96,456
-47	4425	1.66	7.345	671.6	2.1	-	152.5	118,116
-48	5300	1.63	8.639	671.6	2.2	-	177.7	138,928
-49	5730	1.60	9.168	671.6	2.4	653	186.9	147,433
-50	6150	1.58	9.717	671.6	2.5	-	194.5	156,263
-51	6150	1.58	9.717	671.6	Off Scale	-	194.5	156,263
-52	0	0	0	671.6	2.8	613	0	0
-53	648	1.55	1.004	671.6	2.4	-	20.6	16,147
-54	3600	1.60	5.760	671.6	2.6	-	116.3	92,630
-55	3455	2.34	8.085	721.2	2.8	691	161.8	130,018
-56	4350	2.23	9.700	721.2	2.9	-	192.4	155,989
-57	4330	2.30	9.959	721.2	3.2	-	189.0	160,155
-58	4300	2.50	10.750	721.2	4.0	1027	200.6	172,876
-59	4270	2.70	11.529	721.2	4.9	-	213.3	185,400
-60	3780	2.90	10.962	721.2	4.8	-	202.8	176,283
-61	245	2.55	0.624	721.2	2.6	1079	11.6	10,036
-62	274	1.93	0.599	680.4	2.5	-	11.2	9,630
-63	1585	2.07	3.281	680.4	2.8	-	61.2	52,763
-64	3470	2.10	7.287	680.4	3.2	1040	133.7	117,188
-65	4370	2.17	9.483	680.4	4.1	-	174.0	152,498
-66	4300	2.42	10.406	680.4	7.5	-	187.8	167,345
-67	4230	2.75	11.632	680.4	-	1198	208.2	187,059
-68	3340	2.72	9.084	680.4	6.2	-	162.6	146,085
-69	3320	2.80	9.296	680.4	8.8	-	165.0	149,492
-70	2550	2.70	4.590	680.4	6.2	1243	81.5	73,815
-71	2550	2.68	6.834	680.4	7.6	-	120.3	109,898
-72	2550	2.68	6.834	680.4	6.2	-	119.2	109,898
-73	2150	2.61	5.611	680.4	6.7	1285	98.0	90,231
-74	2160	2.59	6.863	680.4	7.2	-	118.9	110,365
-75	1830	2.57	4.703	680.4	6.2	-	81.5	75,629
-76	1840	2.50	4.600	680.4	6.6	1292	79.7	73,975
-77	1840	2.42	4.453	680.4	7.1	-	77.2	71,610
-78	1685	2.42	4.078	680.4	6.6	-	70.7	65,579
-79	1685	2.40	4.044	680.4	7.0	1305	70.1	65,032
-80	1685	2.38	4.010	680.4	6.7	-	69.5	64,486
-81	0	0	0	680.4	5.4	-	0	0
-82	0	0	0	680.4	2.4	941	0	0
-83	0	0	0	680.4	2.0	-	0	0
-84	110	0.90	0.0099	680.4	1.7	-	0.2	160
-85	110	0.91	0.0100	680.4	1.9	703	0.2	160
-86	0	0	0	680.4	2.0	-	0	0
-87	0	0	0	0	2.8	-	0	0
-88	0	0	0	0	1.9	685	0	0
FE -1	0	0	0	0	0.8	-	0	0
-2	0	0	0	209.4	3.0	-	0	0
-3	0	0	0	715.2	6.4	-	0	0
-4	0	0	0	705.6	3.0	-	0	0
-5	0	0	0	742.5	1.6	-	0	0
-6	0	0	0	736.6	1.6	284	0	0
-7	80	0.93	0.074	736.6	3.0	-		1,192
-8	100	0.80	0.080	736.6	1.6	-		1,286
-9	216	2.88	0.622	736.6	2.0	-		10,003
-10	216	2.82	0.609	736.6	1.6	316	13.9	9,796

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
FE-11	460	3.13	1.439	736.6	1.9	-		23,140
-12	465	3.10	1.442	736.6	1.6	-		23,192
-13	765	3.17	2.425	736.6	1.7	-		39,000
-14	1040	3.25	3.380	736.6	1.7	403	74.4	54,355
-15	1330	3.25	4.323	736.6	1.9	-		69,518
-16	1655	3.23	5.346	736.6	2.0	-		85,972
-17	1990	3.13	6.229	736.6	2.0	478	134.4	100,173
-18	2430	3.00	7.290	736.6	2.1	-		117,235
-19	2835	3.00	8.505	736.6	2.2	-		136,775
-20	3270	2.93	9.581	736.6	3.2	673	197.1	154,076
-21	3740	2.72	10.173	736.6	3.6	-		163,594
-22	4220	2.50	10.550	736.6	2.8	894	205.5	169,658
-23	-	-	-	736.6	5.9	-		-
-24	0	0	0	736.6	3.0	-	0	0
-25	0	0	0	736.6	1.2	505	0	0
-26	245	2.31	0.566	736.6	1.1	-		9,103
-27	835	2.45	2.046	736.6	1.2	-		32,903
-28	1480	2.50	3.700	736.6	1.4	525	77.5	59,501
-29	2160	2.47	5.335	736.6	1.4	-		85,793
-30	2980	2.43	7.241	736.6	1.5	-		116,448
-31	3360	2.44	8.198	736.6	1.5	639	168.6	131,837
-32	3815	2.40	9.154	736.6	1.5	-		147,211
-33	4300	2.32	9.976	736.6	1.6	-		160,428
-34	4380	1.82	7.972	688.6	2.2	831	158.1	128,199
-35	0	0	0	721.7	1.7	-	0	0
-36	0	0	0	721.7	1.4	653	0	0
-37	880	2.62	2.306	721.7	1.4	-		37,082
-38	1765	2.67	4.713	721.7	1.4	-		75,790
-39	2490	2.67	6.648	721.7	1.5	685	131.8	106,911
-40	3340	2.55	8.517	721.7	1.5	-		136,968
-41	3820	2.52	9.626	721.7	1.6	-		154,802
-42	4275	2.43	10.388	721.7	1.7	812	202.3	167,053
-43	4710	2.37	11.163	721.7	1.9	-		179,515
-44	5180	2.28	11.810	721.7	2.1	-		189,924
-45	5615	2.23	12.521	721.7	2.8	961	237.6	201,355
-46	6030	2.20	13.266	721.7	4.1	-		213,337
-47	6030	2.30	13.869	721.7	7.1	-		223,034
-48	6010	2.50	15.025	721.7	-	1081	280.3	241,622
-49	0	0	0	0	3.6	-	0	0
-50	0	0	0	0	1.2	-	0	0
-51	0	0	0	0	1.0	-	0	0
-52	0	0	0	0	1.5	-	0	0
-53	0	0	0	0	1.0	-	0	0

APPENDIX B

Tabulation of EBH Data for 0.030-in.-diam Pure-tungsten Cathodes

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10^{-5} Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
GH -1	0	0	0	0	1.5	-	0	0
-2	0	0	0	635.6	4.5	-	0	0
-3	0	0	0	648.0	1.5	233	0	0
-4	0	0	0	648.0	1.4	-	0	0
-5	72	0.73	0.052	648.0	6.3	-	1.2	834
-6	173	1.20	0.207	648.0	2.1	-	4.8	3,327
-7	0	0	0	648.0	1.2	-	0	0
-8	317	1.51	0.478	648.0	1.7	-	11.1	7,685
-9	892	1.59	1.418	648.0	1.6	-	32.9	22,805
-10	1640	1.58	2.591	648.0	1.9	-	59.4	41,667
-11	2770	1.56	4.321	648.0	2.6	-	98.1	69,490
-12	3570	1.56	5.569	648.0	2.1	-	125.1	89,557
-13	4370	1.56	6.817	648.0	1.5	-	153.1	109,625
-14	0	0	0	648.0	1.4	-	0	0
-15	320	0.90	0.288	648.0	1.9	350	6.5	4,632
-16	1000	1.15	1.150	648.0	1.5	-	25.8	18,494
-17	1705	1.15	1.960	648.0	1.6	-	43.6	31,517
-18	2850	1.13	3.220	648.0	1.9	-	71.6	51,783
-19	3620	1.23	4.452	648.0	1.7	410	98.0	71,596
-20	4420	1.20	5.304	648.0	1.7	-	115.4	85,298
-21	5290	1.18	6.242	648.0	1.9	648	129.6	100,380
-22	-	-	-	648.0	1.6	-	-	-
-23	0	0	0	648.0	1.6	-	0	0
-24	300	1.13	0.339	648.0	1.6	580	7.0	5,452
-25	1000	1.20	1.200	648.0	1.6	-	24.9	19,300
-26	1710	1.27	2.171	648.0	1.6	-	44.7	34,915
-27	2840	1.29	3.663	648.0	1.6	590	75.4	73,043
-28	3625	1.30	4.712	648.0	1.7	-	96.9	75,775
-29	4500	1.28	5.760	648.0	1.7	-	117.4	92,630
-30	4490	1.17	5.253	648.0	2.0	805	104.2	84,473
-31	4520	1.12	5.062	648.0	2.1	-	96.9	81,406
-32	4530	1.07	4.847	648.0	2.5	990	90.4	77,948
-33	4520	1.11	5.017	648.0	2.9	-	92.0	80,680
-34	4510	1.18	5.321	648.0	3.6	-	96.0	85,571
-35	4490	1.33	5.971	648.0	4.6	1180	106.9	96,022
-36	4470	1.50	6.705	648.0	6.2	-	119.0	107,825
-37	4450	1.68	7.476	648.0	8.8	1237	132.7	120,227
-38	4425	1.77	7.832	648.0	10.1	-	137.9	125,951
-39	4420	1.87	8.265	648.0	12.7	-	145.5	132,911
-40	4380	1.95	8.541	648.0	Off Scale	1293	150.4	137,349
-41	4420	0.90	3.978	576.1	6.7	-	70.0	63,972
-42	2180	0.82	1.787	576.1	4.6	-	31.7	28,737
-43	2010	1.67	3.356	648.0	5.1	1272	59.1	53,969
-44	2010	1.65	3.316	648.0	5.0	-	58.4	53,328
-45	0	0	0	648.0	4.5	-	0	0
-46	0	0	0	648.0	2.1	633	0	0
-47	1000	0.94	0.940	648.0	2.6	-	19.1	15,115
-48	1752	1.06	1.857	648.0	2.2	-	37.8	29,863
-49	2910	1.06	3.084	648.0	2.2	-	62.8	49,597
-50	3710	1.08	4.006	648.0	2.2	650	80.9	64,420
-51	4530	1.05	4.756	648.0	2.2	-	94.3	76,482
-52	5370	1.02	5.477	648.0	2.4	-	108.6	88,078
-53	5370	1.00	5.370	648.0	2.4	862	105.3	86,358
-54	0	0	0	648.0	2.1	-	0	0
-55	0	0	0	0	2.9	-	0	0

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
GI -1	0	0	0	0	2.2	-	0	0
-2	0	0	0	126.0	2.1	-	0	0
-3	0	0	0	230.4	3.7	-	0	0
-4	0	0	0	399.8	7.0	-	0	0
-5	0	0	0	510.9	5.4	-	0	0
-6	0	0	0	648.0	4.6	-	0	0
-7	0	0	0	811.2	4.8	-	0	0
-8	0	0	0	662.4	2.2	-	0	0
-9	57	1.38	0.078	662.4	5.3	-	1.9	1,253
-10	100	1.02	0.102	662.4	3.1	140	2.4	1,640
-11	273	1.80	0.491	662.4	4.6	-	12.0	7,897
-12	573	1.80	1.031	662.4	2.9	-	24.9	16,581
-13	907	1.73	1.569	662.4	2.6	170	37.9	25,232
-14	1295	1.59	2.059	662.4	2.8	-	49.2	33,110
-15	1660	1.58	2.622	662.4	1.9	-	61.4	42,166
-16	1990	1.58	3.144	662.4	2.1	240	72.8	50,558
-17	2380	1.57	3.736	662.4	2.1	-	86.5	60,080
-18	2760	1.57	4.333	662.4	2.2	-	100.4	69,683
-19	3170	1.57	4.976	662.4	2.8	350	115.3	80,021
-20	3570	1.54	5.497	662.4	2.9	-	124.7	88,398
-21	4000	1.55	6.200	662.4	2.8	-	136.4	99,707
-22	4420	1.38	6.099	662.4	2.5	549	131.6	98,081
-23	4420	1.33	5.878	662.4	2.5	-	125.6	94,528
-24	0	0	0	662.4	2.0	-	0	0
-25	0	0	0	662.4	2.0	462	0	0
-26	317	0.92	0.291	662.4	2.0	-	6.2	4,679
-27	677	1.00	0.677	662.4	1.7	-	14.6	10,889
-28	1000	1.03	1.030	662.4	1.7	466	22.2	16,562
-29	1710	1.09	1.863	662.4	1.7	-	39.8	29,958
-30	2840	1.10	3.124	662.4	1.9	-	66.7	50,237
-31	3620	1.13	4.090	662.4	1.9	505	86.5	65,772
-32	4420	1.17	5.171	662.4	1.9	-	109.4	83,159
-33	4870	1.20	5.844	662.4	2.0	-	122.5	93,982
-34	5290	1.13	5.977	662.4	2.1	650	124.1	96,121
-35	5560	1.07	5.949	662.4	2.4	-	121.2	95,669
-36	0	0	0	662.4	2.2	732	0	0
-37*	677	0.77	0.521	662.4	2.6	-	10.8	8,378
-38	662	0.91	0.602	662.4	2.1	-	12.5	9,683
-39	0	0	0	662.4	2.5	-	0	0
-40*	677	0.90	0.609	656.6	2.6	455	13.1	9,796
-41	633	1.11	0.702	656.6	1.9	-	15.1	11,290
-42*	1380	1.00	1.380	656.6	2.0	-	29.7	22,193
-43	1340	1.15	1.541	656.6	1.9	480	33.2	24,779
-44*	2100	0.92	1.952	656.6	2.1	-	41.6	31,070
-45	2045	1.15	2.351	656.6	1.9	-	50.7	37,808
-46*	2880	0.95	2.736	656.6	2.1	295	58.4	43,999
-47	2820	1.22	3.440	656.6	1.9	-	72.8	55,321
-48*	3660	0.95	3.477	656.6	2.1	-	73.5	55,915
-49	3600	1.21	4.356	656.6	1.9	565	91.3	70,051
-50*	4490	0.93	4.175	656.6	2.1	-	87.5	67,139
-51	4450	1.27	5.651	656.6	2.0	-	117.3	90,877
-52*	5315	0.96	5.102	656.6	2.4	573	106.9	82,047
-53	5280	1.24	6.547	656.6	2.0	-	134.6	105,285
-54*	4070	0.90	3.663	656.6	Off Scale	-	76.0	58,907
-55	0	0	0	656.6	1.9	590	0	0
-56	2060	1.20	2.472	656.6	1.9	-	51.3	39,754
-57	3600	1.22	4.392	656.6	1.9	-	90.3	70,630

*Indicates a transient test.

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
GI -58	3480	1.84	6.403	720.0	2.0	640	130.5	102,967
-59	3350	2.47	8.274	775.0	2.2	-	167.1	133,057
-60	3240	3.00	9.720	812.7	2.8	-	194.5	156,310
-61	3700	2.90	10.730	812.7	3.0	784	212.7	172,551
-62	4175	2.82	11.773	812.7	3.4	-	229.3	189,325
-63	4650	2.73	12.694	812.7	5.7	-	240.9	204,139
-64	4630	2.80	12.964	812.7	7.2	1038	243.9	208,479
-65	4610	2.90	13.369	812.7	8.2	-	249.4	214,991
-66	0	0	0	812.7	3.3	-	0	0
-67	0	0	0	0	3.3	525	0	0
UK -1	0	0	0	0	0.7	-	0	0
-2	0	0	0	301.0	3.0	-	0	0
-3	-	-	-	-	-	-	-	-
-4	0	0	0	837.2	4.4	230	0	0
-5	0	0	0	837.2	1.4	-	0	0
-6	0	0	0	330.0	1.0	-	0	0
-7	432	0.03	0.012	330.0	2.3	252	0.2	193
-8	1000	0.05	0.050	330.0	1.9	-	1.1	806
-9	1920	0.07	0.134	330.0	1.7	-	3.1	2,153
-10	3100	0.07	0.217	330.0	1.5	250	5.0	3,491
-11	4650	0.07	0.325	330.0	1.6	-	7.6	5,225
-12	5450	0.07	0.381	330.0	1.4	-	8.9	6,125
-13	6230	0.07	0.436	330.0	1.7	253	10.2	7,011
-14	7020	0.07	0.491	330.0	1.5	-	11.5	7,897
-15	7670	0.07	0.536	330.0	1.5	-	12.5	8,618
-16	7600	0.25	1.900	534.3	2.0	260	44.4	30,556
-17	7530	0.47	3.539	496.9	2.3	-	82.0	56,914
-18	0	0	0	837.2	1.4	-	0	0
-19	0	0	0	837.2	1.4	304	0	0
-20	0	0	0	330.0	1.1	-	0	0
-21	1915	0.02	0.038	330.0	1.2	-	0.8	613
-22	3920	0.02	0.078	330.0	1.2	301	1.7	1,253
-23	5880	0.02	0.117	330.0	1.2	-	2.6	1,880
-24	7000	0.02	0.140	330.0	1.2	-	3.2	2,252
-25	7670	0.02	0.153	330.0	1.2	300	3.5	2,460
-26	7600	0.28	2.128	520.0	2.0	-	48.7	34,222
-27	7490	0.78	5.842	595.1	2.3	-	131.2	93,949
-28	7320	1.52	11.126	648.0	2.3	427	244.9	178,922
-29	0	0	0	648.0	1.4	-	0	0
-30	0	0	0	648.0	1.2	-	0	0
-31	0	0	0	330.0	1.1	370	0	0
-32	1180	0.02	0.023	330.0	1.2	-	0.5	368
-33	4680	0.02	0.093	330.0	1.2	-	2.1	1,494
-34	6270	0.02	0.125	330.0	1.2	365	2.8	2,012
-35	7700	0.02	0.154	330.0	1.2	-	3.4	2,478
-36	-	-	-	-	-	-	-	-
-37	7610	0.39	2.967	557.4	1.6	-	65.9	47,712
-38	7450	1.12	8.344	647.5	1.7	427	181.8	134,183
-39	7430	1.30	9.659	647.5	1.7	-	208.4	155,330
-40	0	0	0	647.5	1.4	-	0	0
-41	865	1.36	1.176	647.5	1.2	482	25.6	18,913
-42	1690	1.36	2.298	647.5	1.2	-	50.0	36,955
-43	1440	2.85	4.104	720.0	1.4	-	88.5	65,998
-44	2535	2.67	6.768	720.0	1.6	519	144.6	108,838
-45	3340	2.62	8.750	720.0	1.7	-	183.4	140,714
-46	4250	2.55	10.837	720.0	2.8	-	225.0	174,276
-47	4250	2.50	10.625	720.0	4.1	728	216.5	170,864
-48	4260	2.48	10.564	720.0	2.1	-	213.3	169,884
-49	0	0	0	720.0	1.7	-	0	0

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
GK-50	0	0	0	720.0	1.5	460	0	0
-51	864	2.18	1.883	720.0	1.5	-	40.2	30,283
-52	1555	2.27	3.529	720.0	1.5	-	75.4	56,749
-53	3500	2.12	7.420	720.0	1.7	503	157.0	119,322
-54	4380	2.17	9.504	720.0	1.9	-	199.2	152,837
-55	4780	2.20	10.516	720.0	1.9	-	218.3	169,112
-56	5220	2.18	11.379	720.0	2.0	665	234.1	182,993
-57	5680	2.15	12.212	720.0	2.1	-	248.9	196,388
-58	6100	2.10	12.810	720.0	2.3	-	258.7	206,005
-59	6480	2.07	13.413	720.0	2.4	863	266.0	215,702
-60	0	0	0	720.0	1.6	-	0	0
-61	0	0	0	0	2.4	-	0	0
GL -1	0	0	0	0	1.9	-	0	0
-2	0	0	0	321.8	1.9	-	0	0
-3	0	0	0	521.3	1.7	433	0	0
-4	0	0	0	811.2	1.9	-	0	0
-5	0	0	0	521.3	1.7	-	0	0
-6	187	0.23	0.043	521.3	3.0	432	0.9	693
-7	389	0.29	0.112	521.3	2.1	-	2.4	1,800
-8	950	0.31	0.294	521.3	2.2	-	6.4	4,731
-9	1870	0.31	0.579	521.3	2.4	432	12.6	9,315
-10	1630	1.50	2.445	662.4	2.6	-	53.3	39,330
-11	2000	1.50	3.000	662.4	2.4	-	64.7	48,258
-12	1900	2.00	3.800	712.2	2.5	478	82.0	61,126
-13	2305	2.00	4.610	712.2	2.6	-	98.5	74,159
-14	2650	1.96	5.194	712.2	2.4	-	108.9	83,550
-15	3060	1.85	5.661	712.2	2.5	670	116.5	91,065
-16	3500	1.77	6.195	712.2	2.6	-	125.1	99,655
-17	3950	1.63	6.438	712.2	2.6	-	127.7	103,561
-18	3990	1.48	5.905	712.2	3.3	952	112.0	94,990
-19	4000	1.42	5.680	712.2	3.4	-	106.9	91,371
-20	4030	1.30	5.239	712.2	4.1	-	96.1	84,275
-21	4030	1.29	5.198	712.2	4.8	1143	93.8	83,616
-22	4020	1.36	5.467	712.2	5.4	-	97.0	87,941
-23	4000	1.50	6.000	712.2	6.8	-	106.5	96,517
-24	3960	1.61	6.375	712.2	8.2	1250	112.3	102,548
-25	3900	1.90	7.410	712.2	10.1	-	130.5	119,199
-26	3880	2.05	7.954	712.2	Off Scale	-	140.1	127,949
-27	0	0	0	712.2	5.9	1278	0	0
-28	0	0	0	712.2	1.7	-	0	0
-29	288	1.62	0.466	712.2	1.7	-	9.5	7,496
-30	865	1.85	1.600	712.2	1.6	584	32.9	25,736
-31	1585	1.88	2.979	712.2	1.6	-	61.3	47,919
-32	2680	1.82	4.877	712.2	1.6	-	100.3	78,452
-33	3490	1.80	6.282	712.2	1.9	632	128.0	101,054
-34	4320	1.75	7.560	712.2	2.0	-	152.7	121,612
-35	5230	1.69	8.838	712.2	2.0	-	176.9	142,170
-36	5180	2.02	10.463	751.4	2.2	810	205.7	168,311
-37	5180	2.11	10.929	751.4	2.6	-	205.6	175,802
-38	5170	2.25	11.632	751.4	3.6	-	217.0	187,116
-39	5150	2.62	13.493	751.4	8.8	1110	247.5	217,050
-40	5080	3.00	15.240	751.4	Off Scale	-	279.6	245,151
-41	0	0	0	751.4	2.5	-	0	0
-42	0	0	0	751.4	1.6	678	0	0
-43	1515	2.40	3.636	751.4	1.6	-	72.7	58,488
-44	3430	2.32	7.957	751.4	1.9	-	157.8	127,996
-45	4320	2.27	9.806	751.4	2.0	780	192.7	157,742
-46	5180	2.23	11.551	751.4	2.1	-	225.0	185,810
-47	5630	2.28	12.836	751.4	2.5	-	247.9	206,481

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH. Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
GL -48	5610	2.40	13.464	751.4	3.0	919	257.8	216,583
-49	0	0	0	751.4	1.7	-	0	0
-50	2540	2.65	6.731	751.4	1.7	-	130.0	108,277
-51	2660	2.00	5.320	703.2	1.7	914	101.8	85,576
-52	2630	2.09	5.496	703.2	1.9	-	102.5	88,408
-53	2630	2.10	5.523	703.2	2.0	-	101.3	88,846
-54	2610	2.23	5.820	703.2	2.6	1150	104.1	93,619
-55	2590	2.32	6.008	703.2	3.3	-	106.6	96,644
-56	2565	2.43	6.232	703.2	4.5	-	109.7	100,249
-57	2550	2.52	6.426	703.2	6.2	1258	113.2	103,368
58	2520	2.60	6.552	703.2	8.2	-	114.5	105,399
-59	2500	2.65	6.625	703.2	8.8	-	115.7	106,572
-60	2650	2.02	5.353	664.1	7.0	1300	93.5	86,108
-61	2650	2.00	5.300	664.1	7.2	-	92.6	85,256
-62	0	0	0	664.1	4.1	-	0	0
-63	0	0	0	664.1	3.9	1128	0	0
-64	0	0	0	0	5.6	-	0	0
GM -1	0	0	0	0	1.1	212	0	0
-2	0	0	0	781.2	6.6	-	0	0
-3	0	0	0	735.0	2.4	-	0	0
-4	86	0.85	0.073	735.0	2.8	225	1.7	1,173
-5	245	2.60	0.637	735.0	2.5	-	14.9	10,243
-6	503	2.92	1.468	735.0	2.6	-	34.3	23,606
-7	755	3.05	2.302	735.0	2.9	255	53.9	37,021
-8	1040	3.19	3.317	735.0	2.9	-	76.8	53,342
-9	1065	2.95	3.141	717.6	2.6	-	72.7	50,511
-10	1400	3.00	4.200	717.6	2.9	320	97.3	67,544
-11	1700	3.08	5.236	717.6	3.0	-	120.0	84,200
-12	2040	3.08	6.283	717.6	3.4	-	144.0	101,040
-13	2420	3.09	7.447	717.6	4.6	445	167.9	120,241
-14	2820	3.04	8.572	717.6	7.8	-	188.7	137,849
-15	3240	3.00	9.720	717.6	12.7	-	211.8	156,310
-16	0	0	0	717.6	2.5	515	0	0
-17	0	0	0	717.6	1.5	-	0	0
-18	763	2.90	2.212	717.6	1.6	-	48.2	35,574
-19	1410	3.05	4.300	717.6	1.5	465	92.8	69,151
-20	2430	3.12	7.581	717.6	1.9	-	162.0	121,913
-21	2820	3.19	8.995	717.6	2.2	-	188.5	144,653
-22	2880	2.89	8.323	706.8	3.3	565	174.4	133,844
-23	3280	2.79	9.151	706.8	6.7	-	190.0	147,159
-24	3310	2.72	9.003	706.8	10.1	-	185.2	144,780
-25	0	0	0	706.8	2.5	670	0	0
-26	0	0	0	706.8	1.2	-	0	0
-27	863	2.40	2.071	706.8	1.4	-	43.8	33,303
-28	1830	2.52	4.611	706.8	1.4	520	96.6	74,150
-29	2520	2.63	6.627	706.8	1.5	-	137.6	106,572
-30	3340	2.63	8.784	706.8	1.6	-	180.7	141,260
-31	3780	2.69	10.168	706.8	2.0	650	207.2	163,514
-32	4220	2.68	11.309	706.8	2.1	-	228.4	181,867
-33	4650	2.65	12.322	706.8	2.4	-	246.5	198,155
-34	5000	2.60	13.000	706.8	3.6	795	260.1	209,058
-35	0	0	0	706.8	1.6	-	0	0
-36	0	0	0	715.2	1.2	-	0	0
-37	863	2.52	2.174	715.2	1.5	450	46.4	34,962
-38	1785	2.69	4.801	715.2	1.4	-	102.6	77,208
-39	2520	2.73	6.879	715.2	1.5	-	145.6	110,624
-40	3310	2.82	9.334	715.2	1.6	550	195.6	150,104
-41	4200	2.88	12.096	715.2	2.8	-	251.2	194,522
-42	4170	2.95	12.301	715.2	4.8	-	249.7	197,816

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
GM-43	4170	2.95	12.301	715.2	2.8	840	243.9	197,816
-44	4600	2.92	13.432	715.2	3.2	-	264.0	216,004
-45	4600	3.00	13.800	715.2	3.6	-	268.8	221,922
-46	4580	3.10	14.198	715.2	4.6	970	271.7	228,325
-47	4600	2.89	13.294	696.2	5.1	-	252.2	213,784
-48	4600	3.00	13.800	696.2	6.5	-	259.6	221,922
-49	0	0	0	696.2	2.0	1070	0	0
-50	0	0	0	696.2	1.6	-	0	0
-51	920	1.92	1.766	696.2	1.6	-	35.9	28,398
-52	2660	2.11	5.612	696.2	1.7	625	114.3	90,250
-53	3450	2.16	7.452	696.2	1.6	-	150.5	119,840
-54	4350	2.18	9.483	696.2	1.7	-	189.7	152,498
-55	5180	2.20	11.396	696.2	1.9	740	228.0	183,266
-56	5650	2.29	12.938	696.2	2.1	-	256.5	208,060
-57	6030	2.42	14.592	696.2	2.8	-	284.2	234,658
-58	6020	2.60	15.652	696.2	3.4	900	304.9	251,705
-59	6020	2.80	16.856	696.2	5.7	-	322.6	271,071
-60	6000	2.90	17.400	696.2	7.5	-	333.0	279,816
-61	0	0	0	696.2	1.9	980	0	0
-62	0	0	0	696.2	1.7	-	0	0
GN -1	0	0	0	0	0.8	290	0	0
-2	0	0	0	787.4	4.6	292	0	0
-3	0	0	0	721.1	1.5	223	0	0
-4	46	0.50	0.023	721.1	3.0	238	0.5	368
-5	144	1.61	0.231	721.1	2.0	240	5.4	3,713
-6	0	0	0	721.1	1.2	245	0	0
-7	140	1.18	0.165	721.1	1.5	250	3.8	2,653
-8	475	2.95	1.401	721.1	1.6	254	32.8	22,532
-9	778	3.01	2.341	721.1	1.6	280	54.2	37,647
-10	1685	3.07	5.172	721.1	2.2	300	118.5	83,173
-11	1730	2.83	4.895	715.2	1.7	348	112.2	78,720
-12	2450	2.92	7.154	715.2	2.4	383	162.3	115,048
-13	2880	2.80	8.064	715.2	3.3	414	181.1	129,679
-14	2880	2.87	8.265	715.2	4.0	460	183.7	132,911
-15	2880	2.87	8.265	715.2	4.6	495	180.1	132,911
-16	0	0	0	715.2	1.6	410	0	0
-17	562	2.48	1.393	715.2	1.9	410	30.3	22,400
-18	1785	2.61	4.658	715.2	2.1	423	100.5	74,908
-19	2490	2.69	6.698	715.2	2.2	476	144.5	107,712
-20	2910	2.66	7.740	715.2	2.8	558	163.8	124,472
-21	3310	2.60	8.606	715.2	3.8	594	180.4	138,395
-22	3770	2.62	9.877	715.2	3.3	664	195.8	158,835
-23	4200	2.62	11.004	715.2	3.0	748	222.2	176,962
-24	4625	2.68	12.395	715.2	3.3	865	243.6	199,329
-25	4610	2.83	13.046	715.2	4.2	972	249.7	209,798
-26	4580	3.00	13.740	715.2	5.8	1062	258.5	220,960
-27	0	0	0	715.2	2.5	1047	0	0
-28	0	0	0	715.2	1.4	525	0	0
-29	576	2.10	1.209	715.2	1.4	527	25.3	19,441
-30	1900	2.16	4.104	715.2	1.4	540	86.0	65,998
-31	3450	2.17	7.486	715.2	1.4	570	155.4	120,387
-32	4320	2.20	9.504	715.2	1.5	610	195.5	152,837
-33	5210	2.22	11.566	715.2	1.9	658	235.7	185,999
-34	6060	2.25	13.635	715.2	3.2	759	272.8	219,269
-35	6050	2.40	14.520	715.2	4.0	811	287.9	233,503
-36	6030	2.60	15.678	715.2	4.6	870	308.1	252,124
-37	0	0	0	715.2	1.6	885	0	0
-38	0	0	0	715.2	1.2	537	0	0
-39	907	2.17	1.968	715.2	1.2	532	41.2	31,649

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10^{-5} Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
GN-40	1870	2.32	4.338	715.2	1.2	550	90.0	69,763
-41	3460	2.30	7.958	715.2	1.2	570	163.7	127,978
-42	4320	2.30	9.936	715.2	1.4	620	204.4	159,787
-43	4290	2.52	10.810	715.2	1.6	745	220.3	173,842
-44	4270	2.68	11.443	715.2	1.7	883	222.9	184,020
-45	4250	2.78	11.815	715.2	2.2	1026	232.2	190,004
-46	4210	3.00	12.630	715.2	4.1	1086	235.6	203,107
-47	4200	3.06	12.852	715.2	6.2	1128	237.7	206,679
-48	0	0	0	715.2	1.6	1080	0	0
-49	0	0	0	715.2	1.4	690	0	0
-50	1870	2.36	4.413	715.2	1.4	698	87.5	70,969
-51	3460	2.42	8.373	715.2	1.5	727	164.5	134,649
-52	4330	2.42	10.478	715.2	1.5	769	205.9	168,499
-53	4320	2.51	10.843	715.2	1.6	871	209.3	174,370
-54	4290	2.70	11.583	715.2	1.9	960	219.8	186,272
-55	4220	2.98	12.575	715.2	2.9	1068	234.5	202,222
-56	4220	3.05	12.871	715.2	6.2	1138	236.1	206,985
-57	0	0	0	715.2	1.7	1105	0	0
-58	0	0	0	0	2.5	1093	0	0
GP -1	0	0	0	0	0.6	193	0	0
-2	0	0	0	813.8	2.8	-	0	0
-3	0	0	0	709.0	1.5	-	0	0
-4	245	2.60	0.637	709.0	1.7	212	14.9	10,243
-5	805	2.80	2.254	709.0	1.4	-	52.7	36,248
-6	1750	2.82	4.935	709.0	1.5	-	114.3	79,361
-7	2485	2.87	7.131	709.0	1.5	262	163.5	114,676
-8	2445	3.00	7.335	709.0	4.6	-	168.1	117,956
-9	2440	3.02	7.368	709.0	7.2	-	167.2	118,488
-10	2445	2.98	7.286	709.0	8.8	391	165.3	117,169
-11	0	0	0	709.0	1.2	-	0	0
-12	0	0	0	709.0	0.8	-	0	0
-13	244	2.42	0.590	709.0	0.7	339	13.3	9,490
-14	825	2.72	2.244	709.0	0.7	-	50.9	36,088
-15	1800	2.73	4.914	709.0	0.8	-	110.3	79,022
-16	2490	2.81	6.996	709.0	1.0	415	154.0	112,504
-17	2475	2.87	7.103	709.0	3.6	-	154.8	114,228
-18	2490	2.80	6.972	709.0	2.2	-	150.4	112,118
-19	2490	2.79	6.947	709.0	1.2	600	147.0	111,717
-20	3310	2.73	9.036	709.0	1.7	-	189.4	145,312
-21	4200	2.72	11.424	709.0	1.9	-	235.0	183,714
-22	4650	2.72	12.648	709.0	2.2	781	260.2	203,400
-23	4650	2.74	12.741	709.0	2.2	-	250.4	204,893
-24	0	0	0	709.0	1.2	-	0	0
-25	0	0	0	709.0	1.1	635	0	0
-26	893	2.45	2.187	709.0	1.0	-	44.5	35,169
-27	1830	2.52	4.611	709.0	1.0	-	93.1	74,150
-28	3350	2.53	8.475	709.0	1.2	695	169.6	136,289
-29	4220	2.63	11.098	709.0	1.2	-	220.0	178,469
-30	5080	2.63	13.360	709.0	1.6	-	262.5	214,849
-31	5080	2.71	13.766	709.0	2.2	812	261.2	221,375
-32	5070	2.79	14.145	709.0	4.2	-	270.7	227,472
-33	5030	3.00	15.090	709.0	6.2	-	283.9	242,668
-34	0	0	0	709.0	1.4	1025	0	0
-35	0	0	0	709.0	1.2	-	0	0
-36	1870	2.46	4.600	709.0	1.2	-	96.4	73,975
-37	1770	2.80	4.956	709.0	1.2	590	102.9	79,700
-38	3360	2.60	8.736	709.0	1.5	-	179.7	140,487
-39	4230	2.60	10.998	709.0	1.5	-	224.1	176,863
-40	5130	2.58	13.235	709.0	2.0	766	264.8	212,837

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode-heating Power, watts	Diode Vacuum, 10^{-5} Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
GP-41	5110	2.77	14.154	709.0	2.2	-	278.2	227,618
-42	5080	2.98	15.138	709.0	2.6	-	292.3	243,441
-43	5080	3.10	15.748	709.0	6.2	1059	298.8	253,251
-44	0	0	0	709.0	1.7	-	0	0
-45	0	0	0	709.0	1.2	-	0	0
-46	1915	2.12	4.059	709.0	1.5	495	85.7	65,273
-47	3450	2.23	7.693	709.0	1.5	-	161.2	123,713
-48	4320	2.31	9.979	709.0	1.5	-	207.2	160,475
-49	5180	2.30	11.914	709.0	1.7	630	245.1	191,592
-50	5160	2.45	12.642	709.0	1.9	-	257.6	203,301
-51	5130	2.62	13.440	709.0	2.0	-	264.1	216,136
-52	5110	2.81	14.359	709.0	2.8	1025	274.8	230,912
-53	5070	3.00	15.210	709.0	6.2	-	288.6	244,600
-54	0	0	0	709.0	1.6	-	0	0
-55	0	0	0	0	2.2	1010	0	0
GT -1	0	0	0	0	1.1	-	0	0
-2	0	0	0	796.7	4.6	-	0	0
-3	0	0	0	718.7	1.2	320	0	0
-4	1870	2.18	4.076	718.7	6.2	-	92.5	65,546
-5	7730	2.90	5.017	718.7	1.9	-	110.4	80,680
-6	0	0	0	718.7	1.4	450	0	0
-7*	1840	2.32	4.268	718.7	1.9	-	93.0	68,637
-8	3385	2.42	8.191	718.7	1.9	-	175.0	131,723
-9	4200	2.50	10.500	718.7	2.2	496	224.4	168,857
-10	4250	2.41	10.242	718.7	2.5	-	199.5	164,706
-11	4700	2.40	11.280	718.7	2.8	-	214.0	181,400
-12	4650	2.43	11.299	718.7	3.7	1112	209.0	181,702
-13	4630	2.62	12.130	718.7	5.9	-	222.5	195,069
-14	4570	3.00	13.710	718.7	12.7	-	251.5	220,475
-15	0	0	0	718.7	2.2	1160	0	0
-16	0	0	0	718.7	1.6	-	0	0
-17*	2650	1.82	4.823	718.7	1.7	-	96.5	77,561
-18	2590	2.18	5.646	718.7	1.5	722	111.9	90,797
-19	4315	2.00	8.630	718.7	1.6	-	171.1	138,782
-20	4765	2.00	9.530	718.7	1.6	-	187.3	153,256
-21	4750	2.05	9.737	718.7	1.9	-	183.2	156,583
-22	4650	2.80	13.020	718.7	12.7	-	236.8	209,379
-23	4600	3.20	14.720	718.7	2.5	-	267.8	236,717
-24	0	0	0	718.7	2.2	1182	0	0
-25	0	0	0	718.7	1.7	-	0	0
-26*	3510	1.70	5.967	718.7	2.2	-	119.4	95,956
-27	3450	2.10	7.245	718.7	1.9	692	144.9	116,509
-28	4770	1.95	9.301	718.7	2.0	-	184.4	149,572
-29	4750	2.03	9.642	718.7	2.2	-	179.8	155,056
-30	4670	2.51	11.721	718.7	9.4	1210	211.4	188,491
-31	4600	3.00	13.800	718.7	2.2	-	249.0	221,922
-32	0	0	0	718.7	2.8	-	0	0
-33	0	0	0	0	3.7	1180	0	0
GW -1	0	0	0	733.5	1.6	368	0	0
-2	245	2.30	0.563	733.5	1.6	-	12.5	9,056
-3	880	2.29	2.015	733.5	1.9	-	44.3	32,403
-4	1900	2.07	3.933	733.5	2.0	372	86.5	62,755
-5	2665	2.10	5.596	733.5	2.1	-	121.9	89,991
-6	2600	2.38	6.188	733.5	2.2	-	129.7	99,513
-7	3440	2.28	7.843	733.5	2.2	608	164.4	126,126
-8	4325	2.06	8.909	733.5	2.4	-	186.7	143,267
-9	4340	1.97	8.549	733.5	2.4	-	169.5	137,481

*Indicates a transient test.

Run No.	Anode Voltage, volts	Emission Current, Amps	EBH Power, kW	Cathode- heating Power, watts	Diode Vacuum, 10 ⁻⁵ Torr	Max Sodium Temp, °F	Wall Temp Drop, °F	Anode Heat Flux, Btu/hr-ft ²
GW-10	4340	1.91	8.289	733.5	2.6	970	162.9	133,297
-11	0	0	0	733.5	1.4	-	0	0
-12	1930	1.98	3.821	733.5	1.5	-	81.6	61,447
-13	3500	2.04	7.140	733.5	1.5	500	149.6	114,822
-14	4780	2.08	9.942	733.5	1.5	-	208.4	159,881
-15	5190	2.12	11.002	733.5	1.7	-	235.1	176,929
-16	5190	2.12	11.002	733.5	3.6	800	220.1	176,929
-17	0	0	0	733.5	1.5	-	0	0
-18	2650	2.19	5.803	733.5	1.4	-	116.1	93,322
-19	4325	2.08	8.996	733.5	1.6	780	178.4	144,667
-20	4300	2.25	9.675	733.5	1.9	-	186.8	155,589
-21	4330	2.05	8.876	733.5	2.5	-	162.0	142,740
-22	4330	2.05	8.876	733.5	4.1	1195	162.1	142,740
-23	4320	2.20	9.504	733.5	7.2	-	168.7	152,837
-24	4270	2.50	10.675	733.5	1.9	-	187.9	171,670
-25	0	0	0	733.5	2.5	1230	0	0
-26	0	0	0	733.5	1.9	-	0	0
-27	4350	1.92	8.352	733.5	2.0	-	161.2	134,310
-28	4300	2.22	9.546	733.5	2.4	1000	179.6	153,511
-29	4280	2.40	10.272	733.5	3.3	-	188.4	165,187
-30	4130	3.20	13.216	733.5	1.9	-	238.4	212,531
-31	0	0	0	733.5	3.2	643	0	0
-32	0	0	0	733.5	1.6	-	0	0
-33	1845	2.60	4.797	733.5	1.5	-	96.8	77,142
-34	3430	2.53	8.677	733.5	1.7	695	173.6	139,540
-35	3390	2.69	9.119	733.5	1.9	-	176.0	146,646
-36	3370	2.70	9.099	733.5	1.9	-	169.7	146,325
-37	3340	2.93	9.786	733.5	2.4	1082	179.5	157,375
-38	3290	3.25	10.692	733.5	4.0	-	194.5	171,943
-39	0	0	0	733.5	2.1	-	0	0
-40	0	0	0	0	2.9	1127	0	0

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REFERENCES

1. R. E. Holtz, Application of Electron-bombardment Heating for Boiling Liquid Metals, ANL-6869 (March 1964).
2. R. E. Holtz, "Heating Techniques for Liquid Metal Loops," Proceedings of the Conference on Application of High Temperature Instrumentation to Liquid-metal Experiments, Sept. 28-29, 1965, ANL-7100, pp. 9-22.
3. C. E. Taylor and J. F. Steinhaus, High Flux Boiling Heat Transfer from a Flat Plate, UCRL-5414 (Nov 1958).
4. B. S. Petukhov, S. A. Kovalev, and V. M. Zhukov, Study of Sodium Boiling Heat Transfer, Proceedings of the Third International Heat Transfer Conference, August 7-12, 1966, Vol. V, pp. 80-91.
- 5-26. ANL-7045, ANL-7046, ANL-7071, ANL-7082, ANL-7090, ANL-7105, ANL-7115, ANL-7122, ANL-7132, ANL-7152, ANL-7176, ANL-7193, ANL-7204, ANL-7219, ANL-7230, ANL-7245, ANL-7249, ANL-7255, ANL-7267, ANL-7279, ANL-7286, and ANL-7302, Reactor Development Program Progress Report, April 1965 through Jan 1967.
27. W. H. Aldous and Sir Edward Appleton, Thermionic Vacuum Tubes, p. 20, John Wiley and Sons, Inc., New York (1952).
28. L. R. Lokker, The Physics of Electron Tubes, pp. 9-11, McGraw-Hill Book Co., Inc., 2nd Edition, New York (1937).