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CATHODE LIFE PREDICTION

ARC Professional Services Group

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13. ABSTRACT (Maximum 200 words)

This report describes the operational characteristics and measurement procedures associated with the Cathode Life Test Facility. The facility was designed to perform periodic emission testing on various types of thermionic cathode emitters operating under simulated life test conditions. Established calibration procedures are outlined and recently developed measurement and operating temperature determination techniques are discussed, as well as additional formats for data presentation and analysis. The software source code for the life test temperature is also provided. A method to facilitate recognition and differentiation between computer data files is described and comprehensive inventory documentation including pertinent data log sheets are presented.

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1.0 Introduction

This report describes the operating and measurement procedures required to conduct life test experiments on thermionic cathodes. It also serves to document all technical work accomplished and information gained during the performance of this acquisition.

1.1 Facility Description

The Cathode Life Test Facility located in building 112, Cell 8, at Griffiss Air Force Base is designed to evaluate various types of thermionic cathodes. Through the use of this facility, Rome Laboratory performs periodic emission testing on various types of thermionic cathodes operating under simulated life test conditions. The facility is presently equipped with 40 power supplies, 38 of which were manufactured by Cober Electronics and 2 which were designed by RADC. The power supply specifications [1] are presented in Table 1. A Liebert Corporation A/C Air-cooled R-22 unit is capable of maintaining constant temperature and relative humidity independent of weather conditions. Measurement and Calibration Equipment includes:

1) 2-Pyro Micro-Optical disappearing filament Pyrometers, Model 95-C33200

2) 2-Two Color Optical Pyrometers, Ircon Model R-14C05-0-2-0-00-0/000

3) 2-Rotek AC/DC Precision Calibrator, Model 3910

4) Test load Vehicle Simulator

1.2 Facility Safety

Lethal voltages exist in the Cathode life test facility. The vehicle power supplies operate at several thousand volts and extreme care should be taken whenever working inside the cabinets.

When high voltage is exposed in the Lab, two (2) or more persons shall be present both of which are knowledgeable in safety procedures and hold a current CPR certification. Exposed high voltage exists whenever the rear door on a test supply is open or when equipment drawers are pulled out while the power supply is plugged in. If the high voltage supply has been fully discharged with a shorting stick, and the Vac-Ion power removed, work may proceed with only a single person present. If a single person is working on a power supply that is in a rack with another power supply the other supply should also be shut down and discharged.

A high voltage warning sign is displayed just inside the main entrance to the facility visible to any one entering the facility. The facility should always be locked when unattended. A safety board equipped with necessary first-aid equipment is located on the facing wall directly across from the front doorway.

1.3 Facility Maintenance

Daily inspection of the facility and its operating equipment is required. Maintenance is divided into two categories. Inspection of the facility support equipment including examination of the lights, AC power, and the air-conditioning system is required on a daily basis. Failure of any of these, requires immediate notification of the facility manager. Each workday morning all power supply meter readings are taken and recorded in the Cathode Life Test daily meter log. Any failures noted at this time requires immediate repair or replacement. Anomalies which are encountered during the maintenance checks must be documented in the daily log book and reported to the facility manager. All repairs are noted in the power supply repair log.

1.4 Facility Power-Down

Occasionally during the process of life testing the cathode vehicles, it will be necessary to systematically shut down the facility for short periods of time. Planned down periods are typically a result of local area thunderstorm activity or scheduled prime power outage. When it is required to power-down the facility, the procedures outlined in Table 2 should be followed.

1.5 Facility Power-Up

In order to safely and effectively bring the cathode test vehicles back on-line after having been turned off, a systematic procedure was developed and documented. The procedure to follow for powering up the test vehicles is outlined in Table 3.

Table 1

Power Supply Specifications

Input Power

115 VAC + 10%   60Hz

Cathode Supply

Zero to 6000 VDC negative @ 20 ma (min.)
1% regulation

Collector Supply

Fixed ratio (0.3 + 10%) of 6 KV, with respect to ground.
Zero to 2000 VDC positive with respect to the cathode.
240 ma (min.), 5% regulation

Filament Supply

Zero to 10 VAC, 4A, 1% regulation isolated to float at cathode potential

Table 2

Facility Power-Down Procedure

1. Turn off the T.U.T. high voltage (Cober model 3399 and RADC supplies only).

2. Turn off the cathode/collector high voltage (for Cober supply model 3260 the cathode and collector high voltages are separate push buttons. First turn off the cathode HV and then the collector HV).

3. Turn off the ion blocking power supply (Cober supply model 3260 only).

4. Turn off the filament power, then turn the filament voltage adjustment dials all the way off (counterclockwise).

5. Turn the system power off.

6. Shut off the main input power breaker on the front panel of the supply. It is not necessary to shut off the supplies at the main breaker.

7. If the power supplies have been powered down for maintenance shut off the Varian vac-ion pump control units that are connected to the vehicles in the Cober model 3399 and RADC power supplies.

8. DO NOT touch the cathode/collector adjustment dials. It is more helpful during power up if they are left at the same setting prior to power down.

9. If the lab will be down longer than 2 days, unplug the fan near the ceiling, turn off the floor fan in the rear of the lab, and turn off the air conditioner using the "STOP" button located in the upper right hand corner of the front panel.

10. Log shut down and the reason in the facility log book located on the front desk (i.e. Shut down the lab due to work being done on the load center which will cause intermittent loss of power during the next week).

Table 3

Facility Power-Up Procedure

1. Ensure the air conditioner in the lab is functioning and both room fans are running prior to energizing any equipment.

2. Turn on the Varian vac-ion pump control units connected to the vehicles in the Cober model 3399 and RADC power supplies.

3. Turn on the circuit breakers on all the supplies that contain test vehicles and turn on the system power. Do this to all supplies before proceeding to the next step. Ensure all blowers are working and the front panel lights are on. Adjust the filament voltage control to it's lowest setting. Pressing the OFF/RESET button should clear the alarms. If it does not there may be a problem with the supply.

4. For all vehicles except the Siemens MK's and the F-D-E oxide and scandate cathodes turn on the filament power and slowly turn up the filament voltage so the filament current does not exceed more than twice the life test level and possibly cause damage to the vehicle. As a general rule of thumb, do not exceed 2.5 amps on all vehicles except the Siemens MK's and the F-D-E oxide and scandates. Allow about 3-5 minutes for the cathode to heat up and the current to drop before turning up the filament voltage again. Continue this for each vehicle and by the time all the vehicles have had the filament power turned on and the voltage initially adjusted, the first vehicles will have settled down and are ready to be readjusted. For the MK, oxide and scandate cathodes first apply the cathode and collector voltages at full life test voltages. Then apply the filament voltage. Slowly increase the filament voltage at a rate slow enough to keep the increase in filament current below .2A for these three types of cathodes.

5. Continue the filament voltage adjustment as per step (4) until the life test filament voltage, which is noted on the vehicle information card (VIC) mounted on the vehicle box, is achieved. Then wait about 5 minutes for the filament current to stabilize.

6. Except for the MK, oxide and scandate cathodes, which already have the beam voltages applied, enable the cathode/collector voltage. On the older Cober power supplies (model 3260) the cathode and collector voltages are separate buttons. First enable the collector voltage and then the cathode voltage. The adjustment knobs are usually preset to the correct values from when either the supply was shut off or when power was lost. If the values are off, adjust the cathode voltage to the value specified by the VIC mounted on the vehicle box.

7. After ensuring the cathode and collector voltages have come up, enable the T.U.T. high voltage to apply the voltages to the test vehicle. If all is working properly the cathode and collector current should come up to normal levels (near 100%) and the body current should not trip off the high voltage.

Table 3 (Concluded)

8. Turn on the Ion blocking supply (Cober supply model 3260 only)

9. Readjust the filament voltage if necessary. If the cathode and collector voltages had to be reset at power up it is best they be checked and adjusted every couple of hours during the first day. If the voltage adjustment knobs were preset at power up do not adjust them the first day. The power supply and test vehicle need time to warm up and stabilize. The voltages can, and often will be unstable for the first 24 hours.

10. After 1 or 2 hours the filament voltages will require further adjustment.

11. At the end of the work day the power supply voltages should be checked again and readjusted if necessary.

12. The next day after readings are taken the voltages should be adjusted if needed.

13. Then on a daily basis all voltages should be checked and adjusted if needed, after the daily readings have been taken.

2.0 Vehicle Preparation

2.1 Initial

Upon receipt of a test vehicle, open and inspect for physical damage including dents, damaged or broken leads and cracked or broken ceramics. If any damage is found the facility manager should be notified immediately. If there is no noticeable damage, the vehicle may be installed in the appropriate power supply test station, and energized. The procedure for placing most new cathode test vehicle on-line is summarized in Table 4. Experience has shown the procedure for placing the MK, oxide and scandate cathodes on-line to be different. The procedure for the MK type cathodes is detailed in Table 5 and oxide and scandate procedure in Table 6.

2.2 Rotek Calibration

The Rotek calibrator is used for calibration and alignment of test vehicle power supplies, and should be allowed to warm-up and stabilize prior to use. Prior to using the Rotek for calibration insure there is a current calibration sticker affixed. Also be aware there may have been a limited calibration performed and noted on the sticker limiting the use of the Rotek to specific ranges or functions. There are four outputs signals from the Rotek used for calibration of a power supply.

The first is an output of negative 1000 VAC for calibration of the cathode and collector voltage meters. Set the "range" selector to 1000 and rotate the range dials to read 10-0-0. The next output delivers 100 ma and is used to calibrate the cathode and collector current meters. Depress the "AMPS" button and set the range to 100, leaving the range dials at 10-0-0.

For calibration of the filament voltage meter, a 5 VAC output is required. Set the selector switch to "HZ x 10", and the frequency dial to "6". Set the "range" selector to "10", the range dials to "5-0-0" and the units to "VOLTS." The fourth output is required to calibrate the filament current meter. Retain the selector switch and frequency dial settings to "HZ x 10" and "6" respectively. Set the units to "AMPS" and the range selector to 1000. Change the range dials to read "10-0-0." The Rotek Calibrator will now output a 1 ampere 60 cycle signal.

2.3 Power Supplies

There are a total of forty operational test vehicle power supplies within the facility. Thirty Eight were manufactured by Cober Electronics and two were designed by RADC. There are two different models of the Cober supplies. Twelve are model #3260, and twenty six are model #3390. Each power supply requires calibration and each power supply model involves a different calibration procedure.

2.3.1 Cober Model 3390 Transformer (T3) Replacement

The on-hand spare transformers manufactured by Elcor, which are used to replace transformer T3 in the event of a failure, are of a slightly different design from the transformers originally installed. In order to install the Elcor transformers the power supplies must be modified. This modification is accomplished as shown in Figure 2-1.

Table 4

General Procedure for Placing a New Vehicle On-Line

NOTE: See Table 4 for MK cathodes and Table 5 for oxide and scandate cathodes

1) Connect the power supply to the vehicle simulator and follow the calibration procedure to calibrate the supply.

2) Unless otherwise noted, install the Cathode test vehicle according to the wiring chart below.

White Wire - Cathode

Yellow Wire - Heater

Red Wire - Collector

3) Turn all voltages down to 0.0V.

4) Set up the Ircon two color optical pyrometer in order to monitor the cathode temperature.

5) Turn on the power supply main circuit breaker and verify cooling blower operation. Energize the VAC-ION pump.

   5a) If the internal pressure exceeds '5' on the vacuum scale inform the facility manager. If not proceed to Step 5.

   5b) Figure 2-2 graphs the current vs. pressure relationship of the VAC-ION pumps. The Cathode facility uses the 2 l/s pump on the test vehicles.

6) Allow the vehicle to stabilize at a vacuum of less than 0.5.

   6a) If a satisfactory vacuum is not obtained within one hour, notify the facility manager.

7) Raise the filament voltage to approximately 1 volt. A surge in vehicle pressure should occur, if no surge is observed, inform the facility manager. If the surge exceeds a '5' on the vacuum scale, reduce the filament voltage.

8) Slowly increase the filament voltage until 1050 deg. C (True) is obtained. If the temperature cannot be reached, inform the facility manager.

Table 4 (Concluded)

9) Energize the Cathode and Collector voltage. Increase the voltage until 100% loading is obtained.

   i.e. 100 ma for Current densities of 2A/cm2

   200 ma for Current densities of 4A/cm2

10) Allow the vehicle to operate under these conditions for 24 hours. [The vacuum should read less than one on the six scale.]

11) Perform the initial Miram curve measurements starting at 1100 deg. C.

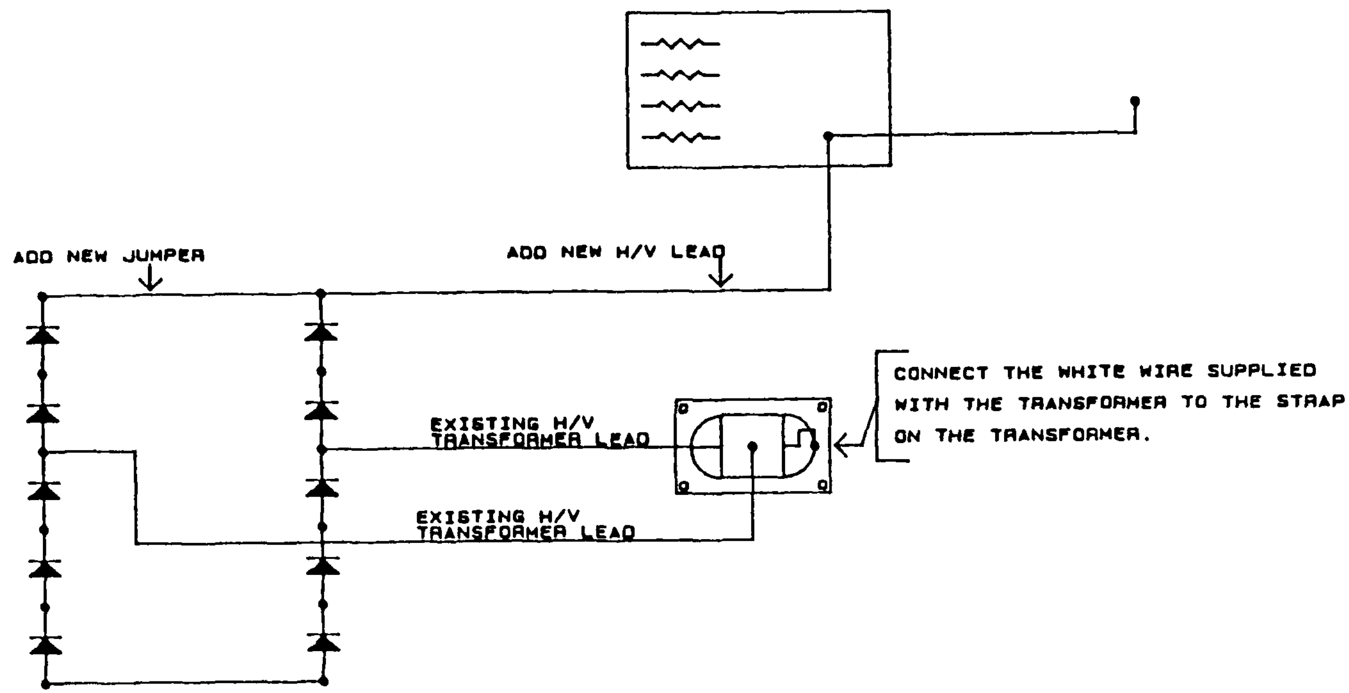

Figure 2-1 Power Supply Modification for Elcor Transformers

Table 5

Procedure For Placing Siemens MK Type Cathodes On-Line

1) The MK cathodes must be installed in a model 3260 power supply. These cathodes are constructed with a built in Ion blocking grid which is activated with a DC power supply. The 3260 is the only supply with the built in Ion blocking supply.

2) Calibrate the power supply while connected to the vehicle simulator.

3) Install the vehicle according to the wiring chart below.

White Wire - Cathode

Yellow wire - Heater

Red Wire - Collector

4) Set up the disappearing filament pyrometer.

5) Set all power supply voltages to 0.0V.

6) Energize the cooling fan.

7) Insure the Ion blocking supply is off.

8) Turn on the filament voltage leaving it set at it's lowest setting.

9) Increase the cathode and collector voltages to the life test values.

10) Slowly increase the filament voltage at a rate such that the filament current does not increase more than 200ma at each increase. Continue increasing the filament voltage until the life test temperature is reached if specified or until 1100 Deg.C if no temperature has been specified.

11) Energize the Ion blocking supply.

12) Allow 24 Hrs. for stabilization. Perform the initial miram curve using a disappearing filament pyrometer.

TABLE 6

Procedure For Placing F-D-E oxide And Scandate Cathodes On-Line.

1) Calibrate the power supply while connected to the vehicle simulator.

2) Install the vehicle according to the wiring chart below unless otherwise noted.

White Wire - Cathode

Yellow Wire - Heater

Red Wire - Collector

3) Energize the cooling fan and the Vac-Ion pump.
   3a- If the Vac-Ion indication is above 2ua allow the vehicle to decrease before applying the filament voltage.

4) Once the Vac-Ion is below 2ua energize the filament voltage with no cathode of collector voltage applied.

5) Slowly increase the filament voltage. Keep the Vac-Ion current below 2ua. Continue increasing the filament voltage until the specified operating voltage is reached.

6) Decrease the filament voltage to 0.0 volts.

7) Energize the cathode and collector voltages. Slowly increase the beam voltages until the specified life test voltages are reached.

8) While keeping the Vac-Ion current below 2ua slowly increase the filament voltage until the specified life test voltage is reached.

9) At this point the cathode current should be about 50ma. This would indicate 100% loading at a current density of 1A/sq.cm.

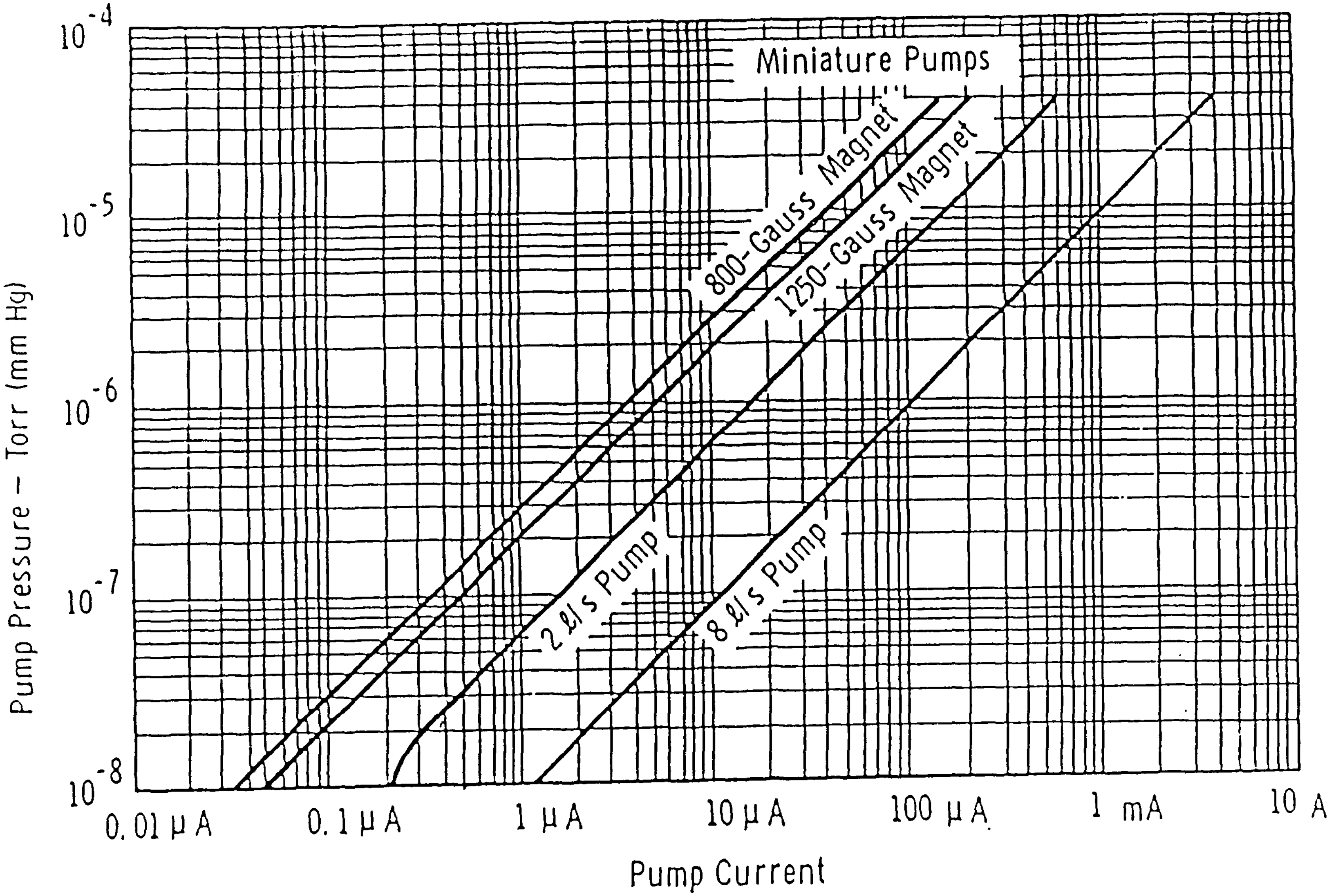

Figure 2-2 VAC-ION current vs. Pressure Relationship for the VAC-ION Pumps

2.4 Calibration Procedure

Power supply calibration is required. There are three instances when it is necessary to calibrate the power supplies.

1) 24 hours prior to placing a new test vehicle on-line

2) 24 hours prior to performing MIRAM curve measurements.

3) Anytime the integrity of the supply is in question.

When calibrating a power supply with a vehicle installed, it is recommended to minimize downtime as much as possible to prevent the cathode from cooling significantly, thus causing errors in the next day measurements. A life test condition sheet is required to be annotated during each calibration. A life test condition sheet is shown in Table 7. For safety purposes, two or more persons holding current CPR certifications, should be present when calibrating the power supplies.

During the performance of this effort it became apparent that a condensed calibration procedure would shorten the time required to calibrate a power supply while increasing the operators safety.

The condensed calibration procedures for each of the power supplies currently in use in the cathode facility are outlined in paragraphs 2.4.1, 2.4.2, and 2.4.3.

Table 7

LIFE TEST CONDITIONS

TEST VEHICLE TYPE __________ P/S __________________ DATE ______________

MFR ______________ S/N ______________ RECORDER ______________

ETM _______________ PREVIOUS ETM ______________

ΔETM ______________

NOMINAL CATHODE LOADING ______________ AMP(S)/CM^2

CATHODE VOLTAGE ______________________ V

CATHODE TEMP _________________________ °C.

INITIAL CATHODE CURRENT ______________ MILLIAMPS

PRESENT CATHODE CURRENT ______________ MILLIAMPS

PERCENT OF INITIAL _________ %

FILAMENT POWER = ___________ V x ____________ A = ___________ WATTS

COLLECTOR VOLTAGE ___________ V

COLLECTOR + BODY CURRENT = ___________ + ___________ = ___________ mAMPS

VACION CURRENT (VACUUM) ______________

CALIBRATION

DATE ______________ ETM ______________

VOLTAGE CURRENT

CATHODE-------READS________ADJ TO________ READS________ADJ TO________
CAL _________ CAL _________

FILAMENT------READS________ADJ TO________ READS________ADJ TO________
CAL _________ CAL _________

COLLECTOR-----READS________ADJ TO________ READS________ADJ TO________
CAL _________ CAL _________

2.4.1 Cober Model 3399

1) Connect high voltage (H/V) meter to the Rotek.
   Set Rotek for 1000VDC. Energize Rotek and adjust pot on H/V meter until the meter reads 1000 volts. Shut off Rotek and disconnect the high voltage meter.

2) CATHODE VOLTMETER ADJUSTMENT
   Connect the H/V meter ground lead to the power supply chassis. Connect H/V meter probe to <u>K21</u> located just above transformer T3. Adjust <u>R24</u> until the cathode voltmeter reading agrees with the H/V meter reading.

3) COLLECTOR VOLTMETER ADJUSTMENT
   Connect the Rotek H/V meter probe to <u>WIRE 70</u> located on C3. Adjust <u>R26</u> until the collector voltmeter reading agrees with the H/V meter reading.

<u>4) SHUT OFF THE TUT H/V AND THE CATHODE/COLLECTOR H/V SWITCHES.</u>

5) CATHODE and COLLECTOR CURRENT METER ADJUSTMENT
   Set Rotek for 100ma DC.
   Connect Rotek to duel terminal strip on left front of supply.
   Enable Rotek. If meters read 0 reverse polarity on Rotek.

   Adjust <u>R10</u> on the B-card until the cathode current indication is 100ma.

   Adjust <u>R9</u> on the B-card until the collector current indication is 100ma.
   Disable Rotek and disconnect test leads.

6) FILAMENT VOLTMETER ADJUSTMENT

   Set Rotek for 5VAC 60Hz.
   Use to verify the accuracy of the VOM at 5VAC.

   Connect the VOM between the Cathode/Heater output jack and the Heater output jack located on the rear of the power supply. Using the front panel filament adjust set the VOM to read 5 volts. Adjust <u>R4</u> on the A-card for a 5 volt indication on the filament meter.

7) SHUT OFF THE FILAMENT AND REMOVE THE METER.

8) FILAMENT CURRENT METER ADJUSTMENT

Set the Rotek for 1A 60Hz. Pass an insulated wire thru T10 (Filament current Sensor) and connect to Rotek output. Energize Rotek.

Adjusc R5 on the A-card for 1A filament current indication on the filament meter

Disable Rotek and remove the wire from T10.

9) The power supply is now ready to be returned to service.

2.4.2 Cober Model 3260

(See Figure 2-3 for TB-1 Test Position Identification)

1) Connect the high voltage meter to the Rotek.
   Set the Rotek for 1000VDC. Energize the Rotek and adjust the pot on the H/V until the pot reads 1000 volts. Shut off Rotek and disconnect the H/V meter.

2) CATHODE VOLTMETER ADJUSTMENT
   Connect the H/V ground lead to the power supply chassis.
   Connect the H/V meter probe to the TB-1 at position 12.
   Adjust **R24** (top left of supply on small circuit board) until the cathode voltmeter reading agrees with the H/V meter reading.

3) COLLECTOR VOLTMETER READING
   Connect the H/V ground lead to the power supply chassis.
   Connect the H/V meter probe to the TB-1 at position 9.
   Adjust **R26** (next to R24) until the collector voltmeter agrees with the H/V meter reading.

4) <u>SHUT OFF THE TUT,CATHODE AND COLLECTOR HIGH VOLTAGE SWITCHES.</u>

   R4,**R5**,**R9** and **R10** located on right-hand side of supply.

5) CATHODE AND COLLECTOR CURRENT METER ADJUSTMENT
   Set Rotek for 100ma DC and connect to the TB-1 at positions 1 and 2.
   Energize Rotek.
   Adjust **R9** for collector current.
   Adjust **R10** for cathode current.
   Disable Rotek and disconnect test leads.

6) FILAMENT VOLTMETER ADJUSTMENT
   Set Rotek for 5VAC 60Hz.
   Use to verify accuracy of VOM at 5VAC.
   Connect VOM to TB-1 positions 12 and 14.
   Using the front panel filament adjust set VOM to read 5VAC.
   Adjust **R4** for a 5 volt indication on the filament meter.
   Disable Rotek and remove test leads.

7) Shut off filaments.

8) FILAMENT CURRENT METER ADJUSTMENT
   Set Rotek for 1A 60Hz and connect thru T4 (Filament Current Sensor)
   Energize Rotek. Adjust **R5** for a 1A indication on the filament meter.
   Disable Rotek and remove test leads.

9) The power supply is now ready to be returned to service

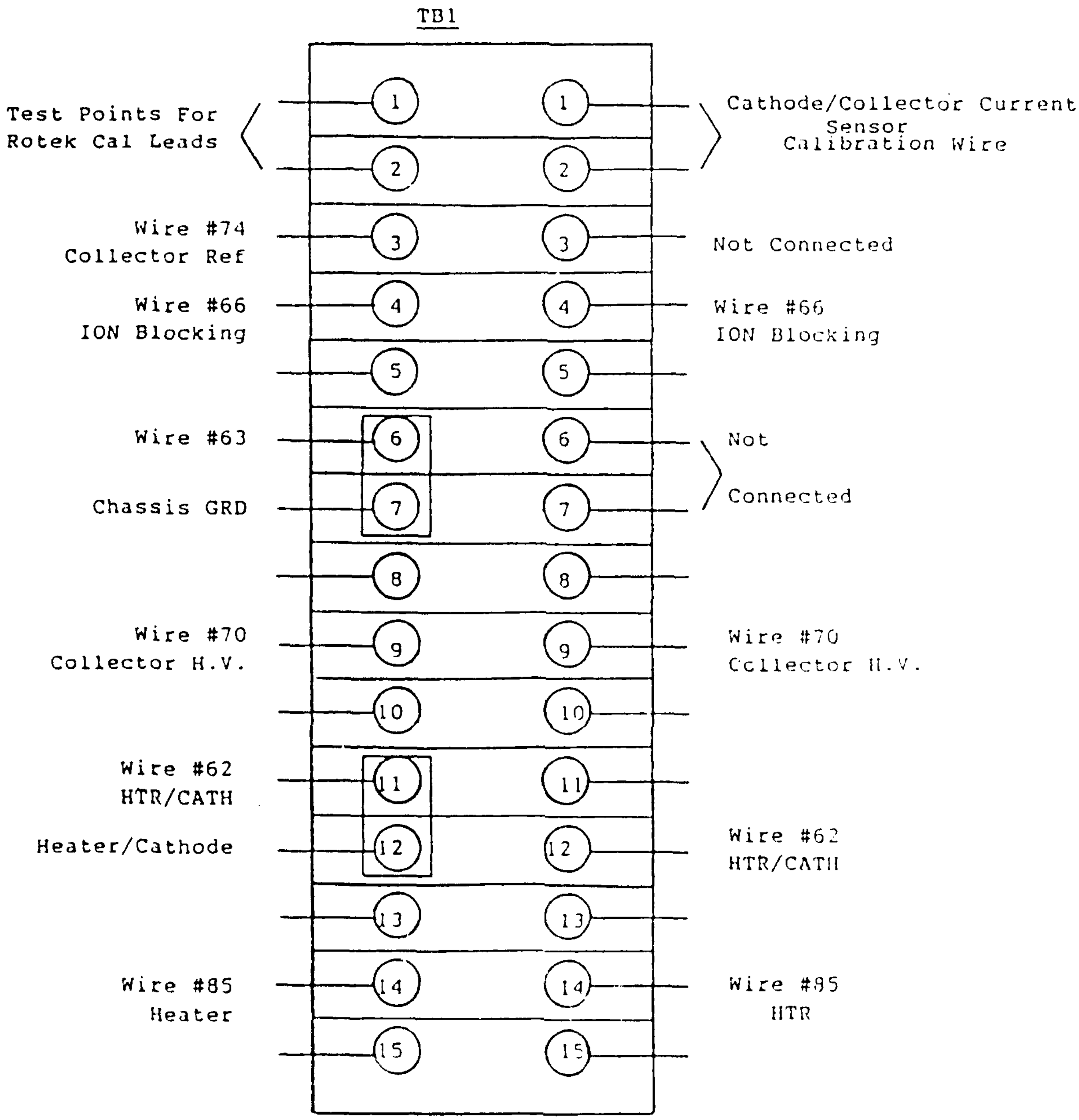

Figure 2-3 P/S 3260 Test Point Terminal

2.4.3 RADC Model HVPS-1

1) HIGH VOLTAGE (H/V) METER CALIBRATION
Connect the high voltage meter to the Rotek.
Set Rotek for 1000VDC. Energize the Rotek and adjust the pot on the H/V meter for 1000V. Shut off Rotek and disconnect test leads.

2) CATHODE VOLTMETER ADJUSTMENT
Connect the H/V meter ground lead to the power supply chassis. Connect the H/V meter probe to the cathode voltage output connector. Adjust R24, located in the top left side of the power supply, until the cathode voltmeter agrees with the H/V meter reading.

3) COLLECTOR VOLTMETER ADJUSTMENT
Connect the H/V meter to the collector output voltage connector. Adjust R26, located next to R24, until the collector voltmeter agrees with the H/V meter reading.

4) Remove test leads from supply and return supply to service. No other adjustments are possible on this supply.

2.5 Vehicle Simulator

The Vehicle Simulator emulates the loading characteristics, placed on the power supply, of a thermionic cathode. It is used primarily for power supply calibration and troubleshooting while operating under actual loading conditions. The schematic diagram of the simulator is shown in Figure 2-3. It consists of a simple network of high wattage ceramic resistors. The connections to the simulator are the 'Body', 'Cathode', 'Collector', and the 'Heater'. The current/voltage relationships are given below and can be used to verify the power supply calibration and meter/circuit linearity under actual operating conditions.

$$\text{Body Current} = \frac{\text{Cathode Voltage}}{251\text{ K}}$$

$$\text{Collector Current} = \frac{\text{Cathode Voltage} - \text{Collector Voltage}}{7.46\text{K}}$$

$$\text{Cathode Current} = \text{Collector Current} + \text{Body Current}$$

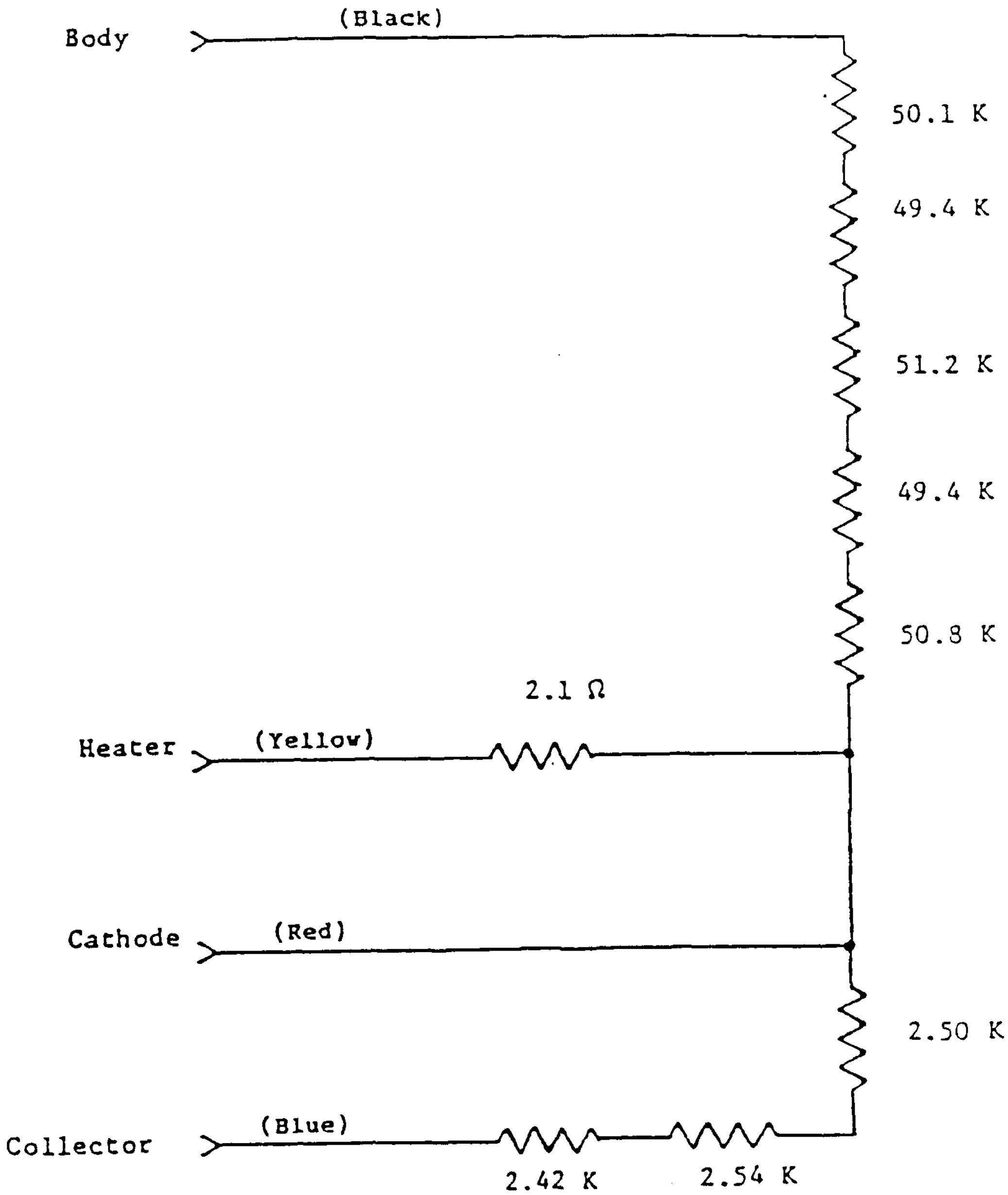

Figure 2-4 Vehicle Simulator Schematic

3.0 Measurement Procedure

3.1 Meter Readings

Each workday morning readings of each meter on all power supplies which contain a test vehicle will be accomplished. The readings will be recorded in the daily meter log shown in Figure 3-1. The daily meter logs are designed to contain one calendar months worth of life test parameter information. Life test operating voltage data from the filament, cathode, collector circuits will be recorded as well as the current consumption of the three as indicated on the respective current meters. Recording the body current and the Elapsed time meter readings is also required and space is provided to document any unusual or downtime occurrences. The Ion-Blocking voltage and current readings are only applicable to the Cober Model 3260 power supplies. Daily meter log books are located on top of each power supply cabinet. The unit number is the equipment accountability number where 'A' refers to the top power supply and 'B' refers to the bottom power supply. The daily readings are performed to accomplish two objectives. The first is to keep continuous records of the test vehicle and power supply operating conditions. Secondly, the daily readings ensure that failure of the power supply or test vehicle is quickly determined and corrected.

3.2 Operating Temperature

The life test operating temperature of a thermionic cathode is determined by two different methods. The first is to compute the operating temperature based upon initial Miram curve data. The second is that the manufacturer has specified the operating temperature. Current cathodes under test had their temperatures specified. To compute the operating temperature of a test vehicle, initial Miram curve measurement data is required. Upon plotting the data, straight line curve fits are established for both the temperature limited region and the space charge region. The intersection of these two lines is defined as the Kneepoint of the curve and the life test operating temperature is typically chosen to be 50 degrees centigrade above the Kneepoint. This procedure is illustrated graphically in Figure 3-2.

3.2.1 Kneecalc

A computer program was developed which computes the vehicle life test operating temperature based upon the initial Miram curve data. The coding uses a least-squares method, along the temperature limited region and the space charged region, in an iterative manner to obtain the best straight line fit to establish the kneepoint of the curve. Upon determination of the kneepoint it is a simple matter to compute the operating temperature. In instances where the operating temperature is not specified by the manufacturers, the operating temperature is typically chosen to be 50 degrees centigrade above the Kneepoint. Fifty degrees above the knee is not always a constant and the facility manager should be contacted for the correct offset. A hard copy listing of the program "KNEECALC" is given in Table 8. It permits the creation of original data files for new test vehicles and allows existing files to be read to recompute the operating temperature.

CATHODE LIFE TEST DAILY METER LOG

UNIT - NUMBER:

CATHODE TYPE:

MONTH:

YEAR:

DAY	TIME	FILAMENT VOLTAGE	FILAMENT CURRENT	CATHODE VOLTAGE	CATHODE CURRENT	COLLECTOR VOLTAGE	COLLECTOR CURRENT	BODY CURRENT	E T M	ION BLOCK CURRENT	ION BLOCK VOLTAGE	COMMENTS	INIT
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
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30													
31													

Figure 3-1 Daily Meter Log

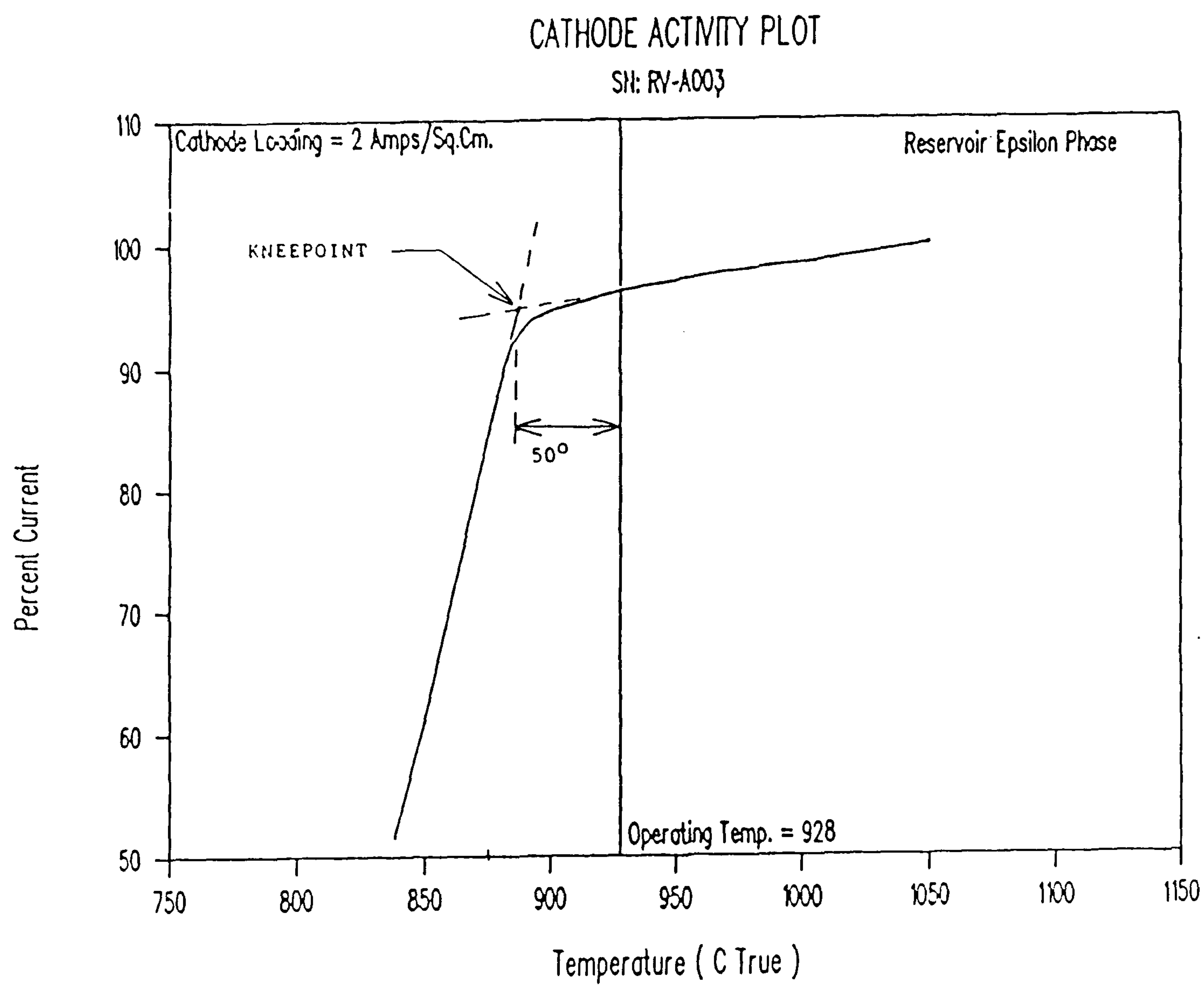

Figure 3-2. Operating Temperature Solution

Table 8

KNEECALC

```
10 'THIS PROGRAM WILL CALCULATE THE LEAST-SQUARES LINES FOR THE TEMPERATURE
20 'LIMITED REGION AND THE SPACE CHARGE LIMITED REGION OF A MIRAM PLOT.
30 'THE PROGRAM WILL THEN CALCULATE THE INTERSECTION POINT OF THESE TWO
40 'LINES TO GET THE KNEE OF THE MIRAM PLOT. THE PROGRAM WILL ALSO CALCULATE
50 'THE OPERATING TEMPERATURE OF THE CATHODE.
60 DIM XXX(100),YYY(100),XTL(100),YTL(100),YPRIMESC(5000),YPRIMETL(5000),DELTA(1
00)
70 INPUT"DO YOU WISH TO CREATE OR READ (C OR R) A DATA FILE? ",A$
80 IF A$<> "C" AND A$<> "R" THEN 70
90 IF A$="C" THEN 100 ELSE 200
100 INPUT"WHAT DO YOU WANT TO NAME THE FILE? ",N$
110 OPEN "O",#1,"A:"+N$
120 INPUT"HOW MANY DATA POINTS ARE TO BE ENTERED? ",NSC
130 WRITE#1,NSC
140 FOR I = 1 TO NSC
150 INPUT"ENTER TEMPERATURE,PERCENT CURRENT(DESCENDING ORDER)",XXX(I),YYY(I)
160 WRITE#1,XXX(I),YYY(I)
170 NEXT I
180 CLOSE #1
190 IF A$="R" THEN 200 ELSE 360
200 INPUT"WHICH FILE DO YOU WANT TO READ? ",N$
210 OPEN "I",#2,"A:"+N$
220 INPUT#2,NSC
230 FOR I = 1 TO NSC
240 INPUT#2,XXX(I),YYY(I)
250 NEXT I
260 CLOSE#2
270 INPUT "DO YOU WISH TO VIEW THE DATA OR COMPUTE THE KNEE(V or K)?",D$
280 IF D$<>"V" AND D$<>"K" THEN 270
290 IF D$="K" THEN 360
300 PRINT CHR$(12)
310 PRINT " PT.             TEMP.          %FSCL"
311 PRINT
320 FOR I=1 TO NSC
330 PRINT I,XXX(I),YYY(I)
340 NEXT I
350 GOTO 1380
360 WIN = .5
370 'THE VARIABLE WIN IS USED FOR REDUCING THE DEVIATIONS BETWEEN THE
380 'MEASURED DATA AND THE LEAST SQUARE PREDICTION.
390 FACTOR = 50
400 'THE VARIABLE FACTOR IS THE NUMBER OF DEGREES CENTIGRADE ADDED TO
410 'TO THE KNEE TEMPERATURE TO OBTAIN THE OPERATING TEMPERATURE.
420 INTCPT=.25
430 'THE VARIABLE INTCPT IS USED TO DETERMINE HOW CLOSE THE LEAST SQUARES
440 PRINT CHR$(12)
450 BEEP
460 PRINT "...............WORKING.............PLEASE STAND BY"
470 'LINES WILL INTERSECT.
480 NTL=NSC
490 NNN = INT(NSC/2)
500 'TEMP LIMITED CALC PART-----------------------------------
510 '
520 SUMXXX=0
530 SUMYYY=0
540 SUMXXX2=0
550 SUMXYSC=0
560 FOR I = 1 TO NNN
570 SUMXXX = SUMXXX+XXX(I)
580 SUMYYY = SUMYYY+YYY(I)
```

Table 8

KNEECALC (continued)

```
590 XXX2 = XXX(I)*XXX(I)
600 SUMXXX2 = XXX2+SUMXXX2
610 XYSC=XXX(I)*YYY(I)
620 SUMXYSC = SUMXYSC + XYSC
630 NEXT I
640 DENOMSC = ((NSC/2)*SUMXXX2)-(SUMXXX*SUMXXX)
650 NUMASC = (SUMYYY*SUMXXX2)-(SUMXXX*SUMXYSC)
660 NUMBSC = ((NSC/2)*SUMXYSC)-(SUMXXX*SUMYYY)
670 ASC1=NUMASC/DENOMSC
680 BSC = NUMBSC/DENOMSC
690 '
700 XXXMAX=XXX(1)
710 FOR I = 2 TO NSC
720 IF XXX(I) > XXXMAX THEN XXXMAX = XXX(I)
730 NEXT I
740 '
750 FOR TEMP=1 TO INT(NSC/2)
760 YPRIMESC(TEMP)=ASC1+(BSC*XXX(TEMP))
770 DELTA(TEMP)=YYY(TEMP)-YPRIMESC(TEMP)
780 IF DELTA(TEMP) < WIN THEN 790 ELSE 800
790 IF DELTA(TEMP) > -WIN THEN 820 ELSE 800
800 NSC=NSC-1
810 GOTO 490
820 NEXT TEMP
830 '-------SPACE CHARGE LIMITED PART------------------------------------
840 SUMXXX=0
850 SUMYYY=0
860 SUMXXX2=0
870 SUMXYTL=0
880 FOR I=NNN TO NTL
890 SUMXXX=SUMXXX+XXX(I)
900 SUMYYY=SUMYYY+YYY(I)
910 XXX2=XXX(I)*XXX(I)
920 SUMXXX2=SUMXXX2+XXX2
930 XYTL = XXX(I)*YYY(I)
940 SUMXYTL=SUMXYTL+XYTL
950 NEXT I
960 '
970 DENOMTL=(((NTL+1)-NNN)*SUMXXX2)-(SUMXXX*SUMXXX)
980 NUMATL=(SUMYYY*SUMXXX2)-(SUMXXX*SUMXYTL)
990 NUMBTL=(((NTL+1)-NNN)*SUMXYTL)-(SUMXXX*SUMYYY)
1000 ATL = NUMATL/DENOMTL
1010 BTL = NUMBTL/DENOMTL
1020 FOR TEMP=NNN TO NTL
1030 YPRIMETL(TEMP)=ATL +(BTL*XXX(TEMP))
1040 DELTA(TEMP)=YYY(TEMP)-YPRIMETL(TEMP)
1050 IF DELTA(TEMP) <WIN THEN 1060 ELSE 1070
1060 IF DELTA(TEMP) > -WIN THEN 1090 ELSE 1070
1070 NNN=NNN+1
1080 GOTO 840
1090 NEXT TEMP
1100 '
1110 '------THIS THE INTERCEPT CALCULATION PART------------------------------
1120 '
1130 I=0
1140 CK=0
1150 CLR=0
1160 FOR TEMP= 0 TO XXXMAX STEP .5
1170 I=I+1
1180 YPRIMESC(I)=ASC1+(BSC*TEMP)
```

Table 8

KNEECALC (concluded)

```
1190 YPRIMETL(I)=ATL +(BTL*TEMP)
1200 '
1210 '
1220 IF YPRIMESC(I) >YPRIMETL(I)-INTCPT THEN 1230 ELSE 1330
1230 IF YPRIMESC(I) <YPRIMETL(I)+INTCPT THEN 1240 ELSE 1330
1240 CLR=CLR+1
1250 BEEP
1260 IF CLR=1 THEN 1270 ELSE 1280
1270  PRINT CHR$(12)
1280 PRINT"KNEE TEMP= " TEMP
1290 PRINT"OP TEMP= " TEMP+FACTOR
1300 PRINT
1310 BEEP
1320 CK=1
1330 NEXT TEMP
1340 IF CK=0 THEN 1350 ELSE 1380
1350 PRINT CHR$(12)
1360 PRINT "USING THE DATA STORED IN THE FILE NAMED ";N$
1370 PRINT "NO KNEE INTERCEPT IS POSSIBLE WITH THE CURRENT VALUE SET FOR THE VAR
IABLE       <INTCPT>.    SUGGEST RELAXING THE TOLERANCE AND RECOMPUTING."
1380 END
```

Observe lines 360, 390 and 420 which contain the program variables WIN, FACTOR, and INTCPT respectively. The WIN variable is used to reduce or minimize the deviations between the measured data and the least-squares prediction. The variable is used during the iteration process when determining which data points are in the temperature limited region, the space charged region, or in the knee of the curve. The variable factor is the number of degrees centigrade added to the kneepoint temperature to obtain the operating temperature. The variable INTCPT is a window used to specify how close the least squares approximation lines will intersect at the kneepoint. The intersection is tested at 0.5 degree intervals therefore the INTCPT window is set to 0.25 degrees. Testing the intersect with finer temperature resolution, decreases the size of the window.

3.3 Miram Plots

A Miram or roll-off plot, shown in Figure 3-3, is the fundamental basis for determining present condition and the life expectancy, of a thermionic cathode. Miram plot measurements are conducted regularly throughout the life test of the vehicle. The first measurement is conducted within one week after the vehicle is initially put on line. A second measurement is conducted after the vehicle has been operating for at least 1000 hours. All other measurements are conducted at 6 month intervals or more frequently if needed. The semi-annual measurements are performed in February and August. The data is plotted as a function of Temperature vs. Cathode loading percentage, and is dependent upon the cathode current density. That is, the percent current-equals 100 when the current loading is 2 amperes per square centimeter and the current drain is 100 ma. Table 9 shows the Cathode Activity data sheet. This data sheet is annotated during the measurement process to obtain the Miram curve data. There are twenty entries in the table. The general procedure in obtaining the data is to record 5 values in the temperature limited region, 5 values in the space charged region and 10 values in between such that the knee of the curve is well defined.

3.3.1 Measurement Procedure

With cooling on, slowly increase the cathode temperature to 1100 degrees centigrade employing the type pyrometer specified for the vehicle. Keep the heater surge current to a maximum of twice the amount specified by the manufacturer for 1100 degrees. Set the anode bias if any. Slowly raise the cathode and collector voltage (keeping col V - 0.70 x cath V +/-5%) to achieve the current that represents the desired cathode loading for that vehicle. During this process, the body current must be less than 5 milliamp. An exception occurs with the SIEMANS MK cathodes or other magnetically focused vehicles. With these, at the desired temperature, all other voltages are preset but not initially applied to the tube. When all voltages are established they are then simultaneously applied. For either procedure, the values will interact slightly and must be iteratively adjusted until desired loading is obtained at the correct temperature. When the loading density selected has been achieved, record all parameters. The cathode voltage measured shall be maintained for all future MIRAM curves.

Let the cathode stabilize for 60 minutes at the starting temperature (usually 1100 degrees) and record all parameters. Next, reduce the filament power to reduce cathode temperature by approximately 10 degrees (8 to 12), wait 5 minutes, record all parameters and reduce temperature another 10 degrees.

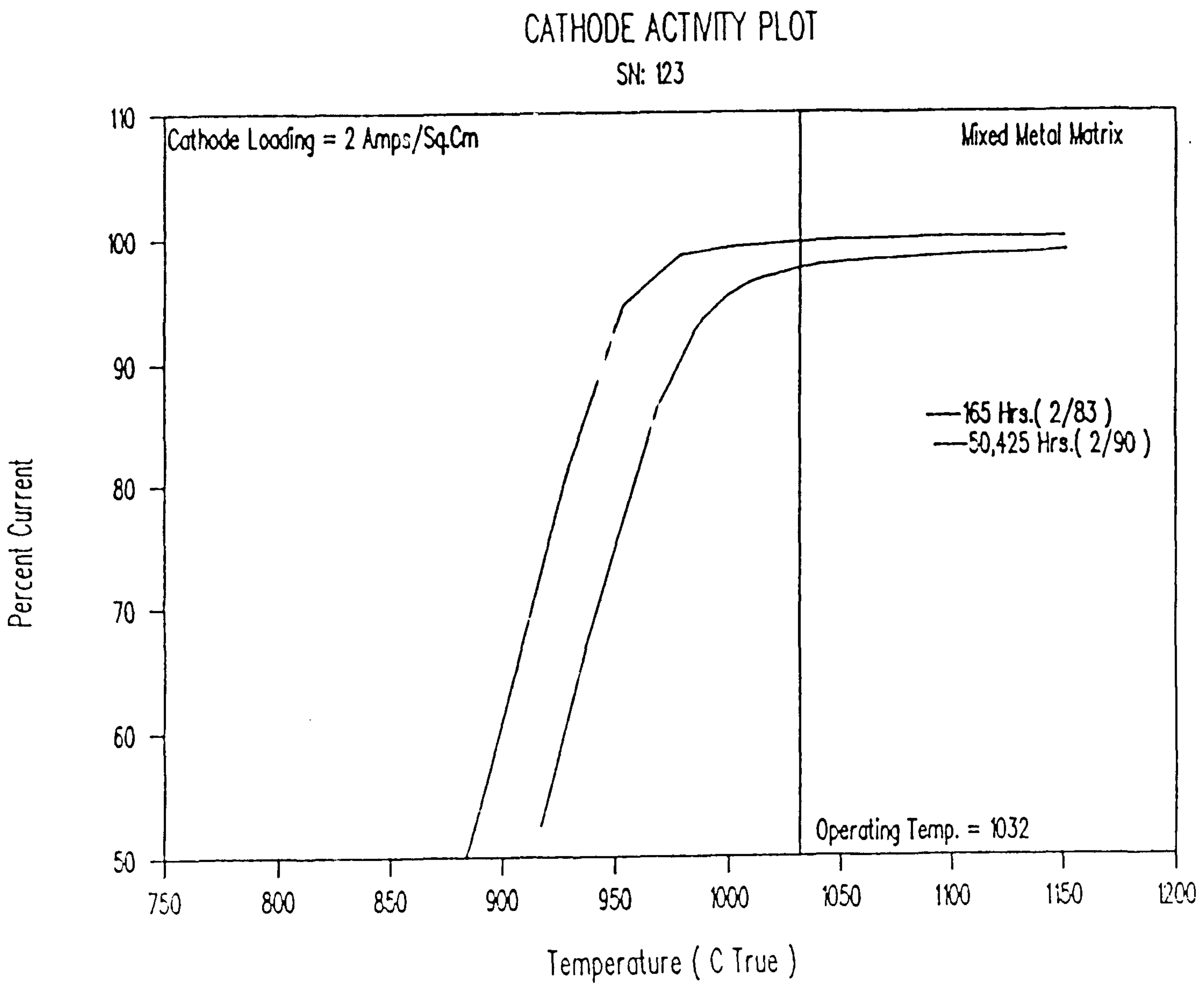

Figure 3-3 Miram Plot

Table 9

CATHODE ACTIVITY DATA SHEET

TEST VEHICLE TYPE ____________________ ETM ________________ DATE________________

MFR ____________ S/N________ PYRO # _____________ RECORDER ____________________

TOTAL LIFE HRS _______________

TEMP	FILAMENT		CATHODE		COLLECTOR		BODY	CATHODE
°C T/B	VOLT	AMPS	VOLT	mAMP	VOLT	mAMP	mAMP	%FSCL

RETEST DATE ____________________ ETM ___________________ PYRO # _______________

TOTAL LIFE HRS _______________

Repeat this procedure until cathode current has decreased by at least 50%. At this point, set the test vehicle to its normal life test condition.

The temperature and percent current data is transferred and stored into the facilities computer and the data sheet is archived for future reference.

3.4 Two Color Pyrometer

The two color pyrometer, manufactured by Ircon Inc., is a MODLINE R Series infrared thermometer. It is a completely modular non-contact temperature measurement and control system consisting of two units. The SENSING HEAD senses the infrared radiation emitted by a heating object and supplies an electrical signal to the indicator unit. For thermionic cathode measurements, use the 'A2' lens. The INDICATOR Unit provides a signal, linear with temperature, to produce a front panel display of temperature in degrees. The two color pyrometer measures temperature by comparison of infrared radiation levels at two wavelengths and computes the temperature, in degrees 'C' true, based upon the ratio of the two radiation signals. For detailed information the reader is referred to the two color pyrometers' Operations Manual.

3.4.1 Temperature Measurements Using a Two Color Pyrometer

A technique has been developed which permits repeatable temperature measurements on cathode test vehicles using a two color pyrometer. Duplicating measured data using pyrometer instrumentation is at best difficult and requires precise orientation of the pyrometer from one set of measurements to another. The method discussed here involved both a modification to the pyrometer fixture as well as procedural changes for establishing the location of the pyrometer referenced to the test vehicle. This technique has been demonstrated and is currently employed on all vehicles in the cathode facility except the Siemens MK's. In order to achieve precise positioning of the pyrometer to the test vehicle, modifications to the existing pyrometer fixture were made. Two single axis micrometer positioners were fastened together such that the axes were perpendicular to each other. The positioners were then placed between the pyrometer and its tripod base, thus permitting micro-motion adjustment of the pyrometer in two planes. Additionally, two calibrated displacement rods were bolted perpendicular to the face plate of the pyrometer to ensure identical focal plane positioning from measurement to measurement. The focal plane was set to be centered in the pyrometers operating focal length and the latter is approximately eleven inches. This configuration is shown in Figure 3-4.

3.4.1.1 Setup Procedure

Upon receipt, new test vehicles are inspected and mounted in their respective chambers where they remain throughout the entire life test measurement program. Initial Miram plot measurements serve as a baseline for data comparison and vehicle performance analysis. The setup of the pyrometer instrumentation for these measurements is critical. The first step is to position the pyrometer in front of the vehicle chamber such that the pyrometer lens is in line with the chamber window. Using the roll and pitch adjustments on the tripod, ensure the pyrometer is level in the X and Y planes and plumb in the Z plane. The yaw adjustment on the tripod is used to set the displacement rods, and consequently the pyrometer measurement plane perpendicular to the vehicle chamber. The micrometer positioners and the tripod's vertical displacement adjustment are used to fine tune position the test vehicle's cathode, directly in the center of the pyrometer's eye, and at the appropriate focal distance. The X axis micrometer positioner is adjusted such that the tips of the displacement rods touch the front panel of the vehicle chamber. To guarantee perpendicularity, the contact made between each rod and the front panel should be identical. This final configuration is shown in Figure 3-5. Upon completion of the instrumentation orientation, the set up parameters are confirmed to be level, plumb, centered, and properly distanced. Once this is accomplished, a cross mark or dot is placed on the front panel of the vehicle chamber at the tip of each calibrated displacement rod. These marker points are used to reposition the pyrometer instrumentation prior to subsequent Miram plot measurements. Thus with proper leveling and positioning of the pyrometer, repeatable temperature measurements are achievable.

3.5 <u>Disappearing Filament Pyrometer</u>

The Pyrometer Instrument micro-optical, model 95 pyrometer is used for measuring temperature in degrees 'C' brightness. For temperature measurements within the Cathode facility a 'D' type lens is used. The 'D' lens places the focal region between 13.5 and 17.5 inches. The test cathode is positioned approximately 6 1/4 inches back from the window of the power supply enclosure. Placing the pyrometer 9 inches in front of the power supply window, positions the device approximately 15 1/4 inches away from the cathode, which is centered within the pyrometers focal region. Using a small level, the pyrometer should be leveled, plumbed and maintained in that orientation throughout the duration of the test. For consistency, adjust the filament from below the cathode temperature, up to the level where the filament disappears. Detailed discussion of the actual operation and reading of the disappearing filament Pyrometer may be found in its operating manual.

3.6 <u>Data Storage</u>

Presently, the data collected at the Cathode Life Test facility is being transported to and processed at the ARC Professional Services Group office. The Zenith Z-150 personal computer which is an IBM XT compatible machine previously used for data processing is no longer available. A new 386 class computer was ordered and has been received for the Cathode Lab's use. It is currently being used by Rome Laboratory Engineers who are in the process of writing new software required to control the Miram Curve Generator. At the present time there are two types of data being processed for the cathode lab. The first is the miram curve raw measured data, and the miram curve processed data. The program used to create the processed data and the miram plots is TECH*GRAPH*PAD. The second type of cathode data is being processed by the program LOTUS 1-2-3. This includes The Measurement Data Log Sheet, the Cathode Facility Vehicle Inventory, and the Monthly Cathode Facility Condition Report. The data is currently stored on a 40M hard drive and fully backed up on 5 1/4 inch floppies.

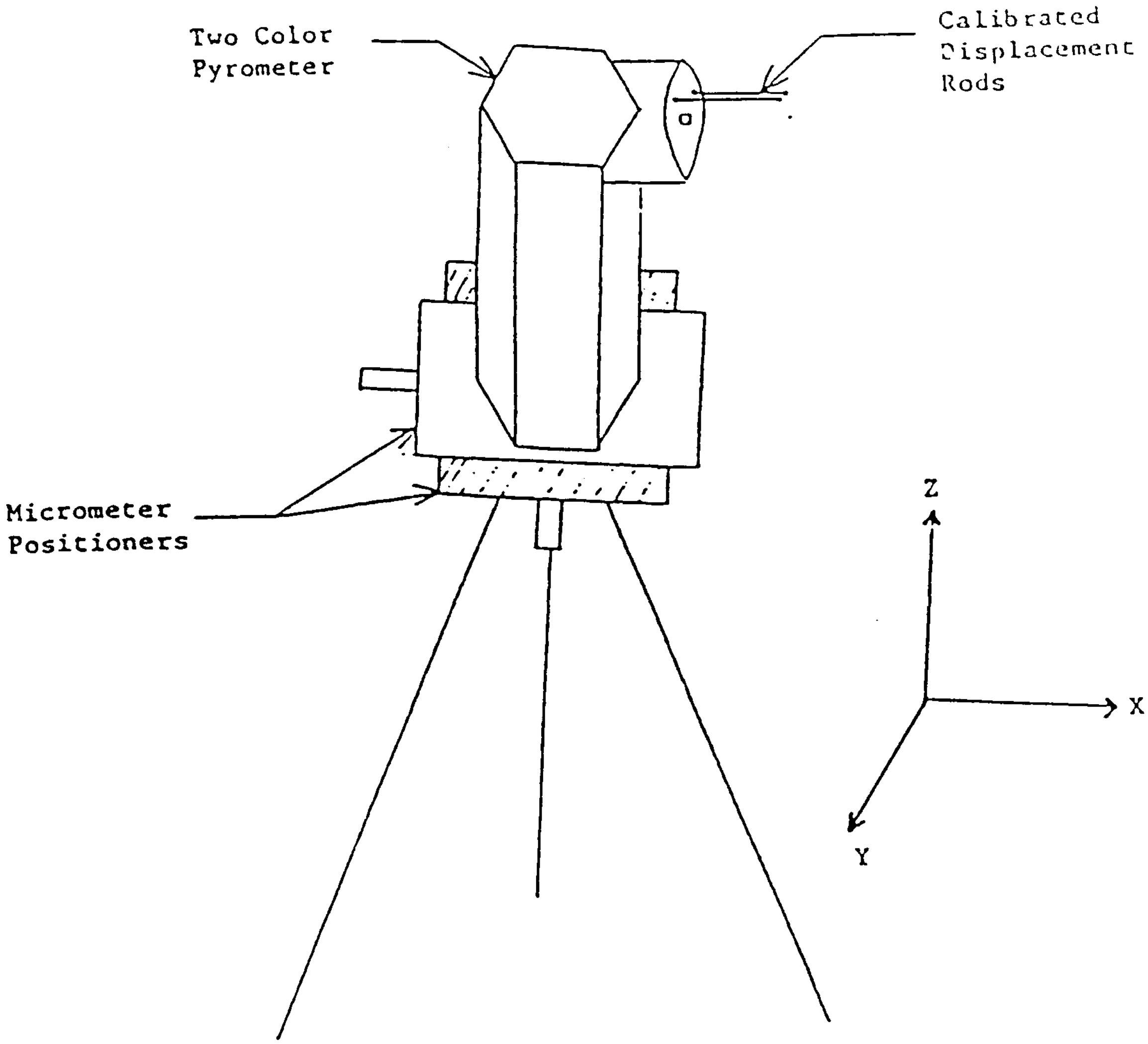

Figure 3-4 Pyrometer Fixture

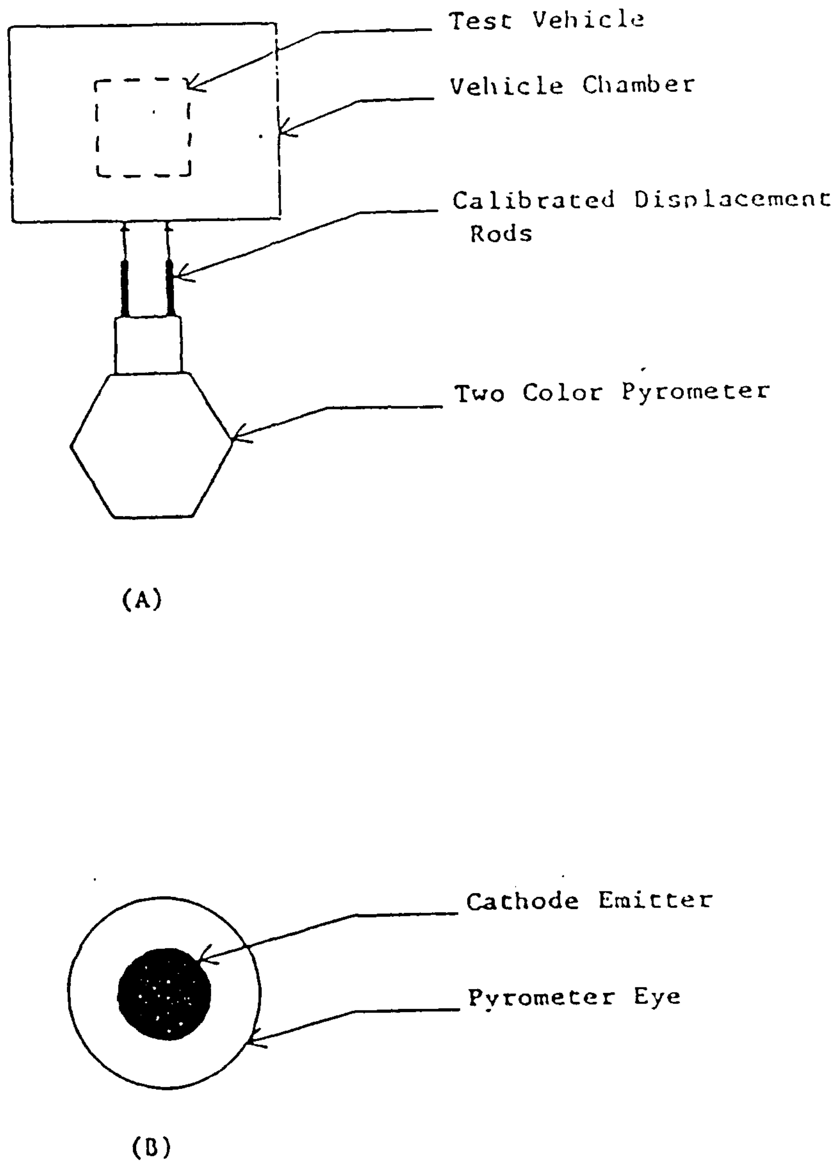

Figure 3-5 Pyrometer Setup

a) Displacement Rod Positioning
b) Cathode Emitter Centering

3.7 Filenames

In order to facilitate recognition and differentiation between data files, a standardized format for naming files was developed. The filename is an eleven character identifier which includes the DOS three character extension. The filename structure and breakdown is as follows:

```
X X X X X X X X. X  X  X
1 2 3 4 5 6 7 8. 9 10 11
```

The first two characters identify the Vehicle Code.

i.e.:
- RV - Reservoir-Epsilon Phase
- TL - Trilayer Series
- SM - Semicon 'M' Type
- HM - Hughes 'M' Type
- M3 - Mixed Metal Matrix
- TM - Transition Metal
- MK - Siemans MK series
- OX - F-D-E Oxide Type
- SC - F-D-E Scandate Type

The third, fourth, fifth and sixth characters identify the test vehicles serial number.

i.e.: 1135
0021

The seventh and eighth characters identify the month the data was recorded.

i.e.: 01
12

The ninth character identifies the type of data file.

i.e.:
- D - raw data file
- G - Graph data file
- R - repeat data file
- T - temperature data file

Characters ten and eleven identify the year the data was recorded/processed in.

An example of a typical filename and its breakdown is as follows:

OX020102.D91

This particular file contains raw measurement data on an F-D-E oxide type cathode whose serial number is 201, and the data was recorded in February of 1991.

4.0 Documentation

During the performance of this effort the need for additional documentation became apparent. As questions arose as the to the location and disposition of vehicles that had previously been on life test and since removed it became evident that a single comprehensive document, containing all known past and present vehicle information, would be of great significance to the Cathode Life Test facility. Cathode lab historical records and current lab documents were examined and the information of interest condensed in a single document. This document titled The RL/OCTP Cathode Facility Vehicle Inventory is described in Section 4.4.

A second document, developed during this effort, is the Measurement Data Log Sheet. The main purpose of this document is to aid the lab operator during the periodic roll offs to keep track of which power supplies have been calibrated and which cathodes have had their the roll off curves completed. Section 4.5 describes this document.

4.1 Daily Logbook

The daily logbook is used to record the daily activities which occur in the facility. It is kept within the facility and should be updated at the end of each working day.

4.2 Vehicle Logbook

There is a logbook associated with each type of test vehicle which is kept within the facility. The logbooks are black 3 ring binders and are organized according to the vehicles serial numbers. They contain the manufacturers documentation which includes schematics, safety and operating procedures and initial measurement data. These logbooks are also used to archive the Cathode activity data sheets, (Section 3.3), which contain the measurement data recorded for the Miram plots.

4.3 Power Supply Repair Logbook

The power supply repair logbook is a red 3 ring binder which contains historical repair and maintenance data on all 40 supplies in the facility. The logbook is sectionalized according to the supply's Equipment Management and Accounting System (EMAS) identification number and is updated whenever a maintenance or repair operation is performed.

4.4 The RL/OCTP Cathode Facility Vehicle Inventory

This document, shown in Table 10, is a consolidation of pertinent information obtained from past and current historical records of cathodes presently on life test and on cathodes with past life test experience no longer on test. It summarizes vehicle data,test conditions, and cathode performance data. There is also a comments section for entry of any additional information. The Cathode Facility Vehicle Inventory is updated monthly and included in the Monthly Status Report.

Table 10

THE RL/OCTP

CATHODE FACILITY VEHICLE INVENTORY

T= True (IRCON Two Color Pyrometer).

B= Brightness (PYROMETER CORP).
Disappearing Filament Pyrometer.

CODES

a- Removed from test due to cathode bushing leakage.
b- Removed from test due to heater burnout.
c- Degradation in excess of 10%.
d- Removed for excessive body current.
e- Removed from test due to collector bushing leakage.
f- Removed from test, power supply needed for more promising type.
g- Returned to Universal Energy Systems for repair.
h- Non-cathode related failure.
i- Returned to F-D-E Enterprises for analysis.

NOTE: No information is available where non-annotated entries are evident.

(JUNE 1991)

Table 10 (continued)

THE RL/OCTP CATHODE FACILITY VEHICLE INVENTORY

	VEHICLE DATA				TEST CONDITION DATA				LIFE		APPROXIMATE % DEGRADATION @ OPER. TEMP.	COMMENTS
	TYPE	MFR	S/N	LOAD I DENSITY	DATE TEST STARTED	OPERATING TEMPERATURE	STATUS	DATE REMOVED	HRS. WHEN REMOVED	CODE		
1	MK	SIEMENS	2	2A/SQ CM	3/6/85	1020 DEG C B	ON TEST				-2.0	
2	MK	SIEMENS	3	4A/SQ CM		1060 DEG C B	SHELF	12/1/88	12,949	d		
3	MK	SIEMENS	4	4A/SQ CM	6/18/85	1060 DEG C B	ON TEST				-3.0	
4	MK	SIEMENS	6	2A/SQ CM		1020 DEG C B	SHELF	7/13/89	20,414		-2.1	
5	MK	SIEMENS	7	2A/SQ CM		1020 DEG C B	SHELF	5/22/89	21,544	d	-1.1	
6	MK	SIEMENS	8	4A/SQ CM	10/9/85	1060 DEG C B	ON TEST				-6.0	
7	MK	SIEMENS	12	2A/SQ CM	8/5/85	1020 DEG C B	ON TEST				-2.0	
8	MK	SIEMENS	17	4A/SQ CM	10/22/85	1060 DEG C B	SHELF	5/21/91	35,672	c,d	-8.5	
9	M	SEMICON	200	1A/SQ CM		938 DEG C B			26,951	f	-1.0	
10	M	SEMICON	201	1A/SQ CM		989 DEG C B			27,136	f	-3.0	
11	M	SEMICON	202	2A/SQ CM	7/17/84	1018 DEG C T	ON TEST				-7.0	
12	M	SEMICON	203	4A/SQ CM		1010 DEG C B			20,169	f	-0.3	
13	M	SEMICON	204	1A/SQ CM		1040 DEG C B	SHELF		18,028	f		
14	M	SEMICON	205	1A/SQ CM		989 DEG C B	SHELF		12,181	f		
15	M	SEMICON	209	2A/SQ CM	7/11/84	957 DEG C T	ON TEST				-1.7	
16	M	SEMICON	210	2A/SQ CM	6/25/90	960 DEG C T	ON TEST				-2.0	
17	M	SEMICON	215	2A/SQ CM	7/12/90	948 DEG C T	ON TEST				+0.9	
18	M	SEMICON	218	2A/SQ CM	7/18/90	945 DEG C T	ON TEST				-0.5	

Table 10 (continued)

	Vehicle Data				Test Condition				Life		Approximate %	Comments
	TYPE	MFR	S/N	LOAD I DENSITY	DATE TEST STARTED	OPERATING TEMPERATURE	STATUS	DATE REMOVED	HRS. WHEN REMOVED	CODE	DEGRADATION @ OPER. TEMP.	
19	M	HUGHES	211	4A/SQ CM		1040 DEG C T			22,145	h	-0.8	
20	M	HUGHES	212	4A/SQ CM	10/20/85	1013 DEG C T	ON TEST				-2.0	
21	M	HUGHES	214	4A/SQ CM		1030 DEG C T			13,036	h	-1.6	
22	TRI	VARIAN	001	2A/SQ CM		950 DEG C T			24,617	f	-0.2	
23	TRI	VARIAN	002	2A/SQ CM		955 DEG C T			1,270	h	-0.1	
24	TRI	VARIAN	005	4A/SQ CM		1000 DEG C T			275	h	0.0	Shipped to Universal Energy Systems by Boden
25	TRI	VARIAN	006	4A/SQ CM		990 DEG C T			1,200	h	0.0	
26	TRI	VARIAN	007	4A/SQ CM	6/21/89	995 DEG C T	SHIPPED		23,144	d		
27	TRI	VARIAN	008	4A/SQ CM		1000 DEG C T			241	h	0.0	Shipped to Universal Energy Systems by Boden
28	TRI	VARIAN	009	4A/SQ CM	8/29/89	990 DEG C T			22,867	d	-3.5	Shipped to Universal Energy Systems by Boden
29	TRI	VARIAN	010	2A/SQ CM		960 DEG C T	SHELF		20,202	f	-0.2	
30	TRI	VARIAN	011						41	e		Shipped to Universal Energy Systems by Boden
31	TRI	VARIAN	012	4A/SQ CM	9/17/85	985 DEG C T	ON TEST				-2.5	
32	TRI	VARIAN	013						37	h		
33	TRI	VARIAN	014	2A/SQ/CM		950 DEG C T			17,561	f	-0.8	
34	MMM	VARIAN	116	1A/SQ CM	5/21/91	969 DEG C T	ON TEST	7/14/88	48,862	f	0.0	Extension of prior test
35	MMM	VARIAN	118	1A/SQ/CM	5/20/91	994 DEG C T	ON TEST	7/14/88	43,514	f	-2.0	Extension of prior test
36	MMM	VARIAN	119	1A/SQ/CM	5/30/91	968 DEG CT	ON TEST	7/14/88	46,360	f	0.0	Extension of prior test

Table 10 (continued)

	VEHICLE DATA				TEST CONDITION			LIFE			APPROXIMATE %	COMMENTS
	TYPE	MFR	S/N	LOAD I DENSITY	DATE TEST STARTED	OPERATING TEMPERATURE	STATUS	DATE REMOVED	HRS. WHEN REMOVED	CODE	DEGRADATION @ OPER. TEMP.	
37	MMM	VARIAN	120	2A/SQ CM	9/22/82	1018 DEG C T	ON TEST				-3.0	
38	MMM	VARIAN	121	2A/SQ CM	12/17/82	988 DEG C T	ON TEST				+0.2	
39	MMM	VARIAN	122	2A/SQ CM	3/1/83	1021 DEG C T	ON TEST				-2.0	
40	MMM	VARIAN	123	2A/SQ CM	12/18/82	1032 DEG C T	ON TEST				-2.0	
41	MMM	VARIAN	124	2A/SQ CM	1/14/83	994 DEG C T	ON TEST				-1.5	
42	MMM	VARIAN	125	2A/SQ CM	1/18/83	1010 DEG C T	ON TEST				-5.9	
43	MMM	VARIAN	126	4A/SQ CM		1070 DEG C T			14,635	h	-1.7	
44	MMM	VARIAN	127	4A/SQ CM		1125 DEG C T			1,482	c	-20.1	
45	MMM	VARIAN	128							*		
46	TM	VARIAN	B1135	4A/SQ CM	8/22/89	1002 DEG C T	ON TEST				-7.9	
47	TM	VARIAN	B1240	4A/SQ CM	10/31/89	988 DEG C T	ON TEST				-0.8	
48	TM	VARIAN	B1350	4A/SQ CM	8/23/89	989 DEG C T	ON TEST				-2.6	
49	TM	VARIAN	B1352	4A/SQ CM	11/1/89	999 DEG C T	ON TEST				-5.5	
50	TM	VARIAN	B1455	4A/SQ CM	8/15/89	1001 DEG C T		5/21/91	13,977	c	-10.9	Shipped to F-D-E Enterprises 5/29/91
51	TM	VARIAN	B1462	4A/SQ CM	8/9/89	977 DEG C T	ON TEST				-7.0	
52	TM	VARIAN	B1565	4A/SQ CM	8/25/89	976 DEG C T	ON TEST				-1.1	
53	TM	VARIAN	B1667	4A/SQ CM	8/25/89	1009 DEG C T	ON TEST				-2.6	
54	TM	VARIAN	B1671	4A/SQ CM	11/2/89	1013 DEG C T	ON TEST				-4.0	

Table 10 (continued)

	VEHICLE DATA				TEST CONDITION			LIFE			APPROXIMATE %	COMMENTS
	TYPE	MFR	S/N	LOAD I DENSITY	DATE TEST STARTED	OPERATING TEMPERATURE	STATUS	DATE REMOVED	HRS. WHEN REMOVED	CODE	DEGRADATIION @ OPER. TEMP.	
55	TM	VARIAN	B1672	4A/SQ CM	8/16/89	990 DEG C T	ON TEST				-2.7	
56	RV	VARIAN	A002	4A/SQ CM	3/23/90	972 DEG C T	ON TEST				+0.2	
57	RV	VARIAN	A003	2A/SQ CM	3/12/90	928 DEG C T	ON TEST				-4.4	
58	RV	VARIAN	A004				SHELF	NEVER WORK	------	d		
59	RV	VARIAN	A005	2A/SQ CM	3/6/90	952 DEG C T	ON TEST				+2.0	
60	RV	VARIAN	A006	4A/SQ CM	3/19/90	968 DEG C T	ON TEST				0.0	
61	RV	VARIAN	A007	4A/SQ CM	3/21/90	948 DEG C T	ON TEST				+1.0	
62	RV	VARIAN	A008	2A/SQ CM	3/14/90	933 DEG C T	ON TEST				-0.4	
63	RV	VARIAN	A009	2A/SQ CM	3/15/90	934 DEG C T	ON TEST				+1.3	
64	SCANDATE	F-D-E	200	1A/SQ CM	9/27/90	687 DEG C T		5/01/91	5061	c	-90.1	Shipped to F-D-E Enterprises 13 May 91
65	OXIDE	F-D-E	201	1A/SQ CM	9/25/90	715 DEG C T		5/01/91	5139	c	-63.5	Shipped to F-D-E Enterprises 13 May 91
66	SCANDATE	F-D-E	208	1A/SQ CM	5/14/91	733 DEG C T	ON TEST					
67	SCANDATE	F-D-E	214	1A/SQ CM	10/3/90	755 DEG C T		5/01/91	4918	c	-70.2	Shipped to F-D-E Enterprises 13 May 91
68	OXIDE	F-D-E	203									Shipped to F-D-E Enterprises 13 May 91 (Shorted)
69	CD	VARIAN	130	2A/SQ CM		1050 DEG C T			90	h	0.0	
70	CD	VARIAN	131	2A/SQ CM		915 DEG C T	SHELF		12,120	f	-1.1	
71	CD	VARIAN	132	4A/SQ CM		960 DEG C T			12,109	f	-1.8	
72	CD	VARIAN	133	4A/SQ CM		960 DEG C T	SHELF		12,014	f	-1.0	

Table 10 (continued)

	VEHICLE DATA				TEST CONDITION				LIFE		APPROXIMATE %	COMMENTS
	TYPE	MFR	S/N	LOAD I DENSITY	DATE TEST STARTED	OPERATING TEMPERATURE	STATUS	DATE REMOVED	HRS. WHEN REMOVED	CODE	DEGRADATION @ OPER. TEMP.	
73	CD	VARIAN	134	1A/SQ CM		880 DEG C T	SHELF		14,054	f	-0.7	
74	CD	VARIAN	135	2A/SQ CM		920 DEG C T			15,020	f	-0.9	
75	CD	VARIAN	136	2A/SQ CM		950 DEG C T	SHELF		11,982	f	-1.1	
76	CD	VARIAN	138									Received Broken
77	CD	VARIAN	139	4A/SQ CM		990 DEG C T	SHELF		8,710	f	-1.4	
78	CD	VARIAN	1400	2A/SQ CCM		950 DEG C T			12,017	f	-1.2	
79	CD	VARIAN	141	1A/CQ CM		900 DEG C T			60	h	0.0	Shipped to Universal Energy Systems by Boden
80	CPD	HUGHES	206	4A/SQ CM		1045 DEG C T	SHELF	7/13/88	15,959	f	0.0	
81	CPD	HUGHES	207	2A/SQ CM		1000 DEG C T	SHELF	7/14/88	21,106	f	0.0	
82	CPD	HUGHES	129	1A/SQ CM		960 DEG C T			2,070	h	-5.8	
83	LAB6	ORC	216	1A/SQ CM		1605 DEG C T	SHELF		14,477	f	0.0	
84	LAB6	ORC	217	0.667A/SQ		1605 DEG C T	SHELF		12,358	f	0.0	
85	B	VARIAN	101z	1A/SQ CM		1050 DEG C B			12,505	c	-10.2	
86	B	VARIAN	102z	2A/SQ CM		1120 DEG C B			5,396	h	-9.0	
87	B	VARIAN	103z	1A/SQ CM		1050 DEG C B			1,770	h	-0.7	
88	B	VARIAN	104z	1A/SQ CM		1050 DEG C B			24,654	f	-2.9	
89	B	VARIAN	105z	1A/SQ CM		1050 DEG C B			8,351	h	-0.2	
90	B	VARIAN	106z	2A/SQ CM		1080 DEG C B			22,012	f	-9.8	

Table 10 (concluded)

	VEHICLE DATA				TEST CONDITION				LIFE			
	TYPE	MFR	S/N	LOAD I DENSITY	DATE TEST STARTED	OPERATING TEMPERATURE	STATUS	DATE REMOVED	HRS. WHEN REMOVED	CODE	APPROXIMATE % DEGRADATION @ OPER. TEMP.	COMMENTS
91	B	VARIAN	107y	2A/SQ CM		1140 DEG C B			5,623	c	-12.1	
92	B	VARIAN	108x	2A/SQ CM		1080 DEG C B			20,438	c	-10.6	
93	B	VARIAN	109z	4A/SQ CM		1120 DEG C B			8,016	c	-11.6	
94	B	VARIAN	110z	4A/SQ CM		1140 DEG C B			2,318	h	-6.6	
95	B	VARIAN	111z	1A/SQ CM		1050 DEG C B			23,327	f	-4.5	
96	B	VARIAN	112x	2A/SQ CM		1060 DEG C B			1,322	h	0.0	
97	B	VARIAN	113x	2A/SQ CM		1090 DEG C B			3,724	h	-3.4	
98	B	VARIAN	114y	2A/SQ CM		1090 DEG C B			20,298	c	-10.1	
99	B	VARIAN	115z	2A/SQ CM		1100 DEG C B			13,956	c	-10.5	
100	B	VARIAN	117y	2A/SQ CM		1070 DEG C B			1,673	h	0.0	

4.5 Measurement Data Log Sheet

During the months of February and August there is a great deal of activity in the cathode facility. During these months all power supplies receive calibration and Miram curves are conducted on each cathode on life test. The operator logs the date of calibration and Miram curve as performed providing an simple way to keep track of which operation has been completed and on what supply or cathode. The Measurement Data Log Sheet, Table 11, also provides the current density and manufacturer of each cathode. The Measurement Data Log sheet is only active during the months of February and August and is included in the Monthly Status Reports for those two months.

4.6 The Monthly Cathode Lab Condition Report

This report shown in Table 12 is used primarily to present the condition of cathodes currently on life test. It includes the following information. The cathodes manufacturer, the cathode type and serial number, the current density selected for life test, the total life hours, and the body current. There is also a comment block where any pertinent information may be entered.

5.0 Unscheduled Events

This section will discuss the unscheduled events in the Cathode Life Test Facility during the performance of this effort. They will be divided into three sections. The first is the power failure section, the second is the section on power supply failures, repairs, and modifications and the third is the cathode vehicle changes made during this effort.

5.1 Power Outages

During the performance of this effort the lab experienced numerous occasions of power supply outages that were not attributed to power supply malfunctions. The main cause of power supplies being off line is the instability of the building primary power. During the period of this report there were 35 instances of power supplies being off the air. 28 of these instances involved 2 or more supplies. In 7 instances only one supply was involved, indicating a possible power supply problem rather than a primary power problem. During the period of performance of this effort these 35 instances of power supply outages caused a total of 518 instances requiring power supply service in order to bring the power supplies back to life test conditions.

5.2 Power Supply Failures, Repairs, and Modifications

During the period of performance of this task there were 39 documented instances of troubleshooting, repair or modification of laboratory equipment. Most of these were directly attributed to component failures within the power supplies. Table 13 lists the parts used during the prior 12 months in the repair of the power supplies. Two model 3399 power supplies were modified to except the Elcor transformers. All power supply cooling blowers which had been mounted using only two bolts were converted to three bolt mounts. The effect of this change was a decrease in power supply vibration and a noticeable decrease in the laboratory's background noise. There were four instances of Vac-Ion cable fabrication or repair and three occurrences of power supply wiring shorting out and needing to be repaired.

Table II

MEASUREMENT DATE LOG SHEET

	TYPE	S/N	MFR	P/S CO.	LOAD I DENSITY	CALIBRATION DATE	ROLL OFF DATE
1	MK	2	SIEMENS	12629B	2A/SQ CM	28 FEB 91	01 MAR 91
2	MK	4	SIEMENS	12628A	4A/SQ CM	28 FEB 91	01 MAR 91
3	MK	8	SIEMENS	12646B	4A/SQ CM	11 MAR 91	12 MAR 91
4	MK	12	SIEMENS	12644B	2A/SQ CM	11 MAR 91	13 MAR 91
5	MK	17	SIEMENS	12646A	4A/SQ CM	05 MAR 91	06 MAR 91
6	M	202	SEMICON	12645A	2A/SQ CM	21 FEB 91	22 FEB 91
7	M	209	SEMICON	12639B	2A/SQ CM	21 FEB 91	22 FEB 91
8	M	210	SEMICON	12633A	2A/SQ CM	18 FEB 91	19 FEB 91
9	M	212	HUGHES	12634A	4A/SQ CM	18 FEB 91	20 FEB 91
10	M	215	SEMICON	12642B	2A/SQ CM	20 FEB 91	21 FEB 91
11	M	218	SEMICON	12647B	2A/SQ CM	20 FEB 91	21 FEB 91
12	TRILAYER	012	VARIAN	12633B	4A/SQ CM	22 FEB 91	25 FEB 91
13	MMM	120	VARIAN	12630A	2A/SQ CM	13 FEB 91	14 FEB 91
14	MMM	121	VARIAN	12635B	2A/SQ CM	12 FEB 91	13 FEB 91
15	MMM	122	VARIAN	12634B	2A/SQ CM	12 FEB 91	14 FEB 91
16	MMM	123	VARIAN	12637B	2A/SQ CM	11 FEB 91	13 FEB 91
17	MMM	124	VARIAN	12638A	2A/SQ CM	08 FEB 91	11 FEB 91
18	MMM	125	VARIAN	12639A	2A/SQ CM	08 FEB 91	12 FEB 91
19	TM	B1135	VARIAN	12630B	4A/SQ CM	07 FEB 91	08 FEB 91

Table 11 (continued)

MEASUREMENT DATE LOG SHEET

	TYPE	S/N	MFR	P/S CO.	LOAD I DENSITY	CALIBRATION DATE	ROLL OFF DATE
20	TM	B1240	VARIAN	12636A	4A/SQ CM	06 FEB 91	07 FEB 91
21	TM	B1350	VARIAN	12631B	4A/SQ CM	01 FEB 91	04 FEB 91
22	TM	B1352	VARIAN	12636B	4A/SQ CM	06 FEB 91	07 FEB 91
23	TM	B1455	VARIAN	12637A	4A/SQ CM	07 FEB 91	08 FEB 91
24	TM	B1462	VARIAN	12632A	4A/SQ CM	04 FEB 91	05 FEB 91
25	TM	B1565	VARIAN	09808B	4A/SQ CM	05 FEB 91	06 FEB 91
26	TM	B1667	VARIAN	12635A	4A/SQ CM	05 FEB 91	06 FEB 91
27	TM	B1671	VARIAN	12631A	4A/SQ CM	01 FEB 91	04 FEB 91
28	TM	B1672	VARIAN	12632B	4A/SQ CM	04 FEB 91	05 FEB 91
29	RV	A002	VARIAN	12638B	4A/SQ CM	22 FEB 91	25 FEB 91
30	RV	A003	VARIAN	12641A	2A/SQ CM	25 FEB 91	26 FEB 91
31	RV	A005	VARIAN	12643A	2A/SQ CM	26 FEB 91	27 FEB 91
32	RV	A006	VARIAN	12640A	4A/SQ CM	27 FEB 91	28 FEB 91
33	RV	A007	VARIAN	12640B	4A/SQ CM	27 FEB 91	28 FEB 91
34	RV	A008	VARIAN	12641B	2A/SQ CM	25 FEB 91	26 FEB 91
35	RV	A009	VARIAN	12643B	2A/SQ CM	26 FEB 91	27 FEB 91
36	SC	200	F-D-E	12628B	1A/SQ CM	---	11 MAR 91
37	OX	201	F-D-E	12628A	1A/SQ CM	---	11 MAR 91
38	SC	214	F-D-E	12644A	1A/SQ CM	---	11 MAR 91

Table 12

MONTHLY CATHODE FACILITY CONDITION REPORT

JUNE 1991

	TYPE	S/N	MFR	P/S CO...	LOAD I DENSITY	PREVIOUS LIFE HRS.	ETM THIS MO.	ETM LAST MO.	LIFE HRS. THIS MO.	TOTAL LIFE HOURS	BODY CURRENT	COMMENTS
1	MK	2	SIEMENS	12629B	2A/SQ CM	34,962.8	60,356.4	59,858.4	498.0	35,460.8	0.8ma	
2	MK	4	SIEMENS	12628A	4A/SQ CM	38,539.2	51,391.1	50,818.3	572.8	39,112.0	0.5ma	
3	MK	8	SIEMENS	12646B	4A/SQ CM	37,522.6	53,049.2	52,532.7	516.5	38,039.1	0.6ma	
4	MK	12	SIEMENS	12644B	2A/SQ CM	35,949.3	15,907.7	15,336.0	571.7	36,521.0	0.1ma	
5	MK	17	SIEMENS	12646A	4A/SQ CM	35,663.6	48,705.4	48,705.4	0.0	35,663.6		OFF LINE 3/08/91 HIGH BODY CURRENT
6	M	202	SEMICON	12645A	2A/SQ CM	43,410.8	38,817.1	38,310.8	506.3	43,917.1	1.0ma	
7	M	209	SEMICON	12639B	2A/SQ CM	50,821.9	60,230.4	59,693.3	537.1	51,359.0	1.0ma	
8	M	210	SEMICON	12633A	2A/SQ CM	7,818.7	45,422.2	44,952.4	469.8	8,288.5	1.3ma	Started lift test - 6/25
9	M	212	HUGHES	12634A	4A/SQ CM	40,168.9	220.8	(350.0)	570.8	40,739.7	2.6ma	NEW HR. MTR @ 59703
10	M	215	SEMICON	12642B	2A/SQ CM	7,607.6	39,618.1	39,111.7	506.4	8,114.0	1.1ma	Started life test - 7/12
11	M	218	SEMICON	12647B	2A/SQ CM	7,439.8	9,763.5	9,257.2	506.3	7,946.1	1.0ma	Started life test - 7/19
12	TL	012	VARIAN	12633B	4A/SQ CM	45,020.9	36,586.5	36,012.7	573.8	45,594.7	2.0ma	
13	MMM	116	VARIAN	12637A	1A/SQ CM	49,449.5	57,141.6	56,569.6	572.0	50,021.5	0.5ma	(RESTARTED) life test - 5/91
14	MMM	118	VARIAN	12629A	1A/SQ CM	43,790.8	5,919.2	5,412.5	506.7	44,297.5	0.4ma	(RESTARTED) life test - 5/91
15	MMM	119	VARIAN	12628B	1A/SQ CM	46,363.0	36,765.1	36,192.4	572.7	46,935.7	0.4ma	(RESTARTED) life test - 5/91
16	MMM	120	VARIAN	12630A	2A/SQ CM	63,446.7	16,173.4	15,666.8	506.6	63,953.3	4.4ma	
17	MMM	121	VARIAN	12635B	2A/SQ CM	62,817.8	59,512.8	59,057.2	455.6	63,273.4	4.5ma	
18	MMM	122	VARIAN	12634B	2A/SQ CM	62,723.7	41,864.8	41,441.3	423.5	63,147.2	1.5ma	

Table 12 (continued)

MONTHLY CATHODE FACILITY CONDITION REPORT — JUNE 1991

	TYPE	S/N	MFR	P/S CO...	LOAD I DENSITY	PREVIOUS LIFE HRS.	ETM THIS MO.	ETM LAST MO.	LIFE HRS. THIS MO.	TOTAL LIFE HOURS	BODY CURRENT	COMMENTS
19	MMM	123	VARIAN	12637B	2A/SQ CM	60,941.4	61,834.1	61,327.8	506.3	61,447.7	0.6ma	
20	MMM	124	VARIAN	12638A	2A/SQ CM	63,436.8	52,857.0	52,387.2	469.8	63,906.6	0.8ma	
21	MMM	125	VARIAN	12639A	2A/SQ CM	65,069.9	65,923.3	65,353.1	570.2	65,640.1	1.0ma	
22	TM	B1135	VARIAN	12630B	4A/SQ CM	14,857.9	47,634.6	47,128.1	506.5	15,364.4	2.5ma	
23	TM	B1240	VARIAN	12636A	4A/SQ CM	13,252.3	57,990.8	57,453.3	537.5	13,789.8	1.5ma	
24	TM	B1350	VARIAN	12631B	4A/SQ CM	14,156.4	57,727.9	57,154.0	573.9	14,730.3	2.1ma	
25	TM	B1352	VARIAN	12636B	4A/SQ CM	13,360.3	58,853.5	58,281.9	571.6	13,931.9	1.0ma	
26	TM	B1455	VARIAN		4A/SQ CM	13,977.2	56,484.6	56,484.6	0.0	13,977.2	0.6ma	OFF LINE 5/21/91, SHIPPED TO F-D-E 5/29/91
27	TM	B1462	VARIAN	12632A	4A/SQ CM	14,986.9	56,781.5	56,244.3	537.2	15,524.1	1.0ma	
28	TM	B1565	VARIAN	09808B	4A/SQ CM	14,524.8	32,402.0	31,829.4	572.6	15,097.4	4.0ma	
29	TM	B1667	VARIAN	12635A	4A/SQ CM	13,378.7	47,591.5	47,226.0	365.5	13,744.2	3.5ma	
30	TM	B1671	VARIAN	12631A	4A/SQ CM	12,085.6	63,534.0	62,960.2	573.8	12,659.4	2.6ma	
31	TM	B1672	VARIAN	12632B	4A/SQ CM	14,794.6	59,706.4	59,169.2	537.2	15,331.8	1.5ma	
32	RV	A002	VARIAN	12638B	4A/SQ CM	9,758.4	55,422.4	55,035.9	386.5	10,144.9	0.1ma	
33	RV	A003	VARIAN	12641A	2A/SQ CM	10,593.1	37,806.8	37,434.5	372.3	10,965.4	0.5ma	
34	RV	A005	VARIAN	12643A	2A/SQ CM	10,479.0	35,986.1	35,449.0	537.1	11,016.1	0.75ma	
35	RV	A006	VARIAN	12640A	4A/SQ CM	10,196.0	55,451.7	54,879.6	572.1	10,768.1	1.1ma	

Table 12 (concluded)

MONTHLY CATHODE FACILITY CONDITION REPORT

JUNE 1991

	TYPE	S/N	MFR	P/S CO...	LOAD I DENSITY	PREVIOUS LIFE HRS.	ETM THIS MO.	ETM LAST MO.	LIFE HRS. THIS MO.	TOTAL LIFE HOURS	BODY CURRENT	COMMENTS
36	RV	A007	VARIAN	12640B	4A/SQ CM	9,855.3	53,479.9	53,010.3	469.6	10,324.9	0.5ma	
36	RV	A008	VARIAN	12641B	2A/SQ CM	10,285.5	40,597.3	40,091.0	506.3	10,791.8	0.5ma	
37	RV	A009	VARIAN	12643B	2A/SQ CM	10,217.7	38,275.8	37,738.7	537.1	10,754.8	0.4ma	
38	SC	200	F-D-E	12628B	1A/SQ CM	5,145.2	36,135.3	36,135.3	0.0	5,145.2	0.4ma	SHIPPED TO F-D-E 5/13/91
39	OX	201	F-D-E	12628A	1A/SQ CM	5,128.6	5,125.4	5,125.4	0.0	5,128.6	0.1ma	SHIPPED TO F-D-E 5/13/91
40	SC	214	F-D-E	12644A	1A/SQ CM	4,907.8	30,883.4	30,883.4	0.0	4,907.8	0.4ma	SHIPPED TO F-D-E 5/13/91
41	SC	208	F-D-E	12644A	1A/SQ CM	305.3	31,813.4	31,198.7	614.7	920.0	0.5ma	STARTED LIFE TEST 5/14/91

Table 13

Power Supply Parts Used

SUPPLIES USED	QUANTITY
Body current meter	2
Current meters	2
P/S-2	1
Hour meters	2
Current sensors	6
Relay K12	1
Transformer T3	2
Inductor L3	1
Relay K21	1
Blower motor	1

5.3 Cathode Vehicle Changes

During the period of performance of this effort there were 15 vehicles removed from or placed on life test. Five cathodes were removed from life test after reaching the 10% degradation point which is the generally excepted criteria for removal from life test. In the attempt to place one of the new oxide cathodes on test it was found to be shorted internally. It was subsequently removed from test and returned to the manufacturer. There were six new cathodes placed on life test and 3 cathodes that had been previously removed from test were placed back on life test. Table 14 gives the type and serial number of the cathode, the type of action taken and the date the action was taken.

Table 14

Cathode Vehicle Changes

Cathode Type -	Serial #	Action Taken	Date
M	215	Placed on line	7/7/90
Oxide	201	Placed on line	8/24/90
Scandate	200	Placed on line	8/27/90
Oxide	203	Placed on line	10/1/90
Scandate	214	Placed on line	10/3/91
Scandate	208	Placed on line	5/4/91
MMM	118	Placed on line	5/20/91
MMM	116	Placed on line	5/21/91
MMM	119	Placed on line	5/29/91
Oxide	203	Removed from test	10/1/90
Scandate	200	Removed from test	5/1/91
Scandate	214	Removed from test	5/1/91
Oxide	201	Removed from test	5/1/91
MK	17	Removed from test	5/20/91
TM	B1455	Removed from test	5/21/91

6.0 New Techniques

6.1 Cathode Current Plotted Over Time

During the process of performing the filament voltage/cathode current roll offs on the oxide and scandate cathodes it was noticed that a marked instability in the cathode currents would occur that would last for as long as a week. A method of assessing the cathode performance without disturbing the cathode was sought. Since the power supply voltages are set to values to operate the cathode at is own particular optimum operating voltage and that these voltages are read and readjusted on a daily basis it was only reasonable to attempt to try to use the data being collected on a daily basis, in the form of daily meter readings, to produce data that would indicate the cathodes performance using this data. It was found that the daily cathode current readings plotted against time (in days) produced a very comprehensive view of a cathodes performance over any desired length of time. Two examples of the results of displaying data collected and plotted in this form are shown in Figures 6-1 and 6-2. Figure 6-1 is a plot covering a relatively short time period of 23 days. Figure 6-2 covers a longer period of 219 days. To date this technique has only been used to present the present the performance data of the oxide and scandate cathodes. It may prove to be of use on other cathode types especially in situations where day to day monitoring of a cathodes performance would be of benefit.

6.2 Miram Curve Generator

In March the miram curve generator software, supplied by NASA Louis, was loaded into a 386-SX P.C. equipped with a I/O Tech I-EEE 488 interface card. It was found that while the software appeared to run satisfactorily on the computer the curve generator showed no response. The I/O Tech interface card was removed and a card manufactured by Capital Equiptment Corp. was tried. It also would not allow communications between the computer and the miram curve generator. Extensive analysis of the communications problem revealed that the software supplied with the curve generator was written such that the code will only interface with a National Instruments IEEE-488 interface card. Extensive source code modification or a complete rewrite of the miram generator software would be required to use either of the two interface cards currently available.

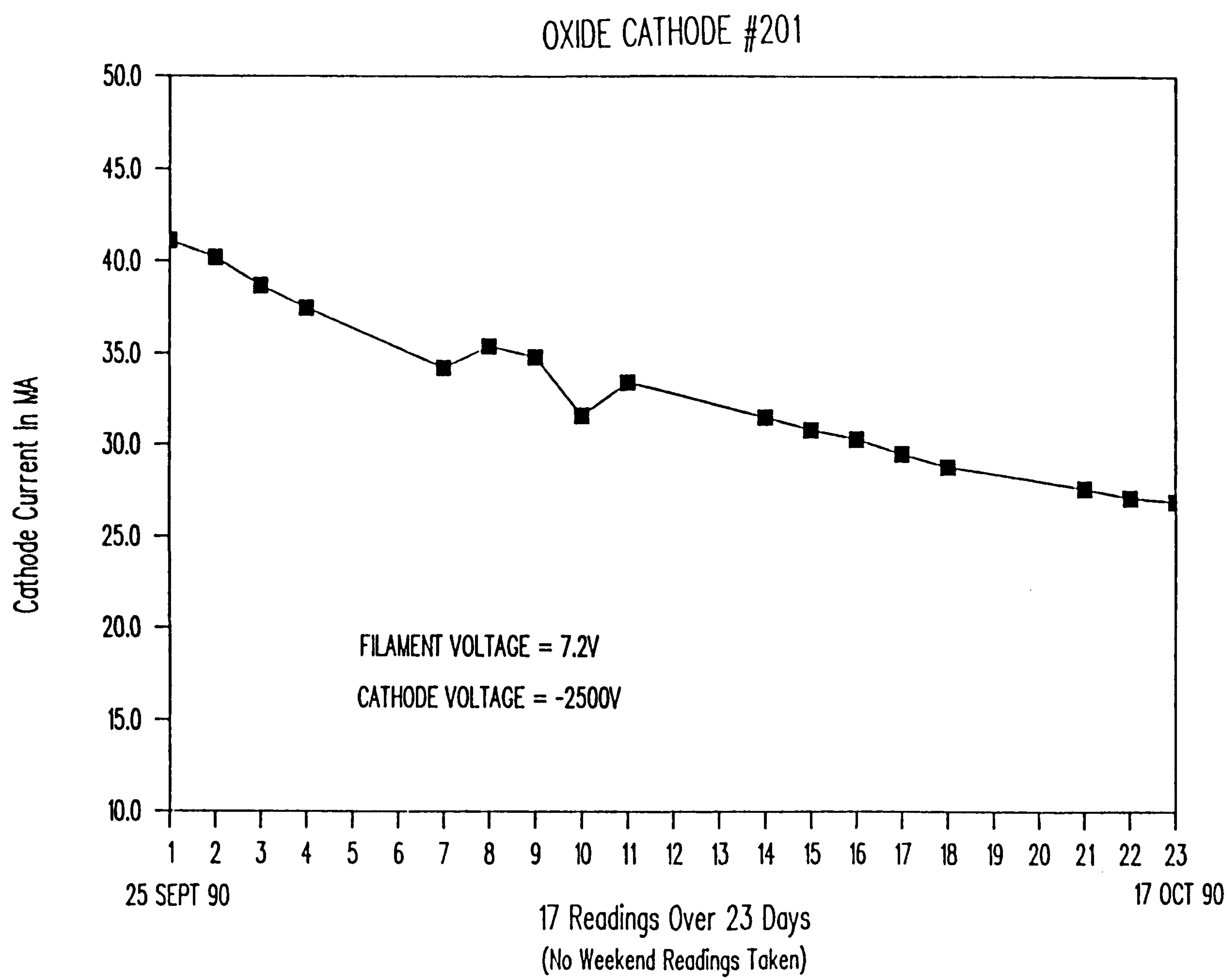

Figure 6-1 23 Day Current Plot

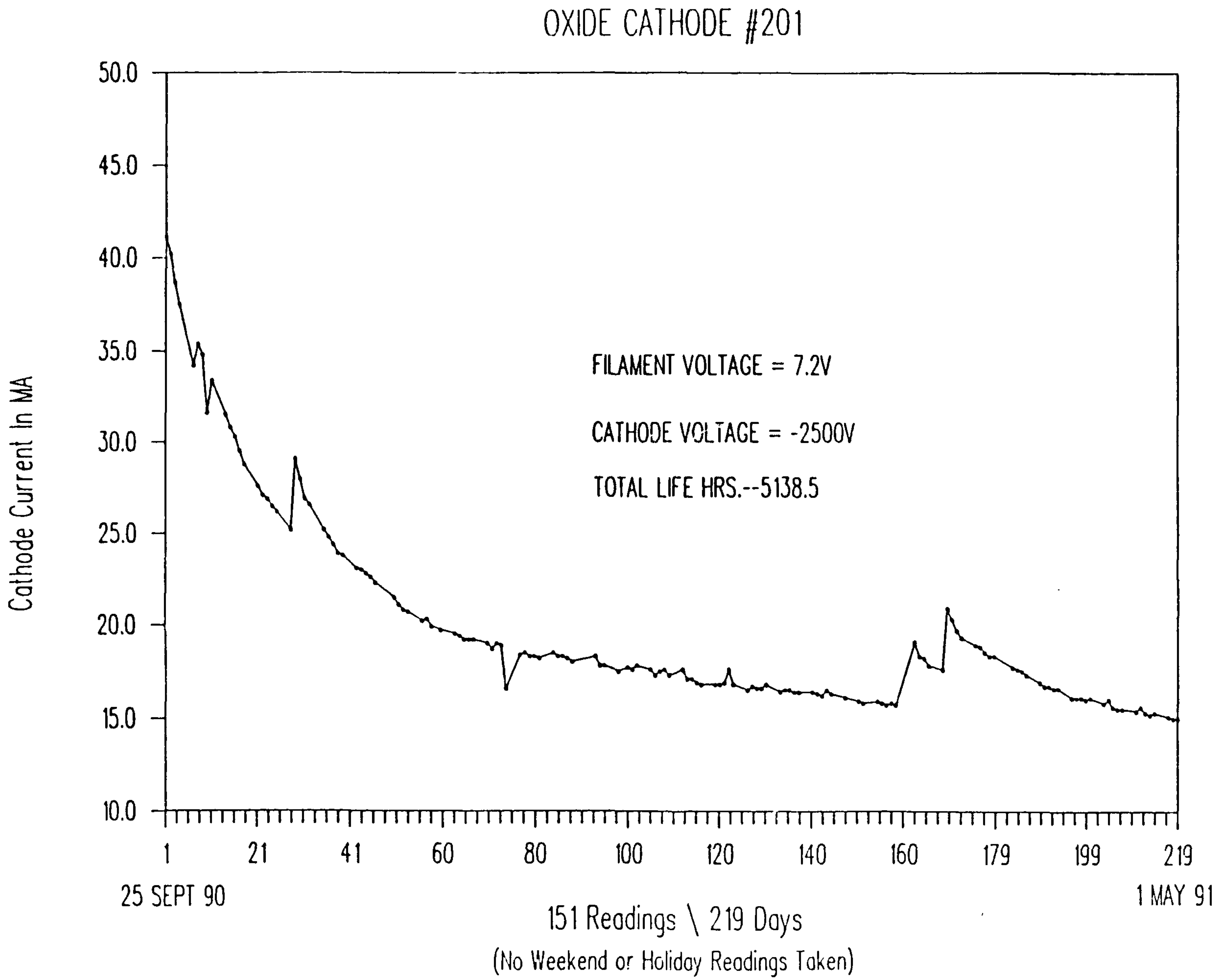

Figure 6-2 219 Day Current Plot

7.0 REFERENCES

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