

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



October 13, 2020

MATERIALS LABORATORY FACTUAL REPORT

Report No. 20-043

A. ACCIDENT

Place	:	Calabasas, California
Date	:	January 26, 2020
Vehicle	:	Sikorsky S76 helicopter
NTSB No.	:	DCA20MA059
Requesting Investigator:		Adam Huray, AS-40

B. COMPONENTS EXAMINED

1) Flight director mode selector; 2) Autopilot controller; 3) Pilot's side master warning annunciator panel; 4) Caution/advisory annunciator panel; 5) Symbol generator reversionary push button switch; 6) #1 and #2 vertical gyros; 7) #1 and #2 rate gyros; and 8) Standby attitude indicator

C. DETAILS OF THE EXAMINATION

The following annunciator panels and lights were submitted to Materials Laboratory for examination.

Flight Director Mode Selector:

The Flight Director Mode Selector sustained significant impact and fire damage as shown in Figure 1. A layout drawing of the selector panel is shown in Figure 2. Most of the annunciator bulbs were missing or inaccessible due to damage¹. Three annunciator lights in this panel had visible intact bulbs-ALT PRE ARM/CAP and VOR-APR ARM/CAP each had two intact bulbs and GA ON had one intact bulb. These annunciators were examined using a 5-50X zoom stereomicroscope. No hot filament stretching was observed in the any of the intact bulbs.

¹ Each annunciator light was designed to have two bulbs per annunciator unless the annunciator was split such as ARM/CAP where each side was illuminated by one bulb.

Autopilot Controller:

The Autopilot Controller sustained significant impact and fire damage as shown in Figure 3. A layout drawing of the selector panel is shown in Figure 4. No bulbs were found in the AP1 ON, AP2 ON, COLL RAD, FD2 and SAS/ATT annunciators. The remaining annunciators had at least one bulb intact. The intact bulbs were x-rayed to visualize the filaments within the individual annunciators. The findings are summarized in the table below. Radiographs of the intact annunciator bulbs are shown in Figures 5-9.

Annunciator	Bulb #1	Bulb #2
TEST ON	Missing	Broken, stretched*
HOV ON	Missing	Intact, not stretched
FD 1	Intact, Not Stretched	N/A
COLL FD/RAD	Intact, stretched*	N/A
CPL ON	N/A	Broken, stretch**

*The globe of this bulb was broken. Therefore, the filament condition is possibly a result of mechanical damage due to the bulb globe and not necessarily an indication of annunciator status at time of impact.

**The globe of this bulb exhibited significant thermal deformation. Therefore, the filament condition is possibly a result of the collapse of the bulb and not necessarily an indication of annunciator status at time of impact.

Pilot's Side Master Warning Annunciator Panel

The pilot's side master warning annunciator panel sustained significant impact and fire damage as shown in Figure 10. A layout drawing of the selector panel is shown in Figure 11. The panel was x-rayed to visualize any annunciators with intact bulbs and/or filaments. The radiographs showed that only three of the annunciators had partially intact annunciators-#1 ENG MAN REV, #1 ENG FIRE and #2 ENG FIRE. However, none of the annunciators had two intact bulbs. #1 ENG MAN REV had one broken bulb with no filament and one intact bulb that had a broken, unstretched filament as shown in Figure 12. #1 ENG FIRE had had two broken bulbs and no recognizable filaments as shown in Figures 13 and 14. #2 ENG FIRE had one broken bulb with no filament and one intact bulb that had a broken, unstretched filament as shown in Figure 15.

Caution/Advisory Annunciator Panel

The caution panel sustained significant impact and fire damage as shown in Figure 16. A layout drawing of one layout option for the selector panel is shown in Figure 17. The actual layout for the accident aircraft could not be determined therefore the lights may have differed from the layout drawing. The intact bulbs were removed from the individual annunciators and x-rayed to visualize the filaments within each bulb. The

findings are summarized in the table below. Since the exact layout of panel could not be determined, the annunciators were labeled by column and row of the panel. Radiographs of the retrieved annunciator bulbs are shown in Figures 18-35.

Annunciator Location (C=column; R=row)	Bulb #1	Bulb #2
C2R1	Broken, not stretched	Broken, not stretched
C2R2	Broken, not stretched	Missing
C2R3	Broken, not stretched	Broken, not stretched
C2R4	Broken, not stretched	Missing
C2R5	Broken, not stretched	Missing
C3R1	Broken, not stretched	Missing
C3R2	Intact, not stretched	Missing
C3R4	Intact, not stretched	Missing
C5R1	Broken, not stretched	Broken, not stretched
C5R2	Intact, not stretched	Intact, not stretched
C5R3	Intact, not stretched	Intact, not stretched
C5R4	Intact, not stretched	Intact, not stretched
C5R5	Intact, not stretched	Missing
C8R1	Missing	Broken, not stretched
C8R2	Intact, not stretched	Missing
C8R3	Intact, not stretched	Broken, not stretched
C8R4	Broken, not stretched	Intact, not stretched

“SG REV” Push Button Switch

The bulbs in the Symbol Generator Reversionary (SG REV) push button switch all exhibited hot filament stretching as shown in Figures 36-39. By design, the bulbs for this push button were always on during helicopter operation.

Gyros and Attitude Indicator Information

The following gyros and indicators were submitted to the Materials Laboratory for examination.

#1 and #2 VERTICAL GYROS

The vertical gyros sustained significant impact and fire damage as shown in Figure 40. The cases for both gyros were taken off and the individual gyros removed to assist with the examination. Both gyros appeared to freely rotate when manually turned indicating that there was no sustained contact between the masses and the structure around them. When the gyros were disassembled, light operational scoring was found on the rotational masses as shown in Figures 41 and 42. This scoring corresponded to the structure that surrounded the masses. The cases covered only the motors on the end of each gyro.

RATE GYROS

The rate gyros sustained significant impact and fire damage as shown in Figure 43. The cases for both gyros were taken off and the individual gyros removed to assist with the examination. Both gyros appeared to freely rotate when manually turned indicating that there was no sustained contact between the masses and the structure around the masses. When the cases around the gyros were removed, no operational scoring was found on the rotational masses, and the cases were unmarked. The rotational masses and exterior of the cases are shown in Figures 44 and 45.

STANDBY ATTITUDE INDICATOR

The standby attitude indicator sustained significant impact and fire damage as shown in Figure 46. The indicator faceplate sustained significant fire damage so any witness marks showing the position of the indicator could not be visualized. The case for the indicator was taken off and the gyro removed to assist with the examination. The gyro appeared to freely rotate when manually turned. When the gyro was disassembled, a small amount of operational scoring was found on the top of rotational mass as shown in Figure 47. The circumference of the mass and the top of the case had light scoring as shown in Figure 48. The scoring on the mass circumference corresponded to a machined ridge on the inside of the case.

Nancy B McAtee
Chemist



Figure 1. Flight Director Mode Selector.

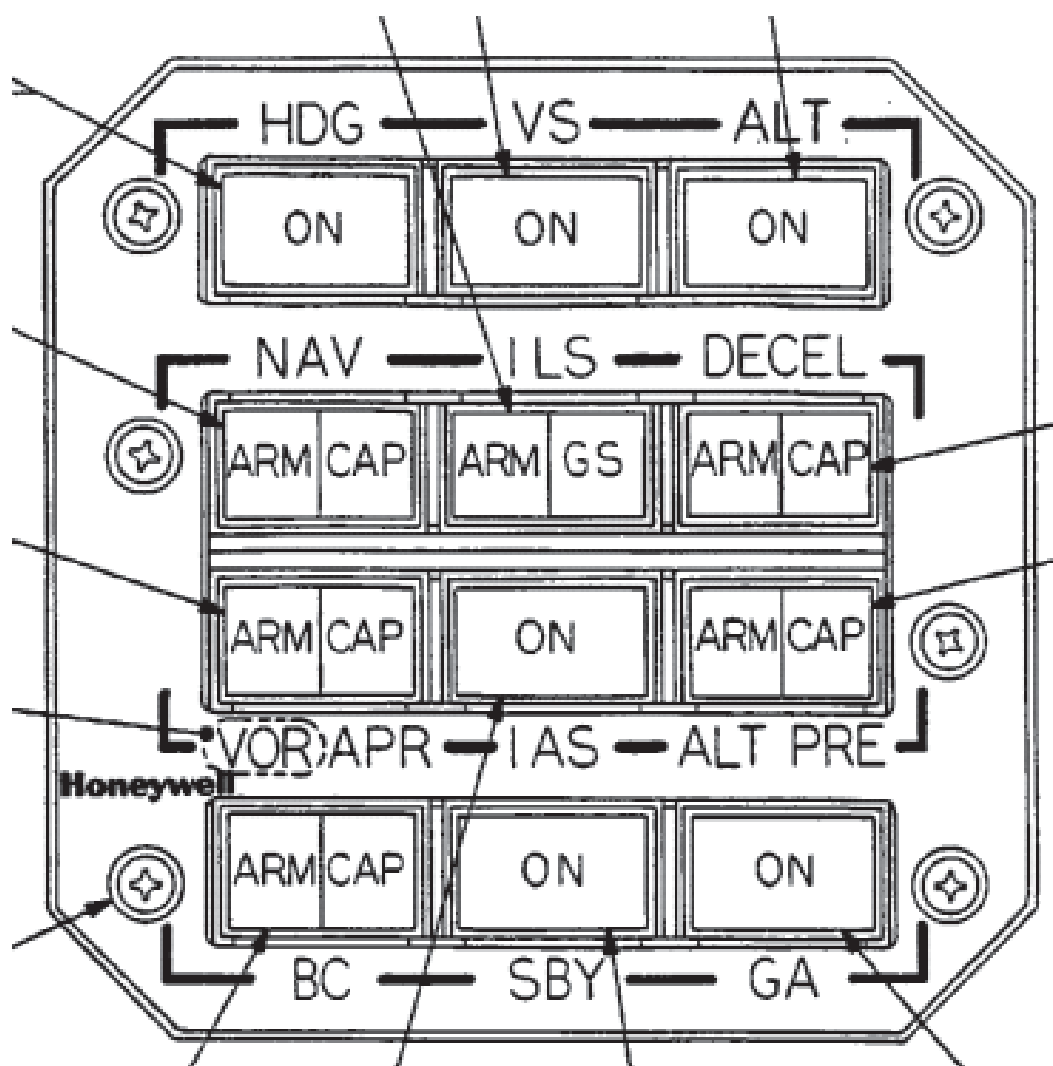


Figure 2. Layout drawing of Flight Director Mode Selector.



Figure 3. Autopilot controller.

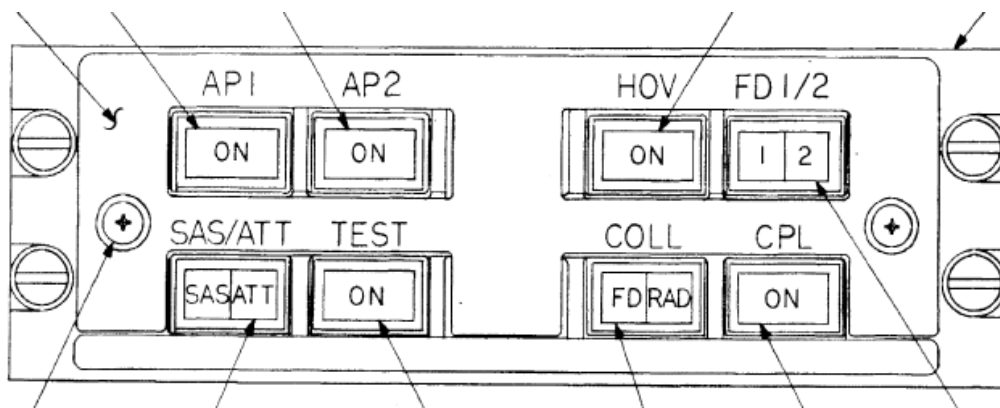


Figure 4. Layout drawing of autopilot controller.

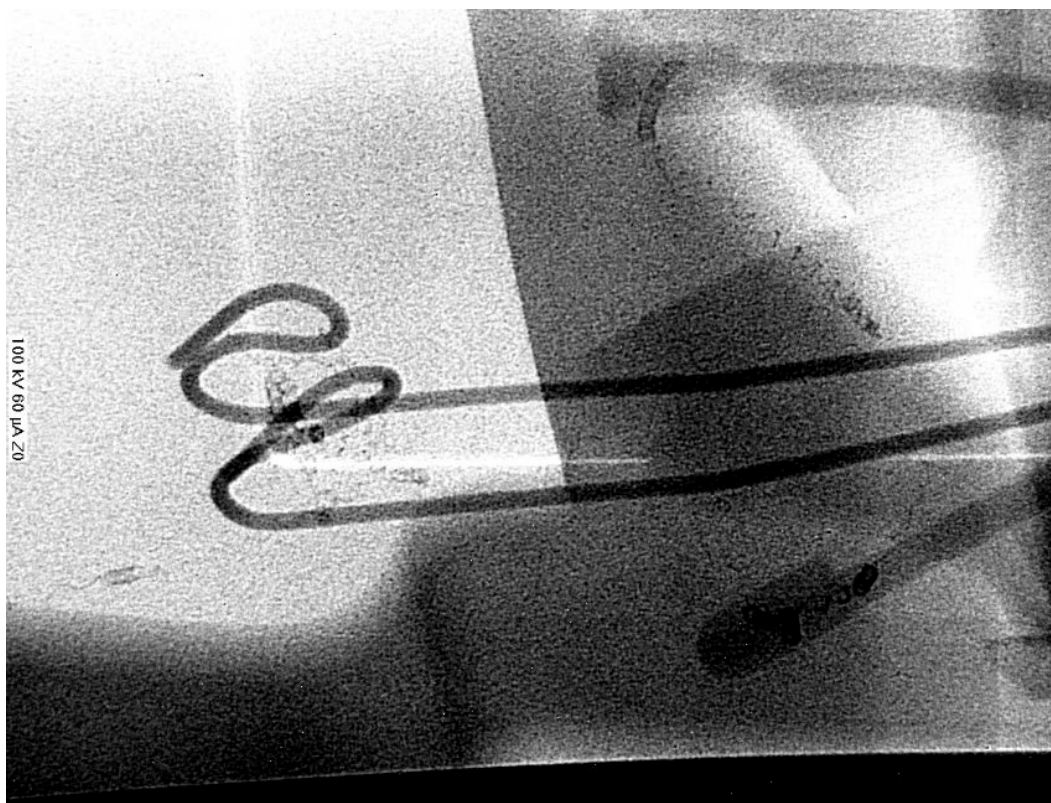


Figure 5. Radiograph of TEST ON bulb filament.

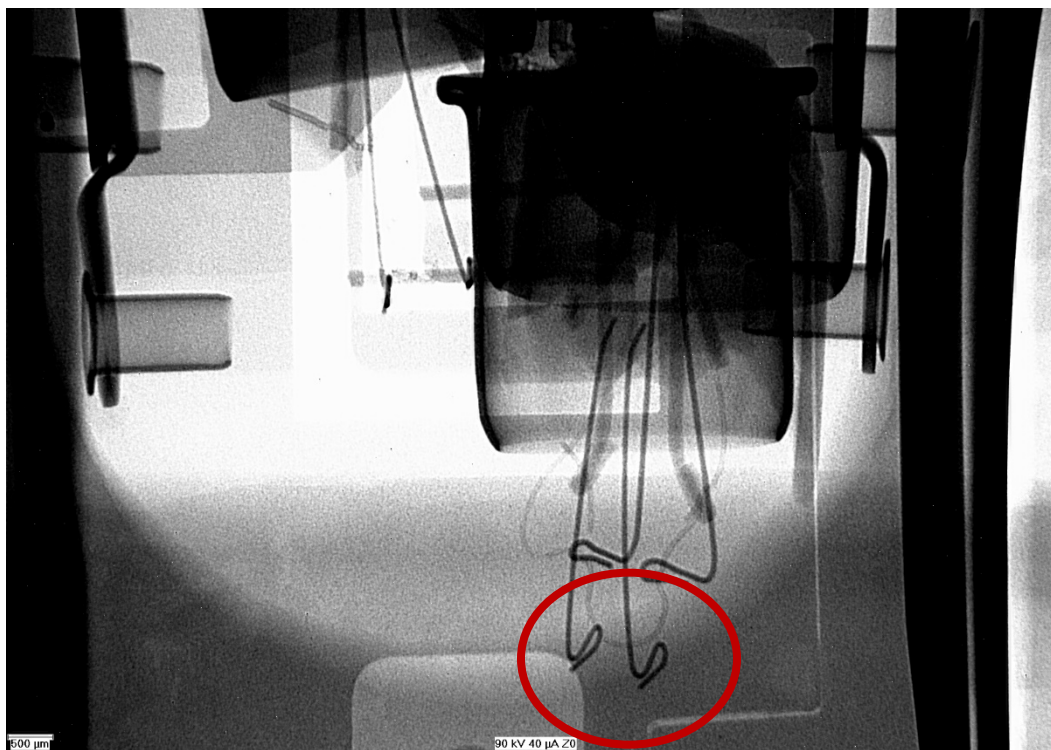


Figure 6. Radiograph of remaining HOV ON bulb filament (circle in red).

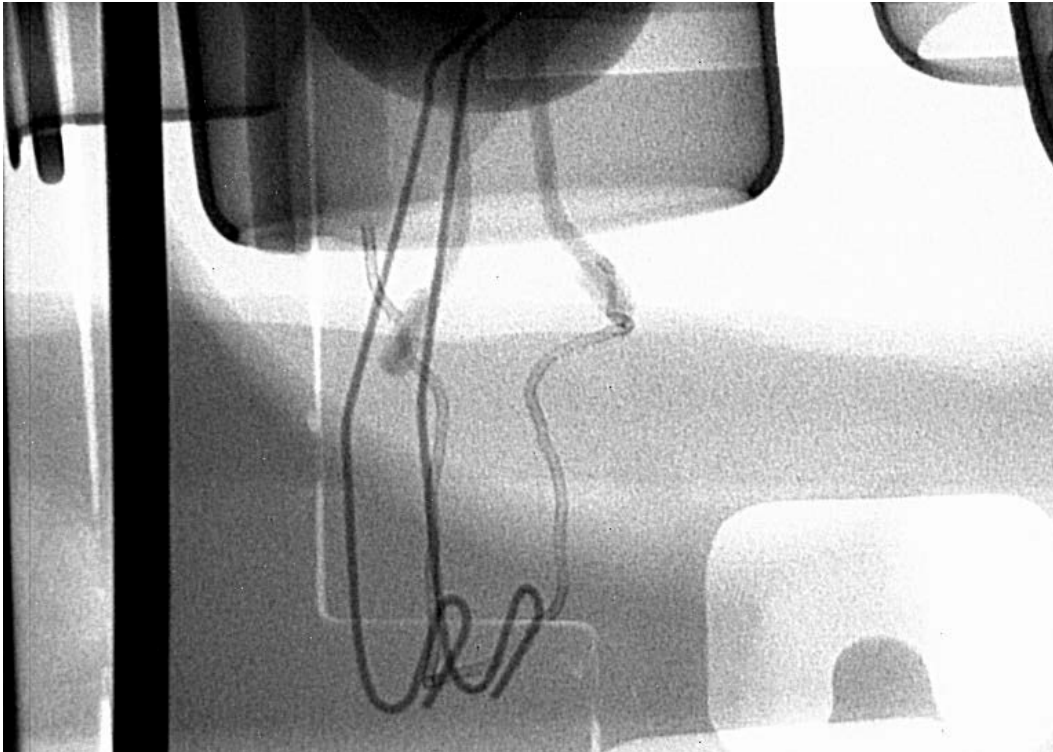


Figure 7. Radiograph of FD1.

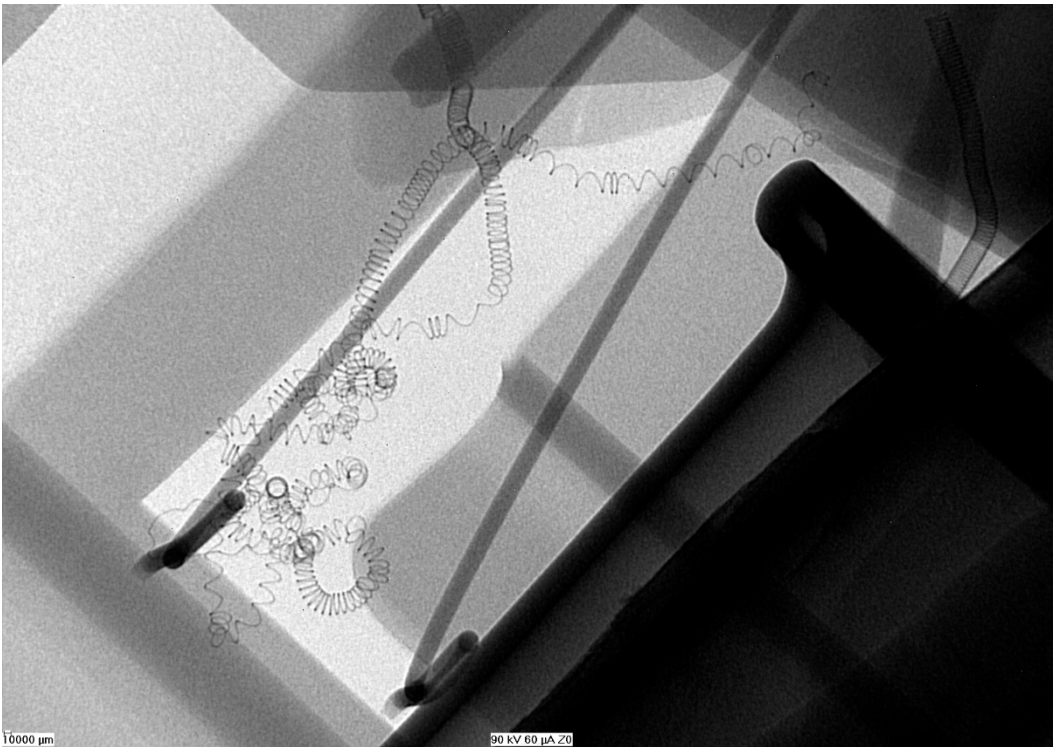


Figure 8. Radiograph of COLL FD bulb.



Figure 9. Radiograph of CPL ON bulb.



Figure 10. Pilot's side master warning annunciator panel (underside of panel shown).

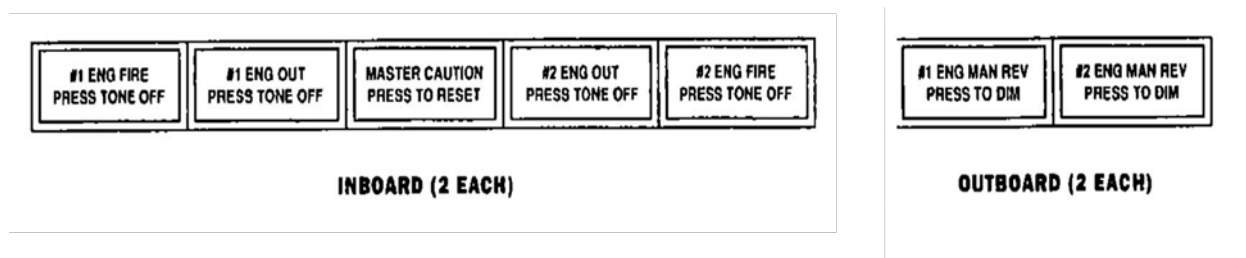


Figure 11. Layout drawing of pilot's side master warning annunciator panel.

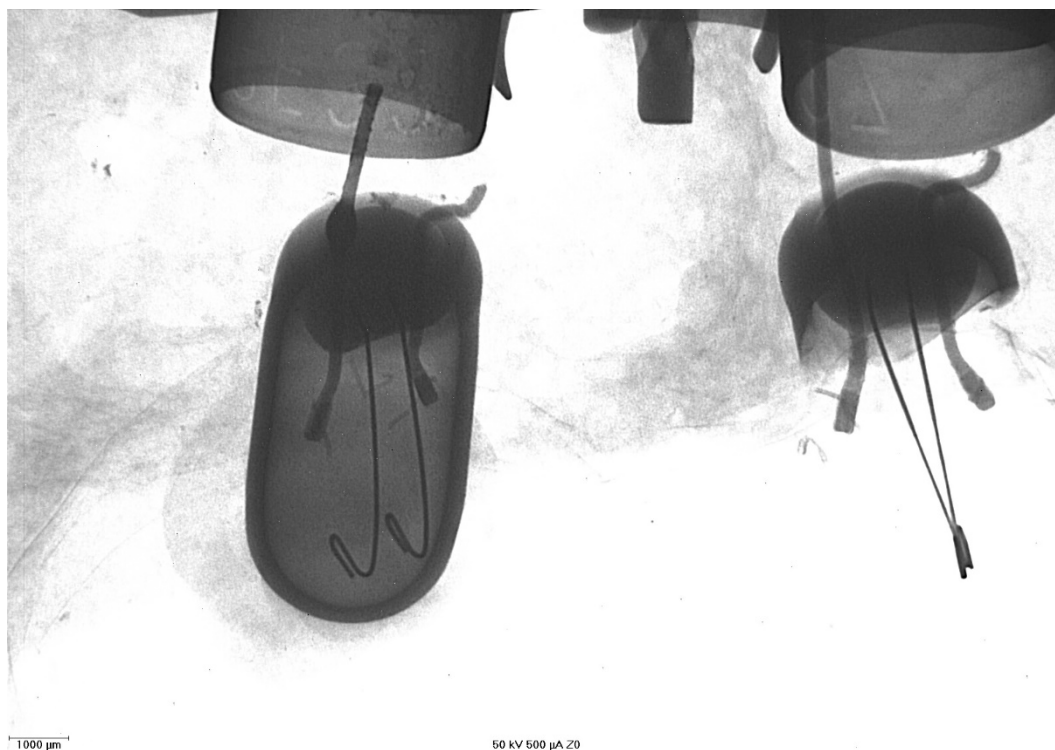


Figure 12. Radiograph of #1 ENG MAN REV annunciator

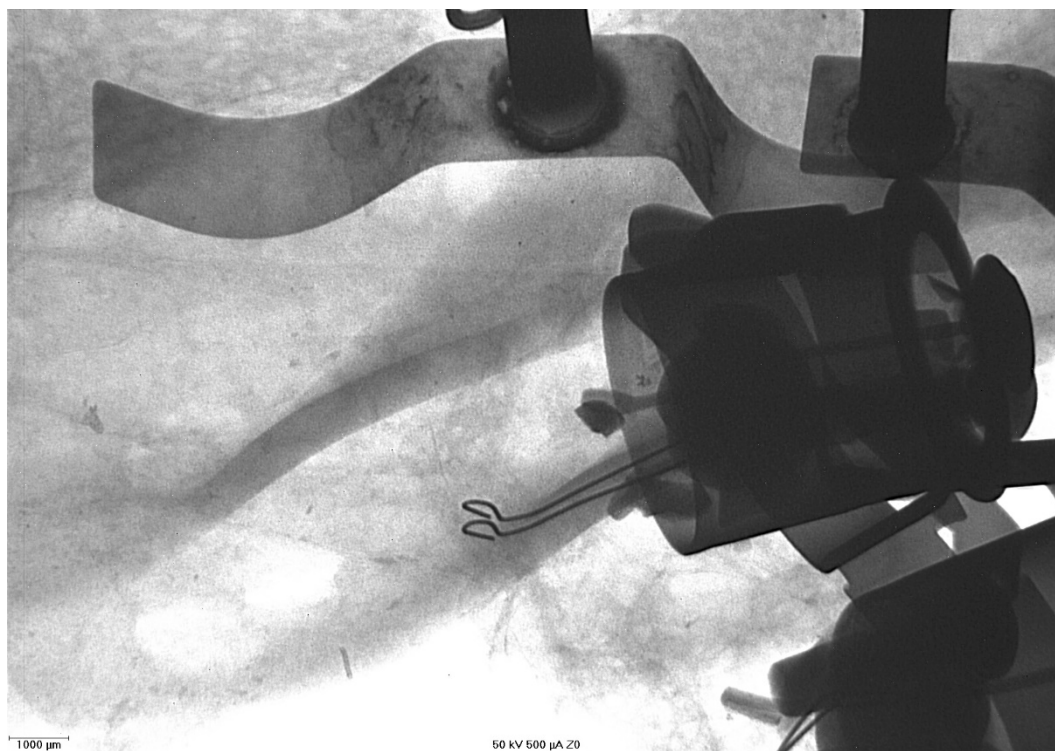


Figure 13. Radiograph of #1 ENG FIRE bulb #1.

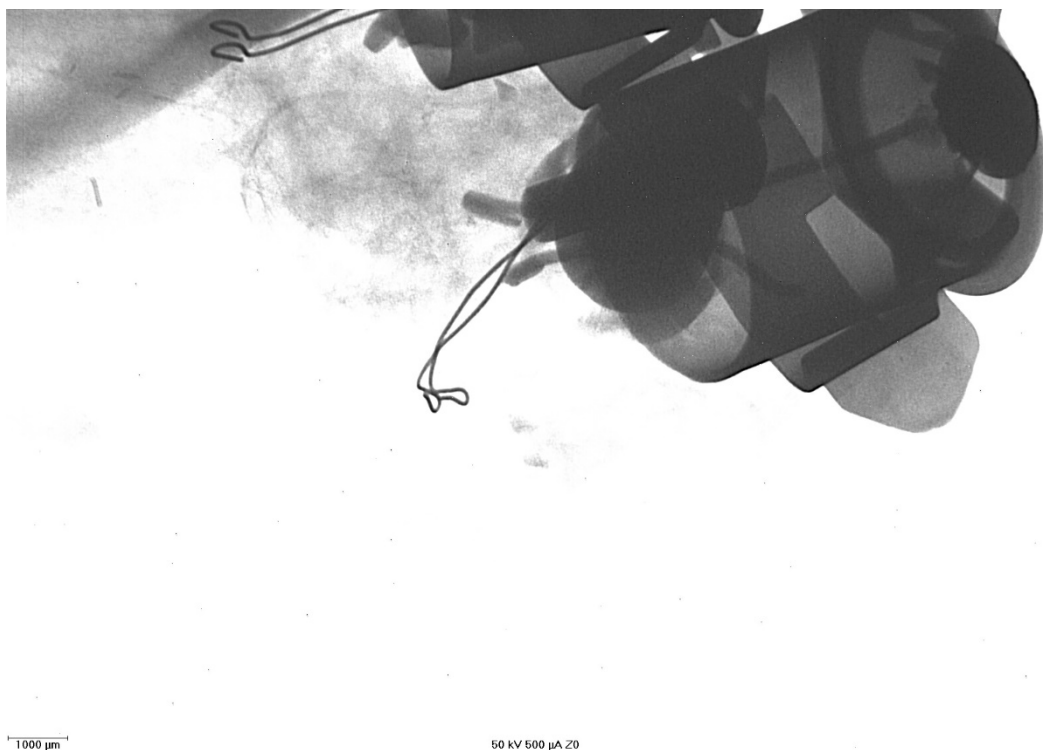


Figure 14. Radiograph of #1 ENG FIRE bulb #2.

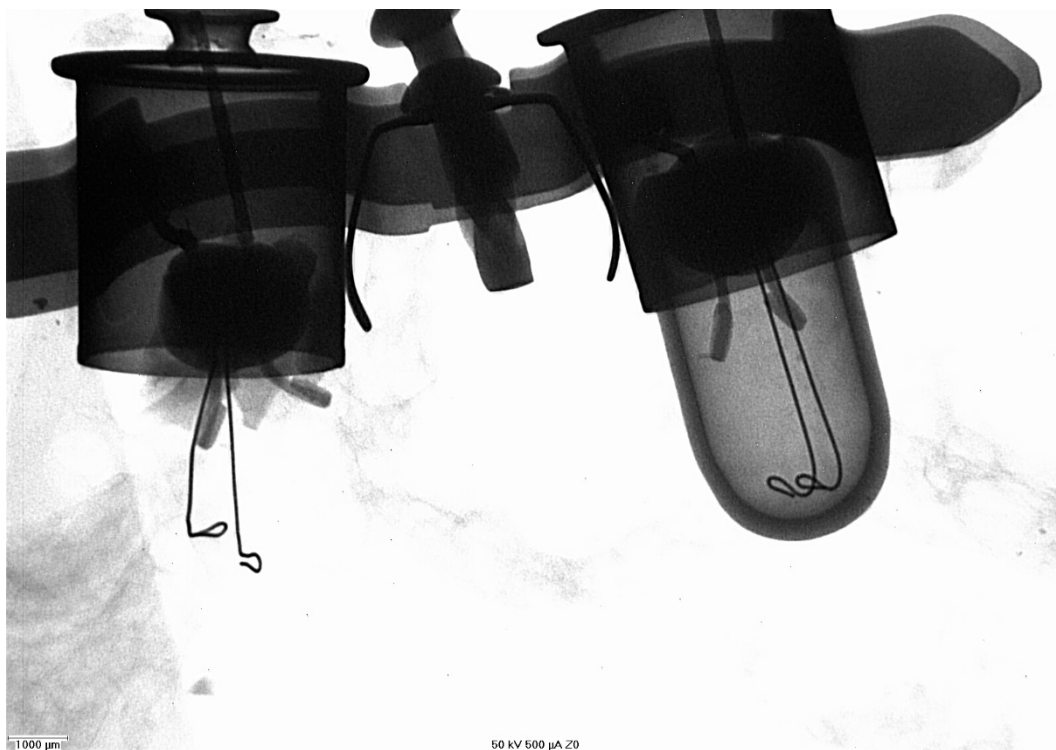


Figure 15. Radiograph of #2 ENG FIRE annunciator



Figure 16. Caution/advisory annunciator panel.

	Column 1	2	3	4	5	6	7	8	9	10
Row										
1	#1 SERVO SYSTEM	#1 DC GEN	#1 ENG OIL PRESS	#1 ENG FUEL PRESS	MAIN XMSN OIL PRESS	SMOKE DET BAGGAGE	#2 ENG FUEL PRESS	#2 ENG OIL PRESS	#2 DC GEN	#2 SERVO SYSTEM
2	BATT HOT	BATT FEED FAULT	#1 FUEL LOW	#1 ENG CHIP	MAIN XMSN OIL HOT	INT GB CHIP - HOT	#2 ENG CHIP	#2 FUEL LOW		ROTOR BRAKE
3	BATT OFF	AC GEN	AUX BATT OFF	#1 EAPS FAIL	MAIN XMSN CHIP	TAIL GB CHIP - HOT	#2 EAPS FAIL			
4	BUS TIE OPEN	AC GEN BEARING	WINDSHIELD HOT	INVERTER	CPLT PILOT HEAT	PLT PILOT HEAT	ESS BUS VOLTS LOW	DOOR OPEN		
5	#1 EAPS ON	BIV ON		ENG BLEED AIR	FLOTATION ARMED	HOOK ARMED	#2 EAPS ON	HOOK OPEN	TEST	BRT DIM

CAUTION/ADVISORY PANEL

Figure 17. Layout drawing of caution/advisory annunciator panel.

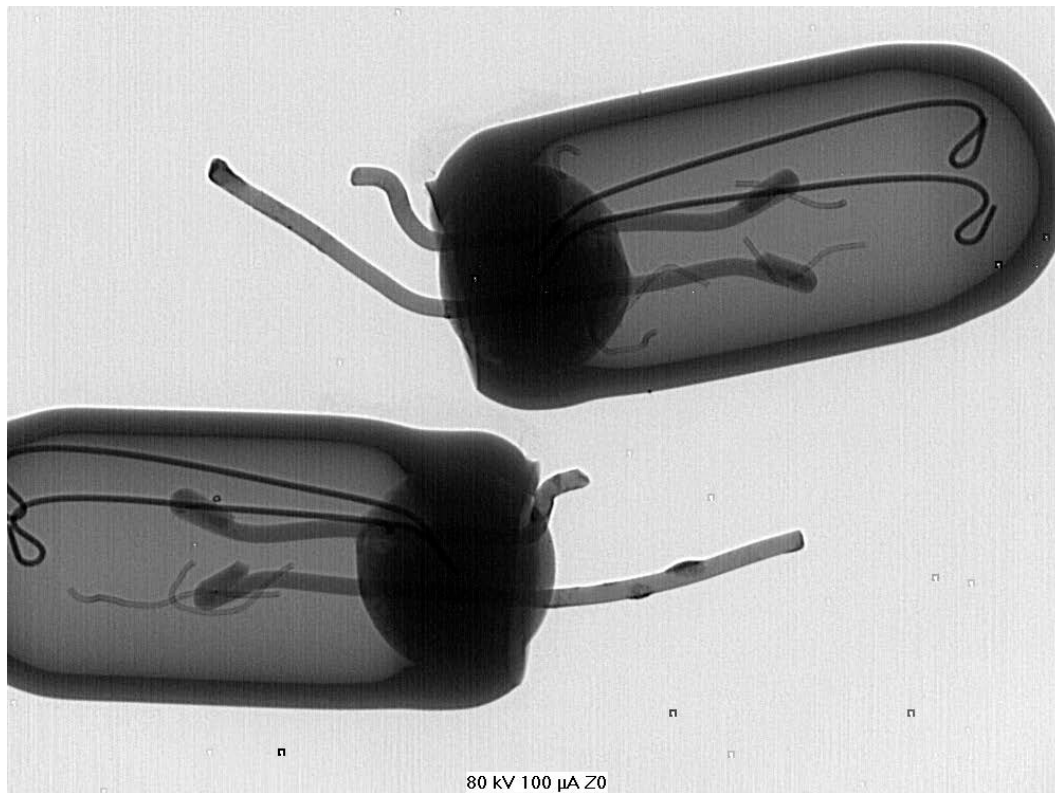


Figure 18. Radiograph of Column 2 Row 1 bulbs of Caution/Advisory Annunciator Panel.

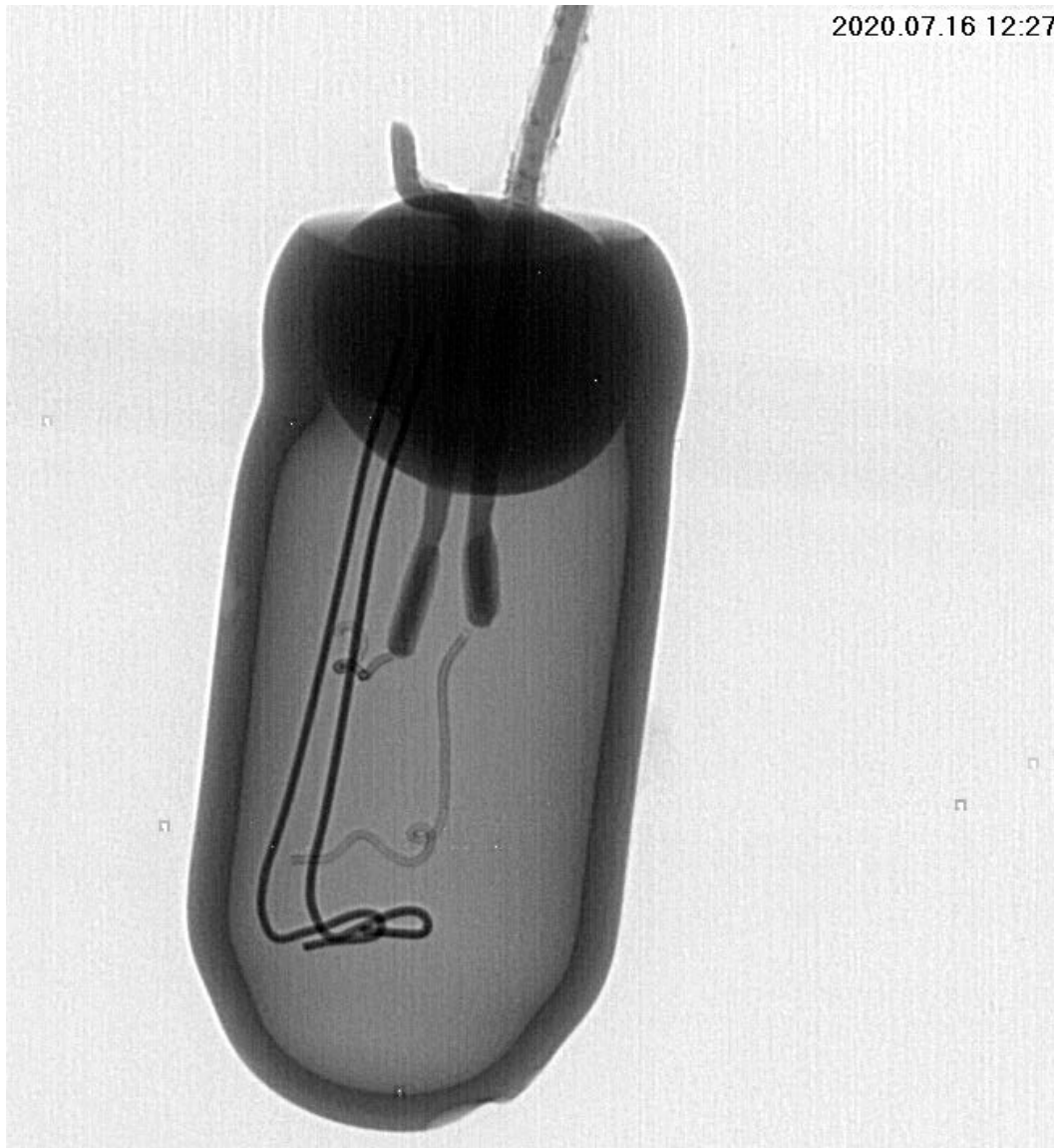


Figure 19. Radiograph of Column 2 Row 2 bulb #1 of Caution/Advisory Annunciator Panel.

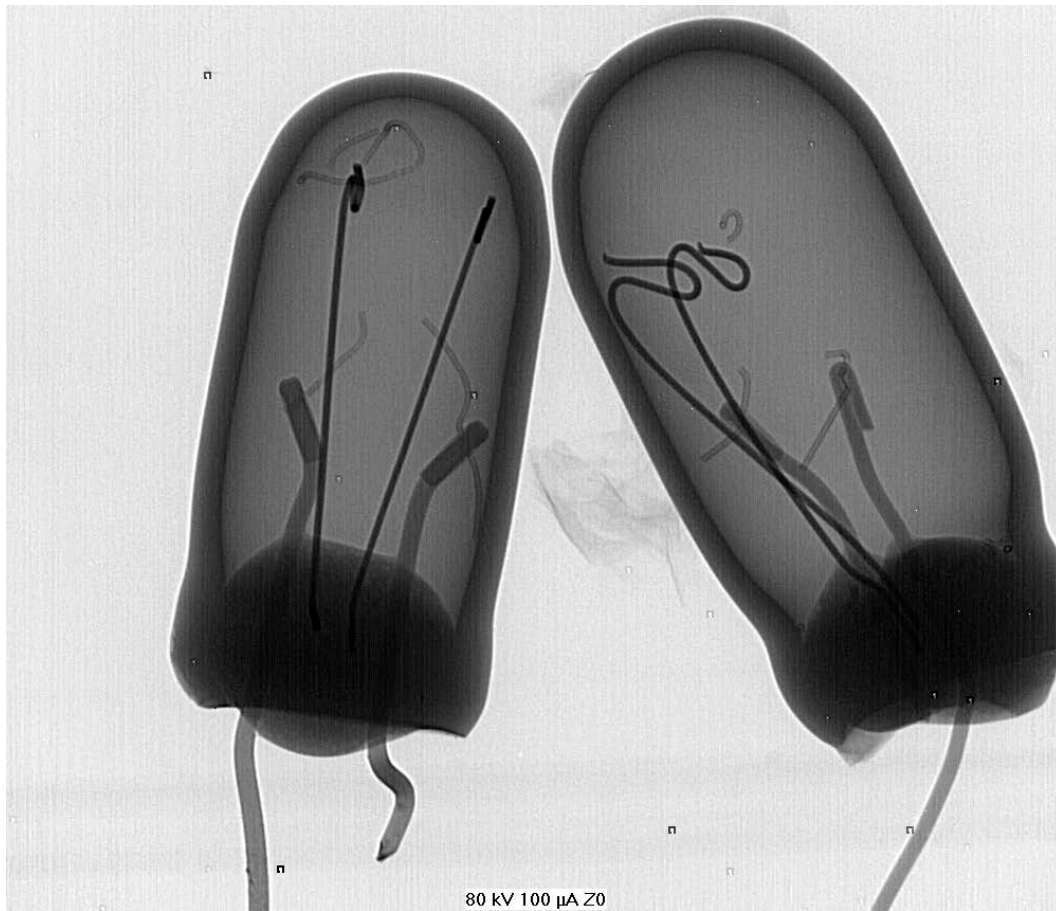


Figure 20. Radiograph of Column 2 Row 3 bulbs of Caution/Advisory Annunciator Panel.

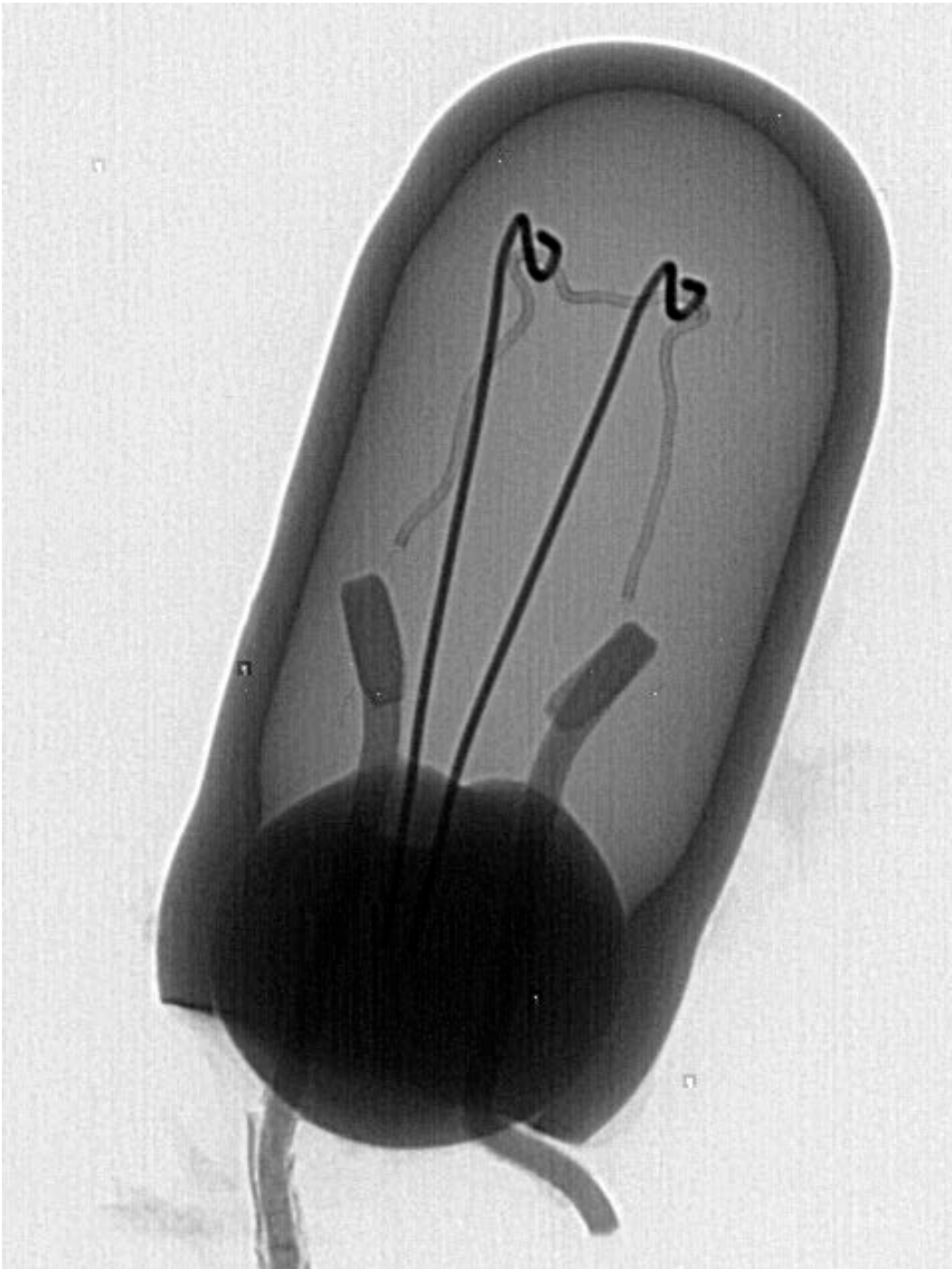


Figure 21. Radiograph of Column 2 Row 4 bulb #1 of Caution/Advisory Annunciator Panel.

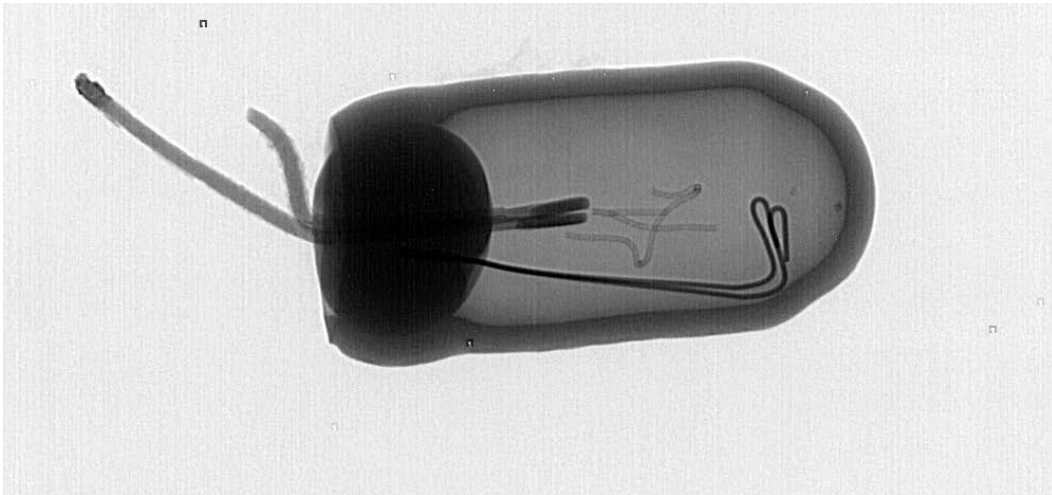


Figure 22. Radiograph of Column 2 Row 5 bulb #1 of Caution/Advisory Annunciator Panel.

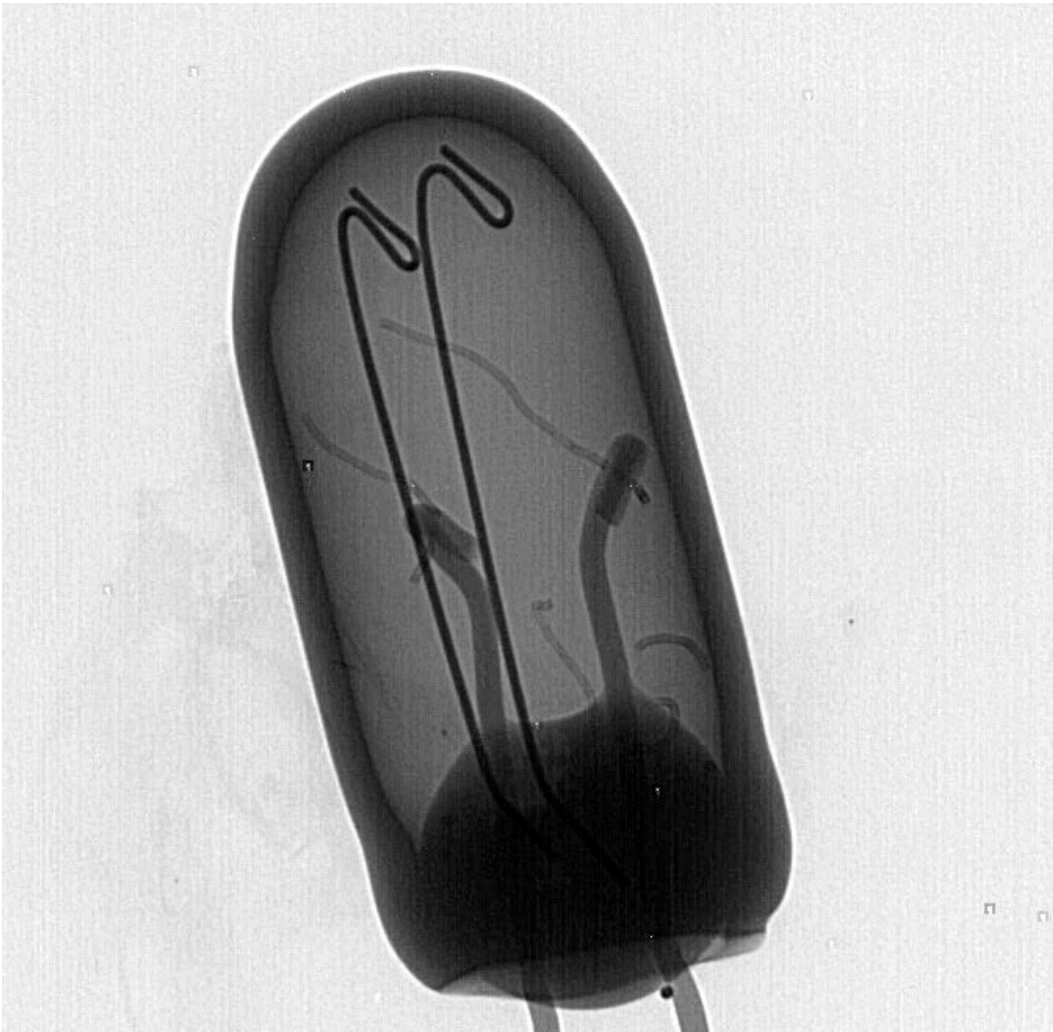


Figure 23. Radiograph of Column 3 Row 1 bulb #1 of Caution/Advisory Annunciator Panel.

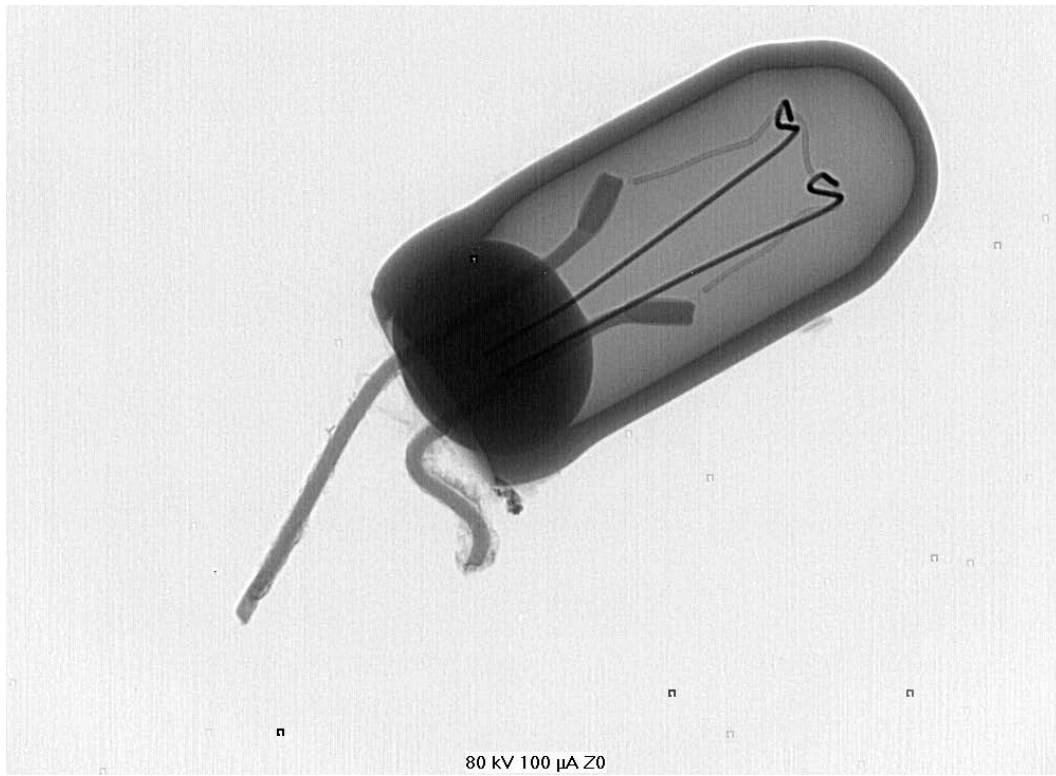


Figure 24. Radiograph of Column 3 Row 2 bulb #1 of Caution/Advisory Annunciator Panel.

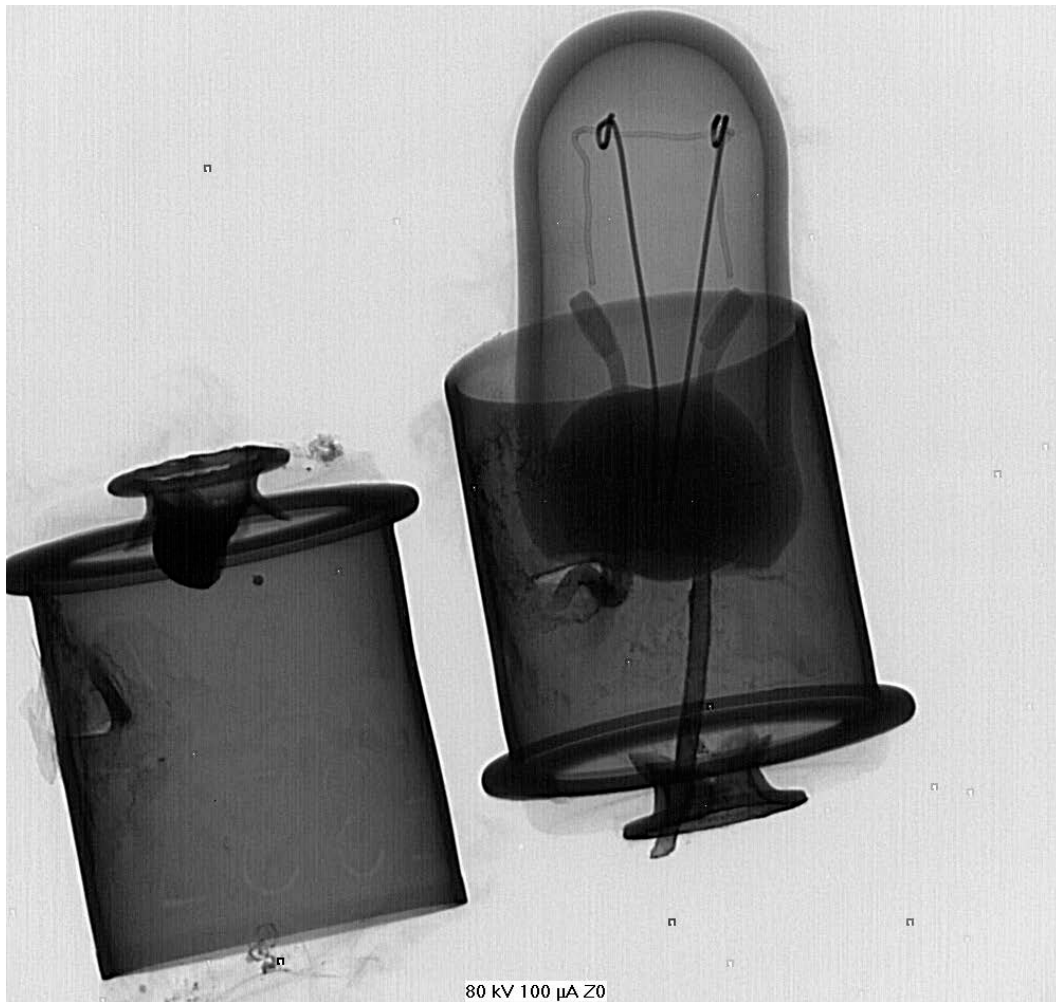


Figure 25. Radiograph of Column 3 Row 4 bulbs of Caution/Advisory Annunciator Panel.

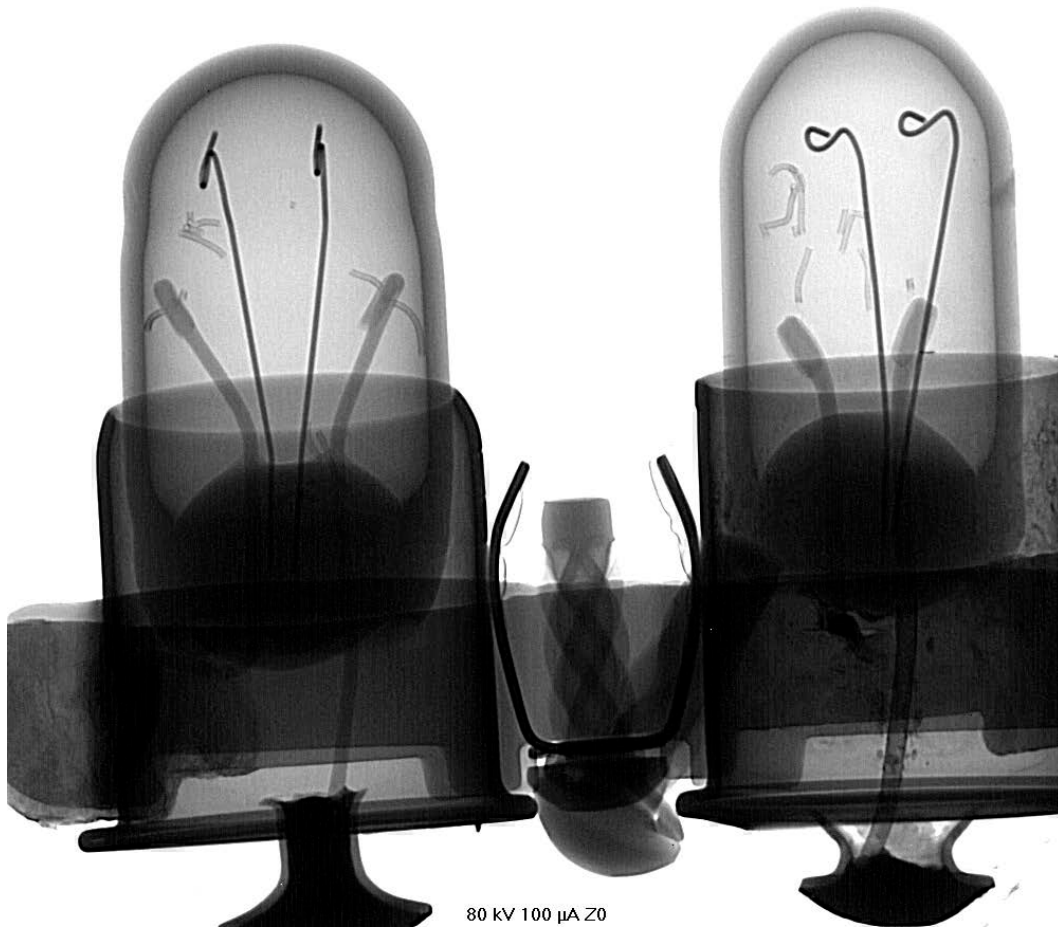


Figure 26. Radiograph of Column 5 Row 1 bulbs of Caution/Advisory Annunciator Panel.

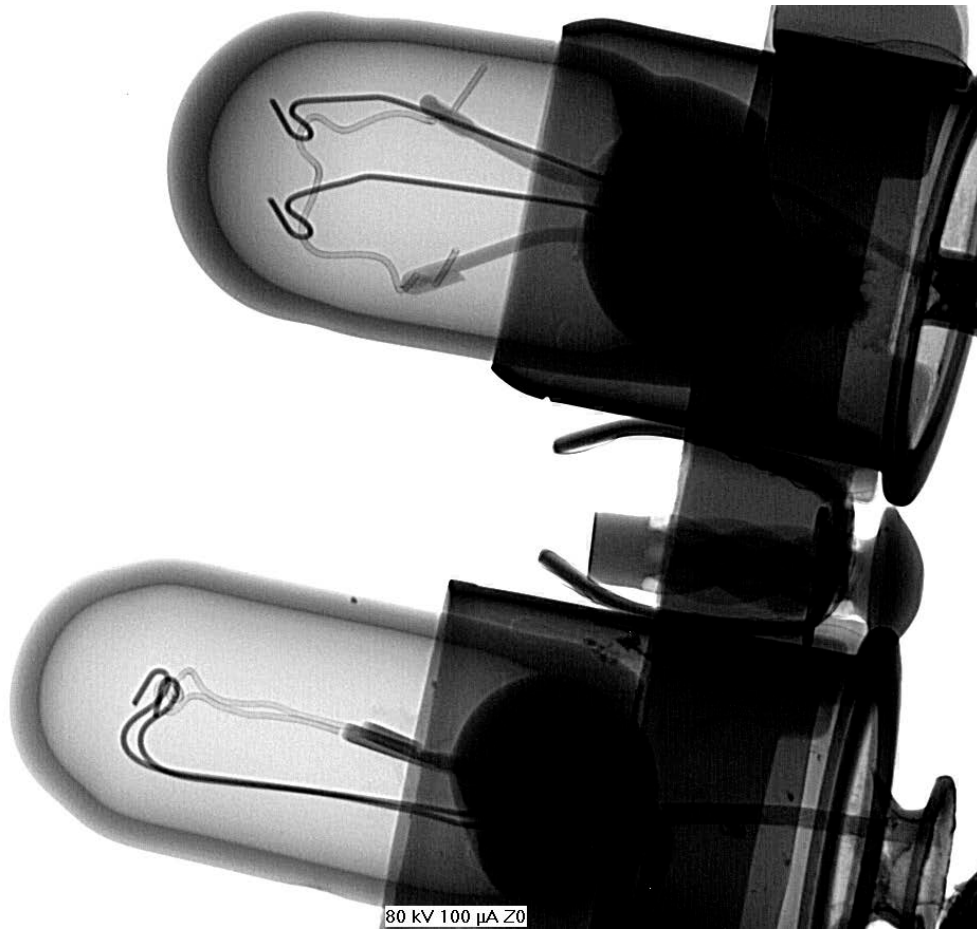


Figure 27. Radiograph of Column 5 Row 2 bulbs of Caution/Advisory Annunciator Panel.

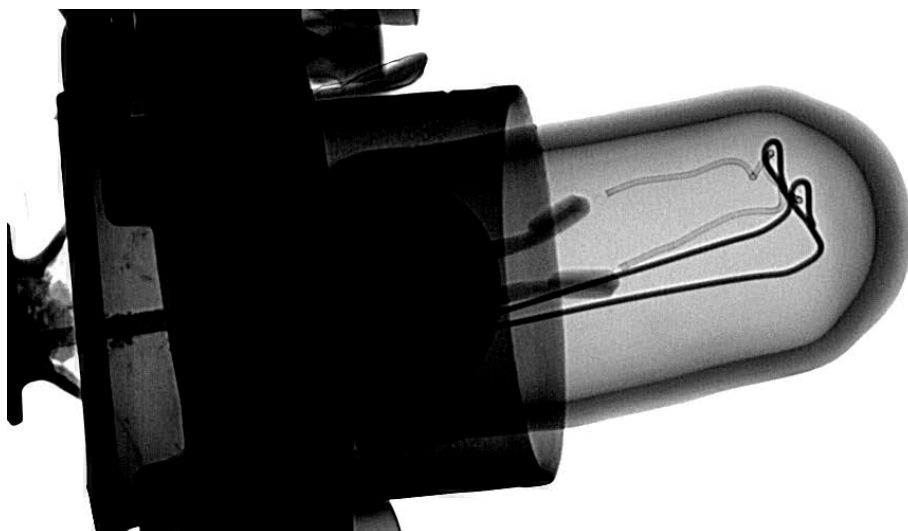


Figure 28. Radiograph of Column 5 Row 3 bulb #1 of Caution/Advisory Annunciator Panel.

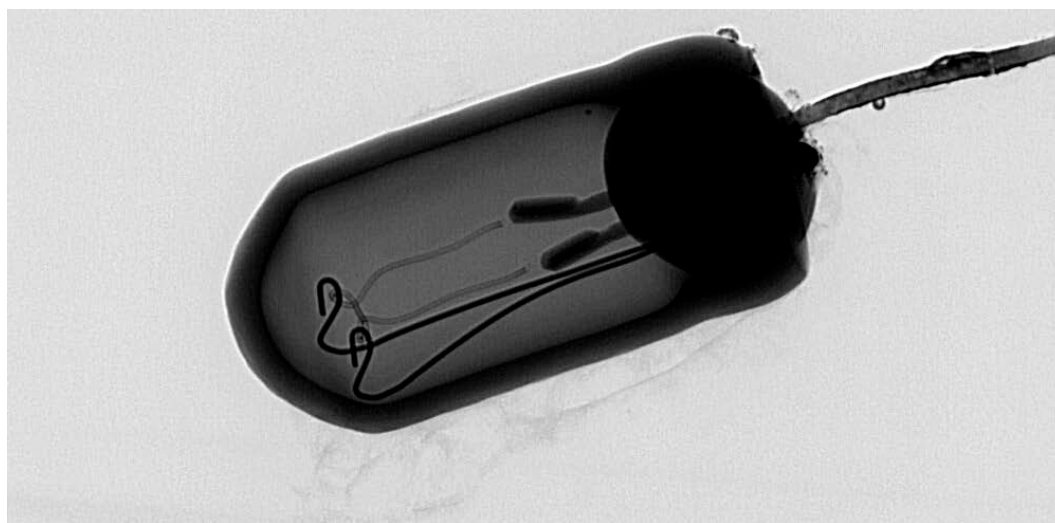


Figure 29. Radiograph of Column 5 Row 3 bulb #2 of Caution/Advisory Annunciator Panel.

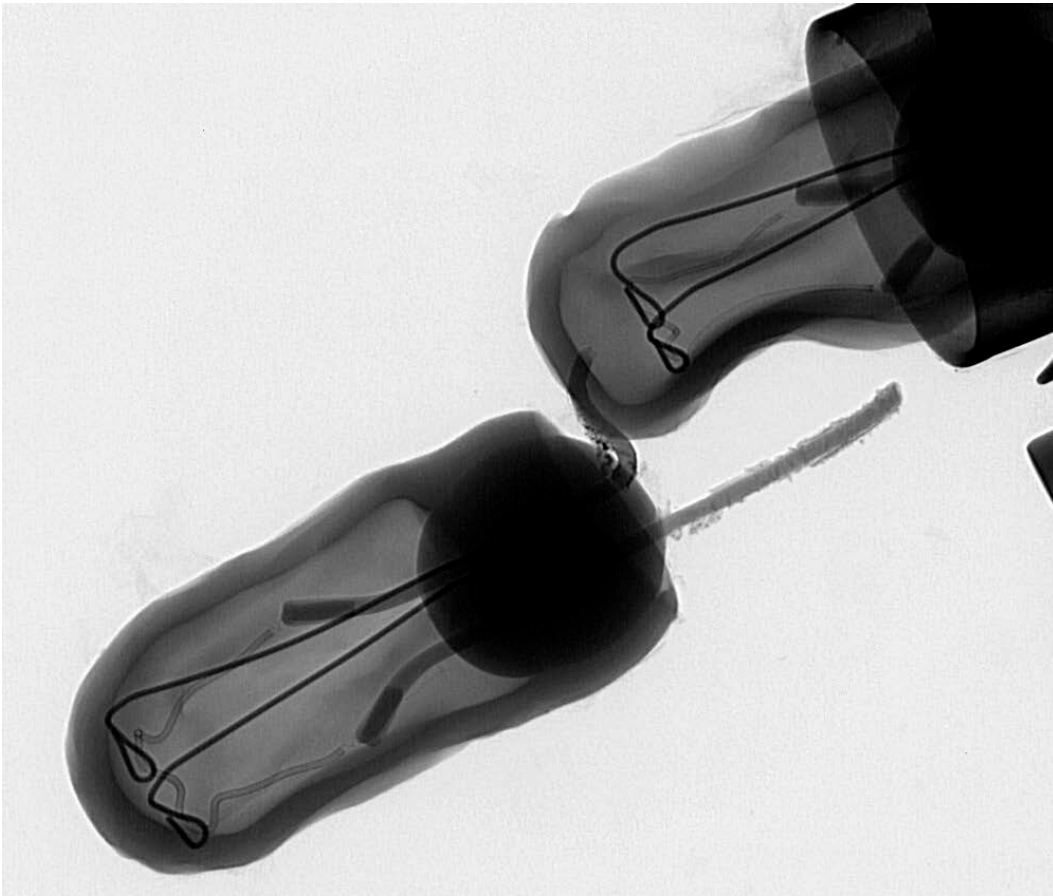
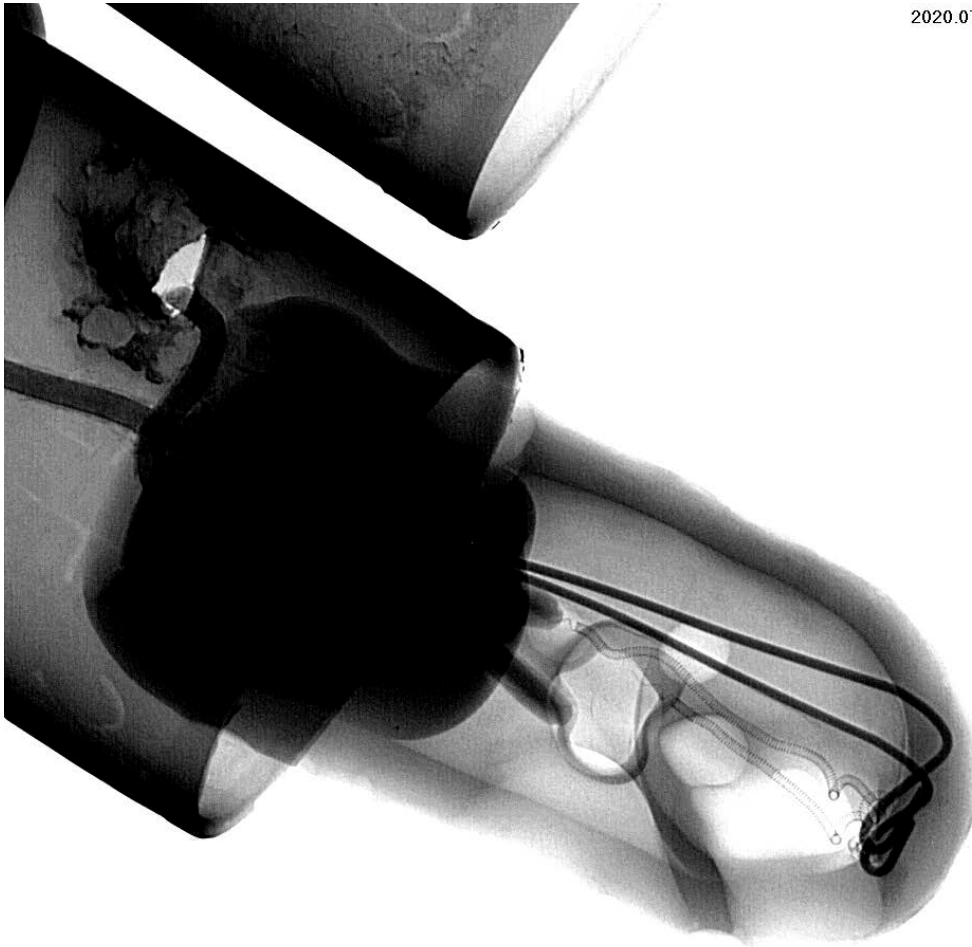


Figure 30. Radiograph of Column 5 Row 4 bulbs of Caution/Advisory Annunciator Panel.



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Figure 31. Radiograph of Column 5 Row 5 bulbs of Caution/Advisory Annunciator Panel.

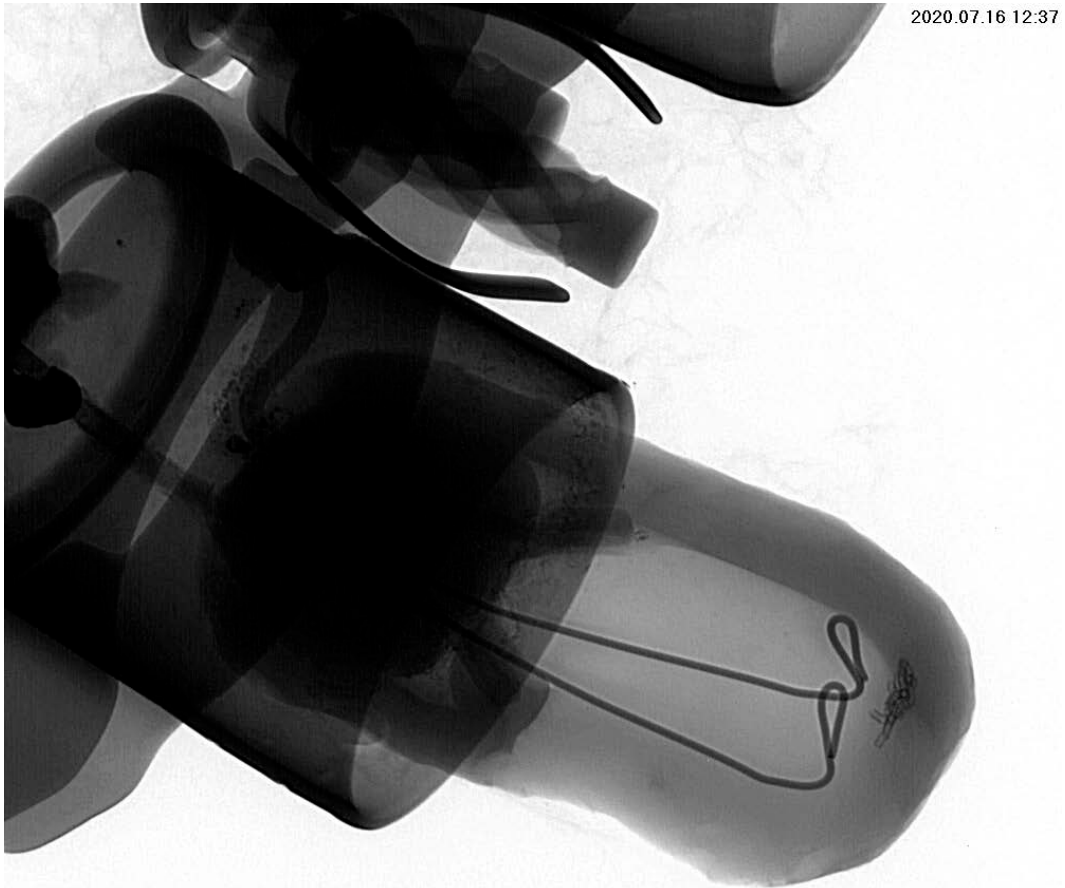
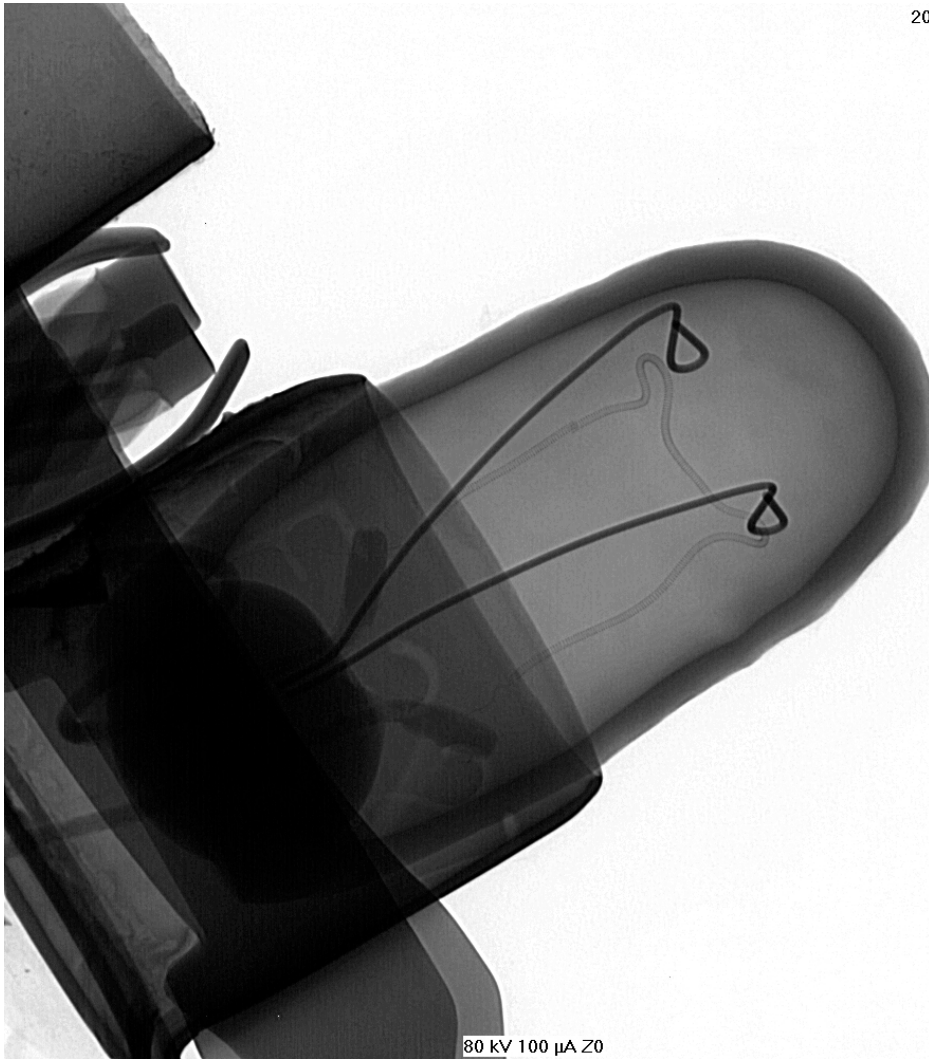


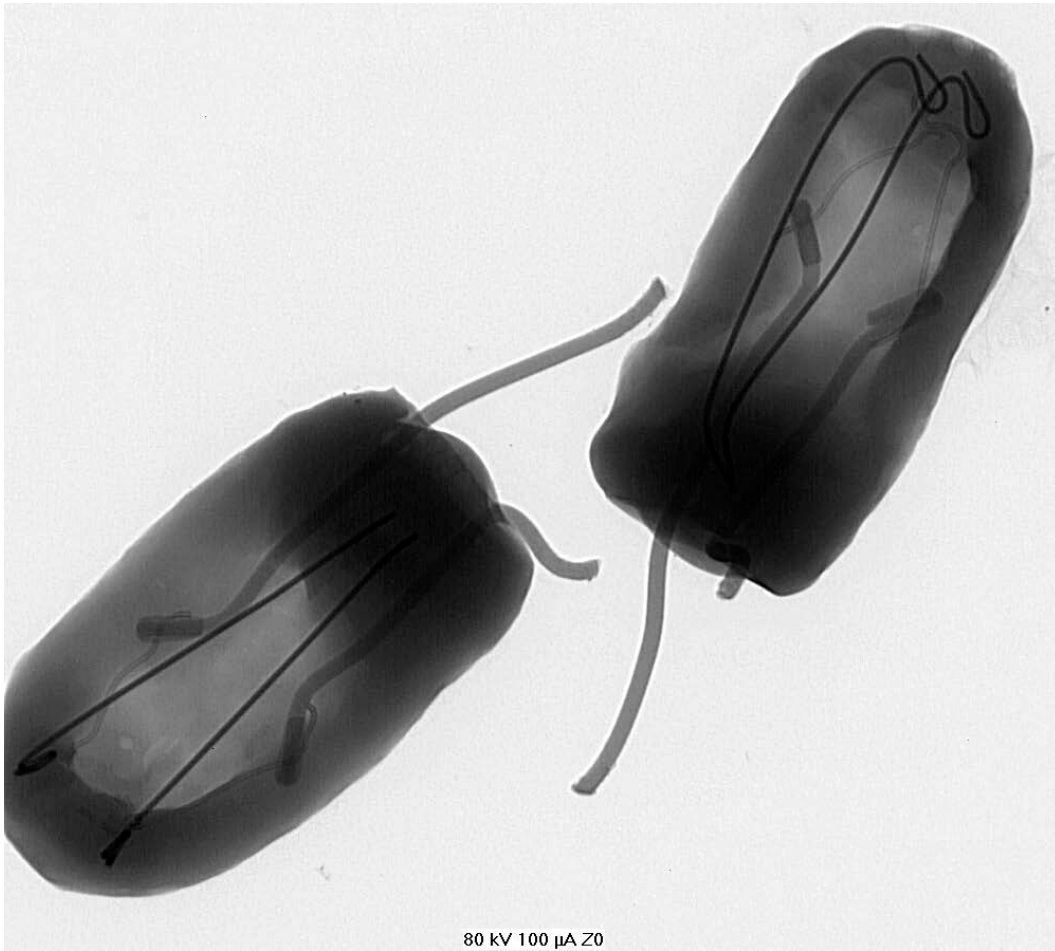
Figure 32. Radiograph of Column 8 Row 1 bulbs of Caution/Advisory Annunciator Panel.

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80 kV 100 μ A Z0

Figure 33. Radiograph of Column 8 Row 2 bulbs of Caution/Advisory Annunciator Panel.



80 kV 100 μ A Z0

Figure 34. Radiograph of Column 8 Row 3 bulbs of Caution/Advisory Annunciator Panel.



Figure 35. Radiograph of Column 8 Row 4 bulbs of Caution/Advisory Annunciator Panel.

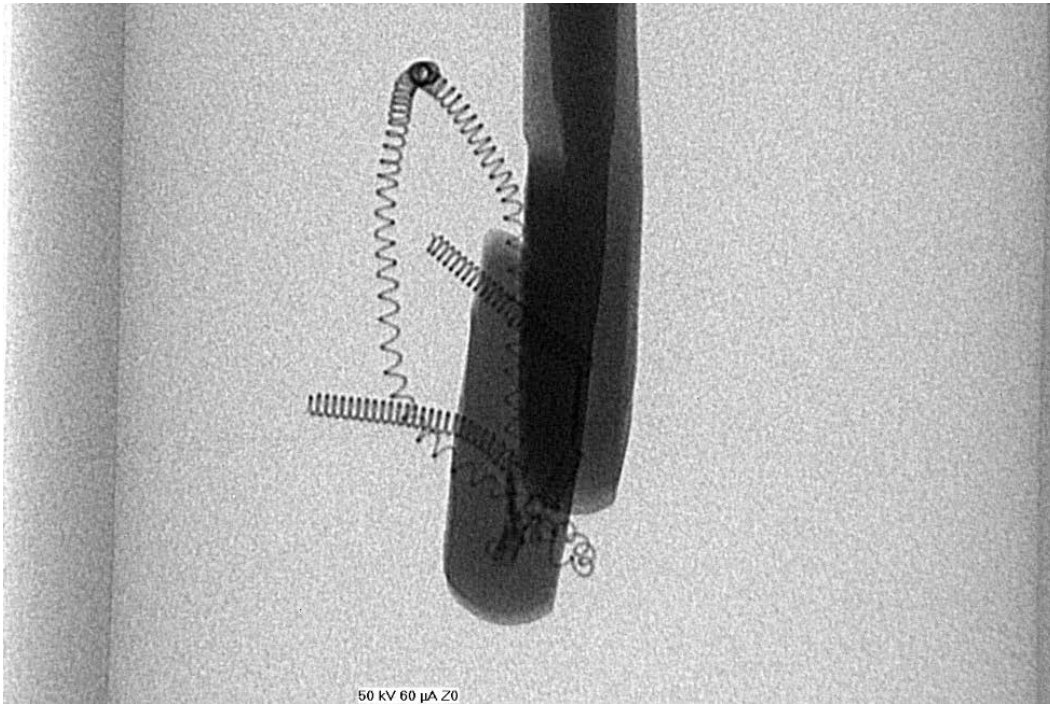


Figure 36. SG REV Bulb #1.

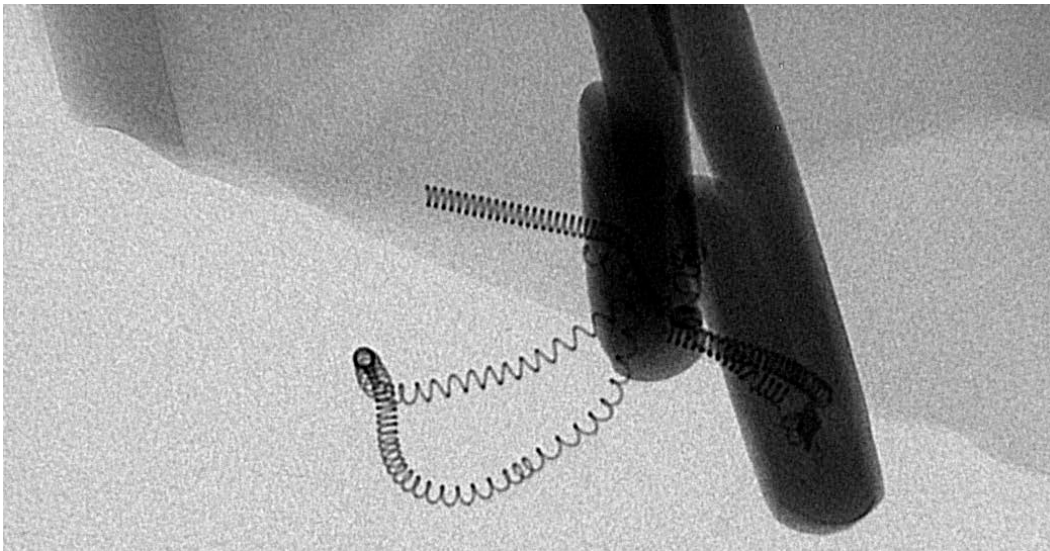


Figure 37. SG REV Bulb #2.

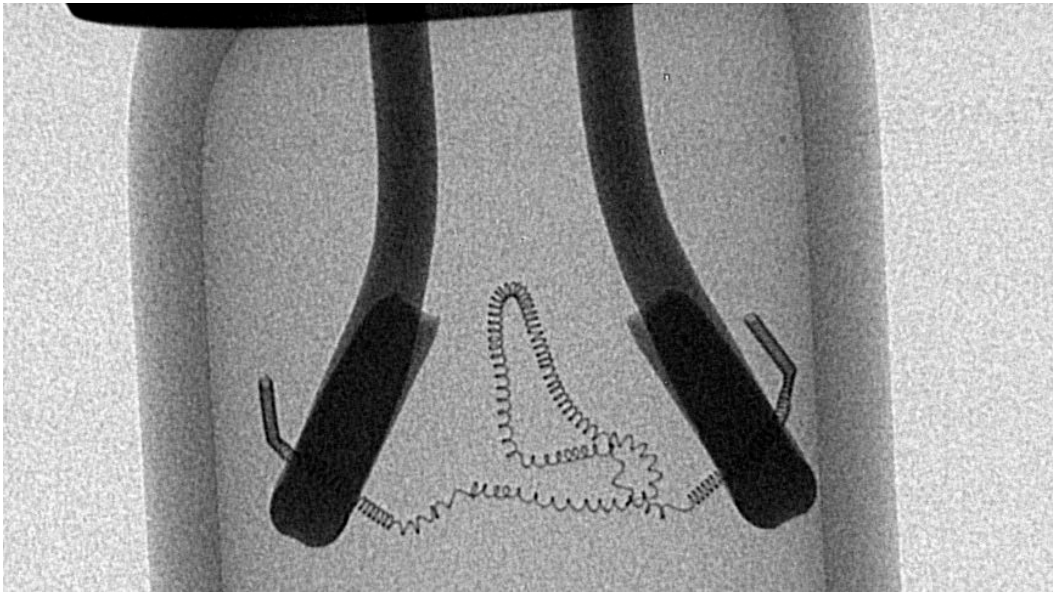


Figure 38. SG REV Bulb #3.

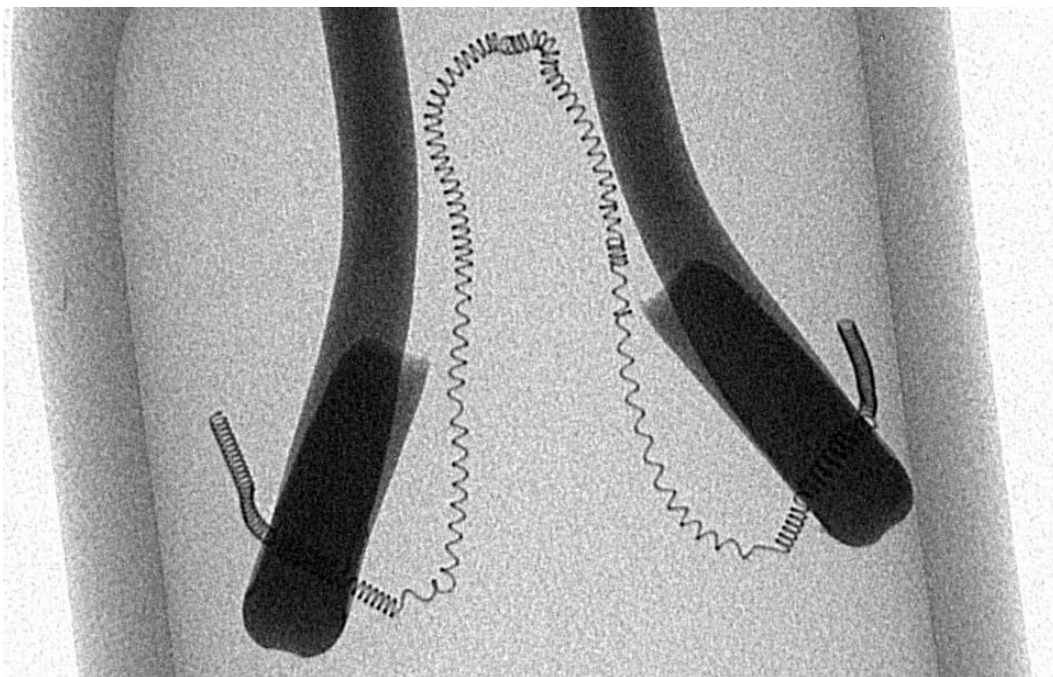


Figure 39. SG REV Bulb #4.



Figure 40. Vertical Gyros.

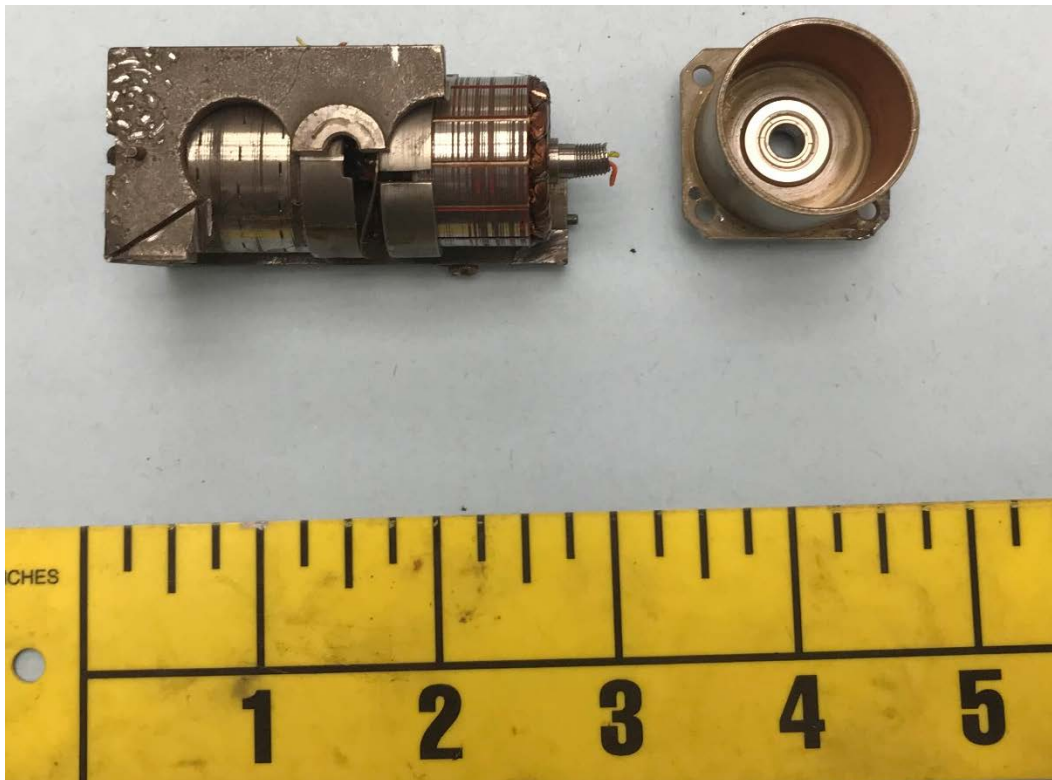


Figure 41. Gyro #1 from Vertical Gyros.



Figure 42. Gyro #2 from Vertical Gyros.



Figure 43. Rate Gyros.



Figure 44. Gyro #1 from Rate Gyros.



Figure 45. Gyro #2 from Rate Gyros.



Figure 46. Standby Attitude Indicator.



Figure 47. Top of gyro rotational mass from Standby Attitude Indicator



Figure 48. Gyro (mass and case) from Standby Attitude Indicator.