ENVIROMENTAL TEST REPORT
FOR THE
WX-32335 SEC CAMERA TUBE

Prepared for:
PRINCETON UNIVERSITY
PRINCETON, NEW JERSEY

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WESTINGHOUSE ELECTRIC CORPORATION
ELECTRONIC TUBE DIVISION
ELMIRA, NEW YORK
14902
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1.0 INTRODUCTION

This report describes the environmental tests performed with the WX-32335 SEC camera tube and the results obtained from these tests. All of these tests were carried out by the Electro-Optical Department of the Westinghouse Electronic Tube Division located in Elmira, New York, on behalf of Princeton University for NASA Goddard Space Flight Center. The activity on this test program was completed at Westinghouse during the period of August 1973 through September 1973.

A total of five (5) SEC camera tubes of the WX-32335 type were subjected to non-operational thermal cycling and sinusoidal vibration tests as required by Amendment #1 to Subcontract #1 under NASA Grant NSF 31-001-286. Random vibration tests initially scheduled were not performed with these tubes at the request of Princeton University.

A detailed discussion of the thermal cycling tests and the sinusoidal vibration tests performed as well as the results obtained from these tests are included in Sections 3.0 and 4.0 of this report, respectively. The electrical testing conditions and photographs of the picture quality of each tube before and after the environmental tests were performed are included in Appendix I of this report. Also included in Appendix I is a description of the design configuration for each tube.
2.0 SUMMARY

The environmental testing activity on the WX-32335 was carried out to determine if this tube type could withstand the environmental requirements established for the International Ultraviolet Explorer (IUE) camera tube (WX-32224). The results of the tests carried out during this test period led to the following conclusions:

1. The WX-32335 as processed with a CsTe photocathode surface can withstand the temperature extremes established for the IUE camera tube without damage to the photocathode surface or without introducing background signal in the tube after one hour of dark integration.

2. The WX-32335 built with a WX-32224 type target support structure can withstand the sinusoidal vibration requirements established for the IUE camera tube.

3. Although the vibration test of the WX-32335 type tubes built with the flat target ring structure could not be completed, there was no indication that these tubes could not withstand the sinusoidal vibration requirements established for the IUE camera tube.
3.0 THERMAL TESTS

Four (4) SEC camera tubes of the WX-32335 type were subjected to non-operational thermal cycling tests as described in Figure 1. Electrical performance tests were performed on each tube before and after exposure to the thermal tests. The performance tests documented the sensitivity, picture quality, and the background (after dark integration for one hour) for each tube. No degradation in tube performance was observed in any of the four (4) tubes tested after exposure to the thermal cycling testing schedule.

The testing sequence and the pertinent data recorded at each electrical test for thermal as well as vibration testing are shown in Table 1.

The thermal tests were performed in a Westinghouse Model El50H Temperature Chamber (Associated Testing Laboratory #K3105).

![Figure 1: Thermal Test Schedule](image-url)

Figure 1 - Thermal Test Schedule
<table>
<thead>
<tr>
<th>Tube Ser. #</th>
<th>Test</th>
<th>Thermal Level</th>
<th>Test</th>
<th>Level I</th>
<th>Test</th>
<th>Level I</th>
<th>Test</th>
<th>Level III</th>
<th>Test</th>
<th>Level III</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>73 09 426</td>
<td>Sensitivity 9.1</td>
<td>14 Aug</td>
<td>9.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Picture Quality Pic.</td>
<td>No Change</td>
<td>7 Sep</td>
<td>No Change</td>
<td>7 Sep</td>
<td>No Change</td>
<td>8 Sep</td>
<td>No Change</td>
<td>8 Sep</td>
<td>No Change</td>
<td>8 Sep</td>
</tr>
<tr>
<td></td>
<td>Background None</td>
<td>22 Aug</td>
<td>None</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>73 09 429</td>
<td>Sensitivity 11.5</td>
<td>N/A</td>
<td>N/A</td>
<td>8 Sep</td>
<td>8 Sep</td>
<td>No Change</td>
<td>8 Sep</td>
<td>No Change</td>
<td>8 Sep</td>
<td>No Change</td>
<td>8 Sep</td>
</tr>
<tr>
<td></td>
<td>Picture Quality Pic.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Background No Test</td>
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<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>73 09 430</td>
<td>Sensitivity 2.9</td>
<td>14 Aug</td>
<td>28</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Picture Quality Pic.</td>
<td>No Change</td>
<td>12 Sep</td>
<td>No Change</td>
<td>12 Sep</td>
<td>No Change</td>
<td>12 Sep</td>
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<td>-</td>
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<td>-</td>
<td></td>
</tr>
<tr>
<td>73 17 353</td>
<td>Sensitivity 30</td>
<td>14 Aug</td>
<td>30</td>
<td>(3)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Picture Quality Pic</td>
<td>-</td>
<td>-</td>
<td>7 Sep</td>
<td>No Change</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td></td>
<td>Background None</td>
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<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>73 17 363</td>
<td>Sensitivity 2.0</td>
<td>14 Aug</td>
<td>2.1</td>
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</tr>
<tr>
<td></td>
<td>Picture Quality Pic</td>
<td>No Change</td>
<td>7 Sep</td>
<td>No Change</td>
<td>7 Sep</td>
<td>No Change</td>
<td>8 Sep</td>
<td>No Change</td>
<td>8 Sep</td>
<td>No Change</td>
<td>8 Sep</td>
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<tr>
<td></td>
<td>Background None</td>
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<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

(1) Sensitivity - Photocurrent in amperes $\times 10^{-8}$ when illuminated with a Pen-Ray lamp.
(2) Tube glass faceplate seal cracked when securing tube in fixture. Tube slowly lost vacuum because of crack and could not be used for further testing.
(3) Tube was dropped after electrical testing and could no longer be used.

| TABLE 1 - ENVIRONMENTAL TEST SEQUENCE AND TABULATED DATA |
4.0 **SINUSOIDAL VIBRATION TESTS**

Five (5) SEC camera tubes of the WX-32335 type were subjected to the sinusoidal vibration test levels described in Figure 2. As indicated, the sinusoidal vibration tests were divided into two (2) levels. Level II represents the full specification levels of sinusoidal vibration as described by the IUE team. Level I represents approximately one-half the IUE specification levels. At each level the exposure consisted of one (1) sweep from the lowest to the highest frequency at a rate of approximately two (2)
The tubes were vibrated along each of the three \( (3) \) mutually perpendicular axes shown in Figure 3.

Before and after the vibration testing, each tube was given an electrical performance test to determine sensitivity, picture quality, and background. In addition, each tube was checked for envelope damage and blemishes after vibration at each level in each axis. Three \( (3) \) of the five \( (5) \) tubes subjected to vibration tests incurred no physical damage or degradation in electrical performance during or after the vibration testing. One \( (1) \) tube was dropped by the test operator and was, therefore, only exposed to the Level 1 vibration levels. The remaining tube was damaged while securing it in the vibration fixture. This tube was built with a glass faceplate and the damage incurred was a fracture in the glass-to-metal seal between the faceplate and the faceplate support flange. This tube was tested following vibration in two \( (2) \) axes at Level 1 but could not be used for further testing because it was losing vacuum due to the seal fracture. The vibration testing
sequence as well as the pertinent data recorded for each test can be found in Table I along with the thermal testing data.

Included in Appendix II of this report is a sketch showing the tubes as mounted in the vibration fixture.

All of the sinusoidal vibration tests were performed at Westinghouse using a Westinghouse Model C-50 Vibration System.
<table>
<thead>
<tr>
<th>Tube Start No.</th>
<th>Tube Serial No.</th>
<th>Date of Start</th>
<th>Plate Type</th>
<th>Photo-Cathode Type</th>
<th>Photo-Cathode Substrate</th>
<th>Photo-Cathode Response</th>
<th>Target Ring Type</th>
<th>Target Buffer Layer</th>
<th>Area of Target Material</th>
<th>Light Gold Coating</th>
<th>Target Shield</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>72 48 031</td>
<td>29 Jan</td>
<td>Glass</td>
<td>S-20</td>
<td>None</td>
<td>N/A</td>
<td>32224</td>
<td>Al Black</td>
<td>Standard</td>
<td>None</td>
<td>None</td>
<td>Inoperable (air tube), could not locate leak.</td>
</tr>
<tr>
<td>2</td>
<td>72 35 137</td>
<td>27 Feb</td>
<td>Glass</td>
<td>S-20</td>
<td>None</td>
<td>155 μA/1m</td>
<td>Flat</td>
<td>None</td>
<td>Standard</td>
<td>None</td>
<td>None</td>
<td>Operable tube; to Princeton</td>
</tr>
<tr>
<td>3</td>
<td>72 35 139</td>
<td>28 Feb</td>
<td>Glass</td>
<td>S-20</td>
<td>None</td>
<td>115 μA/1m</td>
<td>Flat</td>
<td>None</td>
<td>Standard</td>
<td>None</td>
<td>None</td>
<td>Operable tube; to Princeton</td>
</tr>
<tr>
<td>4</td>
<td>73 09 429</td>
<td>7 Mar</td>
<td>Glass</td>
<td>S-9</td>
<td>None</td>
<td>16 μA/1m</td>
<td>Flat</td>
<td>Al Black</td>
<td>Limited</td>
<td>Yes</td>
<td>None</td>
<td>Operable tube; to Princeton</td>
</tr>
<tr>
<td>5</td>
<td>73 09 431</td>
<td>9 Mar</td>
<td>MgF₂</td>
<td>CsTe</td>
<td>Pd</td>
<td>6% Q.E.</td>
<td>Flat</td>
<td>Al Black</td>
<td>Limited</td>
<td>Yes</td>
<td>None</td>
<td>Operable tube; to Princeton</td>
</tr>
<tr>
<td>6</td>
<td>73 09 426</td>
<td>14 Mar</td>
<td>MgF₂</td>
<td>CsTe</td>
<td>Pd</td>
<td>7% Q.E.</td>
<td>Flat</td>
<td>Al Black</td>
<td>Limited</td>
<td>Yes</td>
<td>None</td>
<td>Operable tube; to Princeton</td>
</tr>
<tr>
<td>7</td>
<td>73 09 439</td>
<td>20 Mar</td>
<td>MgF₂</td>
<td>CsTe</td>
<td>Pd</td>
<td>16% Q.E.</td>
<td>Flat</td>
<td>Al Black</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Inoperable tube (air tube); leak in Cu to ceramic seal</td>
</tr>
<tr>
<td>8</td>
<td>73 17 386</td>
<td>12 Apr</td>
<td>MgF₂</td>
<td>CsTe</td>
<td>Pd</td>
<td>N/A</td>
<td>Flat</td>
<td>Al Black</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Operable tube; to Princeton</td>
</tr>
<tr>
<td>9</td>
<td>73 17 353</td>
<td>18 Apr</td>
<td>MgF₂</td>
<td>CsTe</td>
<td>Pd</td>
<td>12% Q.E.</td>
<td>Flat</td>
<td>Al Black</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Inoperable (air tube); leak in target pin seal</td>
</tr>
<tr>
<td>10</td>
<td>73 17 355</td>
<td>26 Apr</td>
<td>MgF₂</td>
<td>CsTe</td>
<td>Pd</td>
<td>N/A</td>
<td>Flat</td>
<td>Al Black</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Inoperable (air tube); leak in Cu to ceramic seal</td>
</tr>
<tr>
<td>11</td>
<td>73 17 454</td>
<td>1 May</td>
<td>MgF₂</td>
<td>CsTe</td>
<td>Pd</td>
<td>N/A</td>
<td>Flat</td>
<td>Al Black</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Inoperable (air tube); leak in Cu to ceramic seal</td>
</tr>
<tr>
<td>12</td>
<td>73 17 445</td>
<td>7 May</td>
<td>MgF₂</td>
<td>CsTe</td>
<td>Pd</td>
<td>N/A</td>
<td>Flat</td>
<td>Al Black</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Operable tube; leak in pinch-off tube</td>
</tr>
<tr>
<td>13</td>
<td>73 17 356</td>
<td>25 May</td>
<td>MgF₂</td>
<td>CsTe</td>
<td>Pd</td>
<td>16 μA/1m</td>
<td>Flat</td>
<td>Al Black</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Inoperable (air tube); leak in pinch-off tube</td>
</tr>
<tr>
<td>14</td>
<td>73 17 434</td>
<td>31 May</td>
<td>MgF₂</td>
<td>CsTe</td>
<td>Pd</td>
<td>N/A</td>
<td>Flat</td>
<td>Al Black</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Operable tube; leak in pinch-off tube</td>
</tr>
<tr>
<td>15</td>
<td>73 17 363</td>
<td>6 Jun</td>
<td>MgF₂</td>
<td>CsTe</td>
<td>Pd</td>
<td>9% Q.E.</td>
<td>32224</td>
<td>Al Black</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Operable tube; machined cover flange.</td>
</tr>
</tbody>
</table>

FIGURE 1
**OPERATING CONDITIONS**

- $E_{g1} = 62\,\text{V}$
- $E_{g2} = 300\,\text{V}$
- $E_{g3} = 70\,\text{V}$
- $E_{g4} = 20\,\text{V}$
- $E_{tc} = 12\,\text{V}$
- $E_{fc} = 7\,\text{kV}$
- $E_5 = 6.3\,\text{V}$

- $I_{\text{focus (image section)}} = 350\,\text{mA}$
- $I_{\text{focus (scanning section)}} = 50\,\text{mA}$

**管型** WX-32335

**管号** 73-09-426

**环境测试前**

**环境测试后**
Tube Type: WX-32335

Operating Conditions:

\[ \begin{align*}
E_{g1} &= -54V \\
E_{g2} &= 300V \\
E_{g3} &= 75V \\
E_{gh} &= 90V \\
E_{TGT} &= 12V \\
E_{fc} &= -2KV \\
E_{g} &= 603V \\
I_{focus (image section)} &= 350mA \\
I_{focus (scanning section)} &= 50mA
\end{align*} \]

Tube S/N: 7309429

Before Environmental Testing

After Environmental Testing
OPERATING CONDITIONS

$E_{g1} = 20\, V$  $E_{g2} = 300\, V$  $E_{g3} = 66\, V$  $E_{gh} = 90\, V$  $E_{tct} = 20\, V$  $E_{pc} = 7.3\, kV$

$E_s = 6.3\, V$

$I_{focus\ (image\ section)} = 350\, mA$  $I_{focus\ (scanning\ section)} = 50\, mA$

Tube Type: WX-32335  Tube S/N: 7309430

BEFORE ENVIRONMENTAL TESTING

AFTER ENVIRONMENTAL TESTING
Tube Type WX.32.335

OPERATING CONDITIONS

\[ E_{g1} = 42 \text{ V} \quad E_{g2} = 300 \text{ V} \quad E_{g3} = 70 \text{ V} \quad E_{gh} = 90 \text{ V} \quad E_{TCT} = 12 \text{ V} \quad E_{pc} = 7 \text{ kV} \]

\[ E_{g} = 6.3 \text{ V} \]

\[ I_{\text{focus (image section)}} = 350 \text{ mA} \]

\[ I_{\text{focus (scanning section)}} = 50 \text{ mA} \]

BEFORE ENVIRONMENTAL TESTING

AFTER ENVIRONMENTAL TESTING
Tube Type: WX-32335

OPERATING CONDITIONS
E_{g1} = 20 V  E_{g2} = 300 V  E_{g3} = 25 V  E_{g4} = 90 V  E_{tg1} = 12 V  E_{pc} = 7 kV
E_p = ? V

I_{focus} (image section) = 350 mA  I_{focus} (scanning section) = 50 mA

BEFORE ENVIRONMENTAL TESTING

AFTER ENVIRONMENTAL TESTING
APPENDIX II - VIBRATION FIXTURE