Output for the Sprint Warhead (U)

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OUTPUT FOR THE SPRINT WARHEAD

by

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ABSTRACT (U)

The results of a complete set of output and debris calculations for the Sprint missile system are presented here. Quite possibly this is the only calculation of its kind which has been completed and thus it has an intrinsic interest in addition to providing data on the Sprint system.

I. INTRODUCTION

The Sprint missile was developed as part of the U. S. ABM system. The warhead for the Sprint is the W66.

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Because the Sprint system functions in a very compact battle-space, all of these outputs are important in designing a system which has the required fraticide range.

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The x-ray and debris motion calculations have been used as input to predict the blast.\(^1\)

The design requirements of the warhead and missile needed to be coordinated very closely during the development of the Sprint missile system. This was done in the Sprint Nuclear Vulnerability and Effects (SNVE) group. The
results presented in this report have, for the most part, been previously reported in the SNVE minutes.\textsuperscript{2} This document provides a summary of all the output calculations for the Sprint missile system.

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III. MISSILE MODELING

A homogenized mockup of the Sprint missile was provided by a Martin-Marietta Corporation document. This document contains a schematic of the missile (shown in Figure 2) and a detailed breakdown of the material composition, mass, and volume of each region shown in the schematic. This information is summarized in Table 1.

Figure 2.
Martin-Marietta Sprint Missile Mockup.

In this model each region was assigned a uniform density adjusted to give the correct total mass for that region. In some instances it was felt that a different description was needed. The modifications made to the Martin-Marietta model are detailed below. In all cases the total mass was conserved for the calculational model.

The nose cone was partially dehomogenized by separating region 1 into a nose cap of silica phenolic at the forward tip of the missile, lead ballast immediately aft of the nose cap, and the remainder of the materials in region 1 homogenized behind the ballast. Discussions with Howard Goldmacher of Martin-Marietta indicated that the autopilot, region 5, consisted of electronic equipment encased by a "can" of aluminum alloy 2014. The thickness of this aluminum varied around the autopilot, but an average value of 3 mm was chosen for the calculational model. The remainder of the autopilot mass was homogenized.

In the Martin-Marietta model, the region containing the motor case and nozzle, region 8, was completely homogenized despite the fact that the fuel mass was not used.

Region 8 was therefore subdivided into the missile skin, the motor case of heat-resistant
TABLE I
SPRINT MISSILE COMPOSITION SUMMARY

<table>
<thead>
<tr>
<th>Region</th>
<th>Missile Part</th>
<th>Principal Constituent(s)</th>
<th>Mass/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nose Cap</td>
<td>Silica Phenolic</td>
<td>1.5</td>
</tr>
<tr>
<td>1</td>
<td>Ballast</td>
<td>Lead</td>
<td>10.0</td>
</tr>
<tr>
<td>1</td>
<td>Electronics</td>
<td>Aluminum</td>
<td>4.6</td>
</tr>
<tr>
<td>3</td>
<td>Missile Guidance System</td>
<td>Aluminum</td>
<td>34.4</td>
</tr>
<tr>
<td>5</td>
<td>Autopilot</td>
<td>Aluminum, Aluminum 2014</td>
<td>19.5</td>
</tr>
<tr>
<td>6</td>
<td>Void</td>
<td>--</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>2nd Stage Motor</td>
<td>Silica Phenolic</td>
<td>149.0</td>
</tr>
<tr>
<td>9</td>
<td>2nd Stage Controls</td>
<td>Aluminum</td>
<td>105.5</td>
</tr>
<tr>
<td>2,4,7,10</td>
<td>Missile Skin</td>
<td>Aluminum 2014</td>
<td>22.6</td>
</tr>
<tr>
<td>2,4,7,10</td>
<td>Heat Shield</td>
<td>Silica Phenolic</td>
<td>20.2</td>
</tr>
</tbody>
</table>

material, and an air-filled interior. Thicknesses and densities were adjusted to conserve each of the elemental masses. The missile skin was taken to be aluminum alloy 2104 in the calculations.

In addition to the warhead itself, the firing set and adaption kit were added at the aft end of the warhead compartment. Masses and material breakdown on the latter components were furnished by M. R. Madsen of Sandia Laboratories-Albuquerque.5

The material interfaces of the final model are shown in Figure 3 at primary nuclear time. This system was surrounded by a 10-m-radius sphere of air with its origin at the center of the secondary at a density of $3 \times 10^{-4}$ g/cm$^3$. (Normal density at 9.1 km altitude.)
IV. NEUTRON AND GAMMA-RAY OUTPUT

A summary of the overall neutron and gamma-ray output of the Sprint missile is given in Table II. All of the neutron and gamma-ray outputs are based on the device yields given in Table II.

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TABLE II
SUMMARY OF SPRINT ZERO-YEAR NEUTRON AND GAMMA-RAY OUTPUT

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A. Neutron Output

The neutron output has been calculated as a function energy and angle measured from the missile axis. A cosine of plus one corresponds to the forward direction.
TABLE IV

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B. Gamma-Ray Output

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C. Experimental Results

No measurements of the neutron and gamma-ray output, given in this report, have been made. Several closely related measurements have been made on the Nevada tests of the W66 warhead.

Comparisons of the calculated and observed results have agreed quite well.

The good agreement between the measurements and the calculated results provides added confidence that the outputs given in this report are valid.
V. X-RAY OUTPUT AND DEBRIS MOTION

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The final energy partition in these calculations is shown in Table V. The energy evolution in the system is shown in Figure 11.

TABLE V

<table>
<thead>
<tr>
<th>DOE</th>
<th>6.2 (a)</th>
</tr>
</thead>
</table>

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| DOE | 6.2 (a) |
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DOE
6.2 (a)
In principle, if enough snapshots were done, one could construct time- and frequency-dependent fluxes for each angle. However, the resolution in available mesh configurations would not give good accuracy for the integrations.

VI. CODE DESCRIPTIONS

REFERENCES

1. Private communication to E. M. Jones, LASL J-10.


4. Private communication from Howard Goldmacher, Martin-Marietta Corporation.

APPENDIX

ADDITIONAL RESULTS OF THE X-RAY AND DEBRIS CALCULATIONS

Some additional results of the x-ray and debris calculations are presented here. The isotropic distributions are shown as dashed circles for comparison.

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DOE 6.2 (a)
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DOE
6.2 (a)
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