SEA KNIFE
ANALYSIS OF SELECTED SEAKEEPING DATA
VOLUME 1 [U]

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ADIRALTY EXPERIMENT WORKS
HASLAR GOSPORT
HAMPSHIRE PO 12 2AG

PROCUREMENT EXECUTIVE
MINISTRY OF DEFENCE

UNCLASSIFIED
November 1976

80227178
REPORT DOCUMENTATION PAGE

1. REPORT NUMBER
   AEW TR N76034

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
   Sea Knife - Analysis of Selected Seakeeping Data Vol. I (U)

5. TYPE OF REPORT & PERIOD COVERED

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
   M. A. Hammond
   K. Nicholson

8. CONTRACT OR GRANT NUMBER(s)
   Payne, Inc.
   N00014-75-C-0926
   P00055

9. PERFORMING ORGANIZATION NAME AND ADDRESS
   Admiralty Experiment Works
   Hampshire PO 12 2 AG
   England

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS

12. REPORT DATE

13. NUMBER OF PAGES
   Vol. I-17 Vol. II-115

14. MONITORING AGENCY NAME & ADDRESS (IF different from Controlling Office)
   DINSRDC
   Bethesda, Maryland 20084

15. SECURITY CLASS. (OF THIS REPORT)
    Unclassified

16. DISTRIBUTION STATEMENT (OF THIS REPORT)
    Unlimited and approved for Public release.

17. DISTRIBUTION STATEMENT (OF THE ABSTRACT ENTERED IN BLOCK 20, IF DIFFERENT FROM REPORT)

18. SUPPLEMENTARY NOTES
    Vol. I Report
    Vol. II Figures
    This report used by OP96V in their study:

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
    Advanced Naval Vehicle Concepts
    Seakeeping Data (Selected)
    Evaluation
    ANVCE
    Technology Assessment
    Sea Knife

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
    This report presents the results of spectral analysis on a selection of seakeeping tests carried out on a 1/16 full size model of SEA KNIFE. SEA KNIFE is an experimental planing hull design.
SEA KNIFE

ANALYSIS OF SELECTED SEAKEEPING DATA

(U)

BY

M. A. HAMMOND
K. NICHOLSON

11 NOV 1976

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PROCUREMENT EXECUTIVE
MINISTRY OF DEFENCE
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Figure 38. Run 893 Bow Acceleration.
Figure 39. Run 893 Encountered Wave.
Figure 40. Run 894 Pitch.
Figure 41. Run 894 Heave.
Figure 42. Run 894 CG Acceleration.
Figure 43. Run 894 Bow Acceleration.
Figure 44. Run 894 Encountered Wave.
Figure 45. Run 896 Pitch.
Figure 46. Run 896 Heave.
Figure 47. Run 896 CG Acceleration.
Figure 48. Run 896 Bow Acceleration.
Figure 49. Run 896 Encountered Wave.
Figure 50. Run 897 Pitch.
Figure 51. Run 897 Heave.
Figure 52. Run 897 CG Acceleration.
Figure 53. Run 897 Bow Acceleration.
Figure 54. Run 897 Encountered Wave.
Figure 55. Run 898 Pitch.
Figure 56. Run 898 CG Acceleration.
Figure 57. Run 898 Bow Acceleration.
Figure 58. Run 898 Encountered Wave.
Figure 59. Run 899 Pitch.
Figure 60. Run 899 CG Acceleration.
Figure 61. Run 899 Bow Acceleration.
Figure 62. Run 899 Encountered Wave.
Figure 63. Run 900 Pitch.
Figure 64. Run 900 Heave.
Figure 65. Run 900 CG Acceleration.
Figure 66. Run 900 Bow Acceleration.
Figure 67. Run 900 Encountered Wave.
Figure 68. Run 908 CG Acceleration.
Figure 69. Run 908 Bow Acceleration.
Figure 70. Run 9 Pitch.
Figure 71. Run 909 CG Acceleration.
Figure 72. Run 909 Bow Acceleration.
Figure 73. Run 909 Encountered Wave.
Figure 74. Run 924 Pitch.
Figure 75. Run 924 Heave.
Figure 76. Run 924 CG Acceleration.
Figure 77. Run 924 Bow Acceleration.
Figure 78. Run 924 Encountered Wave.
Figure 79. Run 925 CG Acceleration.
Figure 80. Run 925 Bow Acceleration.
Figure 81. Run 928 Pitch.
Figure 82. Run 928 Heave.
Figure 83. Run 928 CG Acceleration.
Figure 84. Run 928 Bow Acceleration.
Figure 85. Run 928 Encountered Wave.
Figure 86. Run 929 Pitch.
Figure 87. Run 929 Heave.
Figure 88. Run 929 CG Acceleration.
Figure 89. Run 929 Bow Acceleration.
Figure 90. Run 929 Encountered Wave.
Figure 91. Run 930 Pitch.
Figure 92. Run 930 Heave.
Figure 93. Run 930 CG Acceleration.
Figure 94. Run 930 Bow Acceleration.
Figure 95. Run 930 Encountered Wave.
Figure 96. Run 931 Pitch.
Figure 97. Run 931 Heave.
Figure 98. Run 931 CG Acceleration.
Figure 99. Run 931 Bow Acceleration.
Figure 100. Run 931 Encountered Wave.
Figure 101. Run 935 Pitch.
Figure 102. Run 935 Heave.
Figure 103. Run 935 CG Acceleration.
Figure 104. Run 935 Bow Acceleration.
Figure 105. Run 935 Encountered Wave.
Figure 106. Run 936 Pitch.
Figure 107. Run 936 Heave.
Figure 108. Run 936 CG Acceleration.
Figure 109. Run 936 Bow Acceleration.
Figure 110. Run 936 Encountered Wave.
Figure 111. Run 937 Pitch.
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Figure 113. Run 937 CG Acceleration.
Figure 114. Run 937 Bow Acceleration.
Summary

1. This Report presents the results of spectral analysis on a selection of seakeeping tests carried out on a $\frac{1}{16}$ full size model of SEA KNIFE in No 1 Ship Tank.

2. The work was undertaken on behalf of DTNSRDC under contract number N68171-76-V-9910, and formed part of the US Navy Project on Advance Naval Vehicle Concept Evaluations.

Approved for issue

Superintendent
SEA KNIFE
ANALYSIS OF SELECTED SEAKEEPING DATA

By M A Hammond
K Nicholson

1. INTRODUCTION

Resistance and seakeeping tests were conducted in No 1 Ship Tank during May 1976 on a 1/16 full-scale model of SEA KNIFE.

The purpose of the project, the model configurations, calm water resistance data and experimental arrangements were reported in Reference 1.

AEW was subsequently requested by DTNSRDC to analyse a selection of the data from the seakeeping tests on a repayment basis under contract number N68171-76-V-9910.

This Report presents the results of the requested seakeeping analysis.

2. DESCRIPTION

Photographs of the two model configurations are shown in Figures 1 and 2 respectively, whilst model and ship particulars are given in Table 1 and the irregular seas test programme is summarised in Table 2. Table 3 lists the measured parameters, their ranges and the media on which they were recorded.

This Report contains the results of spectral analysis for the 26 runs selected by DTNSRDC using an adaption of the auto-correlation method outlined in Reference 2.

The resistance in waves was recorded only on ultraviolet paper and a mean level has been determined by averaging peaks and troughs. An estimate of the calm water resistance has been made for the appropriate conditions from measured data and the added resistance deduced as the difference between the two values. No value is available for run 878 as the trace was unreadable.

Certain of the magnetic tape records were unsuitable for computer analysis for a variety of reasons including their short duration and high noise to signal ratios. Root mean square (rms) values have been calculated from the downstream ultraviolet records for these cases and the appropriate values are indicated in Tables 4-6 by an asterisk (*).

No value of heave was recorded on runs 898, 899, 908 and 909.

3. RESULTS

The analysed data for configuration 1 in sea state 3 are in Table 4 and the associated spectra are presented in Figures 3-35. Results for configuration 1 in sea state 5 are given in Table 5 and Figures 36-73, whilst the results of configuration 2 tests in sea state 3 are shown in Table 6 and Figures 74-114.

Figures 3 to 114 are contained in Volume 2 of this report.

Table 1

MODEL AND SHIP PARTICULARS

(a = 17.5 Degrees Hard Chine Bottom No Spray Reversers)

<table>
<thead>
<tr>
<th></th>
<th>Model</th>
<th>Ship</th>
</tr>
</thead>
<tbody>
<tr>
<td>L&lt;sub&gt;OA&lt;/sub&gt; metres (ft)</td>
<td>1.497 (4.91)</td>
<td>23.952 (78.6)</td>
</tr>
<tr>
<td>L&lt;sub&gt;WL&lt;/sub&gt; metres (ft)</td>
<td>1.259 (4.13)</td>
<td>20.144 (66.1)</td>
</tr>
<tr>
<td>L&lt;sub&gt;PP&lt;/sub&gt; metres (ft)</td>
<td>1.219 (4.00)</td>
<td>19.504 (64.0)</td>
</tr>
<tr>
<td>L&lt;sub&gt;K&lt;/sub&gt; metres (ft)</td>
<td>1.036 (3.40)</td>
<td>16.576 (54.4)</td>
</tr>
<tr>
<td>B (at WL without spray reversers) metres (ft)</td>
<td>0.390 (1.28)</td>
<td>6.240 (20.5)</td>
</tr>
<tr>
<td>B (max at deck) metres (ft)</td>
<td>0.591 (1.94)</td>
<td>9.456 (31.0)</td>
</tr>
<tr>
<td>T (standard condition) metres (ft)</td>
<td>0.069 (0.227)</td>
<td>1.104 (3.6)</td>
</tr>
<tr>
<td>T (heavy condition) metres (ft)</td>
<td>0.081 (0.267)</td>
<td>1.296 (4.3)</td>
</tr>
<tr>
<td>Mass (standard condition) kg (lb)</td>
<td>12.950 (28.55)</td>
<td>54430 (120,000)</td>
</tr>
<tr>
<td>Mass (heavy condition) kg (lb)</td>
<td>16.175 (35.66)</td>
<td>68040 (150,000)</td>
</tr>
</tbody>
</table>
Table 2

TEST PROGRAMME

<table>
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<tr>
<th>Test</th>
<th>Configuration</th>
<th>Condition</th>
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<tbody>
<tr>
<td>15</td>
<td>I</td>
<td>Standard condition</td>
</tr>
<tr>
<td></td>
<td>Prototype speeds, 5, 14, 20, 30, 40, 45 knots</td>
<td></td>
</tr>
<tr>
<td></td>
<td>State 3 and state 5</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>I</td>
<td>Heavy condition</td>
</tr>
<tr>
<td></td>
<td>State 3 only</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>II</td>
<td>Standard condition</td>
</tr>
<tr>
<td></td>
<td>State 3 only</td>
<td></td>
</tr>
<tr>
<td>1-11</td>
<td>Were conducted at US Naval Academy</td>
<td></td>
</tr>
<tr>
<td>12-14</td>
<td>Were calm water resistance experiments at AEW</td>
<td></td>
</tr>
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</table>

Table 3

MEASURED PARAMETER RANGE AND RECORDING MEDIA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>Medium</th>
</tr>
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<tbody>
<tr>
<td>Pitch</td>
<td>± 9 degrees</td>
<td>Digital magnetic tape (DMT)</td>
</tr>
<tr>
<td>Heave (at CG)</td>
<td>± 7 cms</td>
<td>DMT</td>
</tr>
<tr>
<td>Vertical acceleration at CG</td>
<td>5 g</td>
<td>DMT</td>
</tr>
<tr>
<td>Vertical acceleration at bow</td>
<td>5 g</td>
<td>DMT</td>
</tr>
<tr>
<td>Encountered wave height</td>
<td>± 22 cms</td>
<td>DMT</td>
</tr>
<tr>
<td>Towing force</td>
<td>400 Newtons</td>
<td>Ultraviolet recorder</td>
</tr>
</tbody>
</table>
Table 4

RESULTS FOR HARD CHINE MODEL (CONFIGURATION 1) IN SEA STATE 3

<table>
<thead>
<tr>
<th>Run No</th>
<th>AEW Star Run No</th>
<th>Model Speed (m/s)</th>
<th>Trim Flap Angle (Degr)</th>
<th>Rms Pitch (Degr)</th>
<th>Rms Heave (CM)</th>
<th>Rms CG Accel (G)</th>
<th>Rms Bow Accel (G)</th>
<th>Rms Wave (CM)</th>
<th>Figure No</th>
<th>Mean Resistance (Newtons)</th>
<th>Deduced Calm Resistance (N)</th>
<th>Deduced Resistance Increase (N)</th>
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</thead>
<tbody>
<tr>
<td>15/2</td>
<td>878</td>
<td>1.820</td>
<td>20</td>
<td>2.13</td>
<td>1.893</td>
<td>0.176</td>
<td>0.235</td>
<td>1.521</td>
<td>3-7</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15/3</td>
<td>879</td>
<td>3.883</td>
<td>4</td>
<td>0.795</td>
<td>1.078</td>
<td>0.140</td>
<td>0.198</td>
<td>1.073</td>
<td>8-12</td>
<td>35.14</td>
<td>27.58</td>
<td>7.56</td>
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<tr>
<td>15/7</td>
<td>883</td>
<td>3.854</td>
<td>4</td>
<td>1.136</td>
<td>1.686</td>
<td>0.232</td>
<td>0.244</td>
<td>2.256*</td>
<td>13-16</td>
<td>33.81</td>
<td>27.58</td>
<td>6.23</td>
</tr>
<tr>
<td>15/8</td>
<td>884</td>
<td>3.901</td>
<td>4</td>
<td>1.135</td>
<td>1.556</td>
<td>0.234</td>
<td>0.236</td>
<td>1.55</td>
<td>17-21</td>
<td>32.92</td>
<td>27.58</td>
<td>5.34</td>
</tr>
<tr>
<td>15/12</td>
<td>888</td>
<td>5.78</td>
<td>2.5</td>
<td>1.164*</td>
<td>2.418*</td>
<td>0.379*</td>
<td>0.664*</td>
<td>2.59*</td>
<td>-</td>
<td>64.05</td>
<td>44.93</td>
<td>19.12</td>
</tr>
<tr>
<td>15/13</td>
<td>889</td>
<td>5.771</td>
<td>2.5</td>
<td>0.813</td>
<td>1.31</td>
<td>0.34</td>
<td>0.357</td>
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<td>22-26</td>
<td>68.46</td>
<td>44.48</td>
<td>23.98</td>
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<td>15/14</td>
<td>890</td>
<td>5.808</td>
<td>2.5</td>
<td>0.73</td>
<td>1.241</td>
<td>0.305</td>
<td>0.291</td>
<td>1.634*</td>
<td>27-31</td>
<td>64.14</td>
<td>44.48</td>
<td>19.66</td>
</tr>
<tr>
<td>15/15</td>
<td>891</td>
<td>5.809</td>
<td>2.5</td>
<td>1.212*</td>
<td>1.338</td>
<td>0.331</td>
<td>0.301</td>
<td>1.747</td>
<td>32-35</td>
<td>64.28</td>
<td>44.48</td>
<td>19.80</td>
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</table>
Table 5

RESULTS FOR HARD CHINE MODEL (CONFIGURATION 1) IN SEA STATE 5

<table>
<thead>
<tr>
<th>Run No</th>
<th>AEW Star Run No</th>
<th>Model Speed (m/s)</th>
<th>Trim Flap Angle (Dega)</th>
<th>Rms Pitch (Degas)</th>
<th>Heave (CM)</th>
<th>CG Accel (G)</th>
<th>Bow Accel (G)</th>
<th>Wave (CM)</th>
<th>Figure No</th>
<th>Mean Resistance (Newtons)</th>
<th>Deduced Calm Resistance (N)</th>
<th>Resistance Increase (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15/17</td>
<td>893</td>
<td>1.804</td>
<td>20</td>
<td>3.623</td>
<td>5.545*</td>
<td>0.300</td>
<td>0.368</td>
<td>3.163</td>
<td>36-39</td>
<td>20.02</td>
<td>16.9</td>
<td>3.12</td>
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<tr>
<td>15/18</td>
<td>894</td>
<td>1.805</td>
<td>20</td>
<td>3.462</td>
<td>3.967</td>
<td>0.326</td>
<td>0.376</td>
<td>3.179</td>
<td>40-44</td>
<td>19.57</td>
<td>16.9</td>
<td>2.67</td>
</tr>
<tr>
<td>15/19</td>
<td>896</td>
<td>3.859</td>
<td>4</td>
<td>2.42</td>
<td>3.289</td>
<td>0.423</td>
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<td>2.961</td>
<td>45-49</td>
<td>36.92</td>
<td>27.58</td>
<td>9.34</td>
</tr>
<tr>
<td>15/20</td>
<td>897</td>
<td>3.864</td>
<td>4</td>
<td>1.812</td>
<td>2.963</td>
<td>0.377</td>
<td>0.393</td>
<td>2.709</td>
<td>50-54</td>
<td>37.36</td>
<td>27.58</td>
<td>9.78</td>
</tr>
<tr>
<td>15/21</td>
<td>898</td>
<td>3.866</td>
<td>4</td>
<td>1.789</td>
<td>-</td>
<td>0.302</td>
<td>0.306</td>
<td>2.488</td>
<td>55-58</td>
<td>35.59</td>
<td>27.58</td>
<td>8.01</td>
</tr>
<tr>
<td>15/22</td>
<td>899</td>
<td>3.864</td>
<td>4</td>
<td>1.981</td>
<td>-</td>
<td>0.423</td>
<td>0.396</td>
<td>2.738</td>
<td>59-62</td>
<td>34.25</td>
<td>27.58</td>
<td>6.67</td>
</tr>
<tr>
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<td>900</td>
<td>3.891</td>
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<td>1.717</td>
<td>0.244</td>
<td>0.239</td>
<td>1.985</td>
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<td>32.38</td>
<td>27.58</td>
<td>4.8</td>
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<td>908</td>
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<td>0.523</td>
<td>0.482</td>
<td>4.28*</td>
<td>68-69</td>
<td>62.72</td>
<td>44.48</td>
<td>18.24</td>
</tr>
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<td>15/32</td>
<td>909</td>
<td>5.701</td>
<td>2.25</td>
<td>1.496</td>
<td>-</td>
<td>0.540</td>
<td>0.488</td>
<td>2.893</td>
<td>70-73</td>
<td>58.67</td>
<td>44.48</td>
<td>14.19</td>
</tr>
</tbody>
</table>
### Table 6

**RESULTS FOR ROUND BILGE MODEL WITH SPRAY REVERSERS (CONFIGURATION 2) IN SEA STATE 3**

<table>
<thead>
<tr>
<th>Run No</th>
<th>AEW Star Run No</th>
<th>Model Speed (m/s)</th>
<th>Trim Flap Angle (Dega)</th>
<th>Pitch (Dega)</th>
<th>Heave (CM)</th>
<th>CG Accel (G)</th>
<th>Bow Accel (G)</th>
<th>Wave (CM)</th>
<th>Figure No</th>
<th>Mean Resistance (Newtons)</th>
<th>Calm Resistance (N)</th>
<th>Resistance Increase (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17/2</td>
<td>924</td>
<td>1.798</td>
<td>22</td>
<td>1.819</td>
<td>1.557</td>
<td>0.103</td>
<td>0.243</td>
<td>1.863</td>
<td>74-78</td>
<td>18.82</td>
<td>18.68</td>
<td>0.14</td>
</tr>
<tr>
<td>17/3</td>
<td>925</td>
<td>1.787</td>
<td>22</td>
<td>3.152*</td>
<td>2.324*</td>
<td>0.105</td>
<td>0.251</td>
<td>2.46*</td>
<td>79-80</td>
<td>19.57</td>
<td>18.68</td>
<td>0.89</td>
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<tr>
<td>17/6</td>
<td>928</td>
<td>3.837</td>
<td>11</td>
<td>1.003</td>
<td>1.608</td>
<td>0.180</td>
<td>0.326</td>
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<td>32.47</td>
<td>26.24</td>
<td>6.23</td>
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<td>1.714</td>
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<td>0.341</td>
<td>1.723</td>
<td>86-90</td>
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Figure 1

SEA KNIFE MODEL CONFIGURATION 1

Figure 2

SEA KNIFE MODEL CONFIGURATION 2