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SANDIA SYSTEMATIC DECLASSIFICATION REVIEW
1st Review Date: 6/23/98
Authority: DOE/OC SADD
Name: [illegible]
2nd Review Date: 6/24/98
Authority: ADD
Name: WClayne
Determination (Circle Number):
1. Classification Retained
2. Classification Changed to: UNCL
3. Contains No DOE Classified Information
4. Coordinate With:
5. Contains UCNI?
6. Comments:
DECLASSIFY

FEB 2 1981

Folder YW-54, 3.2
T-17136
15.434.00

TO: DISTRIBUTION

Re: Drop Tower Test of a Hydroballistic Shape

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eft 29260

Summary of Results

The hydroballistic shape was dropped four times into a water tank to study the effects of the fin loading, integrity of the frangible nose, and the cavity of the water as a result of the hydroballistic shapes impact in the water tank. Three drops were made at 57 ft/sec. impact velocity. One drop was made at 105 ft/sec impact velocity. The hydroballistic shape study is part of the Davey Jones development program.

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Strain gages were placed perpendicular to the fin mounting brackets on the two lower fins to measure fin loading upon water entry. The highest loading was 8748 micro inches/inch with a permanent set of 4797 micro inches/inch with an impact velocity of 105 ft/sec. The maximum faired vertical acceleration was 70.4g on Drop #2. The maximum faired longitudinal acceleration was 31.1g on Drop #4.

The plastic frangible nose was held on to the center section of the hydroballistic shape by a long bolt passing through the plastic nose. The plastic nose was also contoured to the front end of the hydroballistic shapes center section. The bolt bent slightly on two drops at 57 ft/sec but did not come off. On the drop at 105 ft/sec. the frangible nose was broken loose from the center section of the hydroballistic shape. The bolt failed right where it was tapped into the center section of the hydroballistic shape.

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The cavity formed in the water by the hydroballistic shapes entry into the water was covered by two Fastex cameras just below the water level in the tank. A camera was placed on a bracket mounted to the tanks edge eight feet above the water level and parallel to the longitudinal axis of the hydroballistic shape. A third Fastex camera was placed on the 300' Tower about twenty-five feet above the water and about 45° to the longitudinal axis of the hydroballistic shape.

The results of the tests showed the loads on the fins to be about what was expected and the correlation of loads between the 57 ft/sec. impact velocity and 105 ft/sec impact velocity were good. The frangible nose used for aerodynamic stability was designed to break off at water contact to help the unit dive in the water. This appeared to function properly at the higher impact velocity tested. The results of the movie films showed the cavity in the water to be what was expected.

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Object of Test

The object of these tests was threefold. The first was to study the skin loading of a hydroballistic shape, upon impact into water at velocities of 57 ft/sec. and 105 ft/sec. The second was to check the integrity of the frangible nose at the same impact velocities. The third was to observe the cavity formed in the water at water impact. This study is part of the "Davey Jones" program.

Authorization for Test

This test was requested in a Work Order Authorization for Materials Laboratory Investigation, from E. H. Copeland, 7321, to F. R. Adams, 7323, dated June 22, 1960. D. Peak 7182-1 was the consultant.

Function of Object Tested

The hydroballistic shape functions as a projectile used for air to water entry of an underwater explosive device. The frangible nose is supposed to break off and cause the hydroballistic shape to dive and explode under water.

Summary of Past Tests

No previous water tests have been made on this hydroballistic shape by Organization 7322.

Setup for Test

Figure 1 shows the instrumentation of the hydroballistic shape and details of the frangible nose attached to the hydroballistic shape. Figure 2 shows the hydroballistic shape hung in drop position over the water tank.

The components making up the object tested do not have numbers listed because they are assembled for a research vehicle and have not been given numbers yet.

The test equipment used was a Consolidated Engineering Oscillograph Model 5-119B Serial No. 9071, four Kistler Amplifiers Model 111BV and their balance systems.

The instrumentation used on these shape were two strain gages Natmall Metallkin type C12-101, resistance 120 . Figure 1 shows the location of these strain gages. The accelerometer used in the vertical direction (A-1) Fig. 1 was Serial No. 1670 Statham Model AS1-200-350. The accelerometer used in the longitudinal direction (A-2) of Fig. 1 was Serial No. 620 Statham Model AS1-200-350.

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Procedure

The unit was instrumented with a longitudinal accelerometer (A-2) and a vertical accelerometer (A-1) mounted on a block which was mounted on the forward nose cap of the hydroballistic shape as shown in Figure 1.

The metalized Tatnall strain gages were mounted on the two lower fins perpendicular to the fin mounting brackets about midway between the forward and aft ends of the fin mounting bracket as shown in Figure 1. The Hathaway dummy bridge junction boxes were mounted on the same nose cap face as the accelerometers. The accelerometer and strain gages were sealed by wax to prevent shorting by the water.

The first drop unit was mounted on the 300' Tower with the unit hanging on the static boom by means of a ½" cable through a shackle on the boom and the harness attached to the unit. The unit was oriented tail low at an angle of (-12½°) with respect to the longitudinal axis of the unit.

The guillotine cutters were installed on the forward and aft harness cables to cut the unit loose. Another guillotine cutter was installed on the wire holding the instrument cables to the boom. These cutters were initiated with a pulse which fired a squib and cut the appropriate cables to release the unit and instrument cables for free fall. The unit without the plastic nose was then raised over the water tank to a height of 50.5' above the water. With timed pulses from the control building the unit was released and cameras started prior to the impact of the hydroballistic shape in the water tank.

No record was obtained on this drop because the waxed connections did not prevent water from entering to the gage connections and shorting out the signals. This unit was not sealed and filled completely with water around the accelerometers and Hathaway junction boxes. The calibrates on the strain gages were too low and traces went off the paper.

Two more drops were made on this unit with a drop height of 50.5'. The instrumentation water proofing was redone and 100' extension cables to the trailing cables junction were used so these connectors did not fall in the water. The results were much better. The second drop was hung at a release angle of -20°. The plastic nose cap was used in this and the next two drops. The procedure for hanging was the same as Drop #1 except as previously stated.

The third test was also made from 50.5 ft. The unit in this case was released with the unit hanging horizontal. The upper left fin and lower left fin #2 (Fig. 1) were exchanged for this drop because the strain gaged fin #2 had been bent up about 3° during Drop #2. The new fin was strain gaged for this drop in the same way as previously stated.

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For the fourth and final test, the test unit was attached to the boom as previously stated only it was hung at an angle of 37.5° tail down. The unit this time was dropped from a height of 172.3'. Two new fins were strain gaged and marked as on previous drops.

Results

The results of Drop #2 with an impact velocity of 57 ft/sec. gave a vertical acceleration of 70.4g maximum faired pulse. The longitudinal maximum faired pulse was 8.7g. The maximum strain was 6493 micro inches/inch. on Fin #3. The unit impacted nose down at an angle of about 25° to the water. This showed the air pressure on the fins from a drop height of 30.5 ft. caused the unit to pitch about 45° from a release angle of (-20°) tail down to a positive angle of 25° nose down at impact. The plastic nose did not come off, but bent its supporting bolt only slightly. The gage on Fin #2 did not register on this drop because the fin was bent about 5° after the drop and broke the strain gage circuit.

The results of Drop #3 with an impact velocity of 57 ft/sec. gave a vertical maximum faired pulse of 52.6g and a longitudinal faired pulse of 7.8g. The maximum strain on Fin #2 was 5504 micro inches/inch and a permanent set of 3011 micro inches/inch. The other peak accelerations and strains for this drop and the other drops can be found in Table I. This unit pitched forward about 25° also. The plastic nose did not break off on this drop. Figure 3 shows a typical record of Drop #3.

The results of Drop #4 with an impact velocity of 105 ft/sec gave a maximum faired vertical pulse of 10g and a maximum faired longitudinal pulse of 31.1g. The maximum strain on Fin #3 was 3748 micro inches/inch in tension and a permanent set of 4797 micro inches/inch. The unit pitched forward about 65° during a free fall of 172 ft. The plastic nose sheared off during this test. The bolt holding the plastic nose to the unit was sheared off upon impact. The films showed that the cavity formed by the nose was satisfactory on the impacts of all tests.

Conclusions and Recommendations

The results of these tests showed the fin loading to be large enough to cause permanent set in the fins for both the 57 ft/sec vertical velocity and 105 ft/sec vertical velocity. The consultant said these conditions were expected with the present aluminum fins. If this fin bending is harmful to the weapons trajectory in water and orientation at time of detonation under water, then a more rigid fin should be tried and tested.

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The plastic nose did not come off at 57 ft/sec as was first anticipated. Possibly further tests could be run with changes in the nose construction to improve the chances of clean nose separation upon water impact.

J. H. Stoever

J. H. STOEVER - 7323-3

7321 Project Engineer: DULIN WESTFALL - 7321-5

Approved by: R. S. HOOPER - 7321-5

JHS:7323-3:ms

Enc: Figs. 1-3

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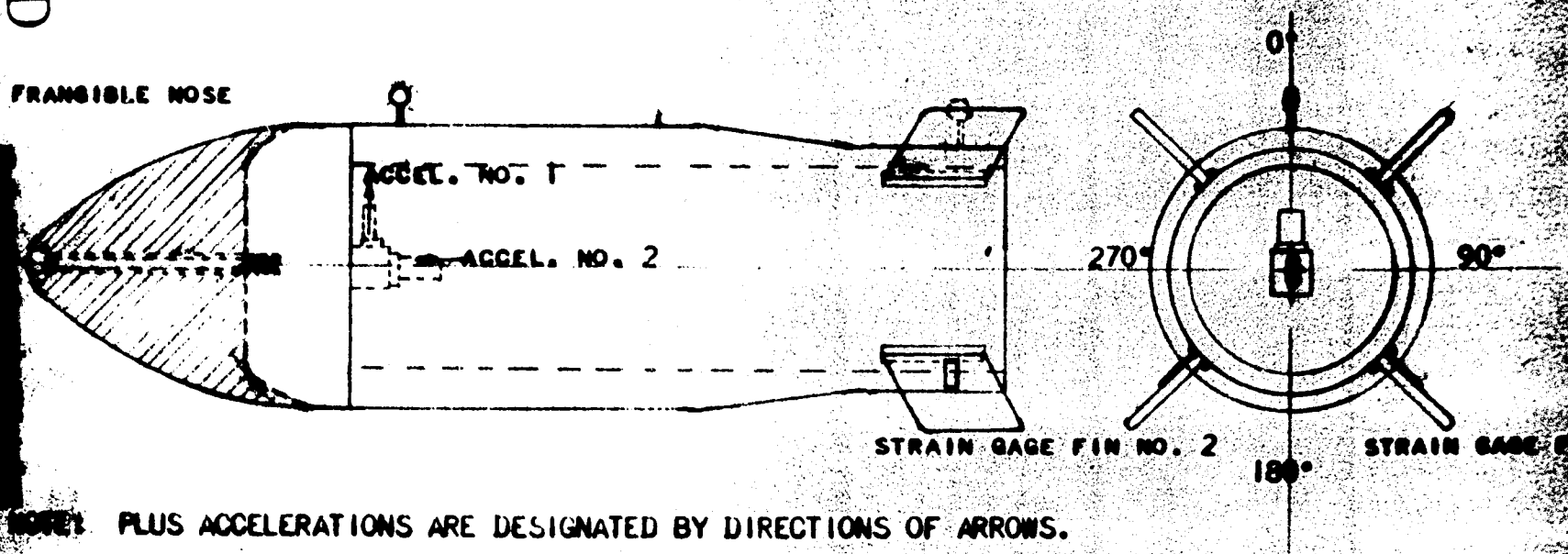

NOTE: PLUS ACCELERATIONS ARE DESIGNATED BY DIRECTIONS OF ARROWS.

FIGURE 1 - DIAGRAM SHOWING THE INSTRUMENTATION AND FRANGIBLE NOSE ON THE HYDROBALLISTIC SHAPE — TOWER TEST OF A HYDROBALLISTIC SHAPE

PROJECT NO. T-1

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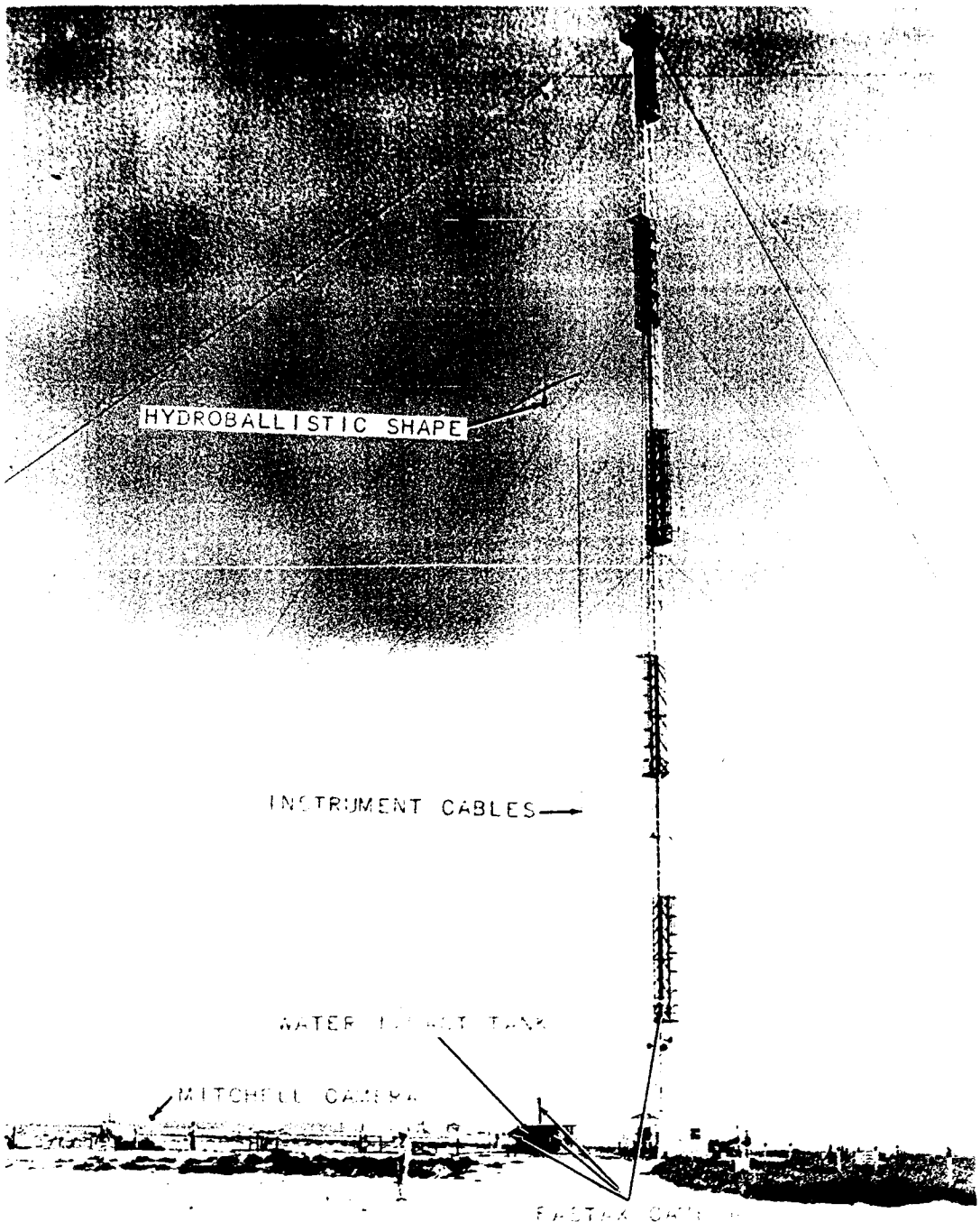

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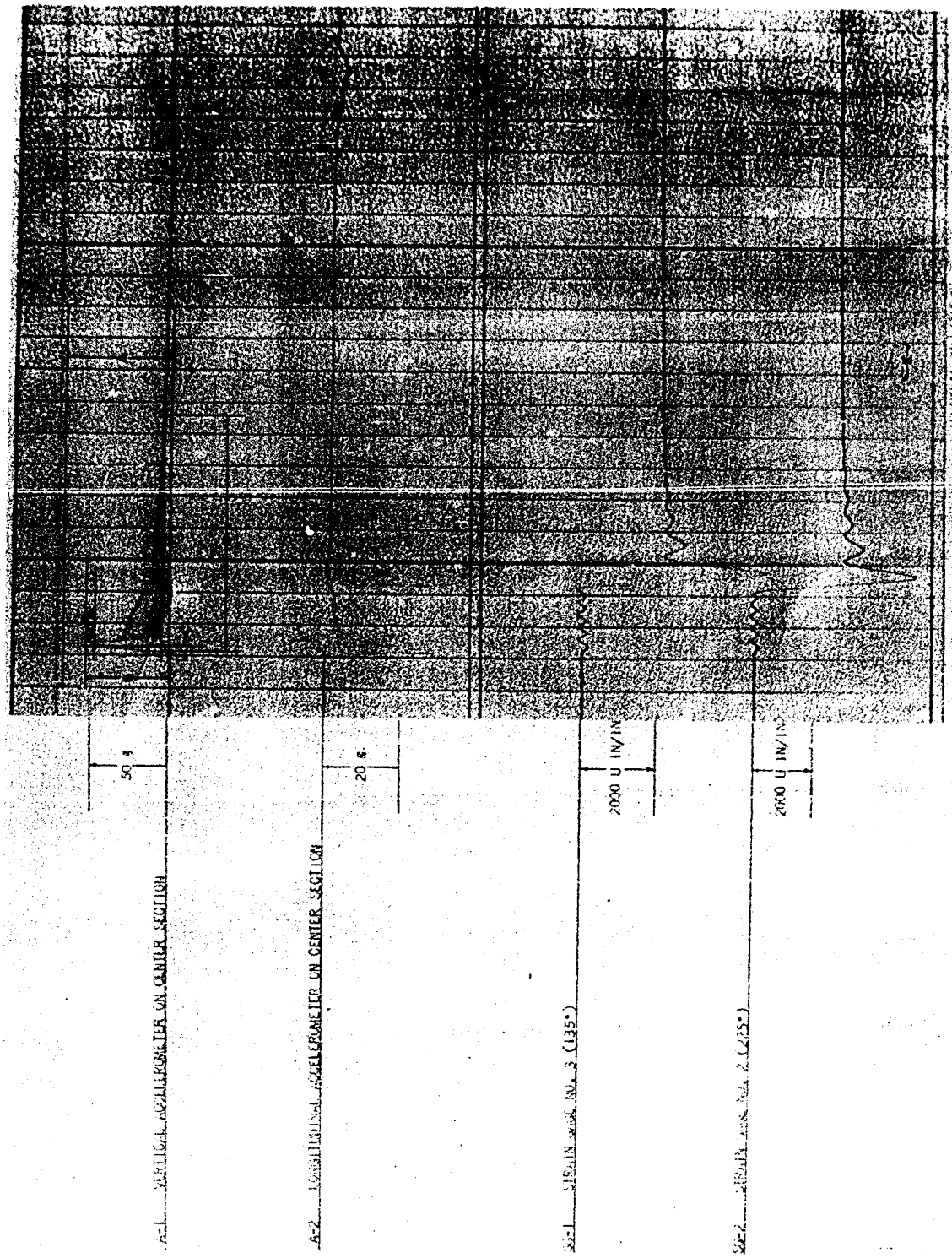

FIGURE 3 - TYPICAL RECORDS OF A HYDROBALLISTIC DROP TOWER TEST, DROP NO. 3, V_v = 57 FT/SEC -- DROP TOWER TEST OF A HYDROBALLISTIC SHAPE

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