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WOODS HOLE OCEANOGRAPHIC INSTITUTION

TECHNICAL MEMORANDUM #DS-21

LONG TERM EXPOSURE AND CYCLING TESTS OF
SYNTACTIC FOAM BUOYANCY MATERIAL USED IN
DSRV ALVIN

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WOODS HOLE, MASSACHUSETTS

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by

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TABLE OF CONTENTS

Equipment	Page 1
Test Procedure	2
Recovery Effect	3
Accelerated Drying	4
Protective Coatings	4
Discussion	5
Conclusion	7
References	9
Data	12 thru 21

LIST OF FIGURES

	Page
Pressure Test Equipment	10
Density Weighing Setup	11
Absorption and Density Table	12
Logarithmic Plot of Absorption	13
Accumulative Absorption	14
Plot of Absorption, High, Low, Avg. Samples	15
Absorption by Packages	16
Sample Locations in Vehicle	17
H ₂ O Weight Loss Due to Drying	18
Plot of Absorption and Drying	19
Drying after Litton Tests	20
Protective Coatings	21

These tests were conducted to determine the long-term water absorption characteristic of ALVIN's syntactic buoyancy material when subjected to repeated hydrostatic loading equal to ALVIN's design depth of 6000 feet. The 24 samples tested were removed from each section of the current buoyancy packages and represents the best material of 120 samples, as determined by previous short term tests reported in Ref.1. Two samples of material poured by WHOI at Otis AFB during the major overhaul of the winter of 1964-65, and a sample of XP-241-40 (3 MCo.) are included in this report.

Equipment.

One of the two hydrostatic test chambers at WHOI was cleaned, repaired, and a new vent plug designed and installed. The plumbing was modified so the chamber could be isolated, while under pressure, and thus free the pumping system to the high pressure manifold and second chamber for use by others.
(Page 10).

The samples were weighed on a Eberbach balance with 1/10 gram divisions on the beam and were read to 1/100 gram.

Densities were obtained by weighing the material in distilled water. A container, heavy enough to sink the sample, was suspended from the pan of an Ohaus triple beam balance.
(Page 11). Weights are recorded to the nearest 1/10 gram and densities were calculated as follows:

$$D = \frac{W}{W_1 - W_2 + W}$$

where

D = density in grams/cc

W = dry weight in grams

W_1 = weight of container in H_2O

W_2 = weight of container and sample in H_2O

and

$$D \times 62.43 = \text{lbs/ft}^3.$$

As a check of the procedure, two separate measurements were made of all samples and the results deviated a maximum of .1 lb/ft³ but in most cases deviated .05 lbs/ft³ or less. This method of measurement was used, as the random shapes of the samples made

accurate linear measurements impossible. The method is correct but the apparatus crude. Initial densities were calculated from the dry weight and final densities calculated from damp weight at end of pressurization tests, which might account for disagreement in % Δ Densities and % Δ Weights. Change in dimensions might also cause disagreement. Sample XP-241-40 (3 MCo.) where density was obtained by linear measurement,

$\frac{WT. (gms) \times 3.81}{Vol (in^3)}$

, volume did not change and the % Δ Wt. and % Δ Density are in agreement. Table page 12.

Procedure.

After initial weights and densities were recorded, the samples were placed in a wire cage inside the pressure vessel which was filled with tap water and pressurized to 2750 lbs/in² (approx. 6200 ft. sea water). At the end of alternate 8 and 16 hour intervals the pressure was released to atmospheric and immediately repressurized to 2750 ± 25 lbs/in².

After each 96 hours and 8 cycles the samples were removed for weighing. The samples were kept submerged in a bucket of water, removed at random, lightly dried with a cloth towel, weighed, and placed in a second bucket of water to prevent overdrying. This procedure was repeated for 3 weighings and the results averaged. The maximum deviation was .05 grams and averaged .02 grams. The per cent weight gain was calculated for elapsed time using the initial dry weights as the base. The samples were kept submerged in water over the weekend (72 hours) and then repressurized and cycled.

After the 7th week or 56 cycles and 672 hours, 4 weekly weighings were omitted while the investigator was at sea. The weekly cycling was, however, continued by others. The last 2 cycles of 6 and 16 hours were added to insure weighing directly after pressurization. This brought the total elapsed time to 1030 hours and 86 cycles. Ref.4.

Results.

The Litton-poured material, used in the test, showed an average gain in weight, due to water absorption, of 1.6% for an elapsed time of 1030 hours and 86 cycles, representing alternate dives of 8 and 16 hours duration at 6200 feet. A

projected log-arithmetic plot of these results shows the tested material, as a whole, has an expected mean life of 5000 hours for 4% water absorption; and would probably not absorb water in excess of 10% of 10,000 hours. The equation of the curve of the results shown on page 13 is:

$W = 0.0276T^{0.583}$, where W = % water absorbed by weight and T = hours of exposure at 2750 psi. This equation is applicable only to the best material poured by Litton. The results of the short term test reported in reference 1, indicate that there are some sections of material to which the above equation would definitely not apply.

Sample No.50-53C-1 (aft. sec. large buoyancy pkg.) showed the greatest gain in absorption, being 4.8% for the test period.

The material poured at Otis (formulation unknown) proved to be of inferior quality. Indeed, sample No.2 had sunk after 1030 hours, having gained 91.9% water weight.

The XP-241-40 (3 MCo.) material was tested for 70 cycles, 838 hours, and showed an increase in weight of 0.91%. Data, pages 14 thru 17.

Recovery Effect.

After the 1030 hour weighing, the samples were kept submerged in water at 1 atm. for 145 hours and reweighed. The Litton and 3 MCo. material showed no significant change in weight. The Otis #2 which sank to the bottom of the bucket had risen to the surface after 24 hours and had lost 2.6% of the final weight at that time. The samples were then removed from the water and allowed to dry in an atmosphere of approximately 70° F and varying (Relative) humidity (20% - 70%). The % loss of absorbed water weight is calculated using initial dry weight and is tabulated on page 18. Graph page 19.

A further check on the recovery was made using the Litton initial dry wts. and WHOI initial dry wts. Ref.3. The samples tested at Litton had been subjected to pressure for 56 hours. The WHOI weighings were made 7 months later, and showed an average loss of water weight of 0.1%. See page 20.

The recovery effect noted above is an encouraging finding and differs from the previous Litton experience. It appears

doubtful that this effect can be practically utilized to any great extent.

Accelerated Drying.

Samples 3-4B, 11-16B1, 44-84C, and 50-53C-1, were placed in an oven at 95° C (203°F) for 48 hours after 718 hours at ambient temp. A plot of each sample shows a leveling off of drying at ambient temp. and a sudden drop of weight due to accelerated drying. Samples 11-16B1 and 44-48C weighed less than their initial weight after 48 hours. A simple oven, properly vented, could dry out the various buoyancy packages during a major overhaul; provided the coating were stripped off.

Protective Coating.

After ALVIN's dive No.92 to 7500 feet, blisters appeared in the rubber compound coating (Thiotuck) which covers the after buoyancy package. This coating is of a thick and viscous nature and is difficult to apply without bubbles and pinholes. In view of these facts, several types of coatings were applied to similar size blocks of Otis #2 foam. The coatings tested were:

- "Tygon" series K plastic paint K-83 (U.S. Stoneware)
- "Dem-kote" Red insulating enamel No.2 x 727 (Dayton Electric Mfg. Co.)
- "Glyptal" 7815 Black Enamel (General Electric Company)

These materials were at hand and appeared tough, flexible, and applicable by brush or spray gun.

Samples No.22-25C and No.51-53C-1 (Litton material) were covered with "Tygon" and samples 3-4B and 5-10C-2, uncoated were also tested.

The samples were subjected to a pressure of 2750 lbs/in² for 96 hours and 8 cycles and the results are tabulated on Page 21.

The uncoated Litton material absorbed water more rapidly than during the first 96 hour test and may be due to breakdown of the outer portion of the samples after the 1030 hour pressure test. The coated Litton samples showed less absorption in one case (22-25C) and more in the other (51-53C-1), which had absorbed the greatest amount of water of all samples in the 1030 hour test. No.22-25C coating had the same appearance as

before pressurization, whereas No.51-53C-1 showed small indentations similar to the surface of the material before coating. Tygon coating appears to offer protection if the material is of good quality.

The Otis poured material seems to be better protected with "Glyptal", or "Dem-kote" and "Glyptal" than with "Tygon" or straight "Dem-kote". However the Otis material is of such poor and erratic quality that the test cannot be considered conclusive.

Discussion.

The original objective of the test procedure was to determine whether the buoyancy material used in ALVIN has a mean life of 5000 hours (θ_0). Since there are 4887 pounds of syntactic foam installed in ALVIN, failure is defined as absorption of 4% by weight of water, representing a loss of buoyancy in ALVIN of approximately 200 pounds. Unacceptable mean life is defined as 1000 hours (θ_1), representing 200 dives of ALVIN to 6000 ft. depth for 5 hours duration. The probability of rejecting material with mean life of 5000 hours was taken as 0.10; and the probability of accepting material with a mean life of 1000 hours was also taken as 0.10. Based upon the above values, from table 2A-1 of Ref.5 Sample Plan C-3 is used and the rejection number (r), or acceptable number of failures, is 3. The sample size was taken as 24 (8r), in order to test at least one sample from all 17 blocks of the material in ALVIN. Using the above values, from Table 2C-1(c) of Ref.5 the value of T/θ_0 is 0.048; or the test termination time is: $T = 0.048 \theta_0 = 0.048(5000) = 240$ hours. The foregoing indicates that, with a sample size of 24, there is only 10% probability of accepting material with a mean life of 1000 hours, if, after 240 hours of test, no more than three samples have absorbed 4% or more of water. Similarly there is only 10% probability that material with mean life of 5000 hours would contain 3 samples which would fail by 240 hours. Note that the test results shown on page 15 do not show 3 samples having exceeded 4% by 288 hours; therefore, by life-testing theory, a mean life of 5000 hours could be predicted with 90% confidence.

In view of the fact that, some reports on syntactic foam indicated that some formulations exhibited normal, slow-water-absorption up to 500 hours, then absorbed water at an accelerated rate, it was decided that a 1000 hour test time should be used.

It is interesting to note however, that the predicted mean life (considering that 4% water absorption is failure) as shown by the projected test results on the graph of page 14 is 5000 hours. The 5000 hour mean life could have been safely predicted by terminating the test at 240 hours, except for the concern over the anomalous behavior of some syntactic foam formulations.

The 24 samples tested, as previously noted, were the "best" of 120 samples cored from the various blocks of buoyancy material in ALVIN. The term "best" refers to the fact that the samples selected all exhibited low water absorption in the short term test reported in Ref.1. Selection of these "best" samples was based upon the following factors:

- a. Investigators at Applied Science Division of Litton had noted that there was little drying effect of syntactic foam, after water absorption at high pressure. Ref.2.
- b. 79% of the samples, as reported in Ref.1, had absorbed less than 1% water after four immersions at 2750 psi, totalling 48 hours exposure.
- c. There are 17 blocks of buoyancy material represented by the 120 samples. From these it was desired to obtain a sample size of 20-25 for the life testing, in order that at least one sample would be taken from those representing each block.
- d. It was desired to learn the characteristic way in which the material absorbs water under pressure vs. time; therefore it was desirable to start the life test with material samples which were as nearly as possible in the same state. In view of a. above, it could not be assumed that the 120 samples would be equally dried out; and in view of b. above, it seemed reasonable to assume that samples that had previously absorbed less than 1% water represented the majority of the material in ALVIN. Since the 120 samples were basically random selections from the blocks, then the 24 samples were still random selections.
- e. All the samples were uncoated, and all investigations to date showed that an intact coating will reduce water absorption of syntactic foams. Since the buoyancy material in ALVIN is all coated, it was assumed that

the life test results would be pessimistic in predicting actual life of the material in ALVIN.

- f. The material in ALVIN is cast in large blocks having small surface/volume ratios, whereas the small samples have large surface/volume ratios. Since water absorption is proportional to the surface/volume ratio, life test of the samples would again be pessimistic in predicting actual life of the material in ALVIN.
- g. The maintenance program for ALVIN includes an annual weighing of the buoyancy material to check on the water absorption of the various blocks. If the left test were grossly in error as to the predicted life of the material of an individual block, this error would be found and the material replaced.
- h. Considering all the above factors, it was considered desirable and reasonable to select from the 120 samples 24 samples whose % water absorption in the previous short-term test was low and as nearly equal as possible.

Conclusion.

The results of these tests indicate that the buoyancy material poured by Litton and used in ALVIN is adequate for this particular vehicle for a mean life of 5000 hours even though coating failures occur. It must be borne in mind however, that the material tested was the best of the current buoyancy packages. Ref.1 Based upon the current test results and those of Ref.1, it appears advisable to maintain a close check on the weight of specified sections of material in ALVIN; namely the blocks housing the 6061 spheres and the after section of the Large Buoyancy Package. If the coatings of these sections remain intact, there should be no absorption of water; however a gain in weight of a section is a good indication that the coating has failed.

The material poured at Otis, and used for small patch work, is worthless as buoyancy material for deep submergence, and should be removed at the first opportunity.

The XP-241-40 (3 MCo.) Test Time 838 hours, 70 cycles, looks attractive as to water absorption, Density, and recovery.

The possible additional loss of buoyancy while actually under pressure should be investigated, especially after several hundred hours exposure.

The accelerated drying, though interesting does not appear practical unless a coating failure were to occur, of such magnitude as to require stripping off all coating of a package. The different coatings tried after the endurance test show some promise; however the tests were generally inconclusive for long-term cyclic exposure.

References

1. ALVIN Buoyancy Material Test Report of Vehicle
Core Samples. November 17, 1964.
2. ALVIN Buoyancy Material Test Report
August 28, 1964.

By: Applied Science Division, Litton Systems, Inc.

H. Froehlich, E. Klemp, R. Meinhardt.
3. Correspondence to W. S. Shultz from R. C. Meinhardt
September 20, 1965.
4. Test Instructions of F. P. Omohundro

December 1964.
5. DOD Handbook H108 - Sampling Procedures and Tables

For Life and Reliability Testing - 29 April 1960.

16 INCH PRESSURE VESSEL
ISOLATED FOR LONG DURATION
TEST OF ALVIN
BUOYANCY SAMPLES

DENSITY WEIGHING RIG

- ① DISTILLED WATER
- ② AL. CAN
- ③ SAMPLE
- ④ TRIPLE BEAM BALANCE
- ⑤ STAND
- ⑥ Pb. WEIGHT

Sample No.	Weight Initial grams	Weight Final grams	% Δ W	Density Initial lbs/ft. ³	Density Final lbs/ft. ³
1-2B	86.33	87.95	1.88	42.140	42.952
3-4B	89.69	91.19	1.67	42.390	43.077
5-10B	89.83	90.70	.97	39.393	39.768
5-10D-2	89.72	91.55	2.04	39.393	40.142
11-16B-1	54.14	54.74	1.11	40.829	41.266
18A	90.20	91.56	1.51	39.705	40.205
19.21C	81.82	82/87	1.28	41.454	41.891
22-25C	90.29	91.72	1.58	41.391	41.953
26-28D	89.96	91.22	1.40	45.636	46.198
26-28F	89.95	91.20	1.39	45.012	45.511
29-31D-1	85.49	86.69	1.40	45.699	46.261
29-31F	87.11	88.27	1.33	45.012	45.511
32-35D-2	90.21	91.50	1.43	46.323	46.823
32-35H	89.93	91.02	1.21	43.014	43.514
36-38E	89.23	90.23	1.12	40.641	40.954
36.38G-1	88.51	89.57	1.20	43.077	43.326
39-41A	66.53	67.63	1.65	45.324	45.701
42-43C	86.62	87.76	1.32	44.887	45.324
44-48C	23.16	23.70	2.33	45.137	45.636
44-48I	55.78	56.55	1.38	44.575	44.950
44-49BB	64.02	65.00	1.53	44.700	45.137
44-49FF	61.00	61.80	1.31	43.451	43.888
50-53C-1	83.17	87.22	4.87	40.704	42.577
50-53E-2	85-48	87.08	1.87	47.322	48.009
AVG.			1.62		
*XP-241-40	9.89	9.98	.91	42.576	42.965
Otis #1	58.74	97.33	65.70	33.462	54.689
Otis #2	83.17	159.60	91.90	33.962	Sunk

1030 Hours 84 cycles

*838 Hours 70 cycles

CYCLES	8	16	24	32	40	48	56	86	INITIAL	FINAL
HOURS	96	192	288	384	480	576	672	1030	Wt. (W ₁)	Wt. (W ₉)
SAMPLE									GRAMS	GRAMS
1-2B	.60	.83	.87	1.04	1.17	1.29	1.45	1.88	86.33	87.95
3-4B	.48	.72	.80	.98	1.09	1.19	1.33	1.67	89.69	91.19
5-10B	.33	.42	.49	.57	.67	.71	.78	.97	89.83	90.70
5-10D-2	.46	.63	.76	.90	1.00	1.14	1.33	2.04	89.72	91.55
11-16B-1	.41	.53	.54	.68	.74	.85	.89	1.11	54.14	54.74
18A	.42	.69	.80	.86	1.00	1.08	1.19	1.51	90.20	91.56
19-21C	.44	.62	.65	.75	.87	.94	1.00	1.28	81.82	82.87
22-25C	.49	.72	.78	.92	1.06	1.13	1.24	1.58	90.29	91.72
26-28D	.29	.52	.60	.73	.89	.99	1.08	1.40	89.96	91.22
26-28F	.31	.52	.63	.73	.89	.98	1.06	1.39	89.95	91.20
29-31D-1	.27	.49	.61	.71	.84	.95	1.08	1.40	85.49	86.69
29-31F	.28	.53	.48	.69	.79	.90	1.00	1.33	87.11	88.27
32-35D-2	.24	.51	.65	.76	.88	.96	1.09	1.43	90.21	91.50
32-35-H	.31	.52	.54	.67	.77	.86	.95	1.21	89.93	91.02
36-38E	.30	.50	.55	.65	.75	.80	.87	1.12	89.23	90.23
36-38G-1	.31	.51	.54	.67	.78	.81	.92	1.20	88.51	89.57
39-41A	.42	.70	.81	.92	1.11	1.16	1.61	1.65	66.53	67.63
42-43C	.34	.56	.65	.77	.89	.96	1.05	1.32	86.62	87.76
44-48C	.60	.86	1.04	1.25	1.47	1.60	1.73	2.33	23.16	23.70
44-48I	.27	.56	.61	.77	.93	.99	1.02	1.38	55.78	56.55
44-49BB	.31	.56	.69	.87	.95	1.06	1.19	1.53	64.02	65.00
44-49FF	.28	.49	.52	.82	.82	.85	1.00	1.31	61.00	61.80
50-53C-1	.87	1.41	1.70	2.04	2.40	2.72	3.14	4.87	83.17	87.22
50-53E-2	.45	.74	.85	1.03	1.18	1.30	1.43	1.87	85.48	87.08
AVERAGE	.4	.6	.72	.86	1.00	1.09	1.23	1.62		

WATER ABSORPTION - % WEIGHT GAIN (ACCUMULATIVE)
INITIAL WT. AS BASE

AVERAGE WATER ABSORPTION(%Wt.Gain) by Packages After 1030 hours

Sample No.	% Δ W	% Δ W Avg.	Package(s)
1-2B	1.88		Internal Block, housing Spheres and Small buoyancy pks. P & S
3-4B	1.67		
19-21C	1.28		
22-25C	1.58		
39-41A	1.65		*Rubber Covered
42-43C	1.32	<u>1.56</u>	
44-48C	2.33		Large Buoyancy Pkg.
44.48I	1.38		
44-49BB	1.53		
44-49FF	1.31		*Rubber Covered
50-53C-1	4.87		
50-53E-2	1.87	<u>2.22</u>	
5-10B	.97		External Block Forebody
5-10D-2	2.04		
11-16B-1	1.11	<u>1.37</u>	
			*Epoxy Covered
26-28D	1.40		Lower Forebody
26.28F	1.39		
29-31D-1	1.40		
29.31F	1.33		*Epoxy Covered
32-35D-2	1.43		
32-35H	1.21		
36-38E	1.12		
36-38G-1	1.20	<u>1.31</u>	

*As Installed in Vehicle
Test Samples Not Covered.

Sample Identification	Pour Location in Vehicle
1-2B	Port Lower, Internal Block Housing Spheres
3-4B	Stbd. Lower, Internal Block Housing Spheres
5-10B	External Block, Port Forebody
5-10D-2	External Block, Port Forebody
11-16B-1	External Block, Stbd. Forebody
18-A	External Afterbody, Port
19-21C	Stbd. Upper, Internal Block Housing Spheres
22-25C	Port Upper, Internal Block Housing Spheres
26-28D	Port Fwd., Lower Forebody
26-28F	Port Fwd., Lower Forebody
29-31D-1	Stbd. Fwd., Lower Forebody
29-31F	Stbd. Fwd., Lower Forebody
32-35D-2	Port Aft., Lower Forebody
32-35H	Port Aft., Lower Forebody
36-38E	Stbd. Aft., Lower Forebody
36-38G-1	Stbd. Aft., Lower Forebody
39-41A	Small Buoyancy Pkg., Port Side
42-43C	Small Buoyancy Pkg., Stbd. Side
44-48C	Fwd. Sec., Large Buoyancy Pkg.
44-48I	Fwd. Sec., Large Buoyancy Pkg.
44-49BB	Ctr. Sec., Large Buoyancy Pkg.
44-49FF	Ctr. Sec., Large Buoyancy Pkg.
50-53C-1	Aft. Sec., Large Buoyancy Pkg.
50-53E-2	Aft. Sec., Large Buoyancy Pkg.
#1	Poured at Otis
#2	Poured at Otis

RELATIVE HUMIDITY	70	70	70	70	70	70	70	36	20	24	42	48	32
HOURS	6	22	46	70	70	94	166	+72	+72	+96	+76	+98	671
SAMPLE NO	+16	+24	+24	+24	+24	+24	+72	+72	+72	+96	+76	+98	+163
1-2B	1.59	1.48	1.36	1.28	1.23	1.05	.87	.75	.66	.58	.52	.45	.17
3-4B	1.44	1.37	1.24	1.18	1.13	.98	.87	.75	.66	.58	.52	.45	.17
5-10B	.66	.61	.52	.48	.46	.37	.24	.21	.19	.17	.17	.17	.52
5-10D-2	1.66	1.57	1.45	1.40	1.34	1.19	.97	.85	.73	.64	.52	.18	.23
11-16B-1	.79	.66	.59	.52	.50	.39	.30	.26	.20	.18	.18	.23	.34
18A	1.18	1.08	.93	.88	.80	.64	.45	.33	.31	.24	.23	.34	.45
19-21C	1.05	.95	.84	.81	.77	.62	.51	.44	.37	.35	.34	.45	.37
22-25C	1.30	1.23	1.12	1.07	1.02	.82	.74	.64	.57	.54	.45	.37	.38
26-28D	1.21	1.17	1.09	1.04	1.02	.83	.69	.59	.49	.42	.38	.39	.32
26-28F	1.21	1.17	1.09	1.04	1.00	.86	.70	.60	.50	.43	.38	.39	.42
29-31D-1	1.23	1.18	1.09	1.04	.98	.83	.67	.58	.49	.46	.38	.32	.26
29-31F	1.16	1.10	1.01	.95	.93	.79	.63	.53	.42	.38	.32	.26	.18
32-35D-2	1.32	1.24	1.16	1.10	1.06	.89	.73	.61	.52	.45	.42	.36	.23
32-35H	1.01	.97	.86	.82	.78	.63	.47	.41	.32	.30	.26	.18	.23
36-38E	.85	.79	.70	.65	.63	.50	.36	.27	.19	.18	.18	.23	.32
36-38G-1	.92	.90	.79	.77	.76	.61	.46	.36	.24	.24	.23	.32	.25
39-41A	1.41	1.29	1.16	1.08	1.04	.84	.68	.56	.41	.35	.32	.25	.30
42-43C	1.10	1.04	.95	.87	.84	.68	.55	.44	.32	.30	.25	.28	.18
44-48C	1.90	1.73	1.43	1.34	1.25	1.05	.69	.60	.47	.30	.30	.25	.28
44-48I	1.22	1.11	1.00	.93	.88	.75	.57	.48	.40	.25	.25	.28	.18
44-49BB	1.26	1.22	1.06	1.02	.98	.83	.61	.55	.39	.23	.23	.36	.49
44-49FF	1.05	.98	.85	.80	.77	.62	.49	.34	.25	.23	.18	.28	.41
50-53C-1	4.47	4.33	4.11	4.00	3.92	3.62	3.29	3.07	2.80	2.66	2.36	.56	.41
50-53E-2	1.62	1.53	1.42	1.33	1.29	1.08	.89	.81	.62	.56	.49	.41	.26
AVG.	1.36	1.27	1.16	1.10	1.06	.89	.73	.62	.52	.46	.41	.26	.18

WEIGHT LOSS DUE TO DRYING IN % - W₁ BASE

Sample	LITTON		WHOI	Gain	%	LITTON	Gain %	%	WT.
	INITIAL	WT.							
Sample	WT.	WT.	7 mos.	Gain	56 Hrs.	7 mos drying	LOSS		
1-2B	86.18	86.33	.15	.17	.44	.27			
3-4B	89.52	89.69	.17	.19	.36	.17			
5-10B	89.65	89.83	.18	.20	.27	.07			
5-10D-1	89.52	89.72	.20	.22	.40	.18			
11-16B-1	53.99	54.14	.15	.28	.34	.06			
18A	89.95	90.20	.25	.28	.35	.07			
19-21C	81.64	81.82	.18	.22	.34	.12			
22-25C	90.07	90.29	.22	.24	.37	.13			
26-28D	89.79	89.96	.17	.18	.26	.08			
26-28F	89.81	89.95	.14	.16	.21	.05			
29-31D-1	85.34	85.49	.15	.18	.22	.04			
29-31F	87.00	87.11	.11	.13	.21	.09			
32-35D-2	90.75	90.21			.21				
32-35H	89.76	89.93	.17	.19	.16				
36-38E	89.06	89.23	.17	.19	.23	.04			
36-38G-1	88.37	88.51	.14	.16	.20	.04			
39-41A	66.43	66.53	.10	.15	.32	.17			
42-43C	86.44	86.62	.22	.25	.22	.02			
44-48C	23.10	23.16	.06	.26	.45	.19			
44-48I	55.67	55.78	.11	.20	.23	.03			
44-49BB	63.89	64.02	.13	.20	.27	.07			
44-49FF	60.90	61.00	.10	.16	.22	.06			
50-53C-1	82.85	83.17	.32	.39	.67	.28			
50-53E-2	85.26	85.48	.22	.26	.36	.10			
AVE.				.21	.31	.106			

DRYING EFFECT AFTER LITTON TESTS
(November 1964 - June 1965)

Protective Coating Data

Otis poured material:

<u>Sample No.</u>	<u>Coating</u>	
Otis		
3	None	
5	None	
0	Tygon	4 coats (brush)
1	Dem-kote	4 coats (spray)
2	Glyptal	4 coats (brush)
4	Demi-kote & Glyptal	4 alternate coats

Litton Material:

3-4B & 5-100-2 uncoated

22-25C & 51-53C-1 Glyptal 4 coats (brush)

<u>Sample No.</u>	<u>Gain % W</u>	<u>Previous gain</u> <u>96 hours</u>	<u>Gain % W after drying</u> <u>22 hours at Amb.Temp.</u>
3	7.00		3.28
5	9.42		4.45
0	3.24		3.63
1	4.51		3.06
2	2.76		2.29
4	1.85		1.87
3-4B	.58	.48	.25
5-10D-2	.95	.46	.42
22-25C	.33	.49	.05
51-53C-1	2.29	.87	1.83