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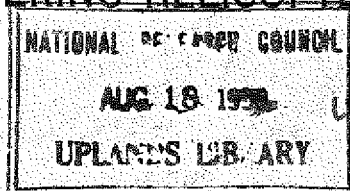
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AERONAUTICAL REPORT

LR - 249

SEA SPRAY SAMPLING TESTS FROM A
HOVERING HELICOPTER



BY

G. A. GIBBARD

DIVISION OF MECHANICAL ENGINEERING

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Ottawa, Canada

REPORT

Division of Mechanical Engineering

Low Temperature Laboratory

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Subject: SEA SPRAY SAMPLING TESTS FROM A HOVERING HELICOPTER

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Approved by: D.C. MacPhail
Director

SUMMARY

Tests were conducted to determine the amount of salt water spray picked up by a helicopter hovering a short distance above the sea. The results show that there is little spray under all operating conditions and, at freezing temperatures, the effect of any resulting icing from the spray should be minor.

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SEA SPRAY SAMPLING TESTS FROM A HOVERING HELICOPTER

1.0 INTRODUCTION

During October and November, 1958, at the request of the Royal Canadian Navy, a study of the sea spray conditions experienced by a hovering helicopter was made off Halifax harbour. The R.C.N. supplied and operated the aircraft while N.R.C. personnel conducted the sea spray measurements.

The tests were made over a range of wind and sea conditions and at various heights above the sea to simulate conditions that would be encountered on anti-submarine helicopter operations.

2.0 PURPOSE OF THE TESTS

The tests were conducted to determine the size and amount of water droplets that would be encountered under sea spray conditions as well as their frequency of occurrence and vertical extent. From these measurements an assessment of the type and amount of ice this spray would produce on the helicopter under freezing conditions could then be made.

3.0 TEST APPARATUS

3.1 Aircraft

The helicopter used for the trials was a Sikorsky HO4S-3 (Fig. 1), Royal Canadian Navy No. 221.

Leading particulars are as follows:

Main rotor,	diameter	53 ft.
	No. of blades	3
Tail rotor,	diameter	8 ft. 9 in.
	No. of blades	2
Fuselage,	width	5 ft. 8 in.
	height	9 ft. 6.7 in.
	length	41 ft. 3 in.

Design gross weight	6859 lb.
Engine, Wright R-1300-3	
Take-off rating	700 b.h.p. at 2400 r.p.m.
Normal rating	700 b.h.p. at 2400 r.p.m.
Engine/main rotor speed ratio	11.3184 to 1.000
Engine/tail drive	1.00 to 1.11

3.2 Droplet Size Measurement

The droplet size was determined by the oiled slide method as described in Reference 1. The slide used is shown in Figure 2 in both its exposed and retracted positions. The microscope and camera mounted in the helicopter (Fig. 4) were the normal apparatus employed in the Low Temperature Laboratory, but the light source was modified. A 150-watt tungsten-filament lamp was used for focussing but an electronic flash was used for the actual photograph to minimize the effects of vibration.

Power was obtained from a 115-volt, 750-wa., 400-c/s inverter on the aircraft.

3.3 Liquid Water Content Measurement

The liquid water content was measured by collecting and weighing a sample of the atmospheric moisture. This was accomplished by exposing an absorbent cylinder (Fig. 2) to the spray for a measured time. The cylinder, which was 1/2 inch in diameter and 2 inches long, was made by building up discs cut from highly absorbent Linters blotting paper. The cylinders were kept in air-tight vials when not in use to prevent any evaporation of the collected spray or absorption of atmospheric moisture.

The determination of the liquid water content (described in Appendix A) also required a knowledge of the droplet size and the air speed over the cylinder.

3.4 Air Speed Measurement

Because both the direction and magnitude of air flow over the sampling cylinders would vary with helicopter weight, wind speed and location beneath the rotor disc, a non-directional

means of air speed measurement was required. To accomplish this three fixed pitots having angular response characteristics similar to the cosine curve $h = H \cos \frac{90}{61} \alpha$ (Fig. 3) were used. To simplify resolution of the resultant air speed and direction from the pitot readings and to avoid negative pressures on the recorder diaphragm, one of the pitots was pointed vertically upwards and the other two inclined forward at 30.5 degrees and 61 degrees (Fig. 2). Only two of the pitots were necessary to resolve the air speed and direction and the third was used as a check. The method of determining the magnitude and direction of the air flow from the pitot readings is shown in Appendix A.

The pressures from the three pitots were recorded by a continuous trace photographic recorder. The helicopter cabin pressure was used as the static pressure and dampers were supplied to compensate for pulsations in the pitot lines.

The calibration of this recorder is given in Reference 2.

3.5 Sampling Boom

To obtain the spray distribution pattern beneath the rotor disc it was intended to take samples at three radial locations, $1/4R$, $1/2R$ and $3/4R$, but because of flexure and vibration problems in the original test boom its over-all length was reduced and samples were taken only at $1/4R$ and $1/2R$.

The sampling head containing the pitots, oiled slide and absorbent cylinders (Fig. 2 and 5) was mounted at the end of the boom which was made of a $2\frac{1}{8}$ -inch diameter aluminum tube, 15 ft. long. The boom was mounted in rollers across the helicopter at the centre line of the rear cabin windows (station 175) (Fig. 1). Sampling was made on the port side of the helicopter but for all positions some portion of the boom projected through the starboard window (Fig. 6 and 7). The samples were removed by fully retracting the boom so that the sampling head was just within the fuselage. For transporting to and from the test site the boom was centralized so that it extended 4 ft. 8 in. on either side of the fuselage.

No structural modifications to the helicopter were necessary to mount the equipment since use was made of the seat clamps and floor bolts exclusively for this purpose.

3.6 Other Equipment

3.6.1 A float and string apparatus was used for height measurements because the helicopter was not equipped with a suitable altimeter. All heights quoted in the results are the distance from the cabin floor to the water surface.

3.6.2 Smoke floats were used as a reference to assist the pilot in keeping the helicopter stationary and headed into the wind.

4.0 TEST PROCEDURE

4.1 Preliminary Tests

A few short preliminary flights were made to check the operating and vibration characteristics of the boom and the recording apparatus and to assess the effect that the equipment and the operators' movements would have on the handling of the helicopter.

4.2 Sampling Tests

Spray sampling tests were carried out whenever suitable conditions existed. Flights were made in wind speeds up to the helicopter's operating limit of about 40 m.p.h.

On the sampling runs, the helicopter was flown from the base to a suitable location a few miles out to sea. A smoke float was dropped and the pilot hovered the helicopter into the wind at 10 ft. above the sea. Droplet samples were taken and photographed, and absorbent cylinders were exposed for measured times at both 1/2R and 1/4R positions. Air speed measurements from the pitots were made whenever the absorbent cylinders were exposed. This procedure was then repeated at 10-ft. intervals higher until no more spray was encountered.

The wind speed was taken as issued by the meteorological office on take-off and landing, and checked by the aircraft indicator.

The Beaufort sea state was purely a visual estimate based on the observations of the pilots and operators.

After each flight the absorbent cylinders were weighed to determine the amount of water picked up, and the droplet photographs and pressure recorder traces were developed for later analysis.

5.0 RESULTS OF TESTS

5.1 Preliminary Performance Tests

Before the test flights the all-up weight of the aircraft was found to be approximately 7400 lb. (including the weights of the helicopter, fuel, sampling equipment, two pilots, and three operators).

During the first few flights the apparatus and technique were thoroughly tested with the following results:

- (1) The sampling boom operated smoothly and was free of vibration at all operating positions.
- (2) Neither the apparatus installed in the cabin nor the movements of the operators during a test had any effect on the handling of the helicopter.
- (3) Pressure dampers were required in the pitot lines to the air speed recorder because of the pulses from the rotor.
- (4) The recorder and microscope operated efficiently and were not greatly affected by vibrations.

5.2 Spray Sampling Runs

The test data of the sampling runs are shown in Table I and the results are summarized along with the test conditions in Table II. The tests were conducted over a range of wind speeds from 5 to 40 m.p.h. and sea states estimated from 1 to 6 on the Beaufort Scale.

Because the amount of spray encountered on all tests was small, the experimental errors could be relatively large, and therefore the numerical results should be used only qualitatively as follows:

- (1) The liquid water content of the sea spray was small under all operating conditions (less than 0.1 gm./m^3).
- (2) Figure 8 shows that the droplet size spectrum was very wide with droplet diameters ranging from ten to several hundred microns. On most runs about 80 percent of the drops were less than 50 microns, but these small drops comprised less than 2 percent

of the liquid water. Most of the total water volume was contained in a few very large drops; thus the droplet median volume diameters were large.

- (3) The intensity of the spray decreased rapidly with increasing height. Figure 9 shows that there was very little spray above 30 ft. for the helicopter used.
- (4) The greatest amount of spray was found with the calmest conditions (winds less than 15 m.p.h., sea state less than 2).

5.3 Specific Gravity of Sea Water

The specific gravity of sea water in the Halifax area as determined by the Naval Research Establishment is between 1.020 and 1.026.

6.0 DISCUSSION

Because of the small amount of spray encountered it was necessary to expose both the absorbent cylinder and the oiled slide for much longer periods than expected (5 to 8 minutes and about 1 minute, respectively). Consequently there was likely some evaporation, particularly of the smaller droplets from the oiled slide. These small droplets were of no importance in the calculations, however, as was shown in Figure 8.

There is little correlation between the noted wind speeds and the wind speeds corresponding to the observed sea state conditions in the Beaufort Scale (Table III). This is because the tests were performed in fairly close proximity to land and usually with off-shore winds, while the Beaufort Scale requires 150 miles of fetch to be applicable.

The tests indicate that there were two sources of spray: natural spray blown from the wave crests by the wind, and spray picked up by the rotor downwash. At low wind speeds, where there was little natural spray, the downwash whipped up the water causing blowing spray extending from about $1/2R$ to $1\ 1/2R$ all around the helicopter. The spray samples under these conditions consisted of a fairly large number of droplets less than 350 microns in diameter. At high wind speeds, however, when the sea was choppy, most of

the downwash tended to expend its energy in calming the sea in a large circle (3 or 4R) around the aircraft which resulted in the production of less induced spray and likely also reduced the amount of natural spray. Samples taken under higher wind speed conditions contained just a few drops ranging up to 700 microns in diameter.

If the sea spray was to be encountered under severe freezing temperatures it would cause icing on the rotors similar to that produced under only light cloud icing conditions with slightly greater extent and more runback due to the larger drops. These ice accretions should not be sufficient to cause appreciable loss of performance except after quite long exposures (probably not less than 1/2 hour).

Because of the low freezing point of salt water (27.5°F) and the large droplets, quite low ambient temperatures would be required for the droplets to freeze completely on the rotors. At only moderate freezing temperatures the large drops would likely be blown off the rotor before they were cooled sufficiently to freeze. Meteorological data show that, except in the extreme north, the minimum January mean temperature over the Atlantic Ocean is about +10°F. Therefore, encounters with extremely low temperatures would likely be rare.

Spray was picked up on the pilot's windshield on most flights below 20 ft. and, under freezing conditions, the resulting ice could impair vision in a fairly short time, particularly on the Sikorsky and other helicopters with relatively small windshield glass areas.

Any ice deposited on the fuselage, exposed controls and linkages, engine air intakes, etc., would again require considerable time for build-up before causing any difficulties.

A helicopter equipped with windshield anti-icing and a rotor de-icing system designed for cloud icing conditions should have no difficulty with ice picked up from sea spray. The ice on the unprotected portions of the helicopter would be very light and would cause little difficulty other than a slight increase in weight.

An unprotected helicopter could avoid most of the spray ice conditions by increasing the hovering height slightly whenever icing was encountered.

If a larger and heavier helicopter were used the intensity and vertical extent of the spray encountered would likely be somewhat greater because of the higher downwash velocity.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Salt water spray picked up by a helicopter hovering a short distance above the sea will be of light intensity, and any resulting icing condition on the rotors and fuselage will be minor except after prolonged exposures. A standard rotor de-icing system should handle the ice with little difficulty.

7.2 Windshield icing is expected to be the major problem and some form of anti-icing system is recommended.

7.3 Unprotected helicopters can avoid most of the icing hazard by hovering slightly higher. For the Sikorsky HO4S-3, 30 or 35 ft. would be sufficient to avoid the severest spray condition.

8.0 REFERENCES

1. Golitzine, N. Method for Measuring the Size of Water Droplets in Clouds, Fogs and Sprays.
NAE Note 6 (ME-177), 1951.
2. Vincelette, G.E. Calibration of Wake Rake Recorder.
NRC Test Report MIT-110, 21 Aug., 1958.
3. Ship Code Card - Meteorological Division, Department of Transport, Canada. Canadian Form No. 2361-1/1-55.
4. Langmuir, I. Blodgett, K.B. A Mathematical Investigation of Water Droplet Trajectories.
U.S. AAF/MC Tech. Rept. 5418, Feb., 1946.

/AM

TABLE I

Table I
LR-249

RESULTS OF SAMPLING TESTS

Flight Number	Boom Position	Absorbent Cylinder Tests				Oiled Slide Tests			Liquid Water Content gm./m ³
		Weight Water Collected gm.	Time Exposed min.	Air flow over sample		No. of drops in sample	max. dia. microns	median volume diameter microns	
				velocity m.p.h.	Angle from Vertical				
A-4	1/4R	.07	4 1/2	33.5	23.5°	-	-	} assumed large	.03
B-1	1/2R	.05	3 1/2	21	80	-	-		.04
B-2	1/4R	.04	4 1/2	22	86	-	-		.025
B-3	1/2R	.04	5	27	62	-	-		.02
B-4	1/4R	.05	5	25	78	-	-		.02
B-5	1/2R	.02	5	27.5	67	-	-		.01
B-6	1/4R	.03	5	25	74	-	-	.01	
C-1	1/2R	.10	5	19	45	207	300	230	.06
C-2	1/4R	.07	5	11	47	33	340	290	.07
C-3	1/2R	.07	5	28	43	103	210	160	.03
C-4	1/4R	.05	7	11.5	53	5	50	50	.05
C-5	1/2R			no droplets					0
C-6	1/4R			no droplets					0
D-1	1/2R	.06	7	27	75	10	120	120	.02
D-2	1/4R	.05	7 1/6	25	50	10	680	680	.02
D-3	1/2R	.03	8 1/3	27.5	69	2	380	380	.01
D-4	1/4R			no droplets					0
D-5	1/2R	.06	6 1/2	32	63	1	240	240	.01
D-6	1/4R			no droplets					0
E-1	1/2R	.07	5 1/2	22	36	498	320	220	.03
E-2	1/4R	.06	5	-	-	4	100	100	-
E-3	1/2R	.04	6	27.5	29	134	240	120	.01
E-4	1/4R	.04	6	6.5	32	128	320	230	.06
E-5	1/2R	.02	6 1/2	24	26	132	160	140	.01
E-6	1/4R			few small droplets					0
E-7	1/2R			no droplets					0
F-1	1/2R	.04	6	15	53	46	220	220	.03
F-2	1/4R	.05	6 1/2	11.5	52	72	320	320	.06
F-3	1/2R	.05	6 1/2	25.5	39	115	100	90	.02
F-4	1/4R			few small droplets					trace
F-5	1/2R			few small droplets					trace
F-6	1/2R			no droplets					0
G-1	1/2R	.04	7	22	33	211	610	420	.01
G-2	1/4R	.03	7	14.5	44	53	510	510	.02
G-3	1/2R	.03	6 1/2	31	35	119	300	300	.01
G-4	1/4R			no droplets					0
G-5	1/2R			no droplets					0
G-6	1/4R			no droplets					0

TABLE II

SUMMARY OF RESULTS

Hovering Height ft.	Beaufort Sea State	Wind Speed m.p.h.	1/2 Radius			1/4 Radius		
			Flt. No.	Droplet Median Vol. Dia. microns	L.W.C. gm./m ³	Flt. No.	Droplet Median Vol. Dia. microns	L.W.C. gm./m ³
20	1 1/2	10		-	-	A-4	-	.03
10	4	20-30	B-1	-	.04	B-2	-	.025
20	4	20-30	B-3	-	.02	B-4	-	.02
30	4	20-30	B-5	-	.01	B-6	-	.01
10	1 1/2	12-15	C-1	230	.06	C-2	290	.07
20	1 1/2	12-15	C-3	160	.03	C-4	50	.05
30	1 1/2	12-15	C-5	0	0	C-6	0	0
10-15	6	25-40	D-1	120	.02	D-2	680	.02
20-25	6	25-40	D-3	380	.01	D-4	0	0
30-35	6	25-40	D-5	240	.01	D-6	0	0
10	1	5-15	E-1	220	.03	E-2	100	-
20	1	5-15	E-3	120	.01	E-4	230	.06
30	1	5-15	E-5	140	.01	E-6	0	0
40	1	5-15	E-7	0	0	-	-	-
10	2 1/2	12-18	F-1	220	.03	F-2	320	.06
20	2 1/2	12-18	F-3	90	.02	F-4	trace	trace
30	2 1/2	12-18	F-5	trace	trace	-	-	-
50	2 1/2	12-18	F-6	0	0	-	-	-
10	3	15-20	G-1	420	.01	G-2	510	.02
20	3	15-20	G-3	300	.01	G-4	0	0
30	3	15-20	G-5	0	0	G-6	0	0

TABLE III

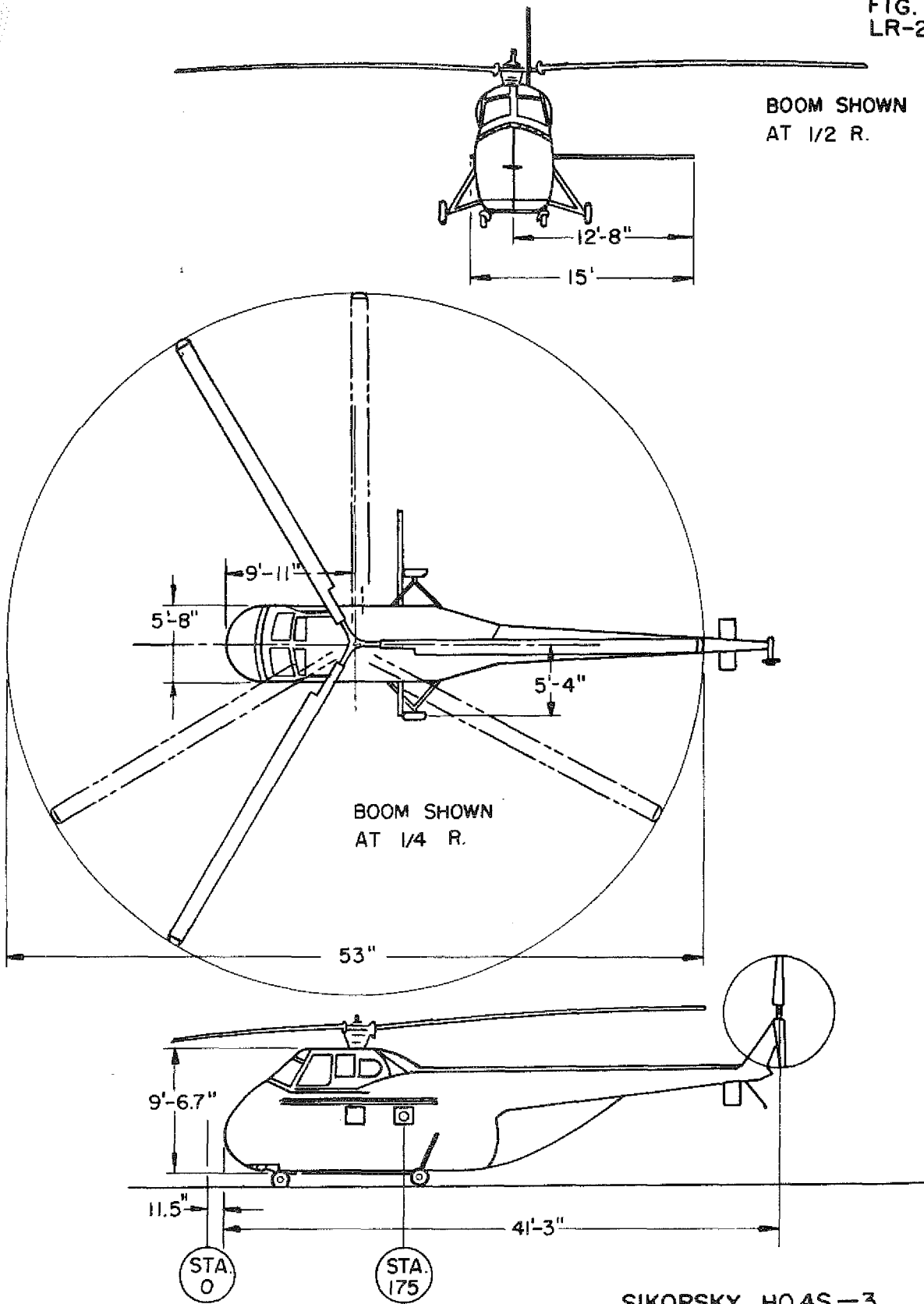
BEAUFORT SCALE OF THE STATE OF THE SEA

(From Reference 3)

Wind Speed Knots	Beaufort	Appearance of the Sea	Probable Mean Height of Waves(ft.)	Probable Max. Height of Waves(ft.)
00	0	Sea like a mirror	-	-
02	1	Scale-like ripples without crests	1/4	1/4
05	2	Small wavelets; glassy crests do not break	0.5	1
09	3	Large wavelets; crests break, foam glassy; perhaps scattered white horses	2	3
13	4	Small waves; fairly frequent white horses	3.5	5
19	5	Many white horses; chance of some spray	6	8.5
24	6	Large waves; white crests everywhere; probably some spray	9.5	13
30	7	Sea heaps up; white foam begins to be blown in streaks along the direction of the wind; spindrift begins	13.5	19
37	8	Moderately high waves; well-marked streaks of foam along the wind; edges of crests break into spindrift	18	25
		etc.		

FIG. 1
LR-249

BOOM SHOWN
AT 1/2 R.



BOOM SHOWN
AT 1/4 R.

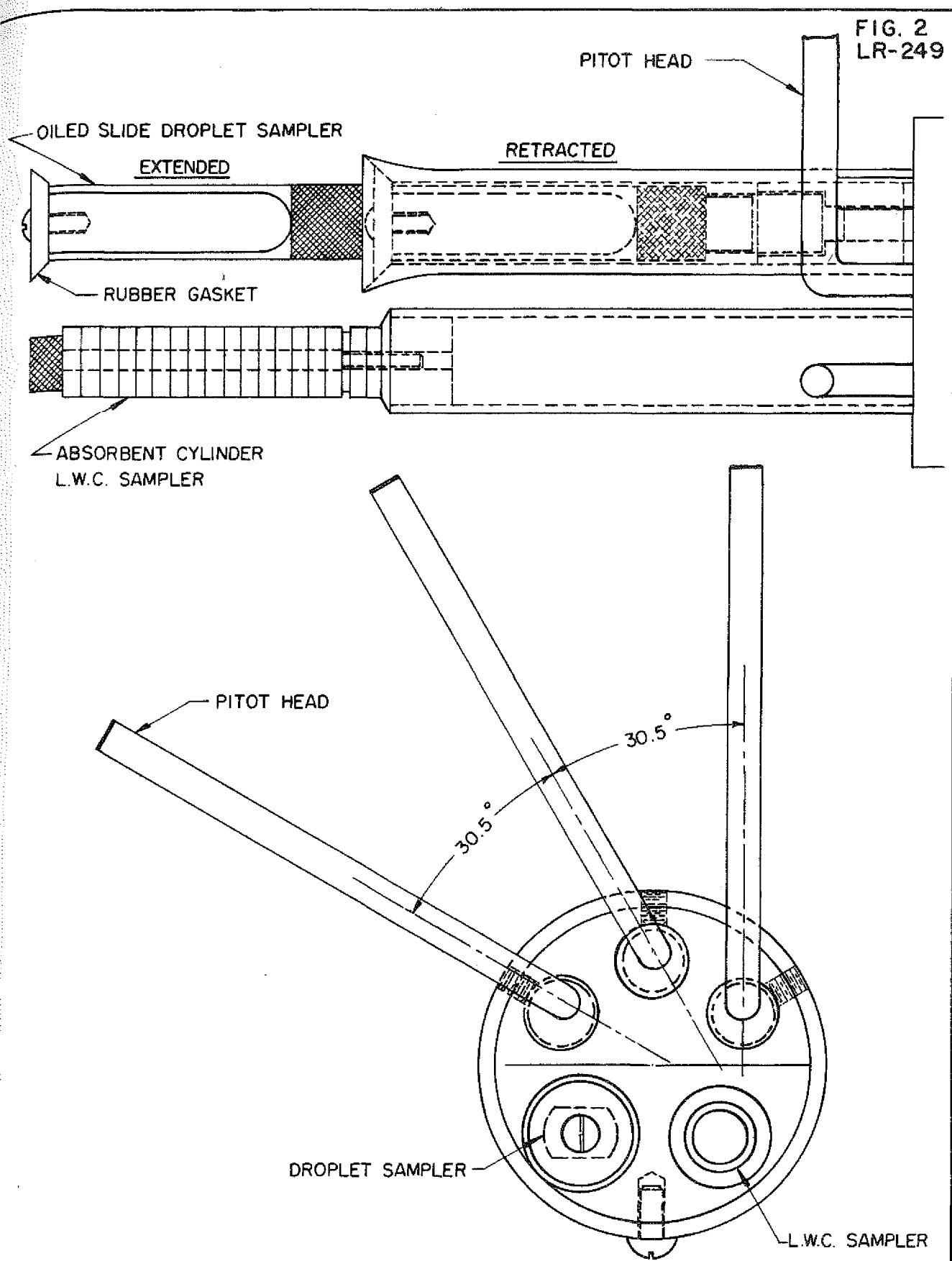
STA.
0

STA.
175

SIKORSKY HO4S-3

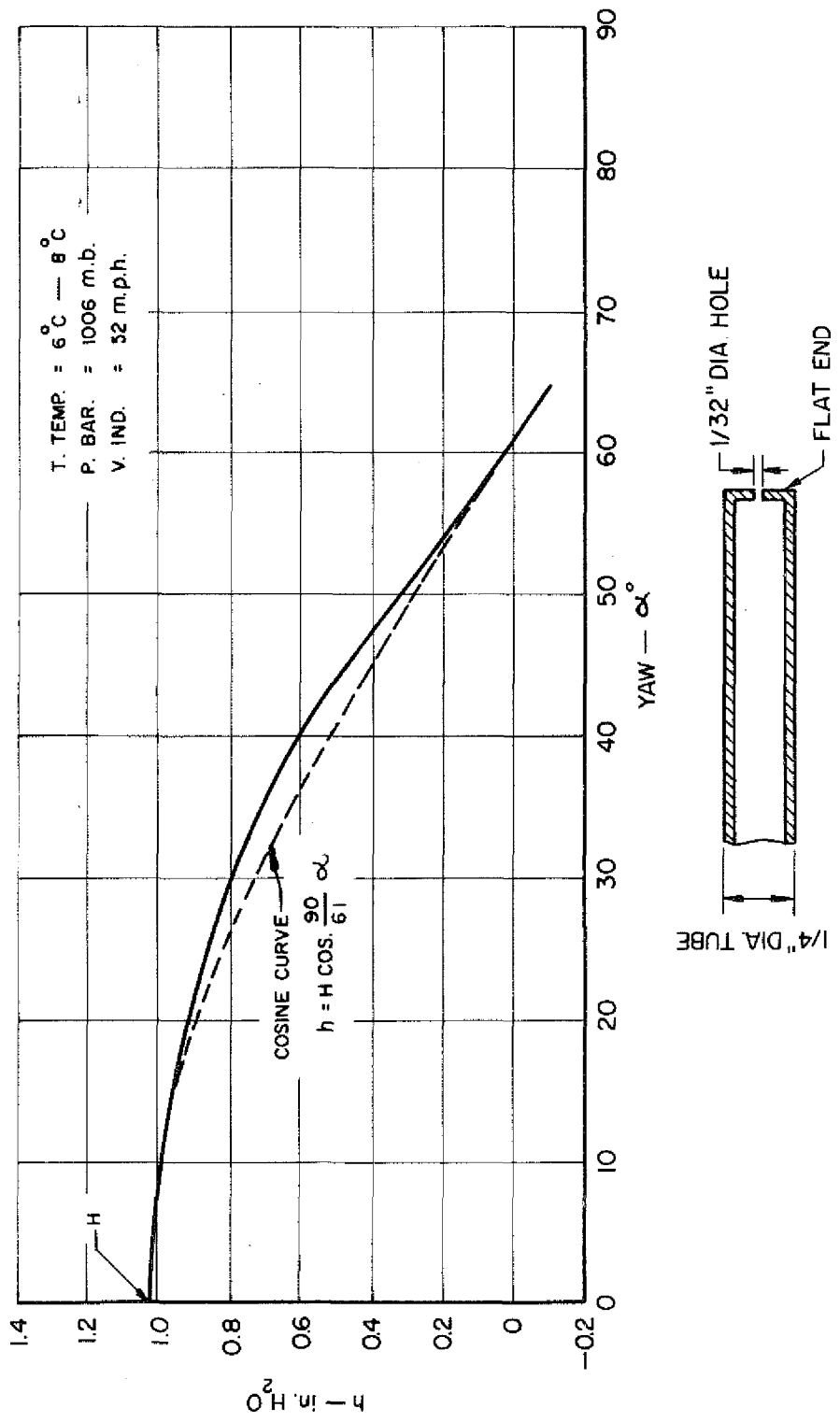
HELICOPTER, SHOWING SPRAY SAMPLING BOOM.

FIG. 2
LR-249



COMPONENTS OF SEA SPRAY SAMPLING HEAD.

SCALE: FULL SIZE



PITOT USED IN SPRAY MEASURING HEAD - ANGULAR RESPONSE.

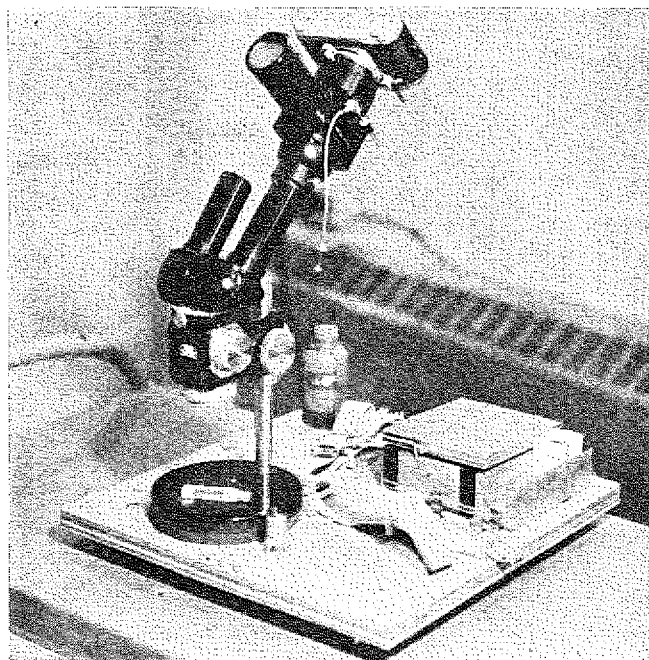


FIG. 4

DROPLET MICROSCOPE AND CAMERA

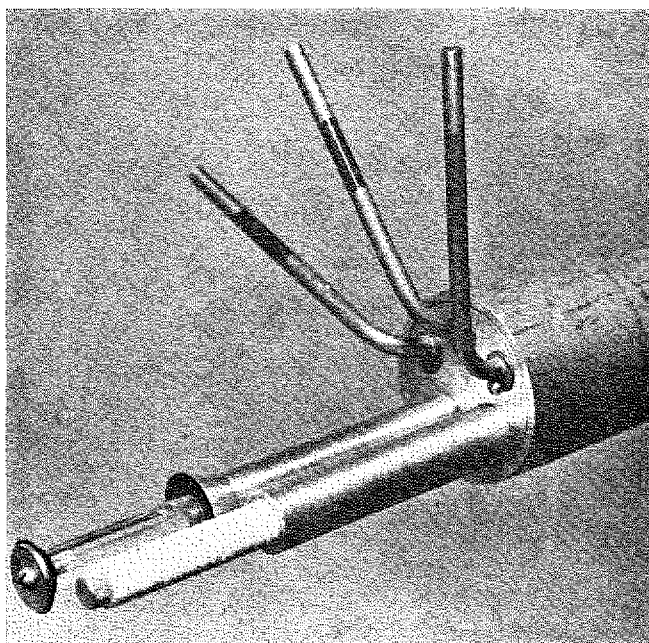


FIG. 5

SEA SPRAY MEASURING HEAD

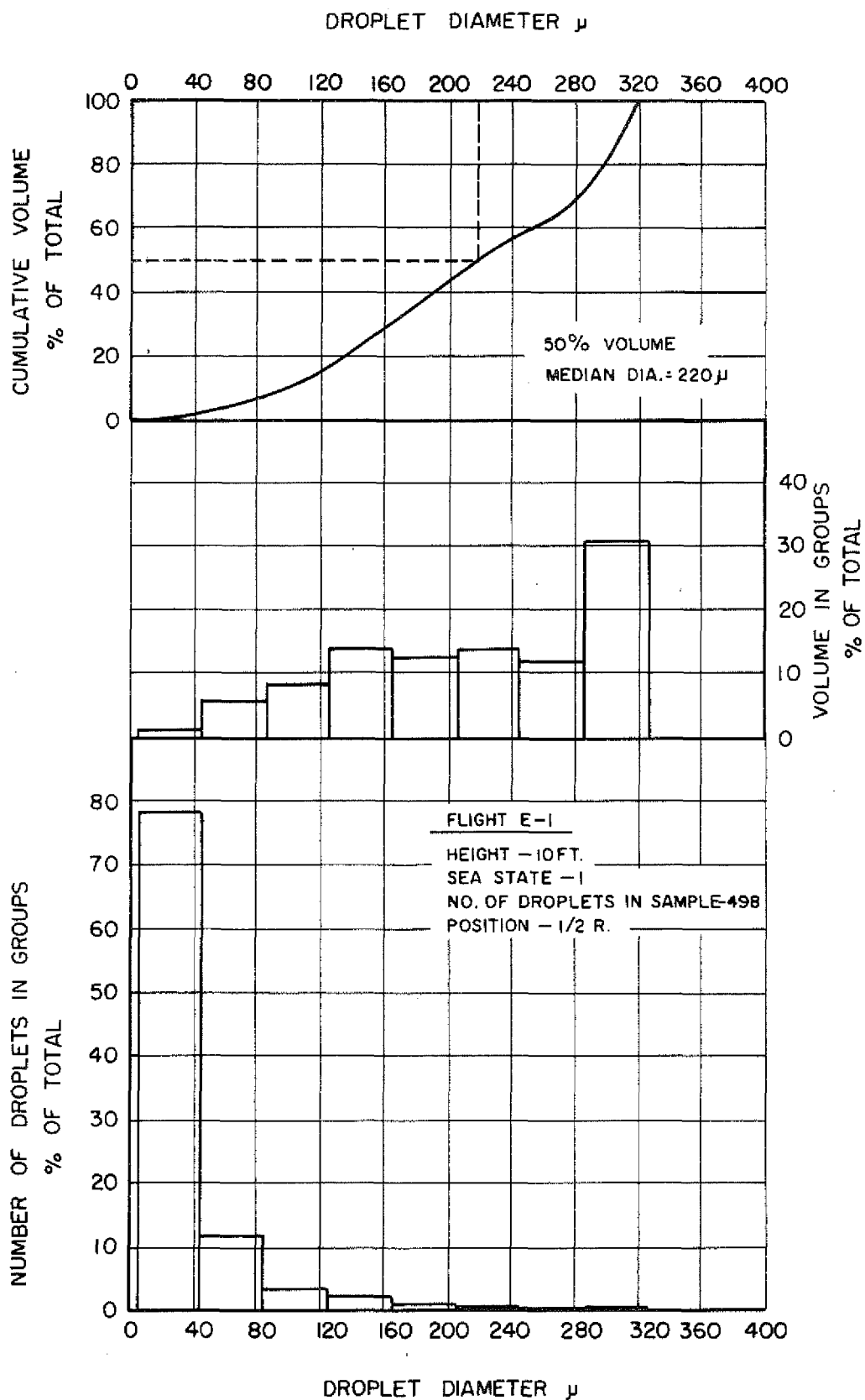


FIG. 6 PORT SIDE EXTENSION OF BOOM AT 1/2 R. POSITION

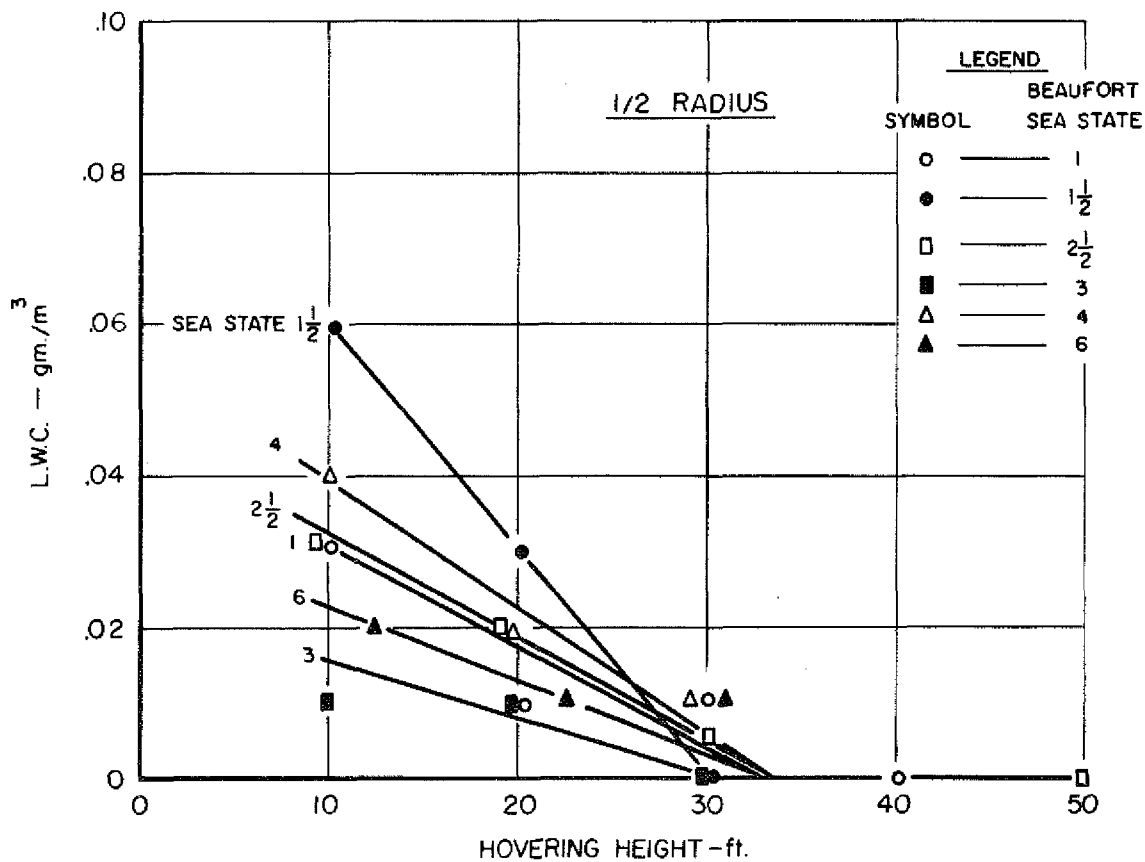
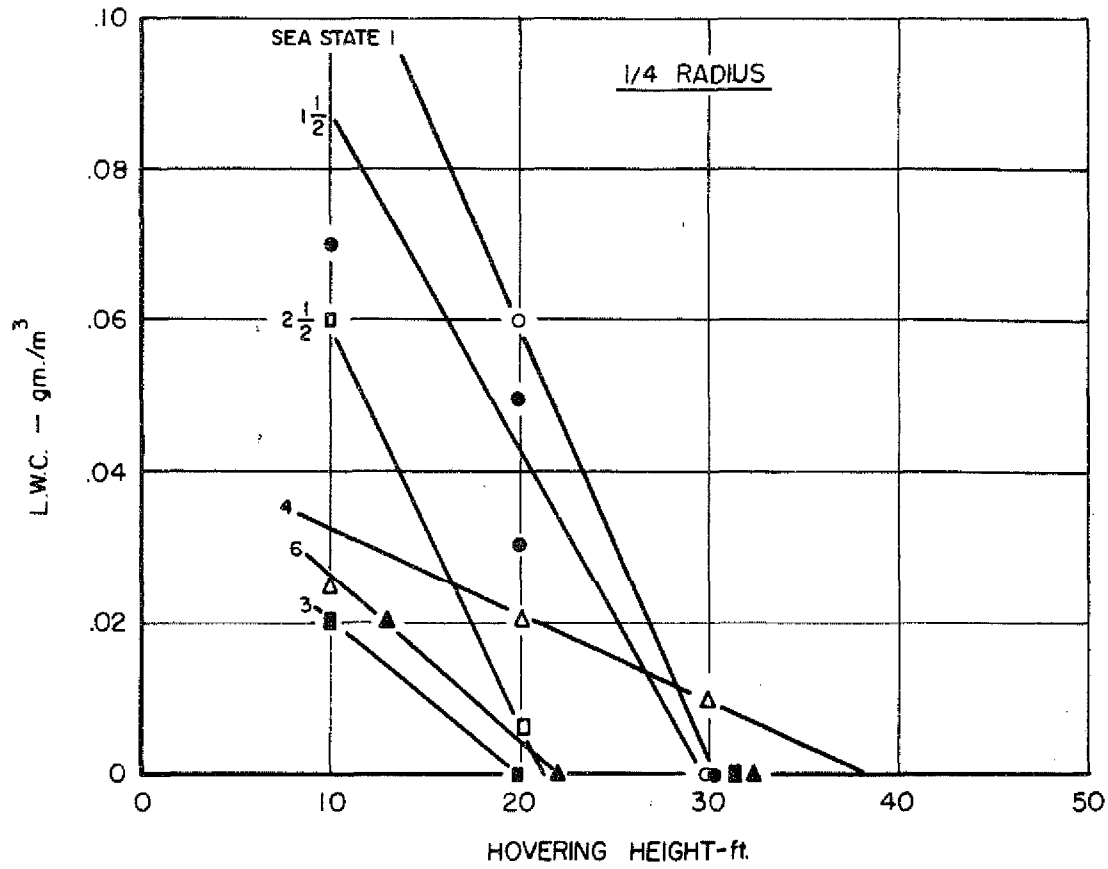


FIG. 7 STARBOARD EXTENSION OF BOOM IN FULLY RETRACTED POSITION

FIG. 8
LR-249

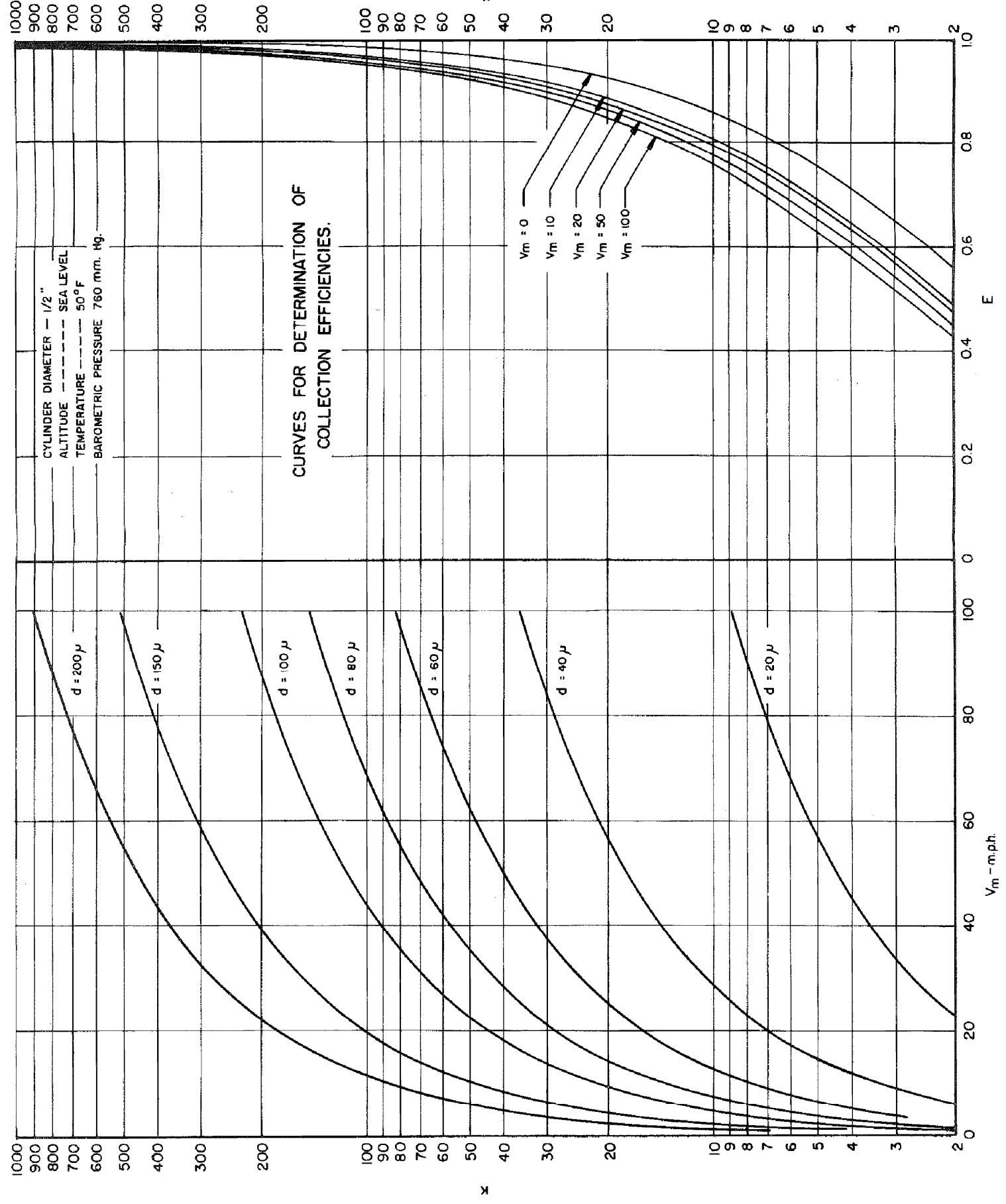


TYPICAL ANALYSIS OF WATER DROPLET SAMPLE FROM SEA SPRAY.



VARIATION OF LIQUID WATER CONTENT WITH HEIGHT FOR VARIOUS SEA STATES.

FIG. 10
LR-249



APPENDIX A

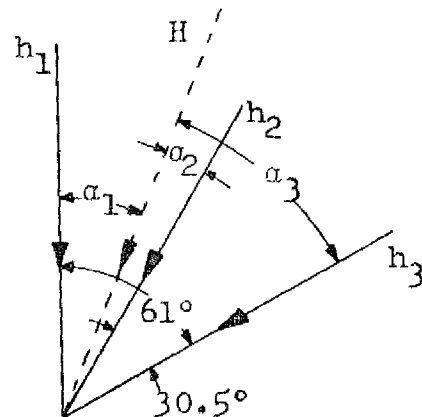
METHODS OF CALCULATION

A.1.0 LIST OF SYMBOLS

d	Droplet diameter	microns
D	Absorbent cylinder diameter	inches
E	Collection efficiency	
h_1, h_2, h_3	Velocity heads of the 3 pitots	in.H ₂ O
H	Resultant velocity head from pitot readings	in.H ₂ O
K	Droplet deposition parameter	
ℓ	Absorbent cylinder length	inches
m	Liquid water content	gm./m ³
S	Specific gravity of sea water	
T _e	Time of exposure	seconds
V _m	Air velocity	m.p.h.
W	Weight of water picked up by absorbent cylinder	gm.
$\alpha_1, \alpha_2, \alpha_3$	Yaw angles of the 3 pitots	
μ	Air viscosity	lb./ft. sec.
ρ _a	Air density	slugs/ft. ³
∅	Droplet deposition parameter	

A.2.0 DETERMINATION OF AIR SPEED AND DIRECTION FROM PITOT READINGS

The response of the pitots is known to be approximately $h = H \cos(\frac{90}{61} \alpha)$. Therefore, considering any two of the pitots and the appropriate angle relationship (Fig. A-1)



$$h_1 = H \cos(\frac{90}{61} \alpha_1) \quad \dots(1)$$

$$h_3 = H \cos(\frac{90}{61} \alpha_3) \quad \dots(2)$$

$$\text{and } \alpha_1 + \alpha_3 = 61^\circ \quad \dots(3)$$

Fig. A-1

$$\therefore \frac{h_1}{h_3} = \frac{\cos(\frac{90}{61} \alpha_1)}{\cos[\frac{90}{61}(61-\alpha_1)]}$$

$$= \frac{\cos(\frac{90}{61} \alpha_1)}{\cos(90 - \frac{90}{61} \alpha_1)}$$

$$= \frac{\cos(\frac{90}{61} \alpha_1)}{\sin(\frac{90}{61} \alpha_1)}$$

$$\therefore \frac{h_1}{h_3} = \cotan(\frac{90}{61} \alpha_1)$$

$$\text{and } H = h_1 \sec(\frac{90}{61} \alpha_1)$$

$$\left. \begin{aligned} \alpha_1 + \alpha_3 &= 61^\circ \text{--if } h_1 \text{ or } h_2 \neq 0 \\ \alpha_1 + \alpha_2 &= 30.5^\circ \\ \alpha_3 - \alpha_2 &= 30.5^\circ \end{aligned} \right\} \text{if } h_1 > h_3$$

also

$$\left. \begin{aligned} \alpha_1 - \alpha_2 &= 30.5^\circ \\ \alpha_3 + \alpha_2 &= 30.5^\circ \end{aligned} \right\} \text{if } h_1 < h_3$$

From the known values of h_1 and h_3 the resultant head and angles can be found and hence the air speed and direction can be determined.

A more convenient means of resolving the pitot readings is by a graphical method. The magnitudes are plotted to scale but all angles are expanded by the ratio $\frac{90}{61}$; i.e. the magnitudes are plotted at 0° (vertical), 45° and 90° (Fig. A-2). Perpendiculars are then drawn from the end of each of the vectors and the intersection of any two of these perpendiculars defines the end of the resultant vector H. It can be seen that equations 1, 2 and 3 are then satisfied.

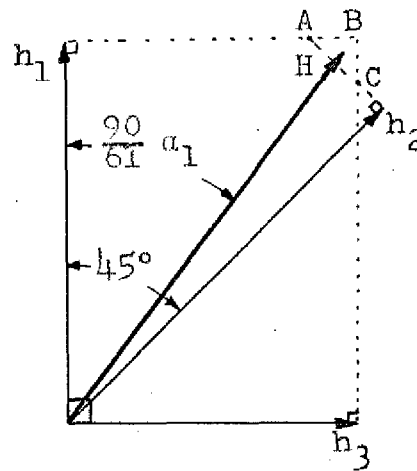


Fig. A-2

Because of the approximations in the pitot response and experimental inaccuracies, the pitot readings give three different solutions for H (points A, B and C, Fig. A-2). The graphical method quickly gives these solutions and makes averaging the simple process of finding the median of the triangle defined by the three points.

A.3.0 DETERMINATION OF LIQUID WATER CONTENT BY ABSORBENT CYLINDER METHOD

A.3.1 Appropriate Formula

$$m = \frac{3.47(10^3) W}{ET_e V_m D \cdot \ell S} \quad \text{gm./m}^3 \quad \dots(4)$$

for $D = \frac{1}{2}$ in.
 $\ell = 2$ in.

$$m = \frac{3.47(10^3) W}{E T_e V_m S} \quad \text{gm.}/\text{m}^3 \quad \dots(5)$$

A.3.2 Determination of Collection Efficiency

In Reference 4, Langmuir and Blodgett present values of E plotted as a function of a parameter K for a series of values of parameter ϕ where:

$$K = 1.31 \times 10^{-9} \frac{d^2 V_m}{\mu D} \quad \dots(6)$$

and

$$\phi = 18.3 \frac{\rho_a^2 D V_m}{\mu} \quad \dots(7)$$

If it is assumed that the air temperature is 50°F, barometric pressure is 760 mm. Hg, and the altitude is sea level, then:

$$\mu = 1.173 \times 10^{-5} \text{ lb./ft. sec.}$$

$$\rho_a = 0.00242 \text{ slugs/ft.}^3$$

and

$$D = \frac{1}{8} \text{ in.}$$

then

$$K = 2.235 \times 10^{-4} d^2 V_m \quad \dots(8)$$

and

$$\phi = 4.57 V_m \quad \dots(9)$$

For convenience equation (8) is plotted on the left half of Figure 10 for a number of values of d, while the right hand side presents values of E as a function of K and V_m (using equation(9) to convert from ϕ to V_m). Thus knowing the velocity and droplet size, the collection efficiency, E, can be evaluated directly from this figure.

<p>NRC LR-249 National Research Council, Canada. Division of Mechanical Engineering.</p> <p>SEA SPRAY SAMPLING TESTS FROM A HOVERING HELICOPTER. G.A. Gibbard. June 1959. 18 p. + 10 figs.</p> <p>Tests were conducted to determine the amount of salt water spray picked up by a helicopter hovering a short distance above the sea. The results show that there is little spray under all operating conditions and, at freezing temperatures, the effect of any resulting icing from the spray should be minor.</p>	<p><u>CONFIDENTIAL</u></p> <p>1. Sea spray 2. Icing, Rotor</p> <p>I. Gibbard, G.A. II. NRC LR-249</p>	<p>NRC LR-249 National Research Council, Canada. Division of Mechanical Engineering.</p> <p>SEA SPRAY SAMPLING TESTS FROM A HOVERING HELICOPTER. G.A. Gibbard. June 1959. 18 p. + 10 figs.</p> <p>Tests were conducted to determine the amount of salt water spray picked up by a helicopter hovering a short distance above the sea. The results show that there is little spray under all operating conditions and, at freezing temperatures, the effect of any resulting icing from the spray should be minor.</p>	<p><u>CONFIDENTIAL</u></p> <p>1. Sea spray 2. Icing, Rotor</p> <p>I. Gibbard, G.A. II. NRC LR-249</p>
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