TECHNICAL NOTES.

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SURFACE AREA COEFFICIENTS FOR AIRSHIP ENVELOPES

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By

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In naval architecture it is customary to determine the wetted surface of a ship by means of some formula which involves the principal dimensions of the design and suitable constants. These formulas of naval architecture may be extended and applied to the calculation of the surface area of airship envelopes by the use of new values of the constants which have been determined for this purpose.

There are two obvious expressions connecting the surface area S with the dimensions of the airship:

$$S = C_s \sqrt{VL} \quad \dots\dots\dots\dots\dots \quad (1)$$

$$\text{and } S = C'_s\, DL \quad \dots\dots\dots\dots\dots \quad (2)$$

where V = Volume

L = Overall length

and D = Maximum diameter.

The values of C_s and C'_s have been calculated from the actual dimensions, surfaces and volumes of 52 streamline bodies, which form a series covering the entire range of shapes used in the present aeronautical practice. Although both C_s and C'_s are non-dimensional it is found that neither is constant. Each depends to a certain extent upon the "prismatic coefficient" C_V,

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which is the ratio of the volume of the streamline body (or spindle) to its circumscribing cylinder. That is,

$$V = C_v \, A \, L$$

where A = Area of the maximum cross section

C_s and C_s^1 have been plotted against C_v in Fig. 1 and Fig. 2. It is to be noted that while neither of the coefficients is constant, C_s may be considered constant with a probable maximum error of less than 3%. The value recommended for use under these conditions is

$$C_s = 3.45$$

and it applies equally well to the average non-rigid or rigid airship shape.

Theoretical Limits to C_s.

It is of interest to define the limits of the coefficient C_s. Obviously the maximum and minimum values will be found from a cylinder and a double-cone. The expressions for C_s in these cases are:

$$\text{Cylinder} \qquad C_s = 2\sqrt{\pi}\left(\frac{D + 2L}{2L}\right)$$

$$\text{Double cone} \qquad C_s = \sqrt{3\pi}\left(\sqrt{\frac{D^2 + L^2}{L}}\right)$$

These have been evaluated and are plotted in Fig. 3. It will be noted that the mean value of C_s at $L/D = 7.0$ is $C_s = 3.45$ This is the general mean value for streamline bodies and is due to the fact that in order to obtain the least resistance per unit volume it has been found necessary to increase or decrease the fullness of the lines as the ratio L/D is increased or decreased.

Table I.

Data on Airship Envelopes.

Surface $= C_s \sqrt{VL} = C_s' \; DL$

Volume $= C_v \; AL$

Designation	Length L	Diameter D	Volume V	Surface S	C_s	C_s'	C_v
I.E.	2.99	.641	.596	4.59	3.44	2.40	.617
B	3.53	.696	.831	5.80	3.39	2.36	.618
F	3.12	.641	.670	5.01	3.46	2.50	.661
E.P.	3.09	.641	.589	4.59	3.40	2.32	.590
C	2.97	.641	.624	4.70	3.45	2.47	.651
P	3.21	.641	.589	4.53	3.30	2.20	.575
Goodyear #4	3.19	.687	.784	5.47	3.46	2.50	.663
P-AA'	3.89	.641	.750	5.70	3.34	2.29	.597
P-AD'	3.50	.641	.743	5.57	3.45	2.48	.658
P-BA'	3.83	.641	.749	5.69	3.35	2.32	.616
P-BC'	3.58	.641	.745	5.61	3.43	2.45	.646
P-CB'	3.64	.641	.744	5.62	3.41	2.41	.633
P-CD'	3.39	.641	.737	5.51	3.48	2.53	.673
Göttingen #1	3.79	.638	.643	5.16	3.30	2.13	.531
Göttingen #2	3.41	.639	.643	5.16	3.48	2.37	.598
Göttingen #3	3.47	.589	.643	5.16	3.45	2.52	.681
Göttingen #4	3.79	.617	.643	5.16	3.30	2.20	.567
Göttingen #5	3.46	.597	.643	5.16	3.46	2.50	.664
Göttingen #6	3.89	.630	.643	5.16	3.26	2.10	.531

Table I (Contd.)

Data on Airship Envelopes.

Surface = $C_s \sqrt{VL} = C_s' \; DL$

Volume = $C_V \; AL$

Designation	Length L	Diameter D	Volume V	Surface S	C_s	C_s'	C_V
P1	1.59	.390	.0970	1.275	3.25	2.06	.510
P4	1.23	.387	.0714	0.953	3.22	2.00	.494
E4	1.37	.392	.0972	1.214	3.33	2.24	.586
C.25	3.13	.641	.677	5.023	3.45	2.50	.669
C.50	3.29	.641	.729	5.345	3.45	2.54	.687
C1.0	3.61	.641	.833	5.99	3.46	2.59	.713
C2.0	4.25	.641	1.040	7.28	3.46	2.68	.758
C3.0	4.89	.641	1.248	8.57	3.47	2.73	.792
C4.0	5.53	.641	1.455	9.86	3.47	2.78	.815
C5.0	6.17	.641	1.663	11.15	3.48	2.83	.834
3C	1.925	.641	.404	3.07	3.48	2.49	.651
6C	3.85	.641	.807	6.03	3.42	2.45	.651
8C	5.133	.641	1.077	8.00	3.41	2.43	.651
2321	4.00	.286	.1600	2.70	3.38	2.36	.613
2322	4.00	.286	.1823	2.91	3.41	2.54	.715
2323	4.00	.286	.2059	3.12	3.44	2.73	.803
2324	4.00	.286	.2265	3.33	3.50	2.91	.883
2325	4.00	.348	.2360	3.29	3.39	2.36	.621
2326	4.00	.348	.2685	3.54	3.42	2.54	.706

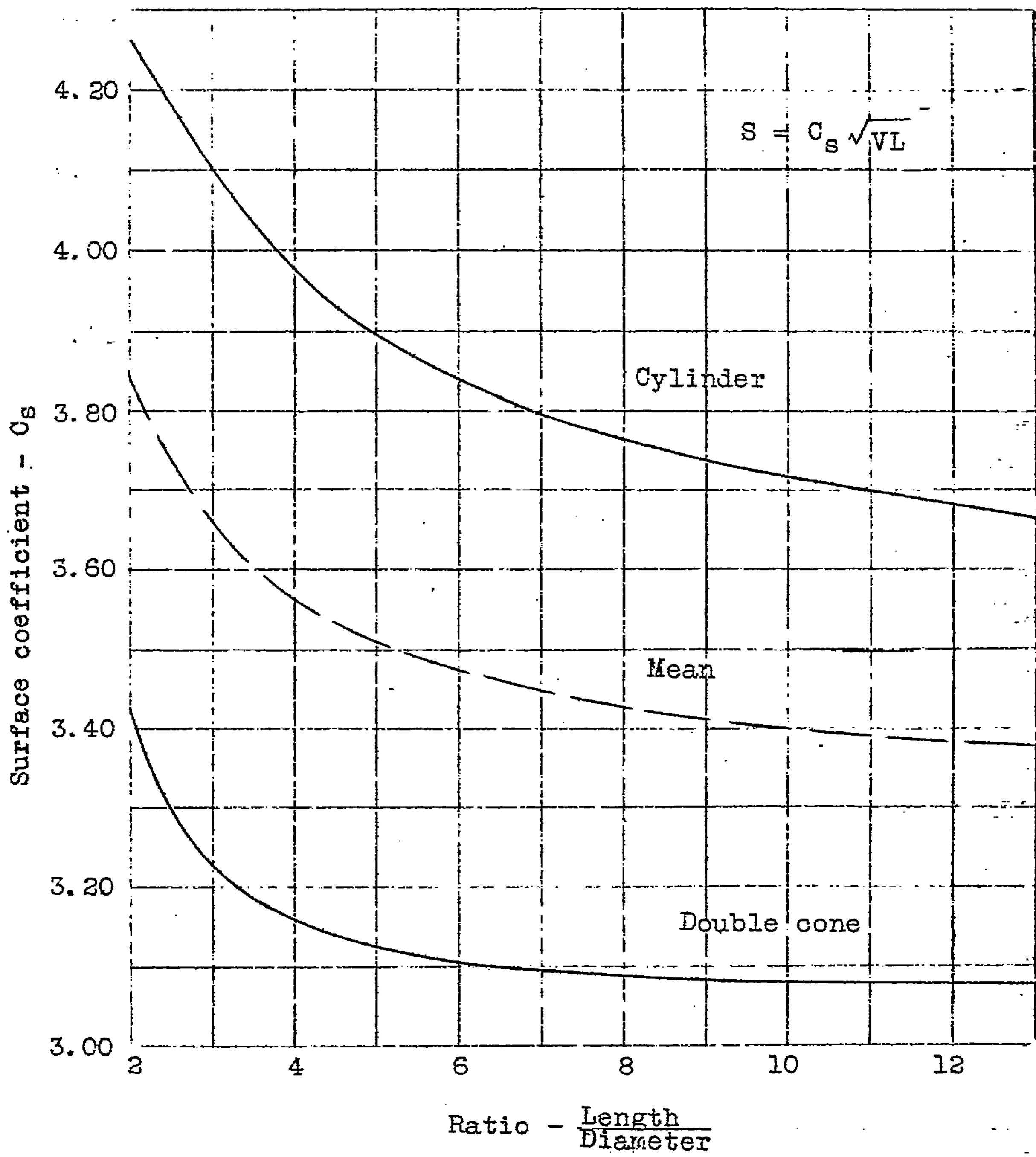
Table I (Contd.)

Data on Airship Envelopes.

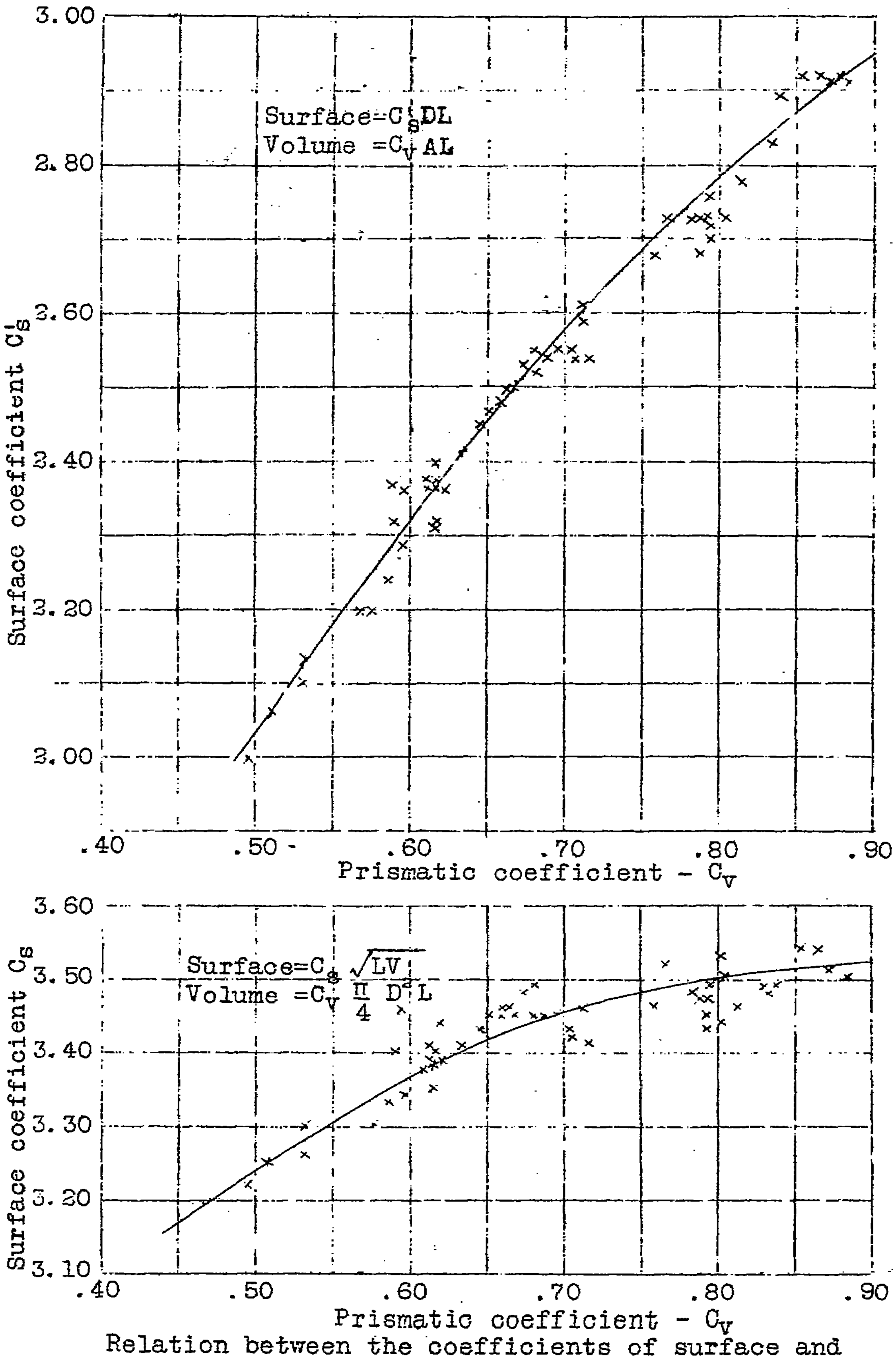
Surface = $C_s \sqrt{VL} = C_s' \; DL$

Volume = $C_v \; AL$

Designation	Length L	Diameter D	Volume V	Surface S			
2327	4.00	.348	.301	3.79	3.45	2.72	.793
2328	4.00	.348	.334	4.06	3.51	2.92	.878
2329	4.00	.444	.382	4.21	3.40	2.37	.616
2330	4.00	.444	.436	4.53	3.43	2.55	.704
2331	4.00	.444	.488	4.85	3.47	2.73	.788
2332	4.00	.444	.541	5.17	3.51	2.91	.873
2333	4.00	.615	.726	5.82	3.41	2.37	.611
2334	4.00	.615	.827	6.28	3.45	2.55	.696
2335	4.00	.615	.930	6.72	3.48	2.73	.782
2336	4.00	.615	1.030	7.18	3.54	2.92	.866
2337	4.00	1.000	1.865	9.45	3.41	2.36	.595
2338	4.00	1.000	2.155	10.19	3.49	2.55	.680
2339	4.00	1.000	2.405	10.92	3.52	2.73	.766
2340	4.00	1.000	2.680	11.65	3.54	2.91	.853



Limits for the surface coefficient.



Relation between the coefficients of surface and volume for airship envelopes.