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PRELIMINARY REPORT ON THE CHARACTERISTICS OF THE N.A.C.A. 44OOR SERIES AIRFOILS

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At the request of the Bureau of Aeronautics, Navy Department, tests were made in the variable-density wind tunnel of airfoils of the N.A.C.A. 4400 series (reference 1) modified by reflex at the trailing edge designed to reduce the pitching moment to the value of -0.03. The modified airfoils are designated the N.A.C.A. 4400R series.

MODELS AND TESTS

The test procedure and the description of the standard airfoil models are given in reference 2. The tests comprised the 9-, 12-, 15-, and 18-percent thick airfoils of the series, designated, respectively, the N.A.C.A. 4409R, 4412R, 4415R, and 4418R. The N.A.C.A. 4400R series is identical with the N.A.C.A. 4400 series from the leading edge to the 40-percent chord station, and has also the same thickness distributions, maximum camber, and position of maximum camber. It differs only in the shape of the mean camber line from the 40-percent station to the trailing edge. The equation for this portion of the mean line for the N.A.C.A. 4400R series is:

$$Y_c = 0.419x^3 - 0.865x^2 + 0.491x - 0.045 \quad (\text{for } x=0.4 \text{ to } x=1.0)$$

where Y_c is the ordinate and x the abscissa in decimal fractions of the chord. It was derived so that, from the theory of reference 3, a pitching-moment coefficient of -0.03 would be obtained for the N.A.C.A. 4400R mean-camber line.

The ordinates of the models are given on the characteristics plots.

RESULTS

The test results are presented on standard characteristics plots in figures 1 to 4. These results are fully corrected according to the methods of references 4 and 5. The important aerodynamic characteristics are tabulated in table I together with the fully corrected characteristics of the corresponding N.A.C.A. 4400 series airfoils taken from earlier tests. The data for the N.A.C.A. 4418 airfoil were taken from a test made earlier than the others.

From table I, it can be seen that the design pitching-moment coefficient was realized. Reflex reduced the maximum lift coefficients (approximately 10 percent), but for the 9-, 12-, and 15-percent thick sections also reduced the minimum drag coefficients (approximately 5 percent); the resulting speed-range indices ($c_{l_{max}}/c_{d_{o_{min}}}$) being roughly 5 percent lower. The desirable characteristic of rounded lift-curve peaks possessed by the N.A.C.A. 4400 series wasn't adversely affected by imparting reflex.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., January 26, 1939.

REFERENCES

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2. Jacobs, Eastman N, and Abbott, Ira H.: The N.A.C.A. Variable-Density Wind Tunnel. NACA Rep. No. 416, 1932.

3. Glauert, H.: The Elements of Aerofoil and Airscrew Theory. Cambridge University Press (London), 1926.

4. Jacobs, Eastman N., and Abbott, Ira H.: Airfoil Section Data Obtained in the N.A.C.A. Variable-Density Tunnel as Affected by Support Interference and Other Corrections. NACA Rep. No. 669, 1939.

5. Jacobs, Eastman N., and Sherman, Albert: Airfoil Section Characteristics as Affected by Variations of the Reynolds Number. NACA Rep. No. 586, 1937.

6. Jacobs, Eastman N., and Rhode, R. V.: Airfoil Section Characteristics as Applied to the Prediction of Air Forces and Their Distribution on Wings. NACA Rep. No. 631, 1938.

TABLE I

Characteristics of Airfoils[1]

Airfoil N.A.C.A.	Figure No.	N.A.C.A. reference R=report N=note	Classification				Effective Reynolds Number (millions)	Fundamental section characteristics						Derived and additional characteristics that may be used for structural design								
			Chord	PD	SE	$C_{L_{max}}$		$c_{l_{max}}$	α_{l_o} (deg.)	α_o (per deg.)	$c_{l_{opt}}$	$c_{d_{o_{min}}}$	$c_{m_{a.c.}}$	a.c. (percent c from c/4)		$\frac{c_{l_{max}}}{c_{d_{o_{min}}}}$	c.p. at $c_{l_{max}}$ (percent c)	Wing characteristics A=6 round tips		Thickness at percent c			Camber (percent c)
														Ahead	Above			m_6 (per radian)	$C_{D_{min}}$	0.15c	0.65c	Maximum	
4409R	1		A	B11	B6	D	8.7	1.56	-1.9	0.099	0.25	0.0062	-0.025	0.3	5	252	29	4.31	0.0065	8.07	6.21	9	4
4412R	2		A	C11	C5	D	8.5	1.56	-2.1	.099	.18	.0067	-.030	.1	3	233	30	4.31	.0069	10.77	8.30	12	4
4415R	3		A	D11	D4	D	8.7	1.54	-2.4	.096	.18	.0072	-.031	.6	4	214	29	4.20	.0073	13.45	10.39	15	4
4418R	4		A	E11	E3	D	8.6	1.46	-2.8	.092	.20	.0081	-.030	.9	3	180	30	4.07	.0083	16.15	12.47	18	4
4409			A	B10	B4	A	8.1	1.77	-3.9	.096	.26	.0065	-.088	.6	2	272	31	4.20	.0071	8.07	6.21	9	4
4412			A	C10	C4	D	7.9	1.74	-4.0	.098	.32	.0071	-.088	.8	2	245	31	4.28	.0073	10.77	8.28	12	4
4415			A	D10	D4	C	7.9	1.72	-4.0	.097	.22	.0075	-.085	1.0	1	229	31	4.24	.0079	13.45	10.34	15	4
4418			A	E10	E4	D	8.1	1.57	-3.7	.092	.13	.0078	-.078	1.4	1	201	31	4.07	.0081	16.15	12.40	18	4

[1]Explanation of table is given in reference 6.

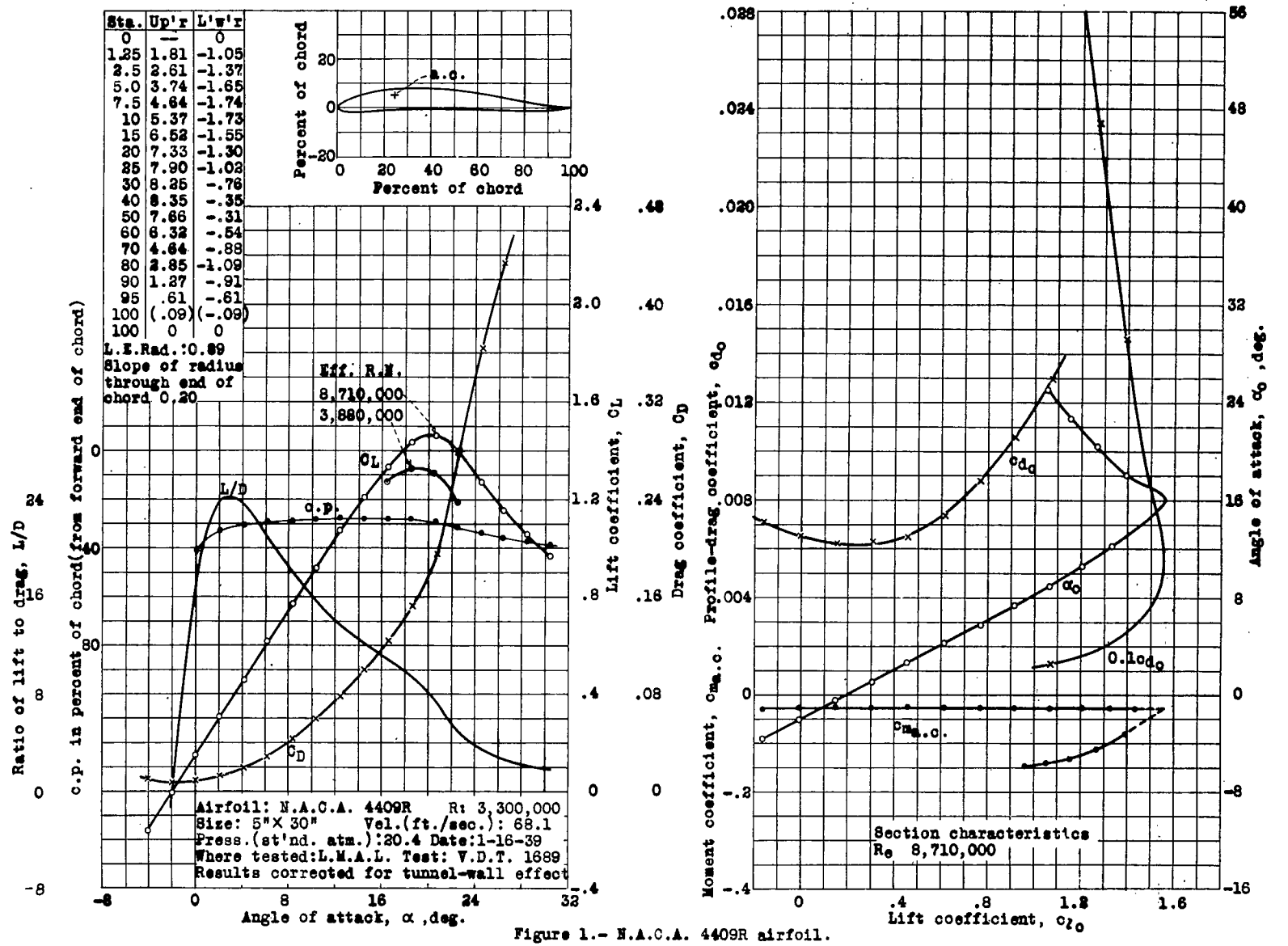

Figure 1.- N.A.C.A. 4409R airfoil.

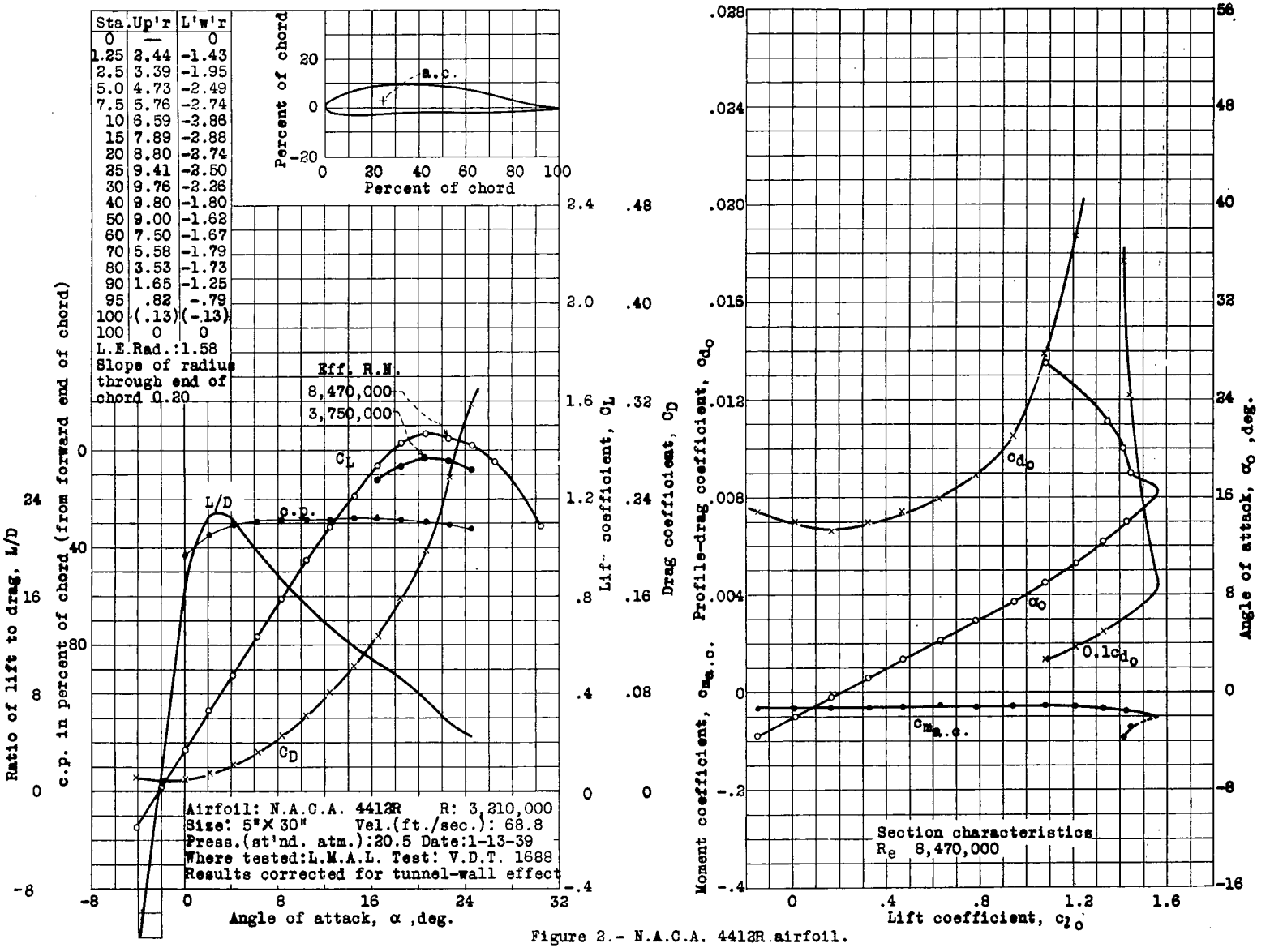

Figure 2.- N.A.C.A. 4412R airfoil.

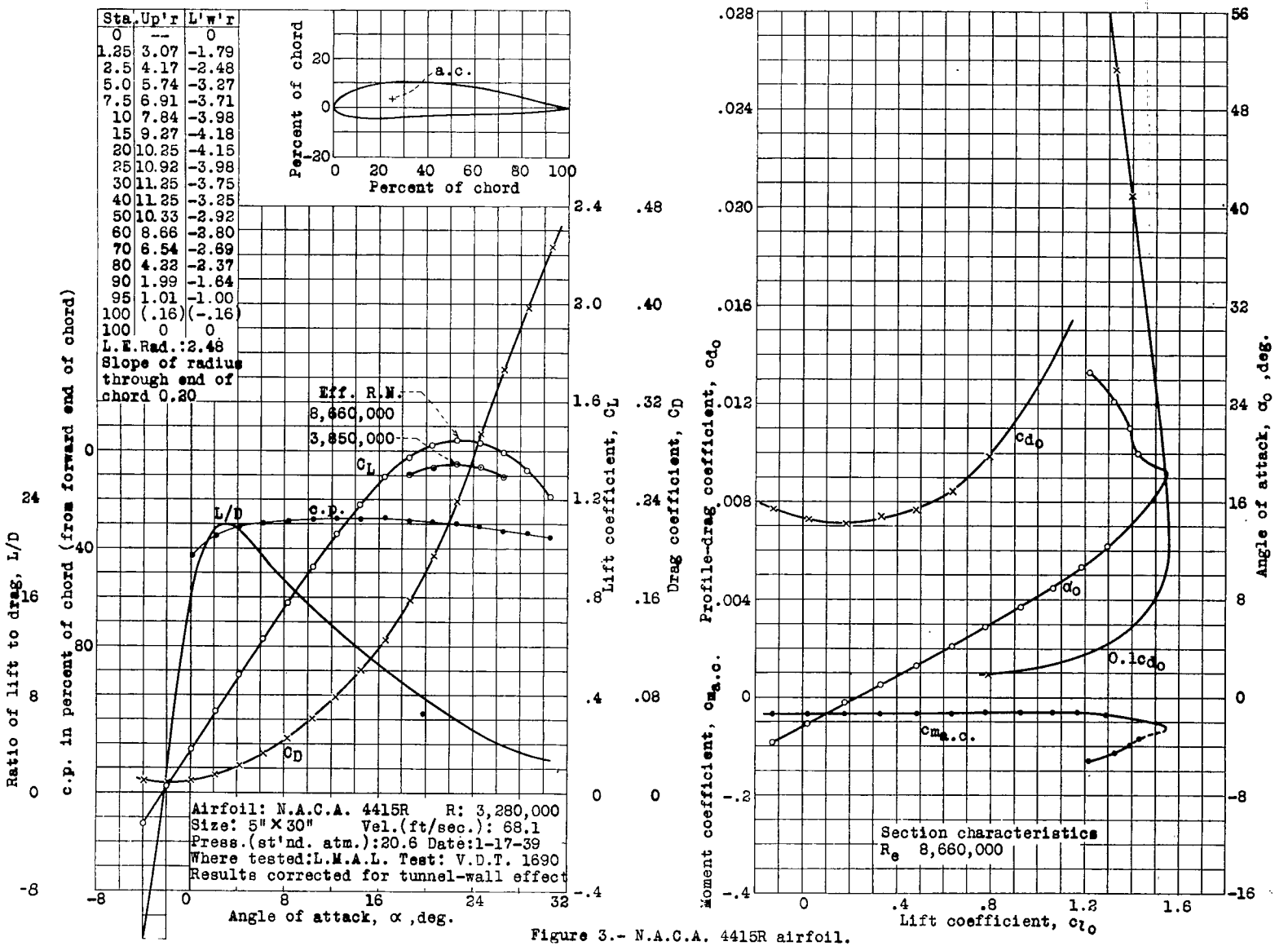

Figure 3.- N.A.C.A. 4415R airfoil.

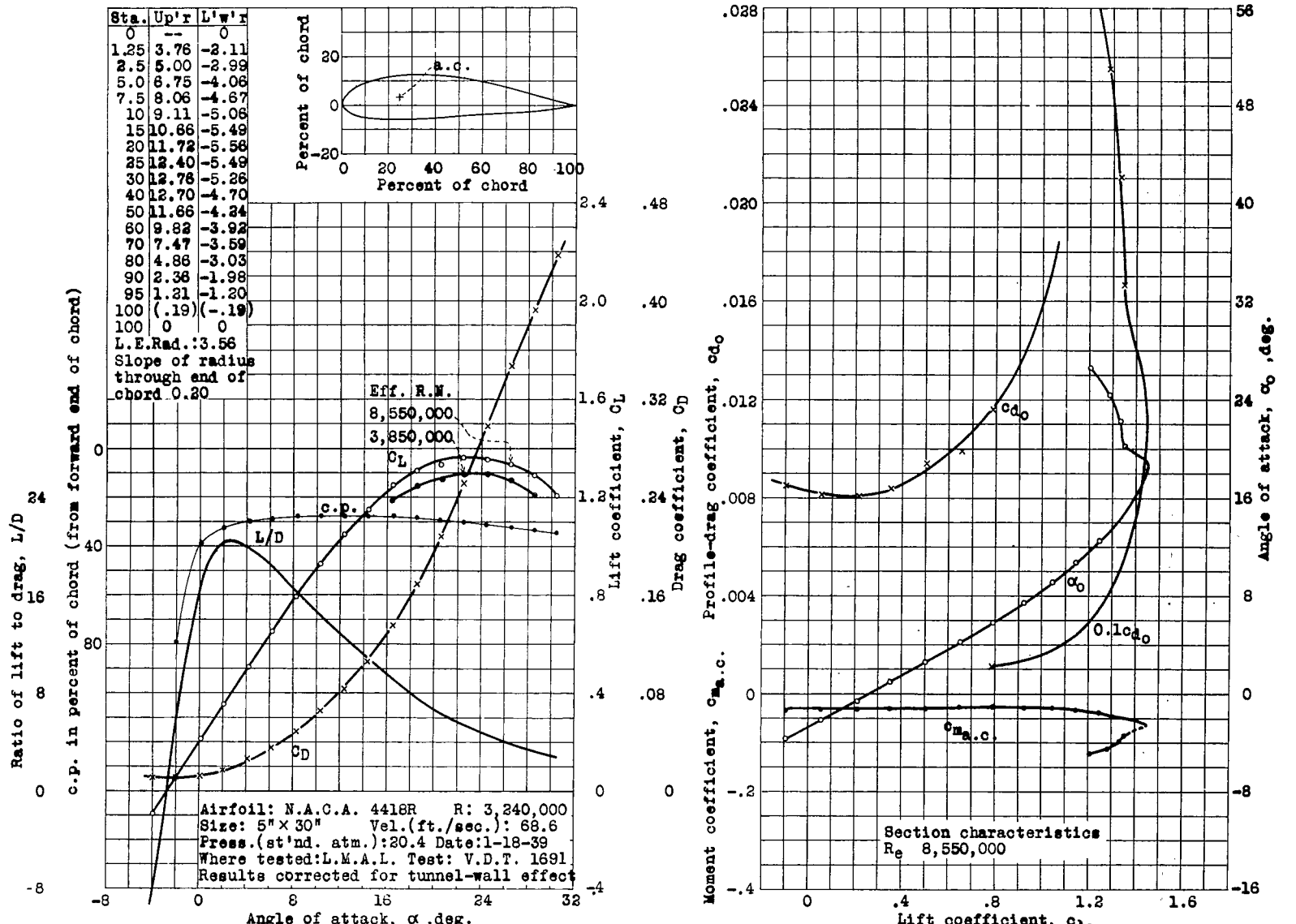

Figure 4.- N.A.C.A. 4418R airfoil.