Benchmark test of power curve computations : final report on the CWD contribution

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BENCHMARK TEST OF POWER CURVE COMPUTATIONS

FINAL REPORT ON THE CWD CONTRIBUTION

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December 1986   R 833 D

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CONTENTS

LIST OF SYMBOLS

c	blade chord	(m)
C_L	lift coefficient	( )
C_D	drag coefficient	(–)
C_P	power coefficient	(–)
C_Q	torque coefficient	(–)
C_T	thrust coefficient	(–)
C_{F_s}	side force coefficient	(–)
$C_{M_{yaw}}$	yawing moment coefficient	(–)
D	rotor diameter	(–)
r	radius	(m)

$$\text{curvature} = \frac{\text{blade thickness}}{\text{chord}} \times 100 \quad (\%)$$

α	angle of attack	(°)
β	blade setting angle	(°)
δ	angle of yaw, i.e. angle between wind direction and rotor axis	(–)
λ	tip speed ratio	(–)
Φ	angle between relative wind and plane of rotation	
Θ_P	nominal pitch angle	
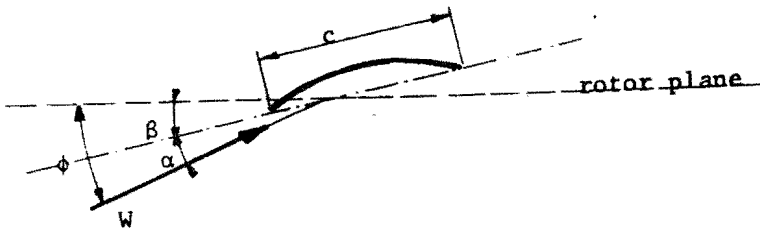
INTRODUCTION

At the meeting of test stations for wind turbines in Lannion, France, in May 1984 proposals were discussed for a series of projects to be carried out in cooperation between the test stations.

This report concerns one of these projects: "Benchmark test of power curve computations". For this project it was agreed that Risø, Denmark, will be project leader. Among other test stations, CWD will participate in the project. CWD will concentrate especially on multiblade rotors, which are typical for water pumping windmills. For the project as a whole, slow running rotors are of specific interest, since the difficulties in computational models can be expected to become evident most clearly for slow running rotors.

The project is partly funded by the European Economic Community under contract 84/B/7033/11/004/17 between the Commission of European Communities and Risø. In February 1986 a contract was concluded between Risø and CWD for CWD's contribution to the project.

In June 1986 the specification of the multibladed rotors, one of the tasks of CWD, was finished and reported in R 793 D, [ref. 1].
This report is included in the present report as section I, with an additional section on the measured rotor characteristics.
Section II contains the results of the power curve computations for all horizontal axis rotors.

SECTION I

DATA ON MULTIBLADED ROTORS

I.1. DEMPSTER 14' ROTOR

The first rotor specification concerns a rotor applied by
Dempster, Nebraska, USA in its water pumping windmill of 14'
diameter. Figure 1 contains an overview of this typical
classical windmill.
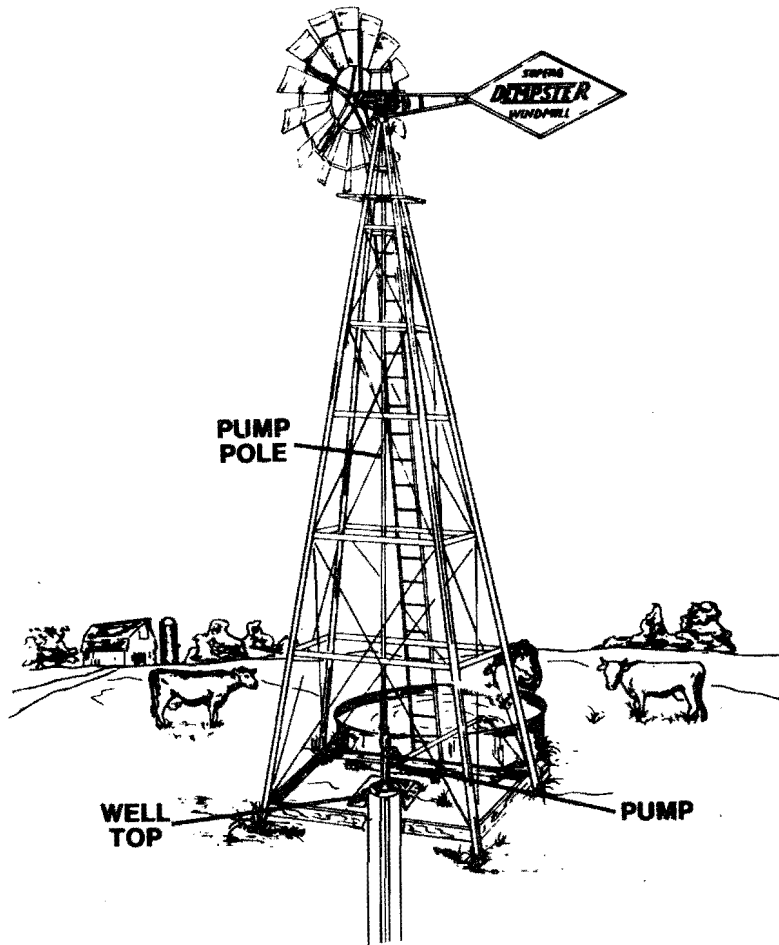
Figure 1   Dempster windmill

The rotor consists of 6 sets of 3 blades each, in total 18
blades, see figures 2 and 3. The rotor blades are supported
by six spokes and two rims. The blades consist of curved
steel plates, having a constant radius of curvature.
The specifications of the rotor are summarized in table 1,
including blade shape and blade angle setting.

(2x)   BOLT ⁷⁄₁₆" x 1-½"

BOLT ⁷⁄₁₆" x 1-½"

BOLT ½" x 1-½"

BOLT   ½" x 1-¾"
      ½" x 1-½"
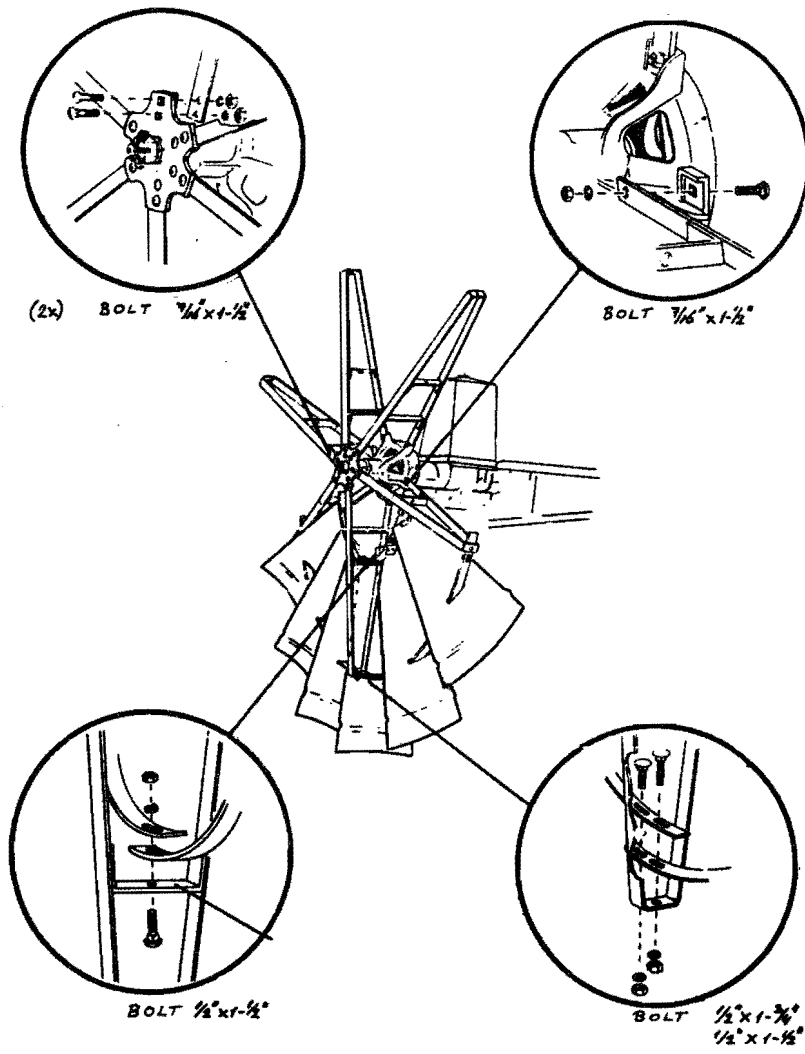
Figure 2   DEMPSTER 14' rotor assembly

BLADES

2 BOLTS
⅜" x 1"

INNER
RIM

2 BOLTS
⁷⁄₁₆ x 1-¼"

BLADE
SUPPORT

3 BOLTS
⁵⁄₁₆" x ¾"

OUTER
RIM
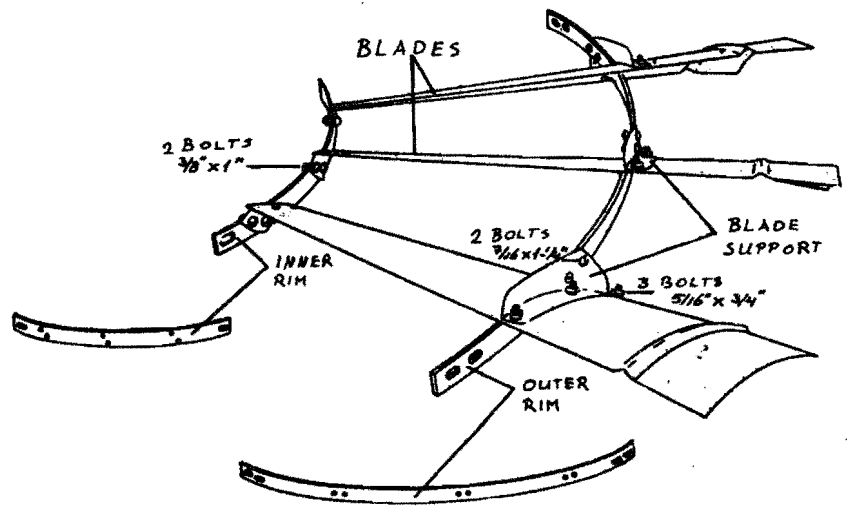
Figure 3   DEMPSTER 14' rotor section with 3 blades

Table 1 DEMPSTER 14' rotor specifications

Rotor diameter : 4.26 m
Number of blades: 18
Blade profile   : curved steel plate, constant radius
                  of curvature

Blade shape and angle setting:

Radius r (m)		Blade chord C (m)	Blade angle setting β	Profile curvature
0.99	blade root, inner rim	.200	45°	5%
1.71	outer rim		35°	
2.13	blade tip	.485		12%

Blade chord and blade angle may be assumed to vary linearly with
radius.
Supporting structure:
    See figures 2 and 3
    6 spokes
    inner rim at r = 0.99 m
    outer rim at r = 1.71 m
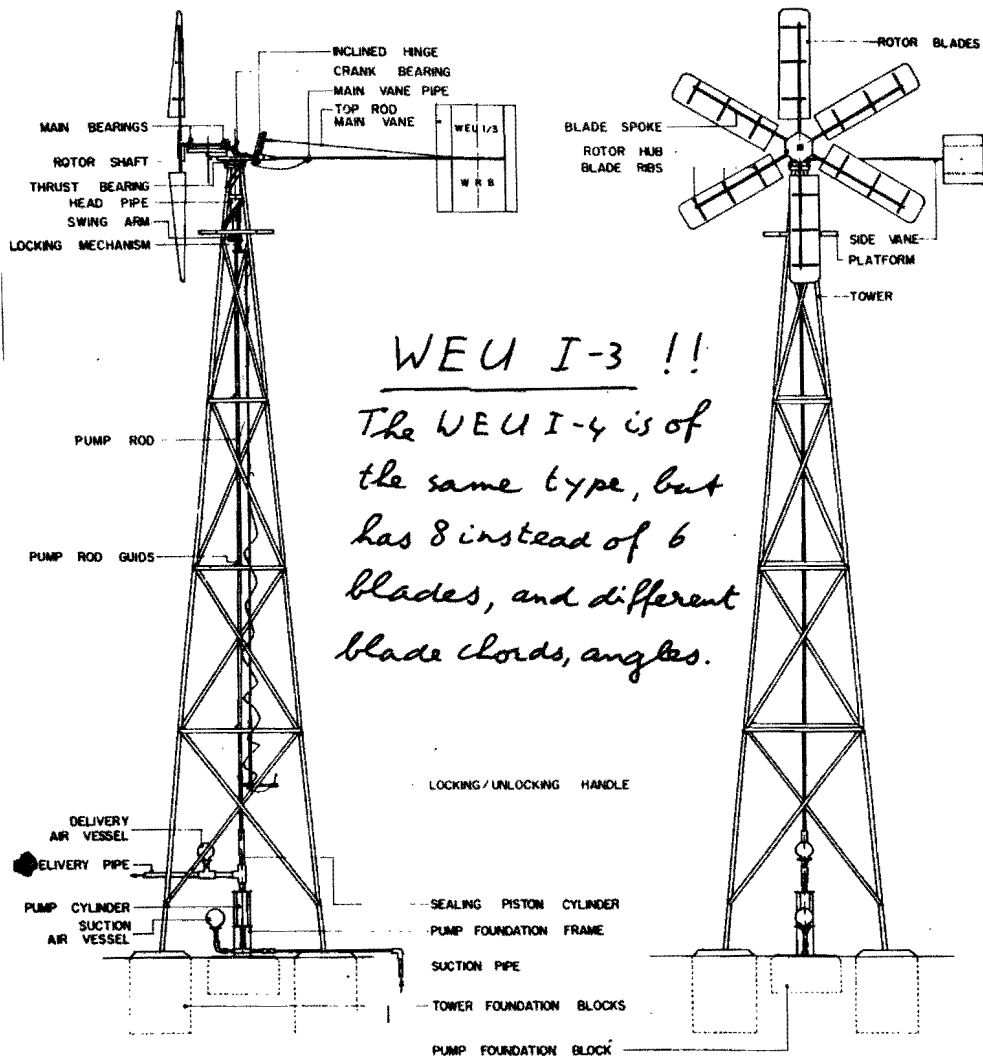
The WEU I-4 rotor has 8 blades. The blades are supported by round pipes at the wind ward side of the blades. The blades consist of curved steel plates of constant width and curvature. See also figure 5.
The specifications of the rotor are summarized in table 2.
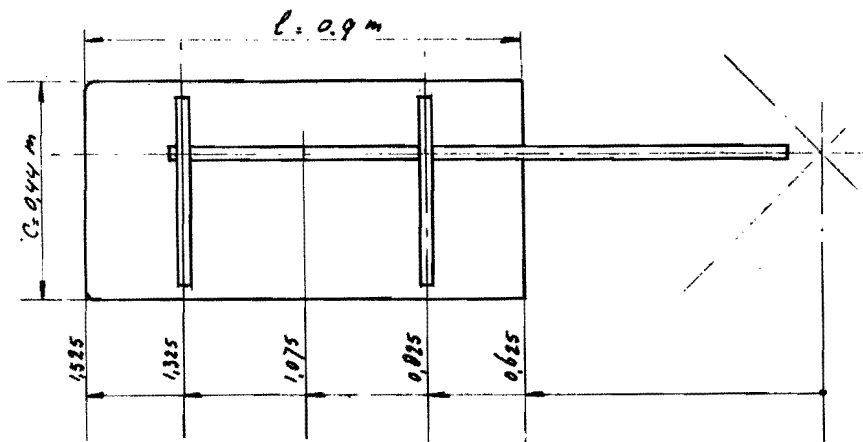
Figure 5   WEU I-4 rotor blade

Table 2   WEU I-4 rotor specifications

Rotor diameter   : 3.05 m
Number of blades: 8
Blade profile   : curved steel plate,curvature 10%
Blade shape and angle setting:

Radius r (m)		Blade chord C (m)	Blade angle setting β
0.625	blade root	0.44	
0.825	supporting rib	0.44	37°
1.325	supporting rib	0.44	28°
1.525	blade tip	0.44 (rounded)	

The blade angle may be assumed to vary linearly with radius.
Supporting structure:
    See figures 4 and 5
    Hub
    Spokes of round tube, diameter approximately 33 mm,
    fixed at 1/3 from the leading edge of the blade,
    extending to r = 1.325 m.
    Two blade supports (see above) for each blade.

I.3. CWD 5000 ROTOR

The CWD 5000 rotor was designed by CWD as part of its water pumping windmill of the same name, see figure 6.
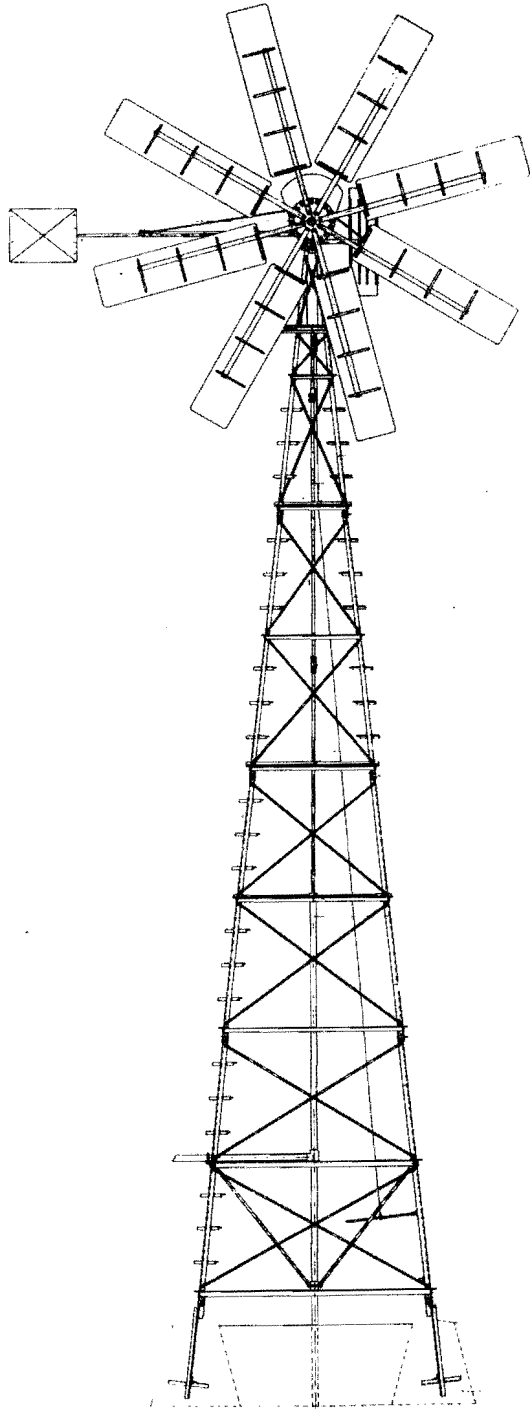
CWD 5000 LW

PURPOSE	: water lifting; designed for use in low and moderate wind regimes (yearly averages below 6 m/s)
ROTOR	: horizontal axis; upwind position by means of a tail vane; rotor diameter 5 m, 8 blades of galvanized steel sheet; fixed pitch
TRANSMISSION	: direct drive crank mechanism with adjustable stroke and overhead swing arm; strokes: 80-200 mm
CONTROL SYSTEMS	: over speed control by yawing, activated by side vane and hinged tail vane system; with manually activated furling device
PUMP SYSTEM	: single acting piston pump with pressure air chamber and starting nozzle; galvanized steel pump; nominal pump diameter of 150 mm.
TOWER	: lattice steel tower; height 12 m (alternative 9 m)
FOUNDATION	: requires about 1 m³ reinforced concrete per leg.
CAPACITY	: 50 m³/day at 20 m static head and 4.5 m/s wind speed.
OPERATING WIND SPEEDS	: - cut-in : 4 m/s - rated : 9 m/s - cut-out : 12 m/s (automatic furling between 8 and 12 m/s) - survival: 50 m/s
AERODYNAMIC PROPERTIES	: - λ (design): 2 - Cp (max): 0.35 - solidity: 0.34 - typical design wind speed: 4.5 m/s
WEIGHTS	: - rotor, head and transmission: ± 350 kg; - tower: 450 kg (9 m) resp. 650 kg (12 m) - pump including 25 m piping below ground level 280 kg
COST	: materials only ± US $ 1000.- (in The Netherlands)

Figure 6   CWD 5000 windmill

The CWD 5000 rotor has 8 blades. The blades are supported by round pipes at the wind ward side of the blades. The blades consist of curved steel plates of constant width and curvature. See also figure 7.
In comparison with the WEU I-4 rotor, the CWD 5000 has a lower solidity.
The specifications of the rotor are summarized in table 3.
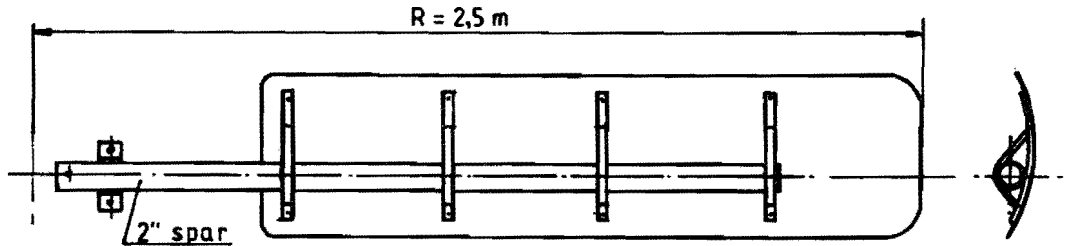
Figure 7   CWD 5000 rotor blade

Table 3   CWD 5000 rotor specifications

Rotor diameter : 5 m
Number of blades: 8
Blade profile   : curved steel plate, curvature 10%
Blade shape and angle setting:

Radius r (m)		Blade chord C (m)		Blade angle setting β
0.67	blade root	0.445	(rounded)	
0.71	support 1	0.445		38°
1.16	support 2	0.445		32°
1.61	support 3	0.445		26°
2.06	support 4	0.445		20°
2.50	blade tip	0.445	(rounded)	

The blade angle varies linearly with the radius.

Supporting structure:
    See figures 6 and 7
    Hub
    Spokes of round tube, diameter approximately 60 mm,
    fixed at 1/4 from the leading edge of the blade,
    extending to r = 2.06 m.
    Four blade supports (see above) for each blade.

I.4. DESIRED RESULTS OF CALCULATIONS

Although the title of the project, "Benchmark test of power curve computations", suggests that the project is concerned with an analysis of complete systems (i.e. including power conversion by the rotor, the transmission, and the load), it became clear from the questionnaires sent by Risø that the project will be focussed on aerodynamic calculations of rotor characteristics.
For slow running rotors of water pumping windmills the following results of calculations are of interest.
For the calculations one must assume a wind speed of 4 m/s (of importance for the calculation of Reynolds numbers!).

Minimum requirement of results

As a minimum, results must be presented of dimensionless rotor characteristics, i.e. dimensionless torque-r.p.m., power-r.p.m. and thrust-r.p.m. curves.
Summarizing:

- $C_Q-\lambda$ curve
- $C_P-\lambda$ curve
- $C_T-\lambda$ curve

Desirable results 1

For water pumping windmills one is especially interested in the characteristics of rotors in oblique flow. The behaviour of the safety system of a water pumping windmill depends strongly on the forces and moments, acting on the rotor in oblique flow (i.e. non axial flow). One is interested in the characteristics mentioned above with the angle of yaw as a parameter.

Summarizing:

- $C_Q-\lambda$ curves with δ as a parameter
- $C_P-\lambda$ curves with δ as a parameter
- $C_T-\lambda$ curves with δ as a parameter

Desirable results 2

For rotors in oblique flow, two additional force/moment components emerge: lateral (or side) force, and yawing moment. These two components have a strong influence on the behaviour of safety systems. Therefore it is of interest to calculate these components:
- $C_{F_s}-\lambda$ curves with δ as a parameter

- $C_{M_{yaw}}-\lambda$ curves with δ as a parameter.

I.5. MEASURED ROTOR CHARACTERISTICS

In this section the measured rotor characteristics are shown
of the three multibladed windmills. These characteristics have
been obtained from measurements on scale models in an open
windtunnel of 2.2 m. diameter.
In fig. 8 and 9 the $C_Q-\lambda$ and $C_P-\lambda$ curves are shown for the
Dempster 14' model, which has a diameter of 1.42 m. In fig. 10
through 13 the same characteristics are given for the scale
models of the WEU I-4 and the CWD 5000 rotors. Both models
have a diameter of 1.50 m.
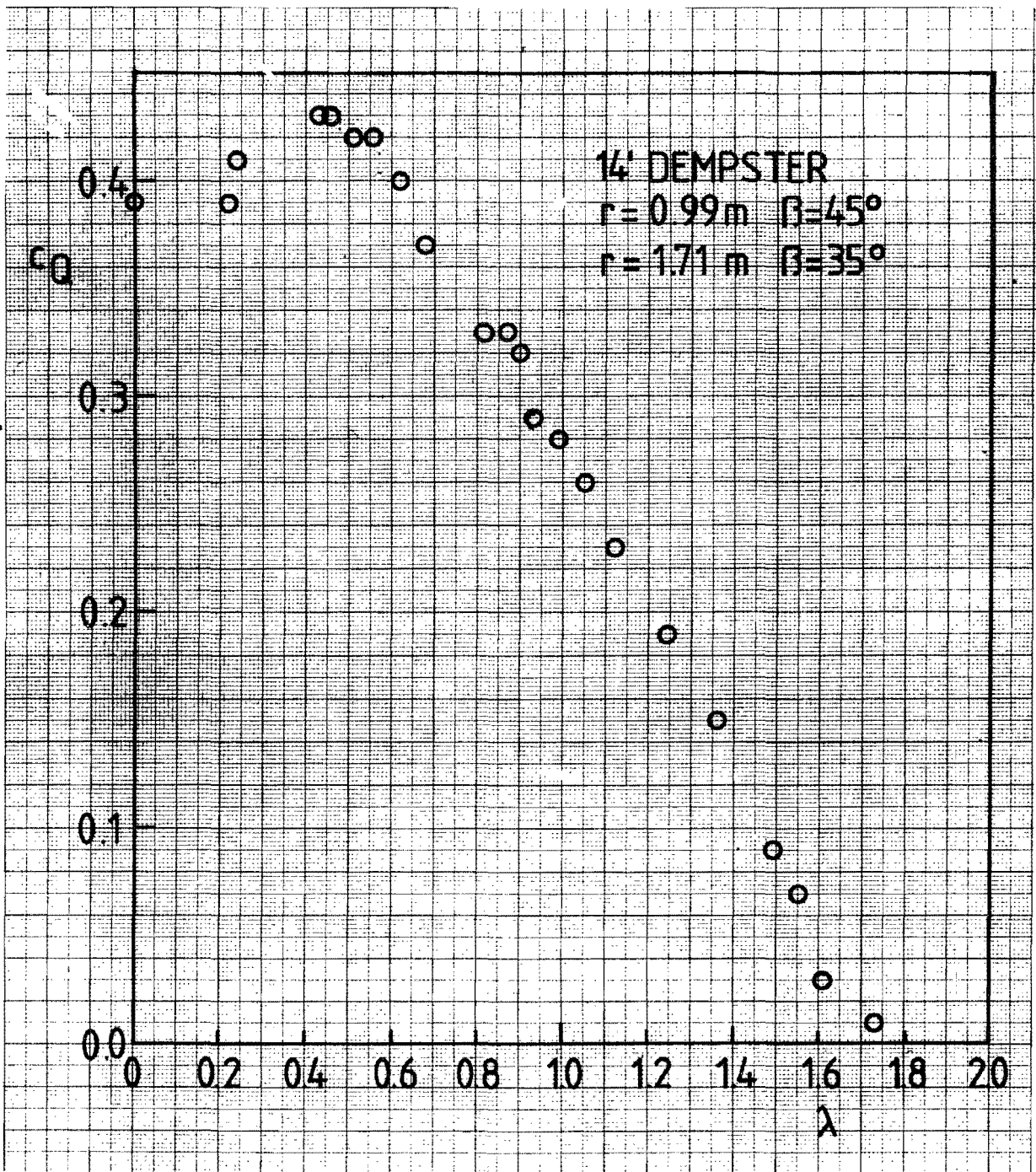
FIGURE 8: Dempster 14'. Torque coefficient as a function of tip speed
ratio [ref.3]
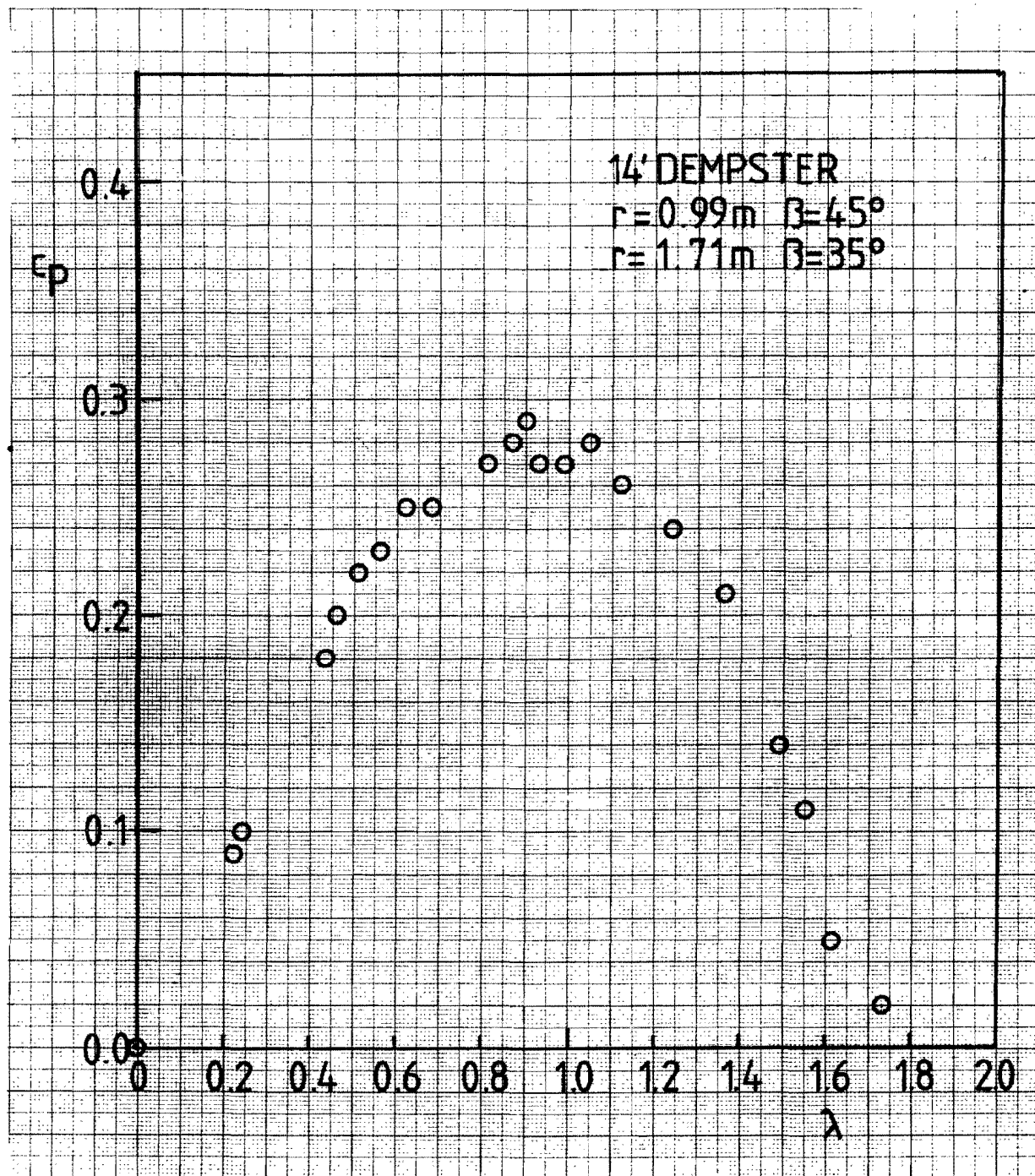
FIGURE 9: Dempster 14'. Power coefficient as a function of tip speed
ratio [ref.3]
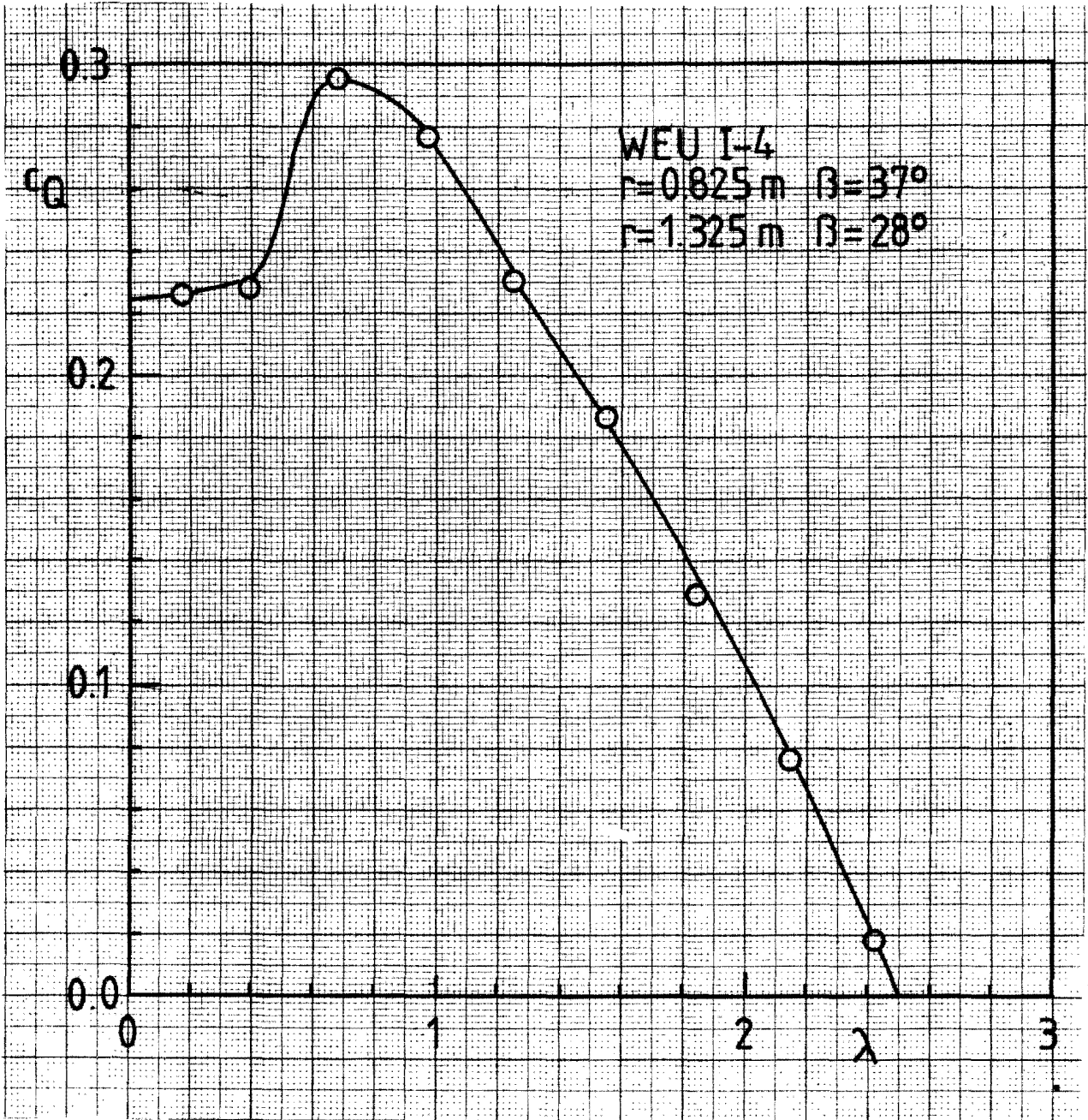
FIGURE 10: WEU I-4. Torque coefficient as a function of tip speed
ratio [ref.4]
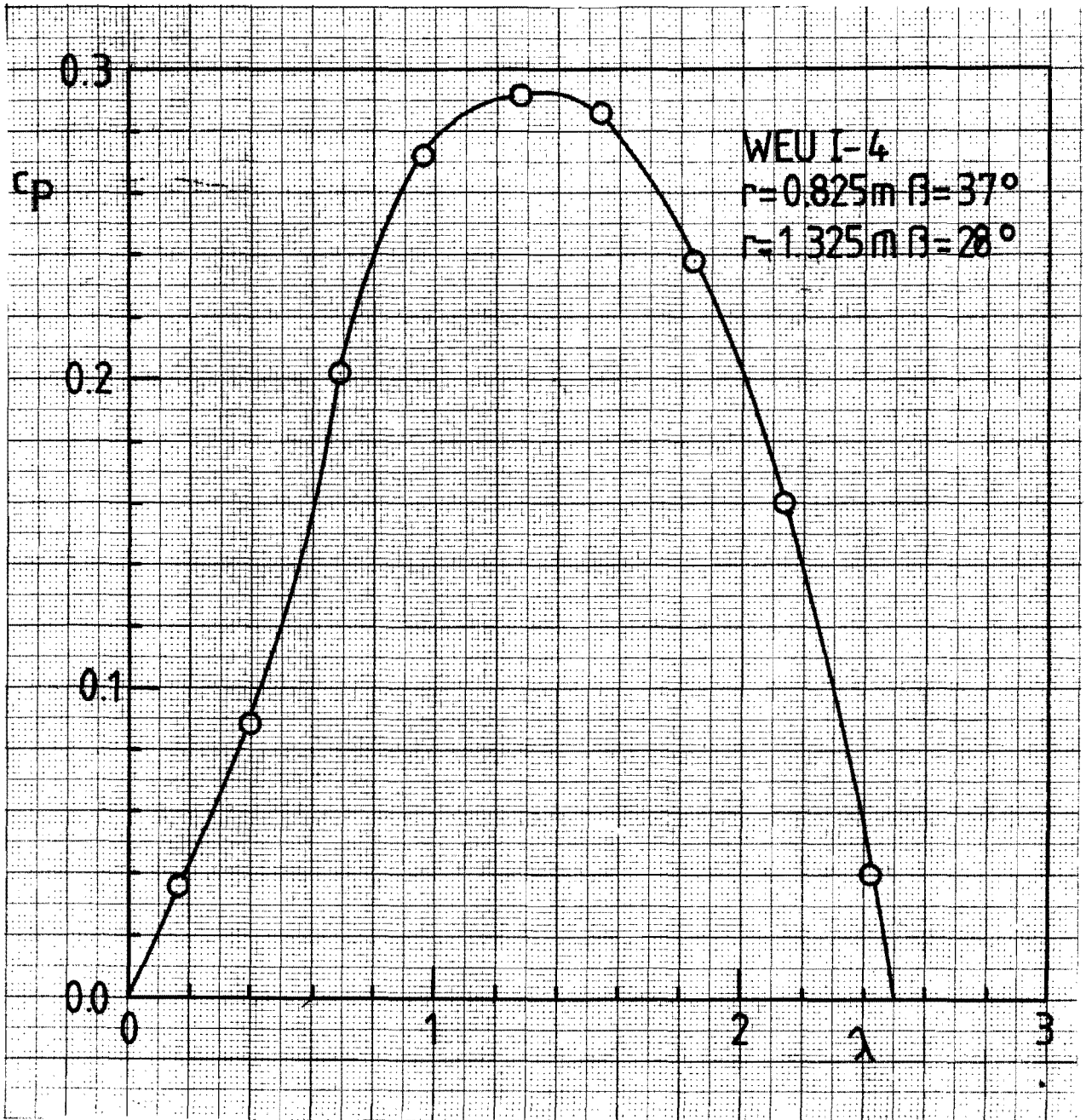
FIGURE 11: WEU I-4. Power coefficient as a funtion of tip speed
ratio [ref.4]
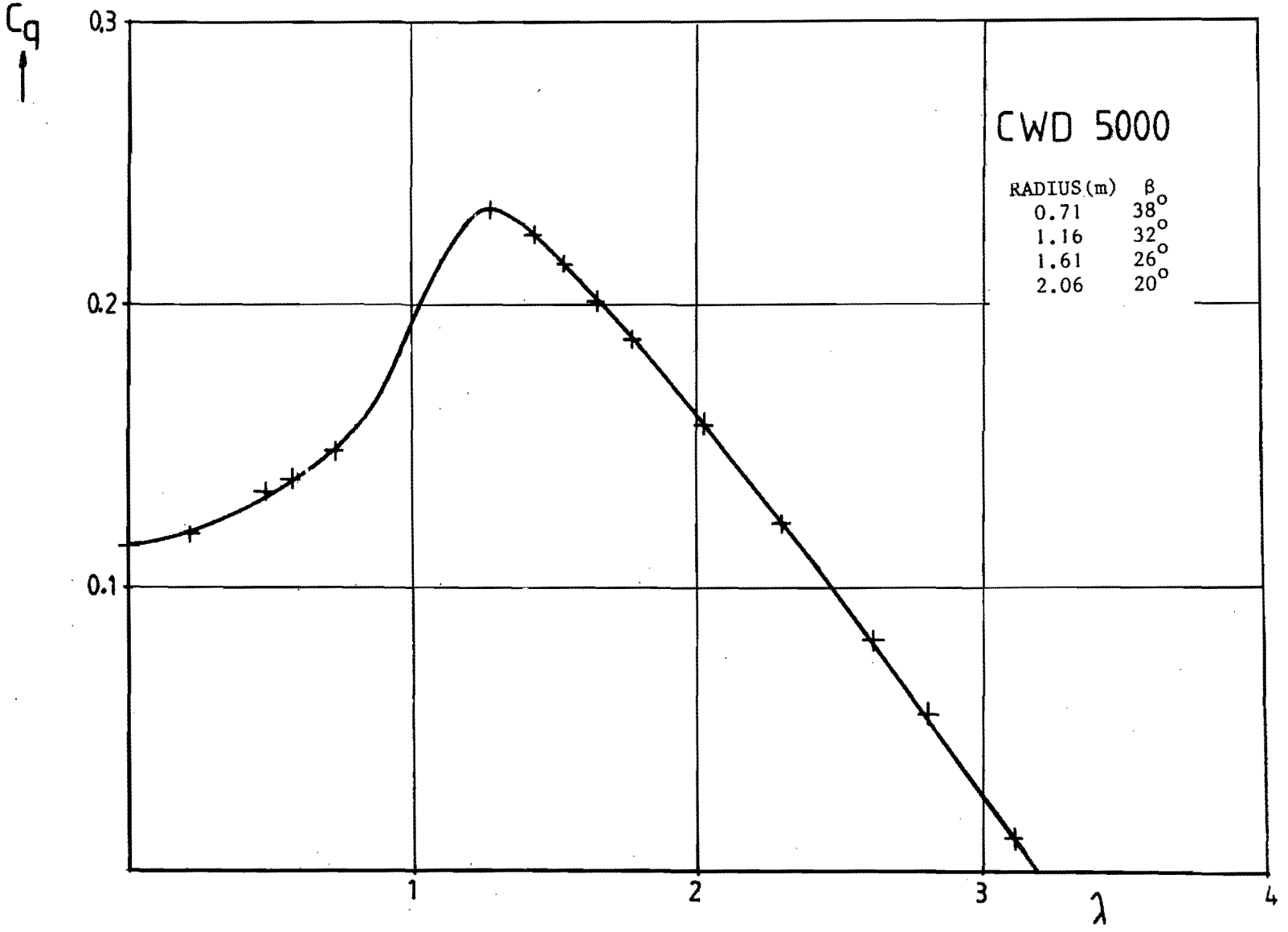
FIGURE 12: CWD 5000. Torque coefficient as a function of tip speed ratio [ref.5]

CWD 5000

RADIUS (m)	β
0.71	38°
1.16	32°
1.61	26°
2.06	20°

16.

FIGURE 13: CWD 5000. Power coefficient as a function of tip speed ratio [ref.5]

CWD 5000

RADIUS (m)	β
0.71	38°
1.16	32°
1.61	26°
2.06	20°

17.
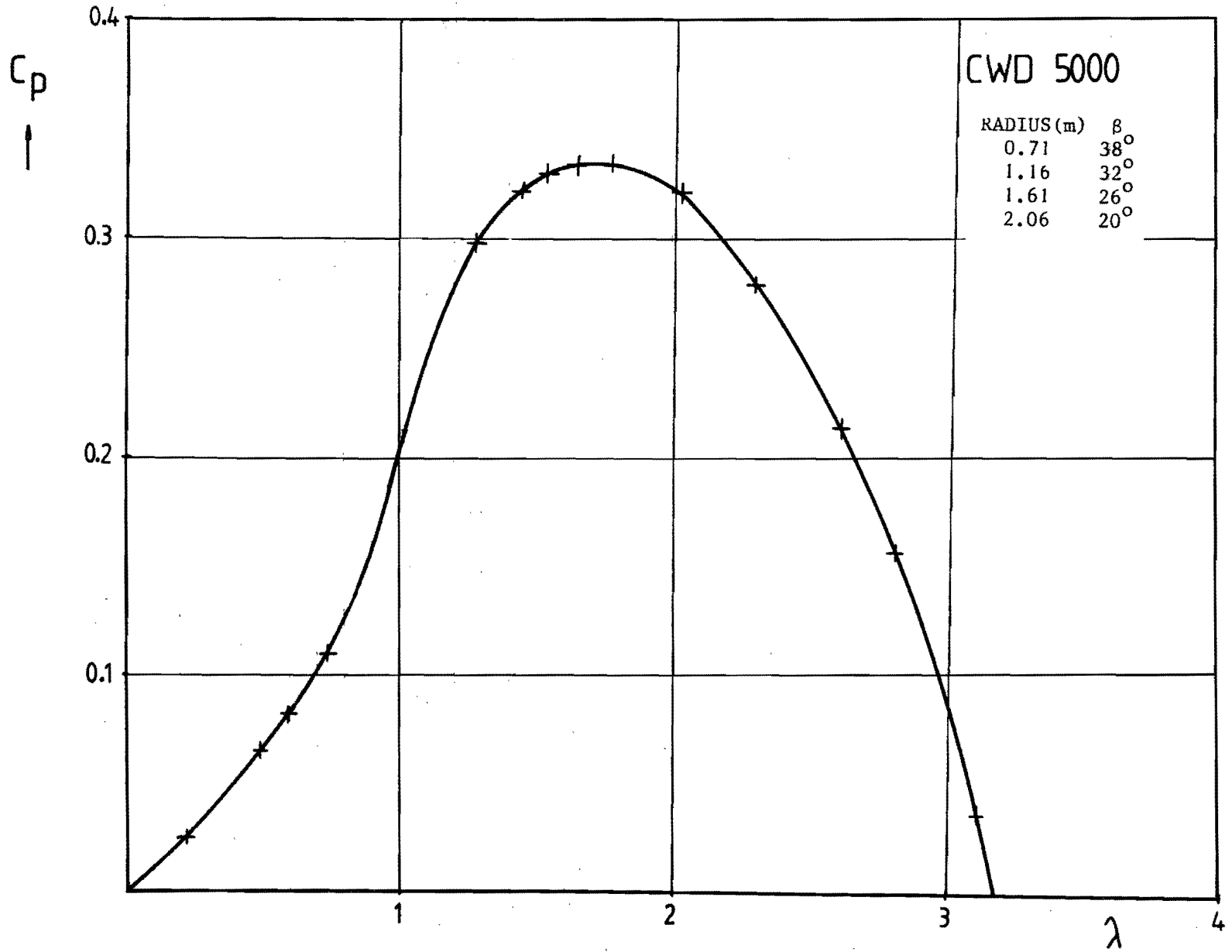
SECTION II

RESULTS OF POWER CURVE MEASUREMENTS

As agreed with the project leader Risø, CWD has carried out
tasks A.1 (stall controlled horizontal axis windturbine,
HAWT), A.2 (pitch controlled HAWT) and A.3 (multibladed HAWT),
according to the specifications.
For each HAWT the $C_P-\lambda$, $C_T-\lambda$ and $C_Q-\lambda$ curves are computed.
Depending on the desired calculation output, P-V and T-V are
also generated. All rotors are assumed to be perpendicular to
the undisturbed flow, which is assumed to be uniform. Table 1
gives a survey:

	HAWT	Output	Remarks
A.1	Windmatic WM 17 S	C_P, C_Q, $C_T-\lambda$	fixed pitch
		P, T-V	idem
A.2.a	Nibe-B	C_P, C_Q, $C_T-\lambda$	$-2° < \theta_P < 12.4°$
		P, T-V	with pitch control
A.2.b	Debra 25	C_P, C_Q, $C_T-\lambda$	$\theta_P = 4°$ and two rpm's (33,3 and 50)
		P, T-V	idem
A.2.c	25 m HAT Petten	C_P, C_Q, $C_T-\lambda$	$\theta_P = -2.5, 0, 2.5, 5, 10°$
A.3.a	Dempster 14')		
A.3.b	WEU I-4)	C_P, C_Q, $C_T-\lambda$	fixed pitch
A.3.c	CWD 5000)		

Each of the next sections contains all computer program
output. The figures refer to the most important pitch angles,
as far as C_P, C_Q and C_T are concerned.
Each section also shows the profile characteristics used in
the program. As the program contains a correction method to
convert the two-dimensional data to three-dimensional data,
both curves are shown: "o" indicated "old", that is the given
2-D characteristic. "n" refers to "new", the characteristic
after correction.
The correction method is known as the "Viterna & Corrigan
correction", and is described in [ref. 7]. Its main feature is
that the aspect ratio of the blade is taken into account. The
calculation method itself is an ordinary blade element/
momentum method, described in [ref. 6].
Finally appendix B gives the input of the program for each
wind turbine, except for the profile characteristics. These
can be found in the tables of the specifications, and in the
figures of the next sections.

II.1   WINDMATIC WM 17 S

task A.1

Wind Matic

Slankheid = 13.2   NACA 63215
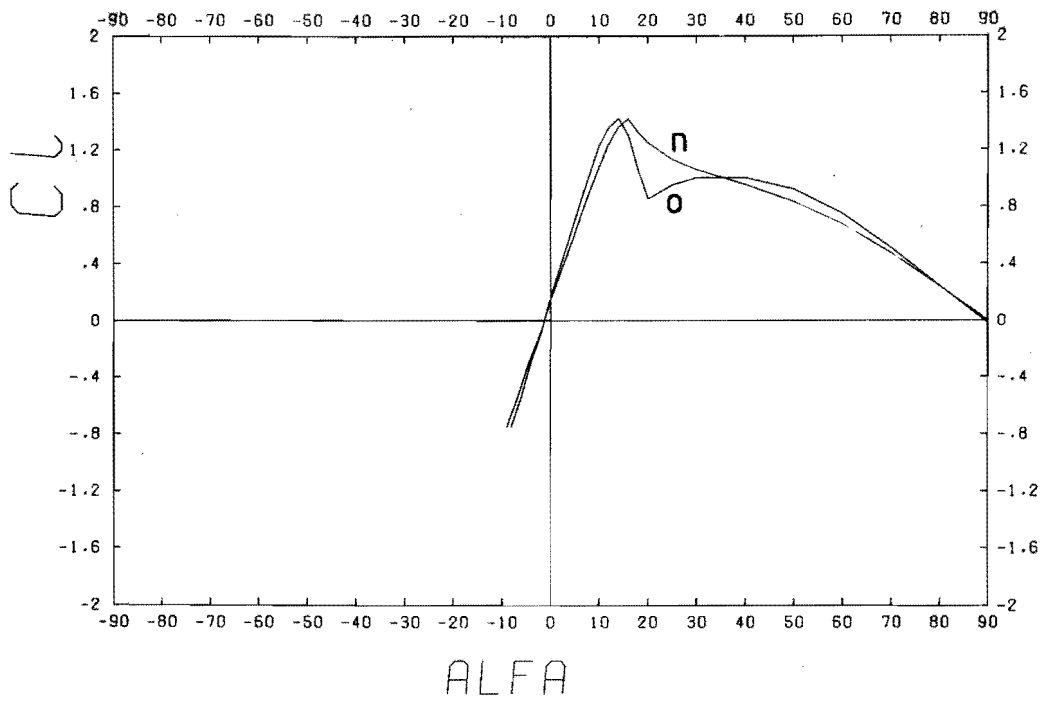
Viterna & Corrigan korrektie.

ALFA

Wind Matic

Slankheid = 13.2   NACA 63215

Viterna & Corrigan korrektie.

ALFA

Wind Matic Pitchhoek = 1.3 graden

Slankheid = 13.2   NACA 63215

Viterna & Corrigan korrektie.

LAMBDA

Wind Matic Pitchhoek = 1.3 graden

Slankheid = 13.2 NACA 63215

Viterna & Corrigan korrektie.

LAMBDA

Wind Matic Pitchhoek = 1.3 graden

Slankheid = 13.2 NACA 63215

Viterna & Corrigan korrektie.

LAMBDA
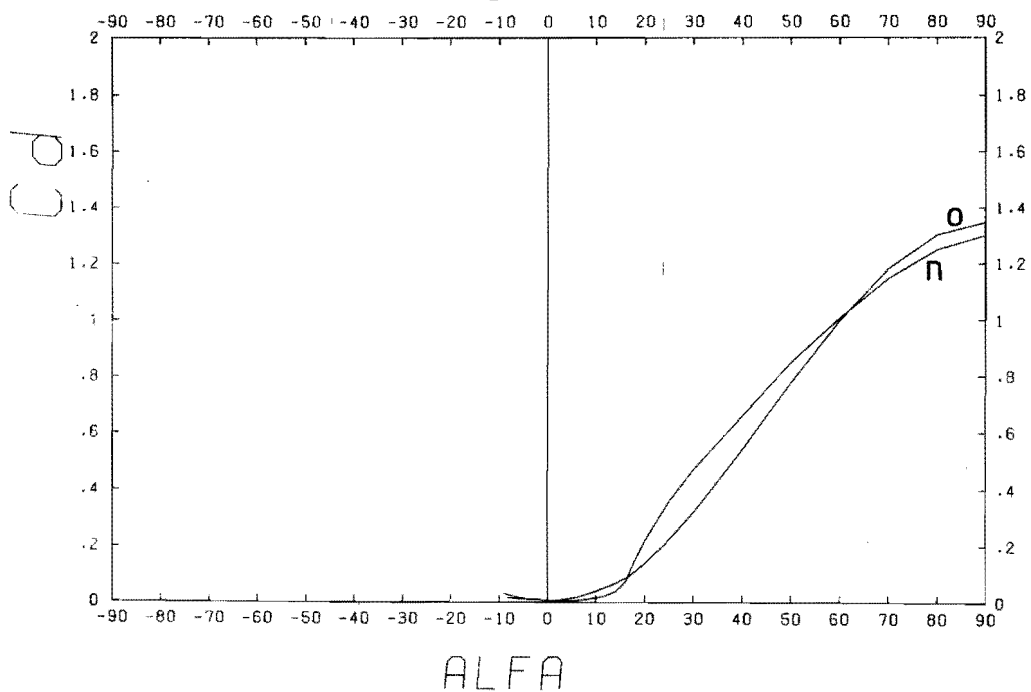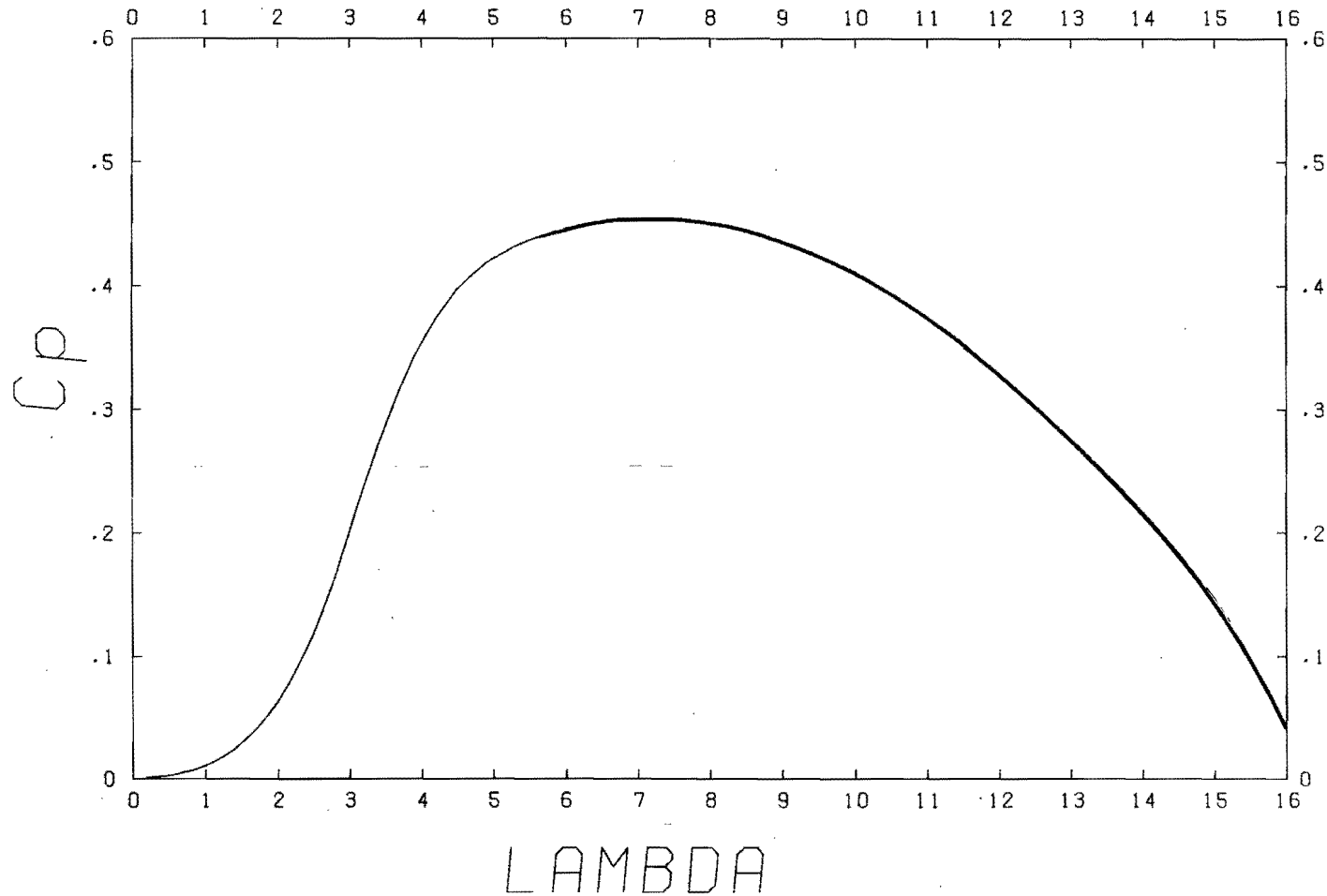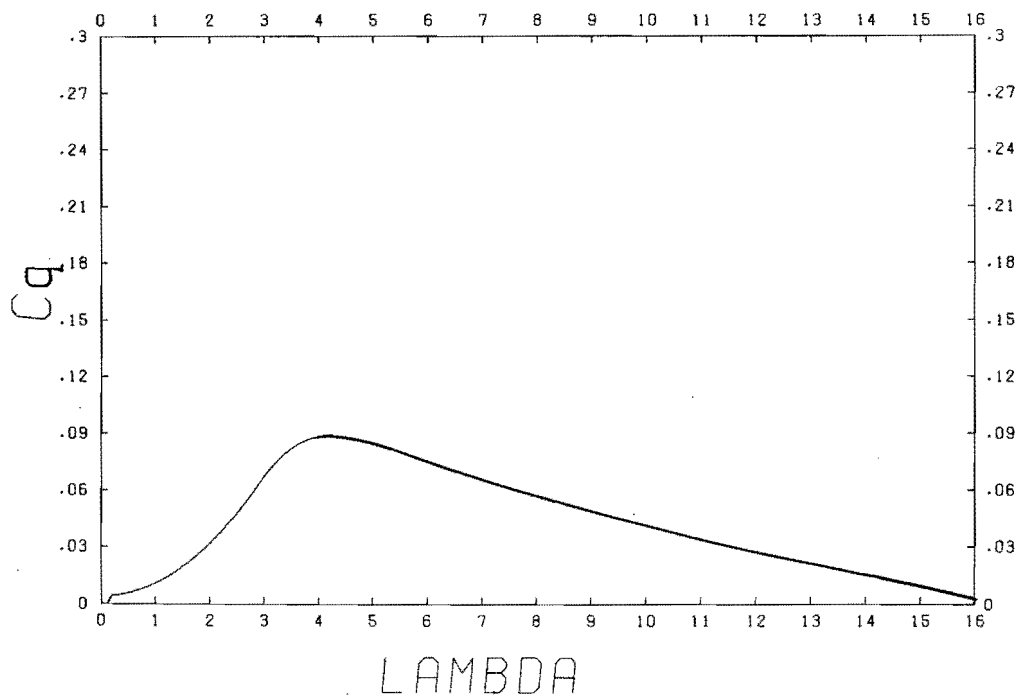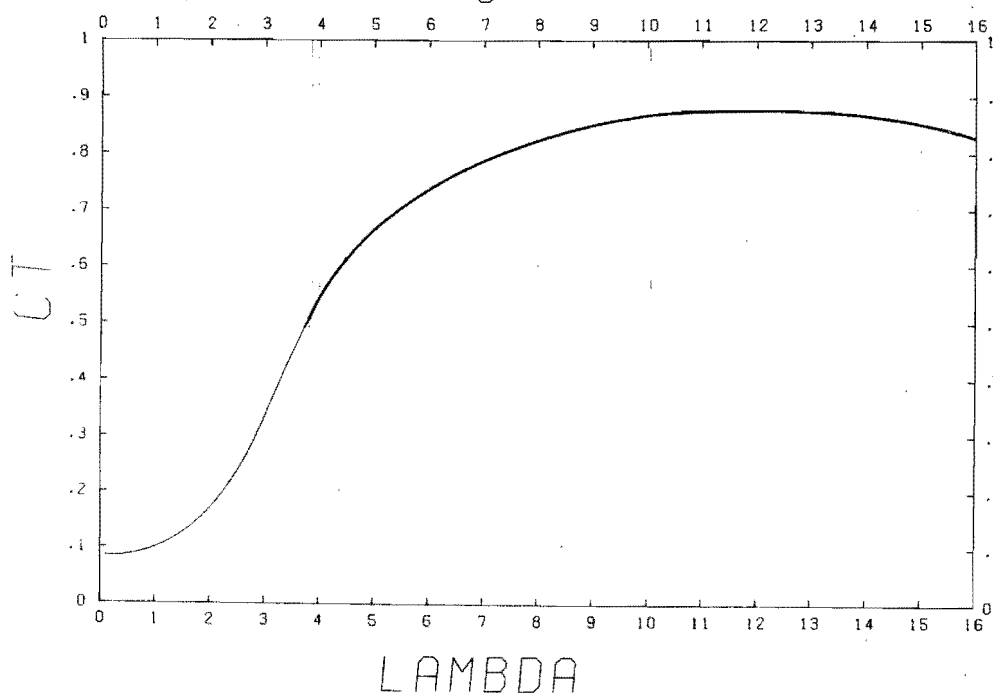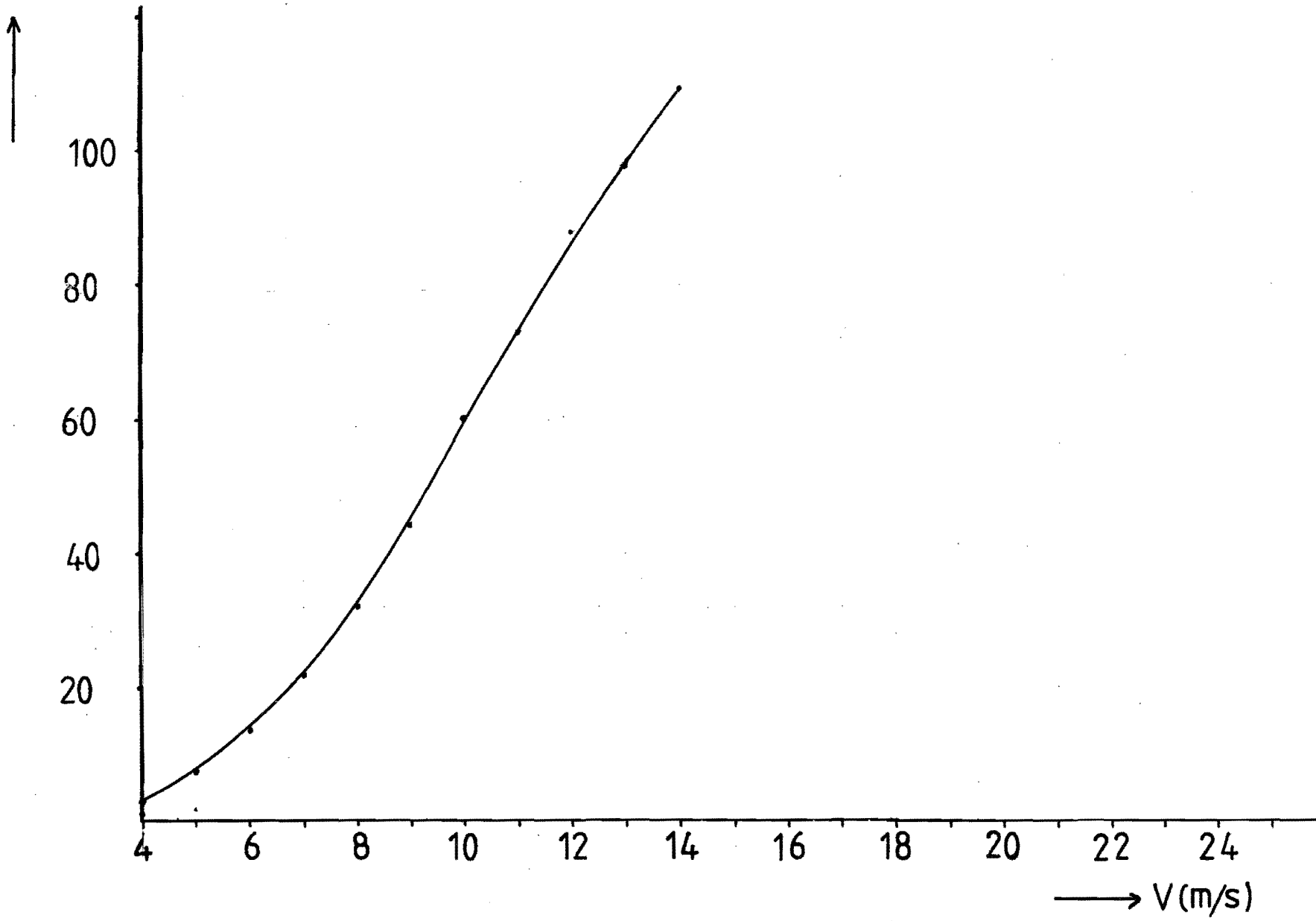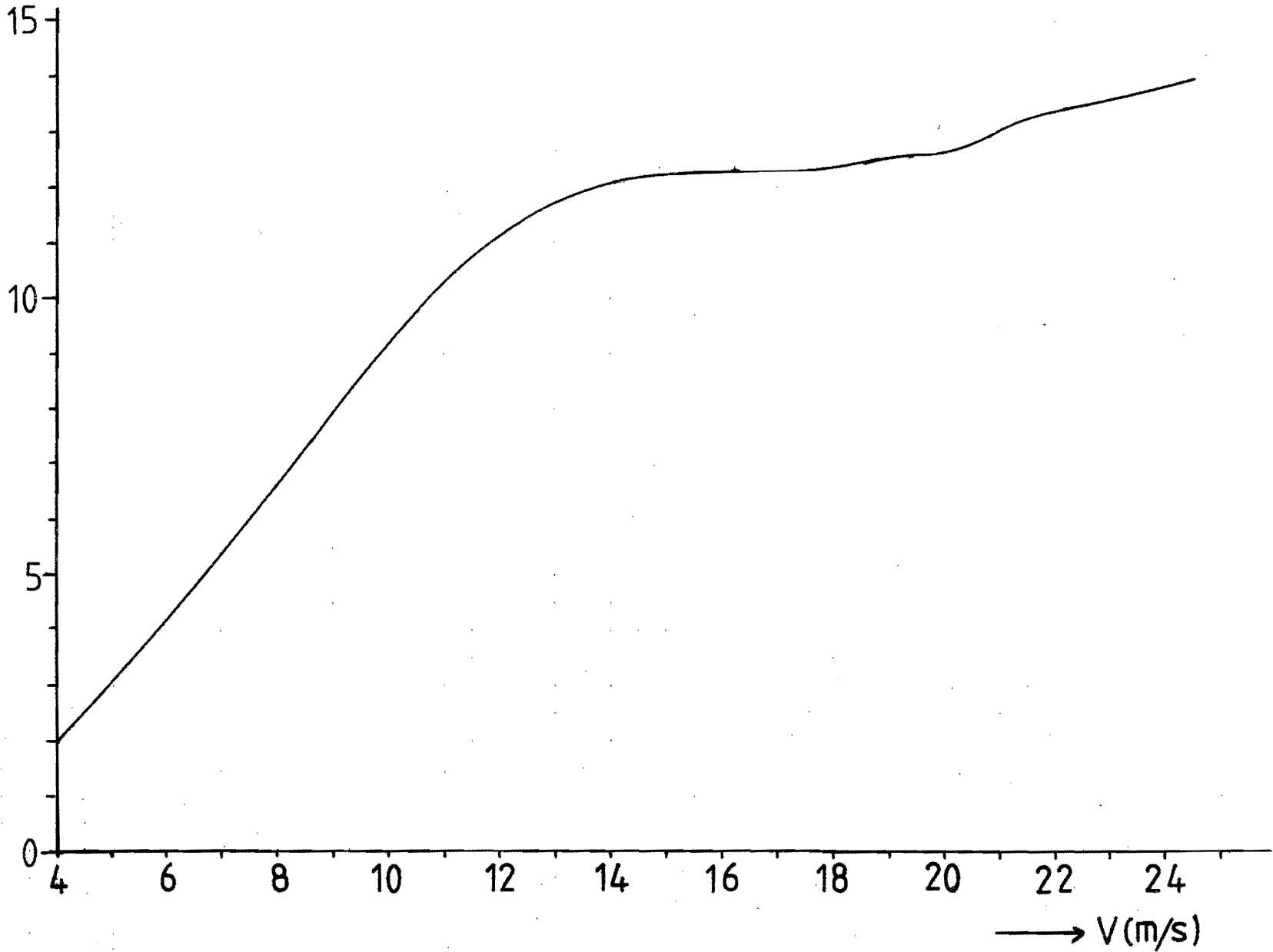
T(kN)   WINDMATIC

Numerieke uitkomsten van de berekeningen aan de Wind Matic molen.
Pitchhoek 1.3 graden.
Viterna & Corrigan korrektie.
Slankheid = 13.2
Het gebruikte profiel is NACA 63215
De straal van de rotor is 8.495 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt 55.0 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 0.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

| Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	-.0001	-.0012	0.0851	489.277	-2011.8	2829.7
0.10	-.0001	-.0012	0.0851	489.277	-2011.8	2829.7
0.20	0.0008	0.0042	0.0845	244.638	1722.5	701.9
0.30	0.0014	0.0046	0.0848	163.092	836.8	313.2
0.40	0.0021	0.0052	0.0859	122.319	523.9	178.4
0.50	0.0029	0.0058	0.0872	97.855	376.5	115.9
0.60	0.0039	0.0066	0.0888	81.546	296.0	82.0
0.70	0.0052	0.0074	0.0909	69.897	247.0	61.7
0.80	0.0068	0.0085	0.0936	61.160	215.8	48.6
0.90	0.0087	0.0097	0.0968	54.364	194.1	39.7
1.00	0.0110	0.0110	0.1004	48.928	178.3	33.4
1.10	0.0136	0.0124	0.1045	44.480	166.5	28.7
1.20	0.0168	0.0140	0.1091	40.773	157.8	25.2
1.30	0.0204	0.0157	0.1144	37.637	150.9	22.5
1.40	0.0246	0.0175	0.1203	34.948	145.5	20.4
1.50	0.0293	0.0195	0.1268	32.618	141.1	18.7
1.60	0.0347	0.0217	0.1339	30.580	137.6	17.4
1.70	0.0407	0.0239	0.1418	28.781	134.8	16.3
1.80	0.0475	0.0264	0.1504	27.182	132.4	15.4
1.90	0.0550	0.0289	0.1597	25.751	130.4	14.7
2.00	0.0633	0.0317	0.1699	24.464	128.8	14.1
2.10	0.0726	0.0346	0.1811	23.299	127.4	13.7
2.20	0.0827	0.0376	0.1933	22.240	126.4	13.3
2.30	0.0938	0.0408	0.2066	21.273	125.4	13.0
2.40	0.1059	0.0441	0.2207	20.387	124.6	12.7
2.50	0.1190	0.0476	0.2362	19.571	123.9	12.6
2.60	0.1333	0.0513	0.2528	18.818	123.3	12.4
2.70	0.1487	0.0551	0.2708	18.121	122.9	12.3
2.80	0.1654	0.0591	0.2905	17.474	122.5	12.3
2.90	0.1833	0.0632	0.3115	16.872	122.2	12.3
3.00	0.2018	0.0673	0.3340	16.309	121.6	12.3
3.10	0.2198	0.0709	0.3562	15.783	120.0	12.3
3.20	0.2376	0.0743	0.3788	15.290	117.9	12.3
3.30	0.2551	0.0773	0.4014	14.827	115.4	12.3
3.40	0.2718	0.0799	0.4238	14.390	112.5	12.2
3.50	0.2874	0.0821	0.4450	13.979	109.0	12.1
3.60	0.3031	0.0842	0.4666	13.591	105.7	12.0
3.70	0.3167	0.0856	0.4867	13.224	101.7	11.8
3.80	0.3302	0.0869	0.5067	12.876	97.9	11.7
3.90	0.3426	0.0878	0.5260	12.546	93.9	11.5
4.00	0.3534	0.0883	0.5431	12.232	89.8	11.3
4.10	0.3639	0.0887	0.5601	11.934	85.9	11.1
4.20	0.3734	0.0889	0.5765	11.649	82.0	10.9
4.30	0.3812	0.0886	0.5903	11.379	78.0	10.6
4.40	0.3893	0.0885	0.6046	11.120	74.3	10.4
4.50	0.3969	0.0882	0.6187	10.873	70.8	10.2
4.60	0.4024	0.0875	0.6298	10.636	67.2	9.9
4.70	0.4078	0.0868	0.6408	10.410	63.9	9.6
4.80	0.4130	0.0860	0.6516	10.193	60.7	9.4
4.90	0.4181	0.0853	0.6625	9.985	57.8	9.2
5.00	0.4218	0.0844	0.6716	9.786	54.9	8.9
5.10	0.4252	0.0834	0.6798	9.594	52.1	8.7
5.20	0.4283	0.0824	0.6877	9.409	49.5	8.5
5.30	0.4313	0.0814	0.6954	9.232	47.1	8.2
5.40	0.4340	0.0804	0.7024	9.061	44.8	8.0
5.50	0.4365	0.0794	0.7093	8.896	42.7	7.8
5.60	0.4388	0.0784	0.7159	8.737	40.6	7.6
5.70	0.4408	0.0773	0.7223	8.584	38.7	7.4
5.80	0.4426	0.0763	0.7285	8.436	36.9	7.2
5.90	0.4442	0.0753	0.7344	8.293	35.2	7.0
6.00	0.4457	0.0743	0.7401	8.155	33.6	6.8
6.10	0.4471	0.0733	0.7456	8.021	32.0	6.7
6.20	0.4483	0.0723	0.7509	7.892	30.6	6.5
6.30	0.4495	0.0713	0.7561	7.766	29.2	6.3
6.40	0.4506	0.0704	0.7612	7.645	28.0	6.2
6.50	0.4516	0.0695	0.7661	7.527	26.7	6.0
6.60	0.4525	0.0686	0.7709	7.413	25.6	5.9
6.70	0.4534	0.0677	0.7755	7.303	24.5	5.7
6.80	0.4543	0.0668	0.7800	7.195	23.5	5.6
6.90	0.4551	0.0660	0.7844	7.091	22.5	5.5
7.00	0.4559	0.0651	0.7887	6.990	21.6	5.4
7.10	0.4562	0.0642	0.7928	6.891	20.7	5.2
7.20	0.4561	0.0633	0.7968	6.796	19.9	5.1
7.30	0.4559	0.0625	0.8007	6.702	19.1	5.0
7.40	0.4554	0.0615	0.8045	6.612	18.3	4.9
7.50	0.4549	0.0606	0.8082	6.524	17.5	4.8
7.60	0.4541	0.0597	0.8117	6.438	16.8	4.7
7.70	0.4533	0.0589	0.8152	6.354	16.1	4.6
7.80	0.4523	0.0580	0.8185	6.273	15.5	4.5
7.90	0.4513	0.0571	0.8218	6.193	14.9	4.4
8.00	0.4502	0.0563	0.8249	6.116	14.3	4.3
8.10	0.4490	0.0554	0.8280	6.040	13.7	4.2
8.20	0.4477	0.0546	0.8309	5.967	13.2	4.1
8.30	0.4464	0.0538	0.8337	5.895	12.7	4.0
8.40	0.4451	0.0530	0.8365	5.825	12.2	3.9
8.50	0.4437	0.0522	0.8391	5.756	11.7	3.9
8.60	0.4422	0.0514	0.8416	5.689	11.3	3.8
8.70	0.4407	0.0507	0.8441	5.624	10.9	3.7
8.80	0.4391	0.0499	0.8465	5.560	10.5	3.6
8.90	0.4375	0.0492	0.8487	5.497	10.1	3.6
9.00	0.4359	0.0484	0.8509	5.436	9.7	3.5
9.10	0.4342	0.0477	0.8530	5.377	9.4	3.4
9.20	0.4325	0.0470	0.8550	5.318	9.0	3.4
9.30	0.4308	0.0463	0.8569	5.261	8.7	3.3
9.40	0.4290	0.0456	0.8588	5.205	8.4	3.2
9.50	0.4271	0.0450	0.8605	5.150	8.1	3.2
9.60	0.4246	0.0442	0.8622	5.097	7.8	3.1
9.70	0.4217	0.0435	0.8638	5.044	7.5	3.1
9.80	0.4185	0.0427	0.8653	4.993	7.2	3.0
9.90	0.4152	0.0419	0.8668	4.942	7.0	2.9
10.00	0.4119	0.0412	0.8681	4.893	6.7	2.9
10.10	0.4084	0.0404	0.8694	4.844	6.4	2.8
10.20	0.4048	0.0397	0.8706	4.797	6.2	2.8
10.30	0.4011	0.0389	0.8717	4.750	6.0	2.7
10.40	0.3974	0.0382	0.8728	4.705	5.7	2.7
10.50	0.3936	0.0375	0.8738	4.660	5.5	2.6
10.60	0.3897	0.0368	0.8747	4.616	5.3	2.6
10.70	0.3858	0.0361	0.8755	4.573	5.1	2.5
10.80	0.3817	0.0353	0.8763	4.530	4.9	2.5

10.90	0.3776	0.0346	0.8770	4.489	4.7	2.5
11.00	0.3735	0.0340	0.8776	4.448	4.6	2.4
11.10	0.3692	0.0333	0.8782	4.408	4.4	2.4
11.20	0.3649	0.0326	0.8787	4.369	4.2	2.3
11.30	0.3605	0.0319	0.8792	4.330	4.1	2.3
11.40	0.3561	0.0312	0.8795	4.292	3.9	2.2
11.50	0.3516	0.0306	0.8798	4.255	3.8	2.2
11.60	0.3470	0.0299	0.88ʊ1	4.218	3.6	2.2
11.70	0.3424	0.0293	0.8803	4.182	3.5	2.1
11.80	0.3377	0.0286	0.8804	4.146	3.3	2.1
11.90	0.3329	0.0280	0.8804	4.112	3.2	2.1
12.00	0.3281	0.0273	0.8804	4.077	3.1	2.0
12.10	0.3232	0.0267	0.8804	4.044	3.0	2.0
12.20	0.3182	0.0261	0.8803	4.010	2.9	2.0
12.30	0.3132	0.0255	0.8801	3.978	2.7	1.9
12.40	0.3081	0.0248	0.8798	3.946	2.6	1.9
12.50	0.3029	0.0242	0.8795	3.914	2.5	1.9
12.60	0.2977	0.0236	0.8792	3.883	2.4	1.8
12.70	0.2924	0.0230	0.8788	3.853	2.3	1.8
12.80	0.2871	0.0224	0.8783	3.822	2.2	1.8
12.90	0.2816	0.0218	0.8778	3.793	2.1	1.8
13.00	0.2762	0.0212	0.8772	3.764	2.0	1.7
13.10	0.2706	0.0207	0.8766	3.735	2.0	1.7
13.20	0.2650	0.0201	0.8759	3.707	1.9	1.7
13.30	0.2593	0.0195	0.8752	3.679	1.8	1.6
13.40	0.2536	0.0189	0.8744	3.651	1.7	1.6
13.50	0.2478	0.0184	0.8736	3.624	1.6	1.6
13.60	0.2419	0.0178	0.8727	3.598	1.6	1.6
13.70	0.2360	0.0172	0.8718	3.571	1.5	1.5
13.80	0.2300	0.0167	0.8708	3.545	1.4	1.5
13.90	0.2239	0.0161	0.8697	3.520	1.4	1.5
14.00	0.2178	0.0156	.8686	3.495	1.3	1.5
14.10	0.2113	0.0150	ʊ.8674	3.470	1.2	1.5
14.20	0.2048	0.0144	0.8661	3.446	1.2	1.4
14.30	0.1982	0.0139	0.8648	3.422	1.1	1.4
14.40	0.1915	0.0133	0.8635	3.398	1.0	1.4
14.50	0.1845	0.0127	0.8620	3.374	1.0	1.4
14.60	0.1775	0.0122	0.8605	3.351	0.9	1.3
14.70	0.1703	0.0116	0.8589	3.328	0.9	1.3
14.80	0.1630	0.0110	0.8573	3.306	0.8	1.3
14.90	0.1555	0.0104	0.8556	3.284	0.8	1.3
15.00	0.1477	0.0098	0.8539	3.262	0.7	1.3
15.10	0.1395	0.0092	0.8520	3.240	0.7	1.2
15.20	0.1303	0.0086	0.8501	3.219	0.6	1.2
15.30	0.1205	0.0079	0.8481	3.198	0.5	1.2
15.40	0.1102	0.0072	0.8462	3.177	0.5	1.2
15.50	0.0995	0.0064	0.8442	3.157	0.4	1.2
15.60	0.0882	0.0057	0.8422	3.136	0.4	1.2
15.70	0.0768	0.0049	0.8402	3.116	0.3	1.1
15.80	0.0652	0.0041	0.8381	3.097	0.3	1.1
15.90	0.0534	0.0034	0.8361	3.077	0.2	1.1
16.00	0.0415	0.0026	0.8340	3.058	0.2	1.1
16.10	0.0294	0.0018	0.8318	3.039	0.1	1.1
16.20	0.0171	0.0011	0.8297	3.020	0.1	1.1
16.30	0.0047	0.0003	0.8275	3.002	0.0	1.0
16.40	-.0079	-.0005	0.8253	2.983	-0.0	1.0

Er is 0 maal geen convergentie bereikt.

II.2   NIBE B

task A.2.a

NIBE B

Slankheid = 18.2   NACA   4418

Viterna & Corrigan korrektie.
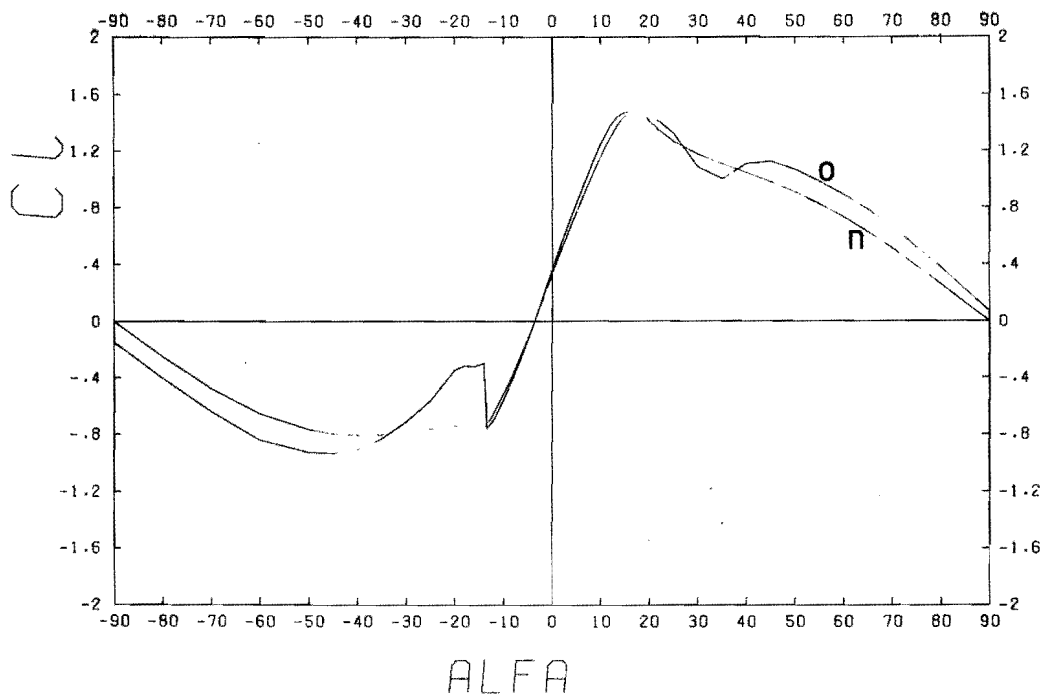
NIBE B

Slankheid = 18.2   NACA   4418

Viterna & Corrigan korrektie.

NIBE B Pitchhoek = -2.0 graden
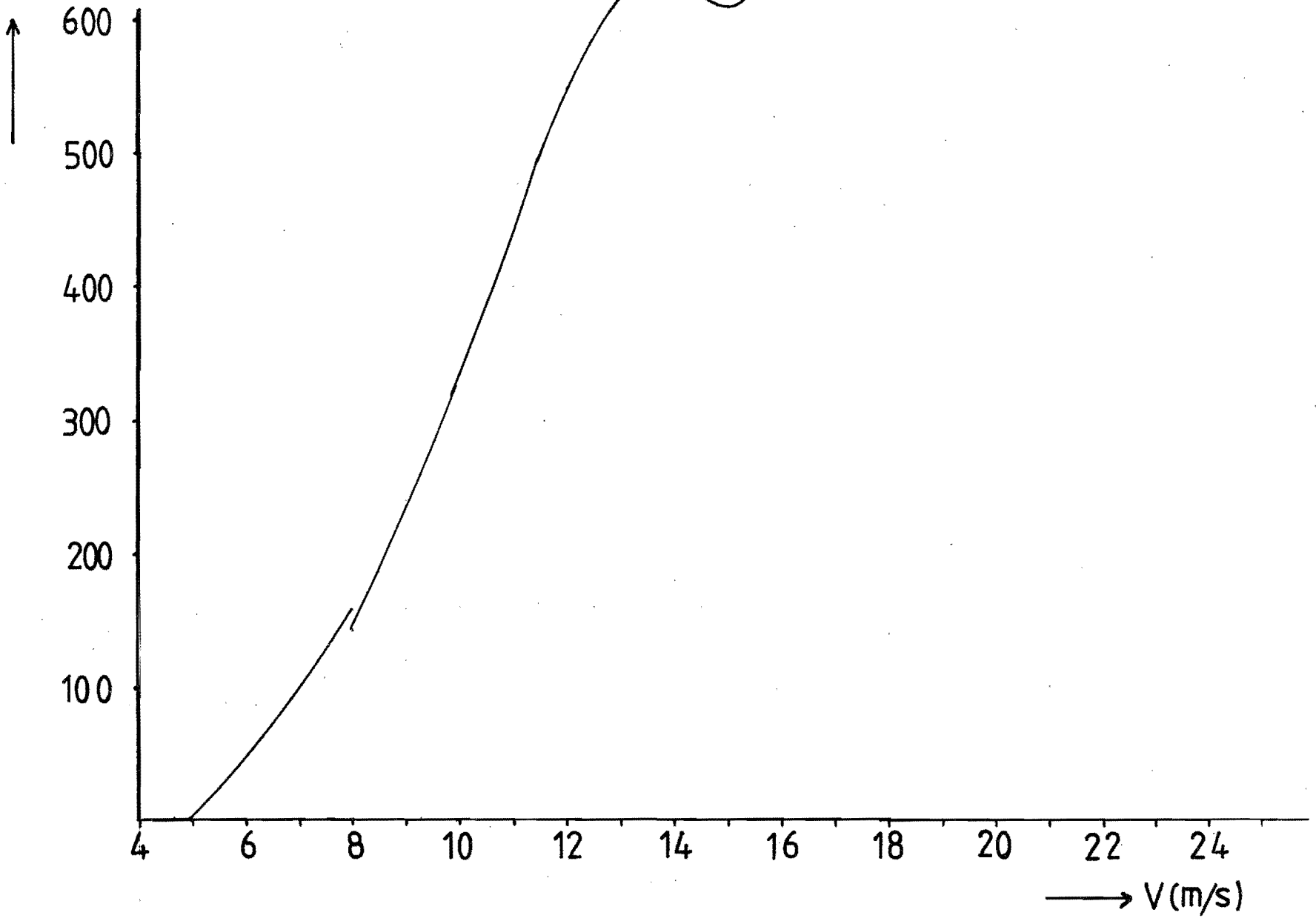
Slankheid = 18.2   NACA 4418

Viterna & Corrigan korrektie.

LAMBDA
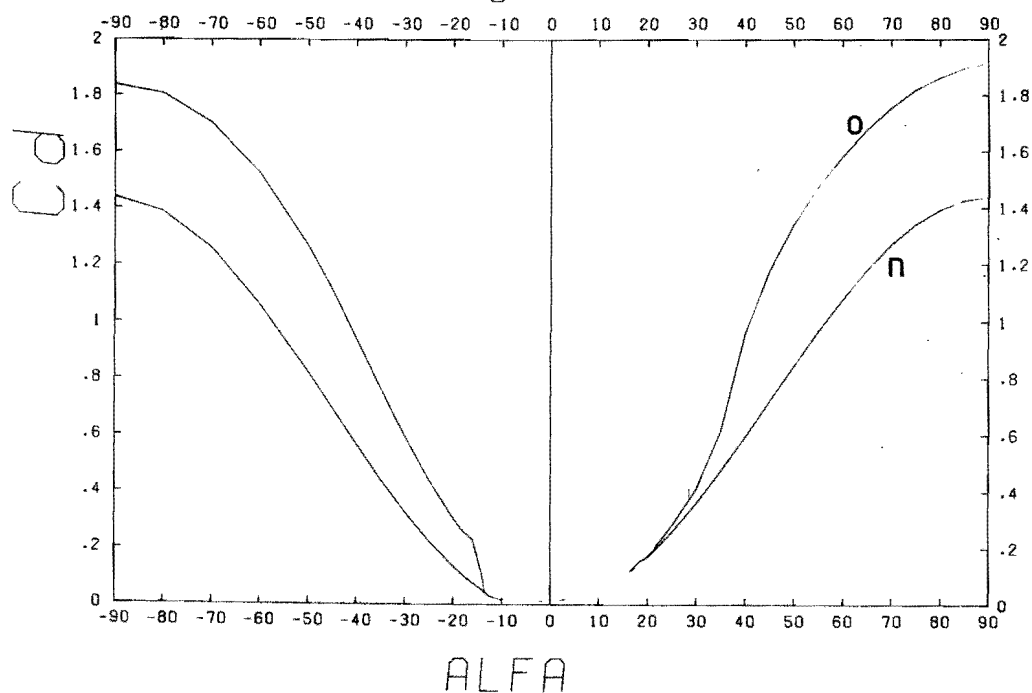
NIBE B Pitchhoek = -2.0 graden
Slankheid = 18.2   NACA 4418
Viterna & Corrigan korrektie.

LAMBDA

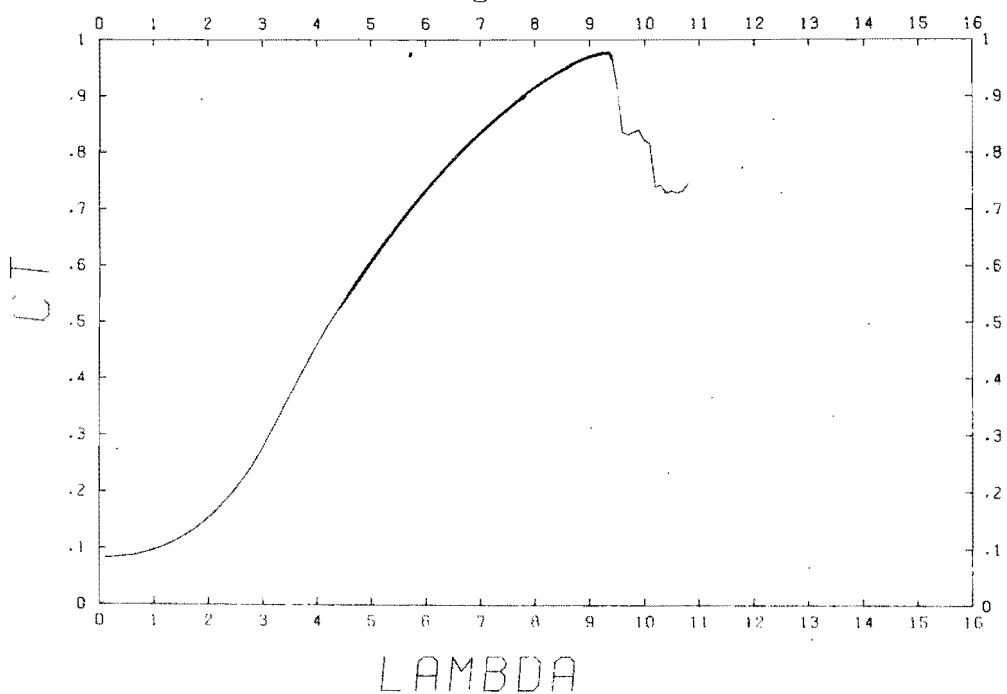# NIBE B Pitchhoek = -2.0 graden
Slankheid = 18.2   NACA 4418
Viterna & Corrigan korrektie.

LAMBDA

NIBE B

T(kN)

NIBE B

15 19 23 27 31 35 39 43 47 51 55 59 63 67 71 75

4 6 8 10 12 14 16 18 20 22 24

→ V(m/s)

33.

Pitchhoek -2.0 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is 20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt 33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 0.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0002	0.0018	0.0835	699.528	48144.5	31440.1
0.10	0.0002	0.0018	0.0835	699.528	48144.5	31440.1
0.20	0.0005	0.0025	0.0837	349.764	16721.4	7883.6
0.30	0.0008	0.0028	0.0842	233.176	8216.3	3523.3
0.40	0.0013	0.0032	0.0850	174.882	5209.8	2001.8
0.50	0.0018	0.0036	0.0862	139.906	3807.6	1298.4
0.60	0.0025	0.0042	0.0877	116.588	3040.4	917.2
0.70	0.0034	0.0048	0.0895	99.933	2575.0	688.0
0.80	0.0044	0.0055	0.0917	87.441	2271.5	539.8
0.90	0.0057	0.0063	0.0943	77.725	2061.9	438.5
1.00	0.0073	0.0073	0.0973	69.953	1910.8	366.5
1.10	0.0091	0.0083	0.1007	63.593	1799.3	313.5
1.20	0.0112	0.0094	0.1045	58.294	1713.6	273.4
1.30	0.0137	0.0106	0.1088	53.810	1647.0	242.4
1.40	0.0166	0.0119	0.1135	49.966	1594.1	218.2
1.50	0.0199	0.0133	0.1188	46.635	1551.9	198.8
1.60	0.0236	0.0147	0.1245	43.720	1516.6	183.2
1.70	0.0277	0.0163	0.1308	41.149	1487.7	170.5
1.80	0.0324	0.0180	0.1377	38.863	1464.1	160.0
1.90	0.0376	0.0198	0.1451	36.817	1443.5	151.4
2.00	0.0433	0.0217	0.1532	34.976	1426.7	144.3
2.10	0.0497	0.0236	0.1620	33.311	1412.8	138.4
2.20	0.0566	0.0257	0.1715	31.797	1400.3	133.4
2.30	0.0642	0.0279	0.1816	30.414	1389.1	129.3
2.40	0.0724	0.0302	0.1925	29.147	1380.0	125.9
2.50	0.0814	0.0326	0.2043	27.981	1372.2	123.1
2.60	0.0911	0.0350	0.2169	26.905	1365.3	120.9
2.70	0.1015	0.0376	0.2304	25.908	1359.1	119.1
2.80	0.1128	0.0403	0.2450	24.983	1354.1	117.7
2.90	0.1249	0.0431	0.2604	24.122	1349.5	116.6
3.00	0.1377	0.0459	0.2771	23.318	1343.3	116.0
3.10	0.1510	0.0487	0.2950	22.565	1335.2	115.6
3.20	0.1647	0.0515	0.3139	21.860	1324.1	115.5
3.30	0.1785	0.0541	0.3322	21.198	1308.6	114.9
3.40	0.1923	0.0566	0.3505	20.574	1289.3	114.2
3.50	0.2065	0.0590	0.3691	19.987	1269.0	113.5
3.60	0.2206	0.0613	0.3872	19.431	1245.7	112.5
3.70	0.2348	0.0635	0.4056	18.906	1221.2	111.6
3.80	0.2490	0.0655	0.4238	18.409	1195.7	110.6
3.90	0.2628	0.0674	0.4415	17.937	1167.4	109.3
4.00	0.2768	0.0692	0.4596	17.488	1139.4	108.2
4.10	0.2897	0.0707	0.4770	17.062	1107.4	106.9
4.20	0.3021	0.0719	0.4934	16.655	1074.4	105.4
4.30	0.3137	0.0729	0.5091	16.268	1039.5	103.7
4.40	0.3241	0.0737	0.5246	15.898	1002.6	102.1
4.50	0.3336	0.0741	0.5395	15.545	964.6	100.4
4.60	0.3431	0.0746	0.5548	15.207	928.8	98.8
4.70	0.3520	0.0749	0.5700	14.884	893.4	97.2
4.80	0.3605	0.0751	0.5841	14.573	858.8	95.5
4.90	0.3684	0.0752	0.5978	14.276	825.1	93.8
5.00	0.3756	0.0751	0.6112	13.991	791.6	92.1
5.10	0.3820	0.0749	0.6243	13.716	758.7	90.4
5.20	0.3880	0.0746	0.6373	13.452	726.9	88.8
5.30	0.3936	0.0743	0.6502	13.199	696.6	87.2
5.40	0.3992	0.0739	0.6631	12.954	667.9	85.7
5.50	0.4045	0.0735	0.6761	12.719	640.5	84.2
5.60	0.4093	0.0731	0.6892	12.492	614.0	82.8
5.70	0.4132	0.0725	0.7010	12.272	587.8	81.3
5.80	0.4167	0.0718	0.7124	12.061	562.7	79.8
5.90	0.4198	0.0712	0.7235	11.856	538.6	78.3
6.00	0.4227	0.0705	0.7345	11.659	515.7	76.8
6.10	0.4253	0.0697	0.7453	11.468	493.7	75.4
6.20	0.4275	0.0689	0.7558	11.283	472.6	74.1
6.30	0.4293	0.0681	0.7660	11.104	452.4	72.7
6.40	0.4309	0.0673	0.7761	10.930	433.1	71.4
6.50	0.4323	0.0665	0.7861	10.762	414.7	70.1
6.60	0.4333	0.0657	0.7959	10.599	397.1	68.8
6.70	0.4339	0.0648	0.8056	10.441	380.1	67.6
6.80	0.4343	0.0639	0.8153	10.287	363.9	66.4
6.90	0.4343	0.0629	0.8249	10.138	348.3	65.3
7.00	0.4342	0.0620	0.8345	9.993	333.5	64.1
7.10	0.4338	0.0611	0.8445	9.853	319.3	63.1
7.20	0.4327	0.0601	0.8543	9.716	305.5	62.1
7.30	0.4313	0.0591	0.8629	9.583	292.1	61.0
7.40	0.4296	0.0580	0.8713	9.453	279.3	59.9
7.50	0.4275	0.0570	0.8795	9.327	267.0	58.9
7.60	0.4251	0.0559	0.8875	9.204	255.1	57.9
7.70	0.4224	0.0549	0.8952	9.085	243.8	56.9
7.80	0.4192	0.0537	0.9027	8.968	232.7	55.9
7.90	0.4156	0.0526	0.9100	8.855	222.1	54.9
8.00	0.4115	0.0514	0.9170	8.744	211.8	54.0
8.10	0.4070	0.0503	0.9238	8.636	201.8	53.0
8.20	0.4022	0.0490	0.9304	8.531	192.2	52.1
8.30	0.3969	0.0478	0.9367	8.428	182.9	51.2
8.40	0.3911	0.0466	0.9428	8.328	173.9	50.3
8.50	0.3850	0.0453	0.9486	8.230	165.2	49.5
8.60	0.3783	0.0440	0.9541	8.134	156.7	48.6
8.70	0.3710	0.0426	0.9591	8.041	148.4	47.7
8.80	0.3631	0.0413	0.9638	7.949	140.4	46.9
8.90	0.3545	0.0398	0.9680	7.860	132.5	46.0
9.00	0.3452	0.0384	0.9716	7.773	124.7	45.2
9.10	0.3348	0.0368	0.9745	7.687	117.0	44.3
9.20	0.3232	0.0351	0.9765	7.604	109.4	43.5
9.30	0.3098	0.0333	0.9770	7.522	101.5	42.5
9.40	0.2924	0.0311	0.9743	7.442	92.8	41.5
9.50	0.2379	0.0250	0.9227	7.363	73.1	38.5
9.60	0.1618	0.0169	0.8359	7.287	48.2	34.2
9.70	0.1426	0.0147	0.8313	7.212	41.2	33.3
9.80	0.1347	0.0137	0.8354	7.138	37.7	32.8
9.90	0.1268	0.0128	0.8394	7.066	34.4	32.3
10.00	0.1009	0.0101	0.8220	6.995	26.6	31.0
10.10	0.0830	0.0082	0.8144	6.926	21.2	30.1
10.20	0.0389	0.0038	0.7377	6.858	9.7	26.7
10.30	0.0321	0.0031	0.7430	6.792	7.7	26.4
10.40	0.0228	0.0022	0.7284	6.726	5.3	25.4
10.50	0.0160	0.0015	0.7322	6.662	3.6	25.0
10.60	0.0128	0.0012	0.7280	6.599	2.8	24.4
10.70	0.0049	0.0005	0.7320	6.538	1.1	24.1
10.80	-.0057	-.0005	0.7432	6.477	-1.2	24.0

34.

Numerieke uitkomsten van de berekeningen aan de NIBE B molen.
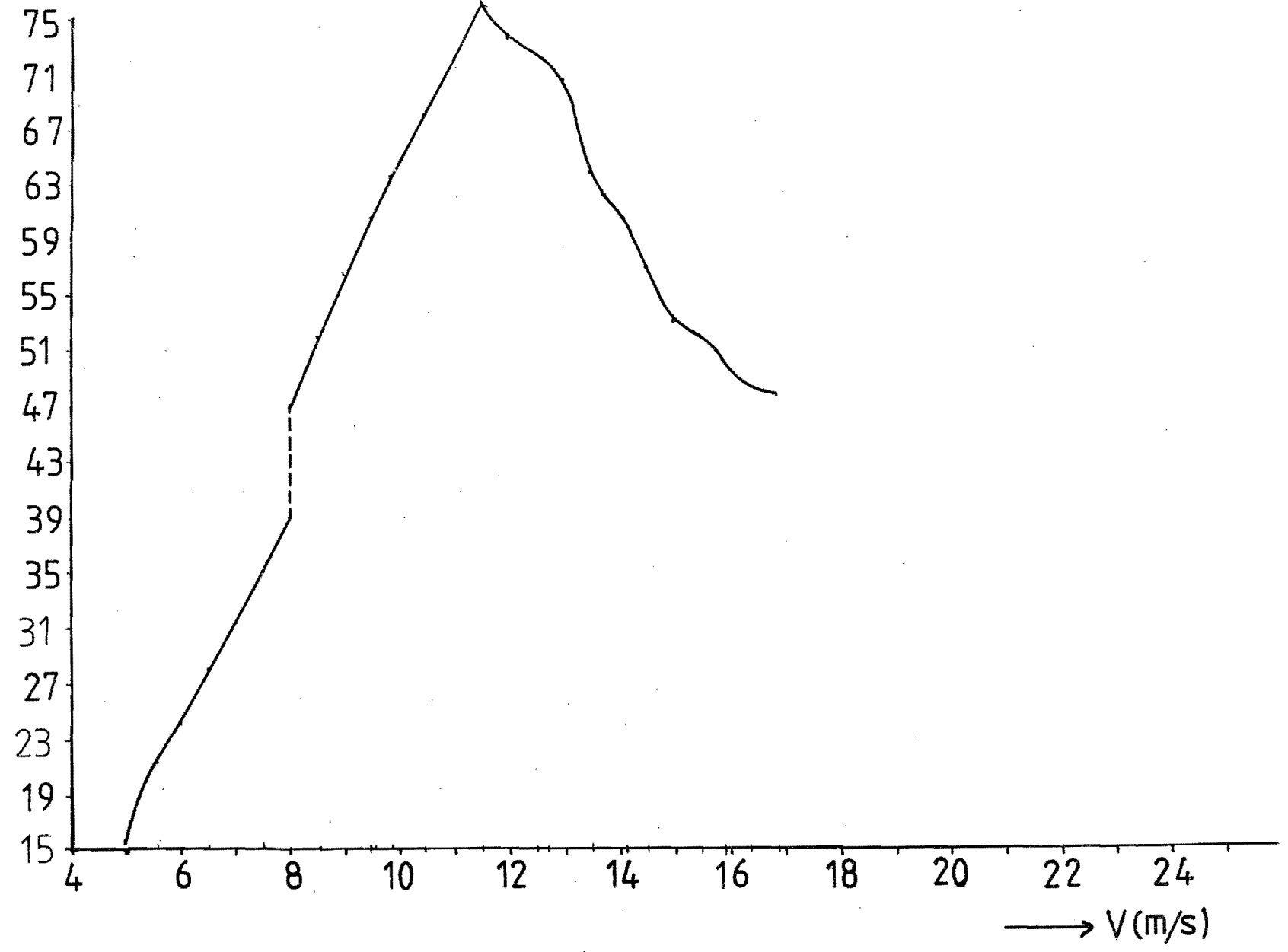# Pitchhoek 1.0 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is 20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt 33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 0.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0005	0.0046	0.0824	699.528	120878.8	31042.3
0.10	0.0005	0.0046	0.0824	699.528	120878.8	31042.3
0.20	0.0010	0.0048	0.0825	349.764	31819.4	7765.7
0.30	0.0016	0.0052	0.0828	233.176	15141.6	3465.5
0.40	0.0022	0.0056	0.0835	174.882	9258.2	1965.3
0.50	0.0031	0.0062	0.0845	139.906	6508.1	1273.1
0.60	0.0041	0.0068	0.0859	116.588	5000.9	898.2
0.70	0.0053	0.0076	0.0876	99.933	4085.1	673.1
0.80	0.0068	0.0085	0.0896	87.441	3485.4	527.6
0.90	0.0085	0.0094	0.0921	77.725	3072.3	428.4
1.00	0.0105	0.0105	0.0950	69.953	2775.7	357.9
1.10	0.0129	0.0117	0.0983	63.593	2554.3	306.1
1.20	0.0157	0.0130	0.1021	58.294	2386.4	267.2
1.30	0.0188	0.0145	0.1064	53.810	2255.5	237.2
1.40	0.0224	0.0160	0.1112	49.966	2151.2	213.6
1.50	0.0265	0.0177	0.1165	46.635	2067.8	195.0
1.60	0.0311	0.0194	0.1224	43.720	2000.6	180.1
1.70	0.0363	0.0213	0.1289	41.149	1944.3	168.0
1.80	0.0420	0.0234	0.1361	38.863	1898.8	158.2
1.90	0.0485	0.0255	0.1439	36.817	1861.1	150.2
2.00	0.0555	0.0278	0.1525	34.976	1828.7	143.6
2.10	0.0633	0.0302	0.1618	33.311	1801.7	138.2
2.20	0.0719	0.0327	0.1720	31.797	1779.6	133.9
2.30	0.0813	0.0353	0.1831	30.414	1760.5	130.3
2.40	0.0916	0.0382	0.1951	29.147	1745.1	127.6
2.50	0.1027	0.0411	0.2082	27.981	1732.1	125.5
2.60	0.1147	0.0441	0.2224	26.905	1718.9	123.9
2.70	0.1273	0.0471	0.2378	25.908	1703.9	122.9
2.80	0.1403	0.0501	0.2537	24.983	1684.5	121.9
2.90	0.1537	0.0530	0.2696	24.122	1659.9	120.7
3.00	0.1669	0.0556	0.2851	23.318	1628.8	119.3
3.10	0.1806	0.0582	0.3011	22.565	1596.8	118.0
3.20	0.1942	0.0607	0.3166	21.860	1561.5	116.5
3.30	0.2078	0.0630	0.3324	21.198	1523.2	115.0
3.40	0.2211	0.0650	0.3477	20.574	1482.3	113.3
3.50	0.2340	0.0668	0.3623	19.987	1437.6	111.4
3.60	0.2463	0.0684	0.3766	19.431	1390.9	109.4
3.70	0.2576	0.0696	0.3907	18.906	1340.0	107.5
3.80	0.2680	0.0705	0.4037	18.409	1286.7	105.3
3.90	0.2780	0.0713	0.4163	17.937	1234.8	103.1
4.00	0.2877	0.0719	0.4288	17.488	1184.4	100.9
4.10	0.2975	0.0726	0.4413	17.062	1137.2	98.9
4.20	0.3060	0.0729	0.4535	16.655	1088.2	96.8
4.30	0.3141	0.0731	0.4656	16.268	1041.0	94.8
4.40	0.3214	0.0730	0.4763	15.898	994.1	92.7
4.50	0.3286	0.0730	0.4870	15.545	950.1	90.6
4.60	0.3353	0.0729	0.4976	15.207	907.7	38.6
4.70	0.3419	0.0728	0.5081	14.884	867.8	86.6
4.80	0.3482	0.0725	0.5183	14.573	829.6	84.7
4.90	0.3541	0.0723	0.5283	14.276	793.1	82.9
5.00	0.3596	0.0719	0.5379	13.991	757.8	81.0
5.10	0.3648	0.0715	0.5477	13.716	724.5	79.3
5.20	0.3695	0.0711	0.5573	13.452	692.4	77.6
5.30	0.3739	0.0705	0.5660	13.199	661.7	75.9
5.40	0.3782	0.0700	0.5745	12.954	632.8	74.2
5.50	0.3824	0.0695	0.5830	12.719	605.6	72.6
5.60	0.3863	0.0690	0.5912	12.492	579.5	71.0
5.70	0.3897	0.0684	0.5992	12.272	554.5	69.5
5.80	0.3930	0.0678	0.6071	12.061	530.7	68.0
5.90	0.3960	0.0671	0.6147	11.856	508.0	66.5
6.00	0.3988	0.0665	0.6222	11.659	486.5	65.1
6.10	0.4015	0.0658	0.6296	11.468	466.0	63.7
6.20	0.4039	0.0651	0.6369	11.283	446.5	62.4
6.30	0.4062	0.0645	0.6442	11.104	428.1	61.1
6.40	0.4085	0.0638	0.6515	10.930	410.6	59.9
6.50	0.4107	0.0632	0.6587	10.762	394.0	58.7
6.60	0.4128	0.0625	0.6662	10.599	378.3	57.6
6.70	0.4146	0.0619	0.6738	10.441	363.2	56.5
6.80	0.4161	0.0612	0.6809	10.287	348.6	55.5
6.90	0.4172	0.0605	0.6873	10.138	334.6	54.4
7.00	0.4182	0.0597	0.6937	9.993	321.2	53.3
7.10	0.4189	0.0590	0.6998	9.853	308.4	52.3
7.20	0.4195	0.0583	0.7059	9.716	296.1	51.3
7.30	0.4199	0.0575	0.7118	9.583	284.4	50.3
7.40	0.4202	0.0568	0.7175	9.453	273.2	49.3
7.50	0.4203	0.0560	0.7231	9.327	262.5	48.4
7.60	0.4202	0.0553	0.7286	9.204	252.2	47.5
7.70	0.4201	0.0546	0.7341	9.085	242.4	46.6
7.80	0.4197	0.0538	0.7394	8.968	233.0	45.8
7.90	0.4193	0.0531	0.7447	8.855	224.1	44.9
8.00	0.4188	0.0523	0.7499	8.744	215.5	44.1
8.10	0.4181	0.0516	0.7550	8.636	207.3	43.3
8.20	0.4171	0.0509	0.7600	8.531	199.3	42.6
8.30	0.4160	0.0501	0.7649	8.428	191.7	41.8
8.40	0.4146	0.0494	0.7696	8.328	184.3	41.1
8.50	0.4131	0.0486	0.7743	8.230	177.2	40.4
8.60	0.4115	0.0478	0.7788	8.134	170.4	39.7
8.70	0.4096	0.0471	0.7833	8.041	163.9	39.0
8.80	0.4076	0.0463	0.7877	7.949	157.6	38.3
8.90	0.4056	0.0456	0.7920	7.860	151.6	37.7
9.00	0.4033	0.0448	0.7962	7.773	145.8	37.0
9.10	0.4010	0.0441	0.8004	7.687	140.2	36.4
9.20	0.3984	0.0433	0.8044	7.604	134.8	35.8
9.30	0.3958	0.0426	0.8084	7.522	129.6	35.2
9.40	0.3930	0.0418	0.8124	7.442	124.7	34.6
9.50	0.3900	0.0411	0.8162	7.363	119.9	34.1
9.60	0.3869	0.0403	0.8199	7.287	115.2	33.5
9.70	0.3836	0.0395	0.8236	7.212	110.7	33.0
9.80	0.3802	0.0388	0.8271	7.138	106.4	32.4
9.90	0.3766	0.0380	0.8307	7.066	102.3	31.9
10.00	0.3730	0.0373	0.8341	6.995	98.3	31.4
10.10	0.3691	0.0365	0.8375	6.926	94.4	30.9
10.20	0.3652	0.0358	0.8407	6.858	90.7	30.4
10.30	0.3610	0.0351	0.8440	6.792	87.1	30.0
10.40	0.3568	0.0343	0.8471	6.726	83.6	29.5
10.50	0.3523	0.0336	0.8501	6.662	80.2	29.0
10.60	0.3476	0.0328	0.8531	6.599	76.9	28.6
10.70	0.3427	0.0320	0.8559	6.538	73.7	28.2

10.80	0.3377	0.0313	0.8587	6.477	70.6	27.7
10.90	0.3324	0.0305	0.8614	6.418	67.6	27.3
11.00	0.3270	0.0297	0.8640	6.359	64.7	26.9
11.10	0.3214	0.0290	0.8665	6.302	61.9	26.5
11.20	0.3155	0.0282	0.8689	6.246	59.2	26.1
11.30	0.3095	0.0274	0.8712	6.191	56.5	25.7
11.40	0.3032	0.0266	0.8734	6.136	53.9	25.3
11.50	0.2969	0.0258	0.8755	6.083	51.4	24.9
11.60	0.2903	0.0250	0.8776	6.030	49.0	24.6
11.70	0.2836	0.0242	0.8795	5.979	46.6	24.2
11.80	0.2766	0.0234	0.8814	5.928	44.4	23.8
11.90	0.2694	0.0226	0.8831	5.878	42.1	23.5
12.00	0.2620	0.0218	0.8847	5.829	39.9	23.1
12.10	0.2543	0.0210	0.8862	5.781	37.8	22.8
12.20	0.2465	0.0202	0.8875	5.734	35.8	22.5
12.30	0.2384	0.0194	0.8887	5.687	33.8	22.1
12.40	0.2301	0.0186	0.8898	5.641	31.8	21.8
12.50	0.2215	0.0177	0.8907	5.596	29.9	21.5
12.60	0.2126	0.0169	0.8914	5.552	28.0	21.1
12.70	0.2033	0.0160	0.8918	5.508	26.2	20.8
12.80	0.1937	0.0151	0.8920	5.465	24.3	20.5
12.90	0.1837	0.0142	0.8918	5.423	22.5	20.2
13.00	0.1727	0.0133	0.8910	5.381	20.7	19.9
13.10	0.1525	0.0116	0.8803	5.340	17.9	19.3
13.20	0.1417	0.0107	0.8797	5.299	16.2	19.0
13.30	0.1246	0.0094	0.8725	5.260	14.0	18.6
13.40	0.1155	0.0086	0.8737	5.220	12.6	18.3
13.50	0.1060	0.0079	0.8747	5.182	11.4	18.1
13.60	0.0963	0.0071	0.8754	5.144	10.1	17.8
13.70	0.0864	0.0063	0.8759	5.106	8.9	17.6
13.80	0.0635	0.0046	0.8530	5.069	6.4	16.9
13.90	0.0255	0.0018	0.8002	5.033	2.5	15.6
14.00	0.0206	0.0015	0.8060	4.997	2.0	15.5
14.10	0.0105	0.0007	0.8064	4.961	1.0	15.3
14.20	0.0001	0.0000	0.8066	4.926	0.0	15.1
14.30	-.0107	-.0007	0.8064	4.892	-1.0	14.9

Er is   0 maal geen convergentie bereikt.

Numerieke uitkomsten van de berekeningen aan de NIBE B   molen.
Pitchhoek -0.5 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is   20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt   33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 1.2 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0003	0.0035	0.0830	699.528	91559.7	31260.3
1.17	0.0126	0.0108	0.1020	59.994	2091.1	282.6
2.33	0.0755	0.0324	0.1857	29.997	1569.2	128.6
3.50	0.2223	0.0635	0.3677	19.998	1368.3	113.2
4.66	0.3476	0.0745	0.5362	14.998	902.7	92.8
5.83	0.4092	0.0702	0.6639	11.999	544.1	73.6
7.00	0.4329	0.0619	0.7672	9.999	333.1	59.0
8.16	0.4241	0.0520	0.8492	8.571	205.5	48.0
9.33	0.3846	0.0412	0.9141	7.499	124.9	39.6
10.49	0.3044	0.0290	0.9544	6.666	69.4	32.6
11.66	0.0994	0.0085	0.8370	5.999	16.5	23.2
12.83	-.0207	-.0016	0.7838	5.454	-2.6	17.9

Er is   1 maal geen convergentie bereikt.

Numerieke uitkomsten van de berekeningen aan de NIBE B   molen.
Pitchhoek   0.7 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is   20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt   33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 1.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0004	0.0044	0.0825	699.528	115013.4	31088.7
1.12	0.0130	0.0116	0.0993	62.458	2444.1	298.2
2.24	0.0739	0.0330	0.1762	31.229	1733.5	132.2
3.36	0.2136	0.0636	0.3426	20.819	1483.9	114.3
4.48	0.3287	0.0734	0.4908	15.614	963.3	92.1
5.60	0.3896	0.0696	0.6014	12.492	584.5	72.2
6.72	0.4188	0.0623	0.6890	10.410	363.6	57.5
7.84	0.4231	0.0540	0.7595	8.923	231.3	46.5
8.96	0.4064	0.0454	0.8161	7.807	148.9	38.3
10.08	0.3691	0.0366	0.8613	6.940	94.9	31.9
11.20	0.3099	0.0277	0.8949	6.246	58.1	26.9
12.32	0.2203	0.0179	0.9113	5.678	31.0	22.6
13.44	0.0538	0.0043	0.8278	5.205	5.8	17.3
14.56	-.0714	-.0049	0.7520	4.804	-6.1	13.4

Er is   1 maal geen convergentie bereikt.

Pitchhoek   1.2 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is   20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt   33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 1.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0005	0.0047	0.0823	699.528	124789.9	31010.9
1.10	0.0132	0.0120	0.0983	63.478	2600.3	304.7
2.20	0.0733	0.0333	0.1725	31.739	1804.4	133.8
3.31	0.2101	0.0636	0.3330	21.159	1532.3	114.8
4.41	0.3209	0.0728	0.4734	15.870	987.2	91.8
5.51	0.3806	0.0691	0.5771	12.696	599.4	71.6
6.61	0.4103	0.0621	0.6580	10.580	374.0	56.7
7.71	0.4172	0.0541	0.7230	9.068	239.5	45.8
8.82	0.4050	0.0459	0.7740	7.935	155.7	37.5
9.92	0.3751	0.0378	0.8147	7.053	101.3	31.2
11.02	0.3269	0.0297	0.8461	6.348	64.4	26.2
12.12	0.2577	0.0213	0.8677	5.771	38.1	22.2
13.22	0.1638	0.0124	0.8764	5.290	18.7	18.9
14.33	0.0259	0.0018	0.8404	4.883	2.3	15.4
15.43	-.1093	-.0071	0.7547	4.534	-7.8	11.9

Er is   1 maal geen convergentie bereikt.

Numerieke uitkomsten van de berekeningen aan de NIBE B   molen.
Pitchhoek   2.0 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is   20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt   33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 1.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0005	0.0053	0.0820	699.528	140436.8	30879.5
1.08	0.0135	0.0126	0.0967	65.012	2858.1	314.5
2.15	0.0726	0.0338	0.1673	32.506	1920.3	136.1
3.23	0.2050	0.0635	0.3190	21.671	1606.1	115.3
4.30	0.3090	0.0718	0.4477	16.253	1021.1	91.0
5.38	0.3655	0.0679	0.5407	13.002	618.5	70.4
6.46	0.3947	0.0611	0.6114	10.835	386.5	55.2
7.53	0.4035	0.0536	0.6669	9.287	248.8	44.3
8.61	0.3944	0.0458	0.7077	8.126	162.9	36.0
9.68	0.3703	0.0382	0.7389	7.224	107.4	29.7
10.76	0.3302	0.0307	0.7618	6.501	69.8	24.8
11.84	0.2737	0.0231	0.7772	5.910	43.5	20.9
12.91	0.2006	0.0155	0.7858	5.418	24.5	17.8
13.99	0.1094	0.0078	0.7874	5.001	10.5	15.2
15.06	-.0034	-.0002	0.7809	4.644	-0.3	13.0

Er is   0 maal geen convergentie bereikt.

Pitchhoek 4.9 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is 20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt 33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 1.0 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0007	0.0070	0.0808	699.528	185384.6	30428.2
1.04	0.0151	0.0145	0.0933	67.522	3571.7	327.4
2.07	0.0761	0.0367	0.1600	33.761	2255.0	140.4
3.11	0.1989	0.0640	0.2922	22.507	1745.9	113.9
4.14	0.2811	0.0678	0.3901	16.881	1040.7	85.6
5.18	0.3240	0.0625	0.4544	13.504	614.2	63.8
6.22	0.3432	0.0552	0.4972	11.254	376.5	48.5
7.25	0.3423	0.0472	0.5207	9.646	236.5	37.3
8.29	0.3249	0.0392	0.5288	8.440	150.3	29.0
9.32	0.2908	0.0312	0.5254	7.502	94.5	22.8
10.36	0.2411	0.0233	0.5121	6.752	57.1	18.0
11.40	0.1754	0.0154	0.4900	6.138	31.2	14.2
12.43	0.0905	0.0073	0.4592	5.627	12.4	11.2
13.47	-.0139	-.0010	0.4205	5.194	-1.5	8.7

Er is 0 maal geen convergentie bereikt.

Pitchhoek 7.3 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is 20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt 33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 1.0 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0009	0.0092	0.0789	699.528	243661.1	29714.4
0.96	0.0161	0.0166	0.0883	72.565	4720.4	357.7
1.93	0.0749	0.0389	0.1466	36.283	2753.8	148.6
2.89	0.1788	0.0618	0.2515	24.188	1947.3	113.3
3.86	0.2382	0.0618	0.3172	18.141	1094.5	80.3
4.82	0.2630	0.0546	0.3507	14.513	618.8	56.9
5.78	0.2632	0.0455	0.3603	12.094	358.4	40.6
6.75	0.2413	0.0358	0.3477	10.366	206.9	28.8
7.71	0.1977	0.0256	0.3165	9.071	113.6	20.0
8.68	0.1349	0.0155	0.2707	8.063	54.4	13.5
9.64	0.0489	0.0051	0.2107	7.257	14.4	8.5
10.60	-.0600	-.0057	0.1377	6.597	-13.2	4.6

Er is 0 maal geen convergentie bereikt.

Numerieke uitkomsten van de berekeningen aan de NIBE B molen.
Pitchhoek 5.9 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is 20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt 33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 1.0 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0008	0.0082	0.0798	699.528	216550.0	30065.2
0.99	0.0155	0.0156	0.0904	70.517	4182.6	346.2
1.98	0.0746	0.0376	0.1517	35.258	2518.2	145.1
2.98	0.1869	0.0628	0.2684	23.506	1868.6	114.1
3.97	0.2570	0.0648	0.3483	17.629	1083.6	83.3
4.96	0.2910	0.0587	0.3959	14.103	628.4	60.6
5.95	0.3015	0.0506	0.4207	11.753	376.7	44.7
6.94	0.2906	0.0418	0.4248	10.074	228.7	33.2
7.94	0.2613	0.0329	0.4118	8.815	137.7	24.6
8.93	0.2141	0.0240	0.3856	7.835	79.3	18.2
9.92	0.1494	0.0151	0.3477	7.052	40.3	13.3
10.91	0.0640	0.0059	0.2984	6.411	13.0	9.4
11.90	-.0428	-.0036	0.2385	5.876	-6.7	6.3

Er is 0 maal geen convergentie bereikt.

Numerieke uitkomsten van de berekeningen aan de NIBE B molen.
Pitchhoek 8.8 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is 20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt 33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 0.9 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0010	0.0103	0.0778	699.528	272466.2	29300.3
0.93	0.0165	0.0177	0.0859	75.057	5358.5	372.4
1.86	0.0743	0.0399	0.1409	37.528	3023.4	152.8
2.80	0.1689	0.0604	0.2337	25.019	2035.8	112.6
3.73	0.2179	0.0585	0.2857	18.764	1108.2	77.4
4.66	0.2336	0.0501	0.3061	15.011	608.3	53.1
5.59	0.2229	0.0399	0.3009	12.509	335.8	36.2
6.52	0.1874	0.0287	0.2719	10.722	177.8	24.1
7.46	0.1293	0.0173	0.2236	9.382	82.2	15.1
8.39	0.0465	0.0055	0.1583	8.340	20.7	8.5
9.32	-.0610	-.0065	0.0774	7.506	-19.8	3.4

Er is 0 maal geen convergentie bereikt.

Pitchhoek 9.7 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is 20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt 33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 0.9 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0011	0.0110	0.0771	699.528	289617.0	29034.6
0.90	0.0163	0.0181	0.0842	77.553	5856.6	389.6
1.80	0.0716	0.0397	0.1354	38.776	3211.5	156.7
2.71	0.1604	0.0593	0.2210	25.851	2132.3	113.6
3.61	0.2049	0.0568	0.2667	19.388	1149.3	77.2
4.51	0.2163	0.0480	0.2811	15.511	621.3	52.0
5.41	0.2009	0.0371	0.2692	12.925	334.0	34.6
6.31	0.1605	0.0254	0.2341	11.079	168.0	22.1
7.22	0.0955	0.0132	0.1785	9.694	67.0	12.9
8.12	0.0056	0.0007	0.1054	8.617	2.8	6.0
9.02	-.1091	-.0121	0.0170	7.755	-39.2	0.8

Er is 0 maal geen convergentie bereikt.

Numerieke uitkomsten van de berekeningen aan de NIBE B molen.
Pitchhoek 10.6 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is 20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt 33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 0.9 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0012	0.0116	0.0764	699.528	306684.1	28759.9
0.88	0.0164	0.0186	0.0827	79.492	6329.3	402.1
1.76	0.0703	0.0399	0.1315	39.746	3396.7	159.9
2.64	0.1538	0.0583	0.2106	26.497	2202.4	113.8
3.52	0.1933	0.0549	0.2500	19.873	1167.9	76.0
4.40	0.1997	0.0454	0.2579	15.898	617.7	50.2
5.28	0.1787	0.0338	0.2393	13.249	319.8	32.3
6.16	0.1322	0.0215	0.1971	11.356	149.0	19.6
7.04	0.0588	0.0084	0.1335	9.936	44.4	10.1
7.92	-.0397	-.0050	0.0521	8.832	-21.1	3.1
8.80	-.1629	-.0185	-.0424	7.949	-63.0	-2.1

Er is 0 maal geen convergentie bereikt.

Numerieke uitkomsten van de berekeningen aan de NIBE B molen.
Pitchhoek 11.6 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is 20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt 33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 1.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0012	0.0124	0.0755	699.528	325479.7	28437.0
1.07	0.0243	0.0228	0.0872	65.530	5272.2	288.3
2.14	0.1119	0.0524	0.1674	32.765	3028.5	138.3
3.20	0.1757	0.0549	0.2276	21.843	1409.2	83.6
4.27	0.1824	0.0427	0.2342	16.382	617.1	48.4
5.34	0.1452	0.0272	0.1995	13.106	251.7	26.4
6.41	0.0657	0.0103	0.1273	10.922	65.9	11.7
7.47	-.0544	-.0073	0.0256	9.361	-34.4	1.7
8.54	-.2146	-.0251	-.0987	8.191	-90.8	-5.1

Er is 0 maal geen convergentie bereikt.

Numerieke uitkomsten van de berekeningen aan de NIBE B molen.
Pitchhoek 12.4 graden.
Viterna & Corrigan korrektie.
Slankheid = 18.2
Het gebruikte profiel is NACA 4418
De straal van de rotor is 20.000 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt 33.4 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 1.0 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0013	0.0129	0.0748	699.528	340421.9	28171.0
1.04	0.0238	0.0230	0.0853	67.587	5658.5	299.8
2.07	0.1070	0.0517	0.1602	33.794	3179.2	140.8
3.11	0.1666	0.0536	0.2152	22.529	1466.0	84.1
4.14	0.1698	0.0410	0.2173	16.897	630.6	47.8
5.18	0.1293	0.0250	0.1783	13.517	245.7	25.1
6.21	0.0456	0.0073	0.1018	11.265	50.2	9.9
7.25	-.0776	-.0107	-.0026	9.655	-53.8	-0.2
8.28	-.2418	-.0292	-.1310	8.448	-112.2	-7.2

Er is 0 maal geen convergentie bereikt.

II.3   DEBRA 25

task A.2.b

DEBRA 25

Slankheid = 26.1   NACA   4418

Viterna & Corrigan korrektie.
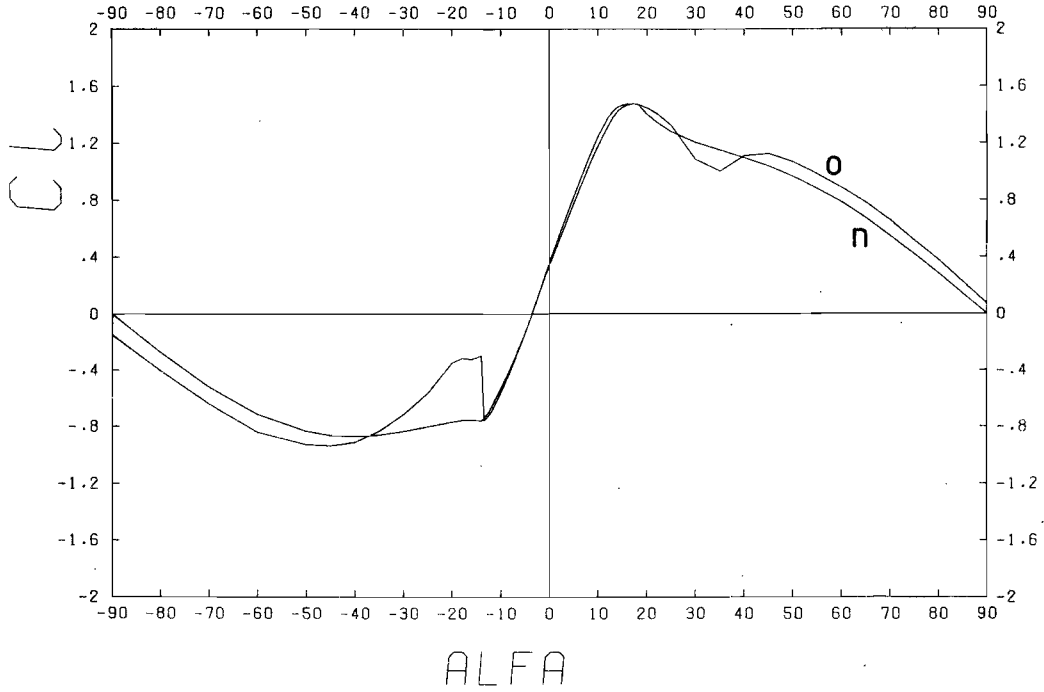
DEBRA 25

Slankheid = 26.1   NACA   4418

Viterna & Corrigan korrektie.

DEBRA 25 Pitchhoek = 4.0 graden
Slankheid = 26.1   NACA 4418
Viterna & Corrigan korrektie.

LAMBDA

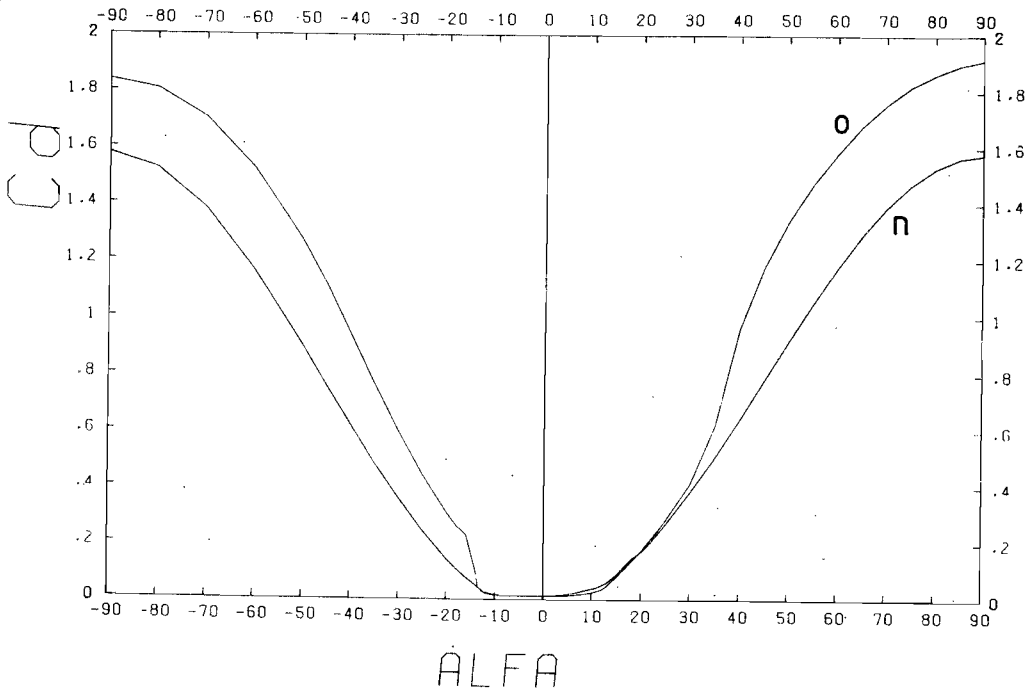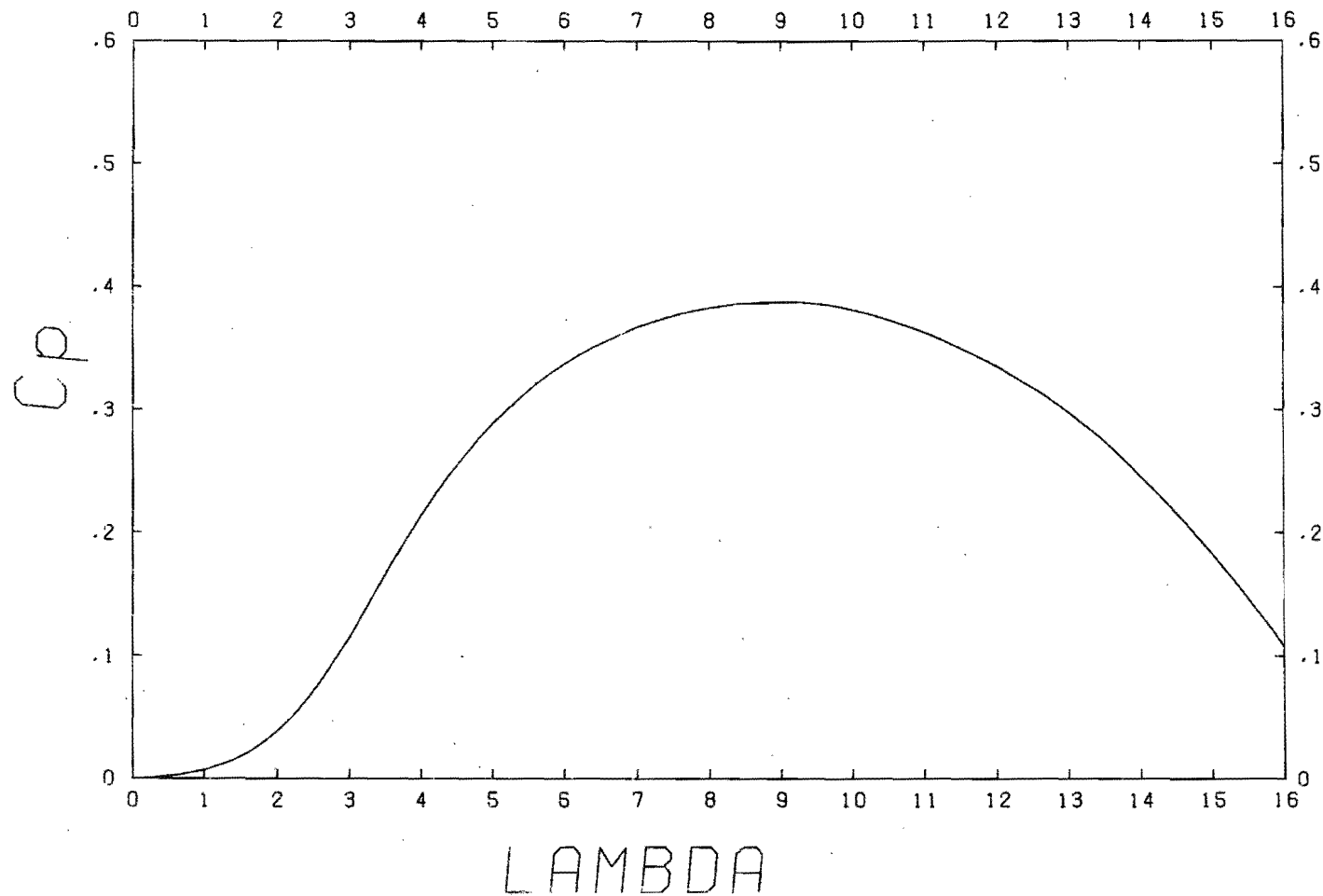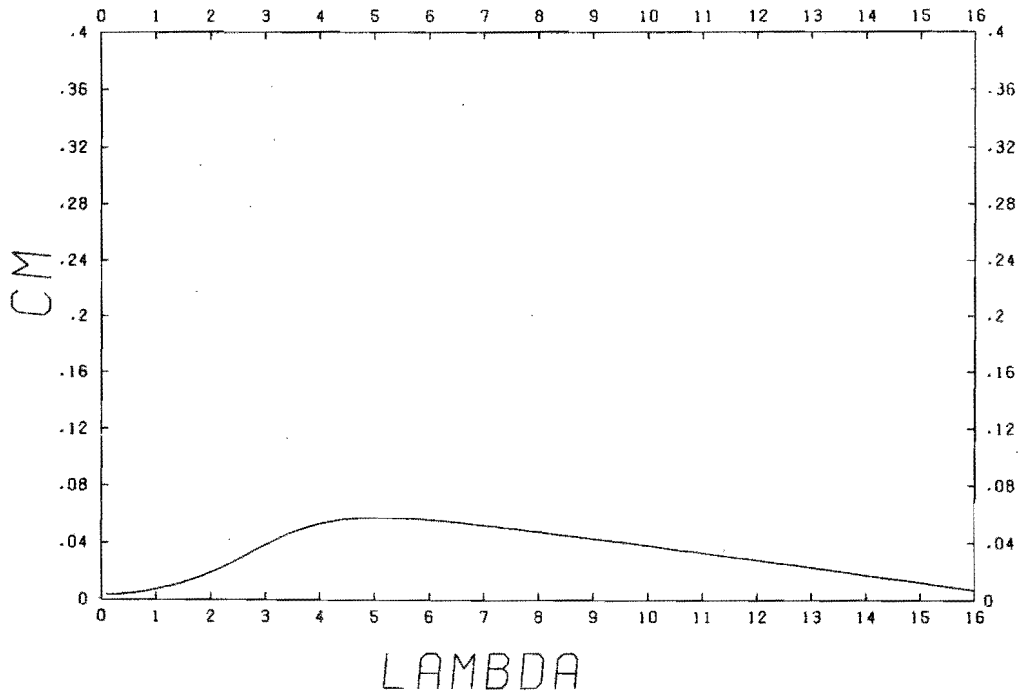DEBRA 25 Pitchhoek = 4.0 graden

Slankheid = 26.1   NACA   4418

Viterna & Corrigan korrektie.

LAMBDA

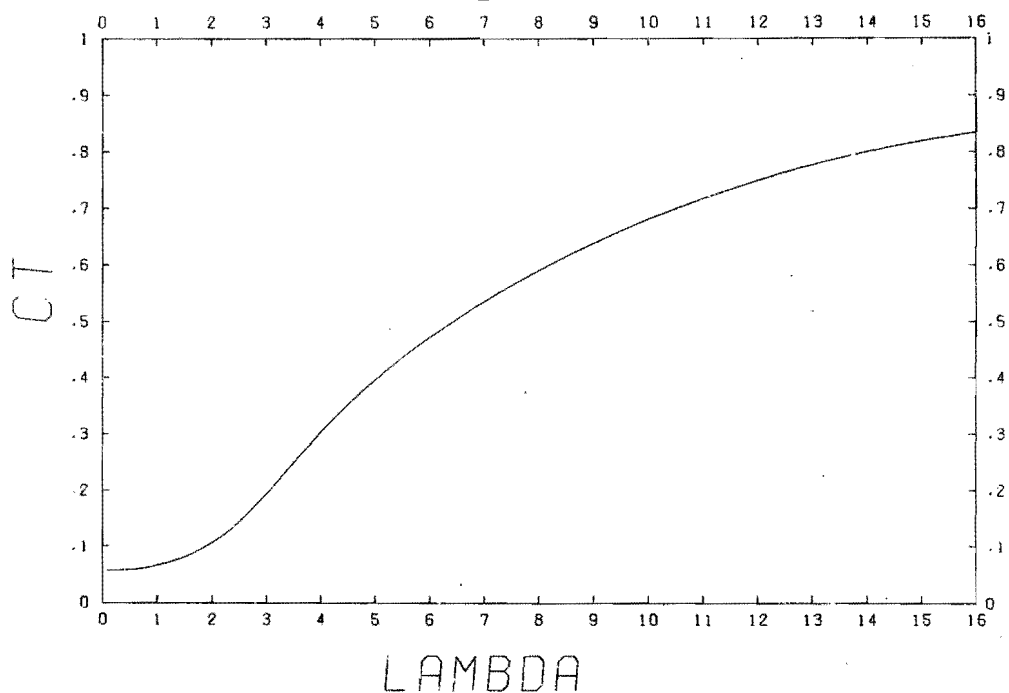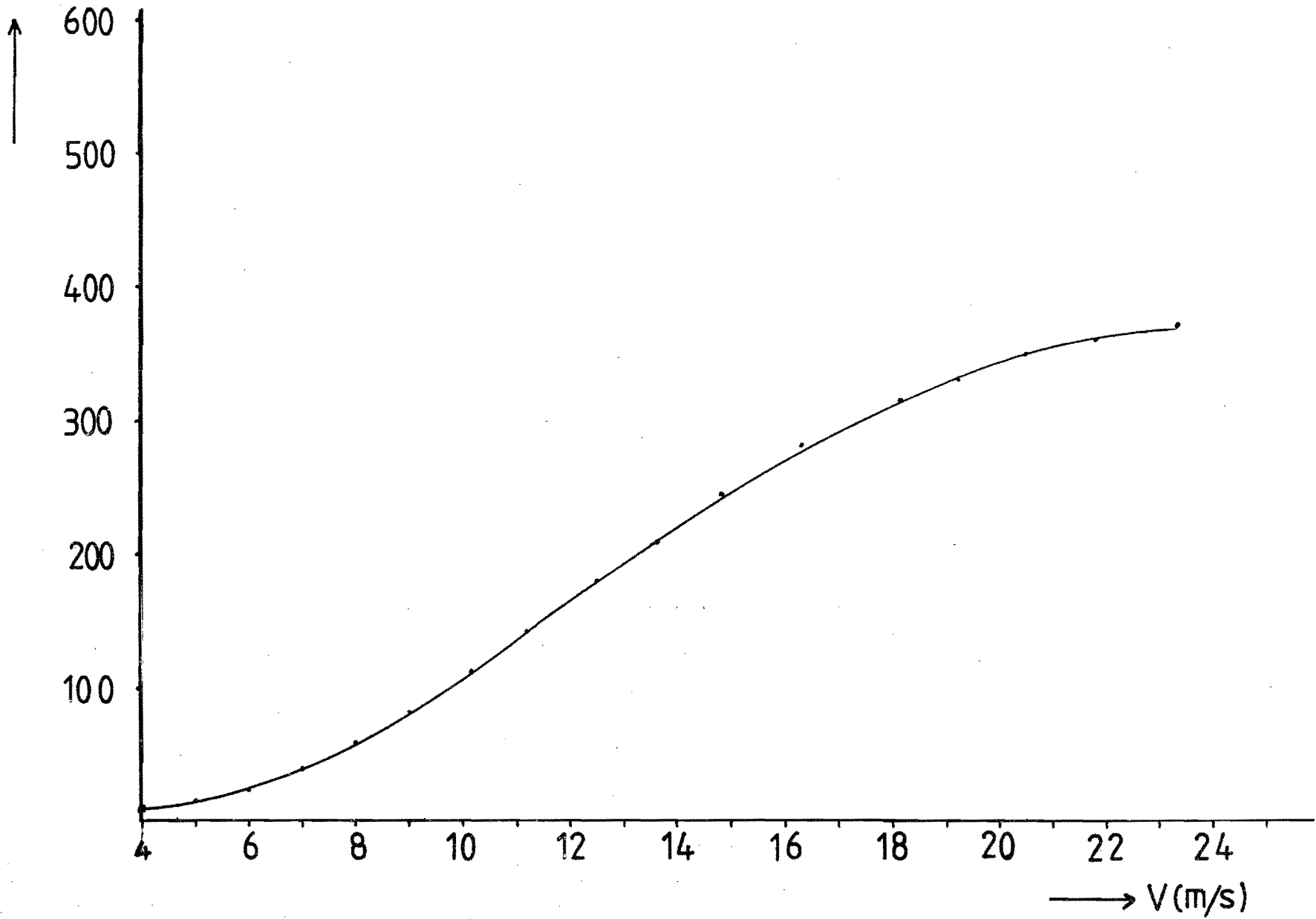DEBRA 25 Pitchhoek = 4.0 graden

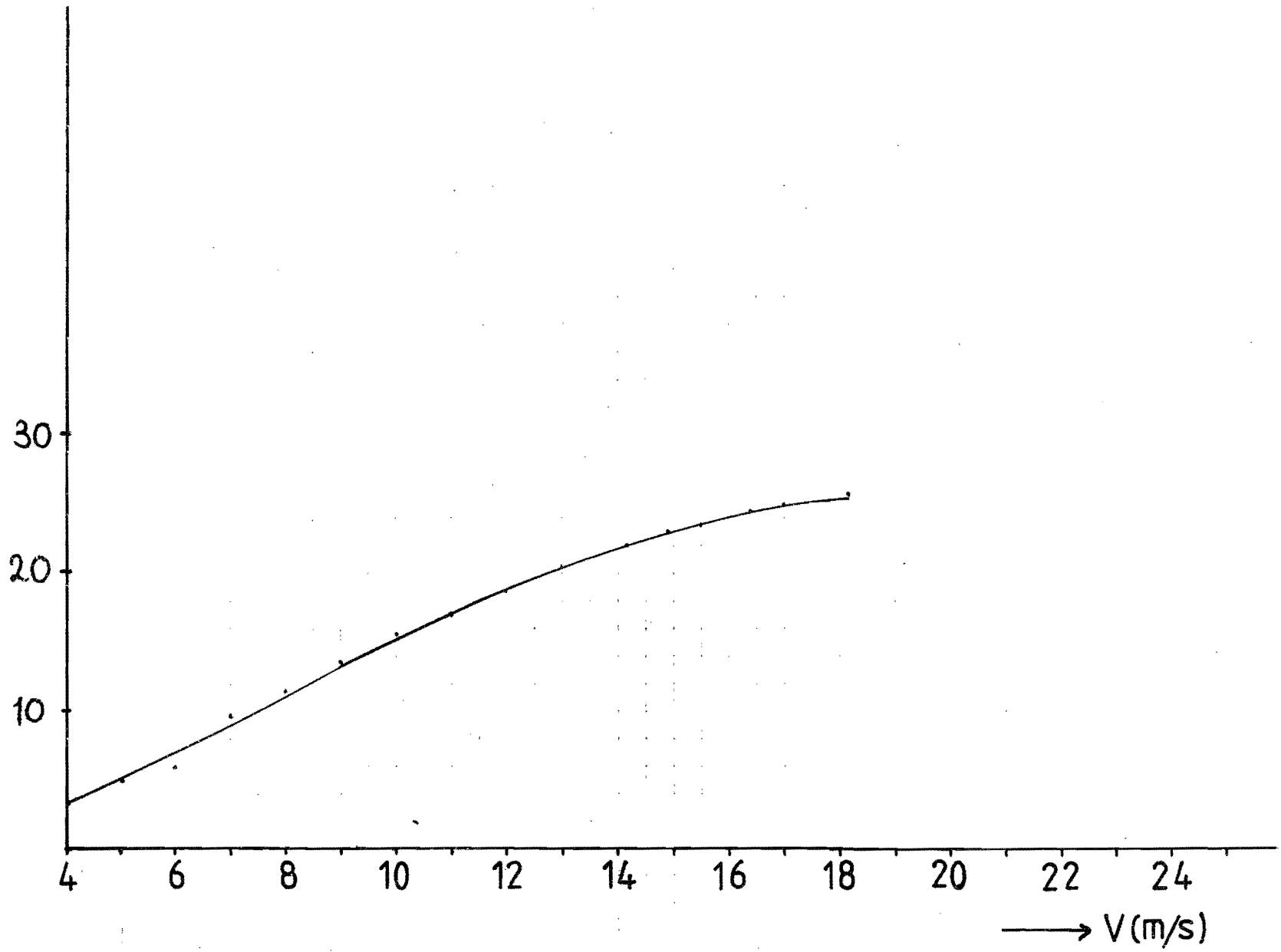Slankheid = 26.1   NACA   4418

Viterna & Corrigan korrektie.

LAMBDA

T(kN)

DEBRA25

30

20

10

4   6   8   10   12   14   16   18   20   22   24

⟶ V (m/s)

45.

Numerieke uitkomsten van de berekeningen aan de DEBRA 25   molen.
Pitchhoek   4.0 graden.
Viterna & Corrigan korrektie.
Slankheid = 26.1
Het gebruikte profiel is NACA 4418
De straal van de rotor is   12.500 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt   33.3 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 0.2 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0003	0.0031	0.0570	435.896	7809.3	3258.3
0.20	0.0007	0.0033	0.0570	217.948	2052.8	814.7
0.40	0.0015	0.0038	0.0578	108.974	597.5	206.2
0.60	0.0028	0.0047	0.0594	72.649	323.3	94.3
0.80	0.0046	0.0058	0.0622	54.487	225.9	55.5
1.00	0.0072	0.0072	0.0659	43.590	180.1	37.7
1.20	0.0108	0.0090	0.0709	36.325	155.1	28.1
1.40	0.0154	0.0110	0.0772	31.135	140.0	22.5
1.60	0.0214	0.0134	0.0850	27.243	130.3	19.0
1.80	0.0290	0.0161	0.0943	24.216	123.7	16.6
2.00	0.0383	0.0191	0.1054	21.795	119.1	15.1
2.20	0.0496	0.0225	0.1185	19.813	115.9	14.0
2.40	0.0631	0.0263	0.1339	18.162	113.6	13.3
2.60	0.0787	0.0303	0.1518	16.765	111.5	12.8
2.80	0.0963	0.0344	0.1716	15.568	109.2	12.5
3.00	0.1151	0.0384	0.1927	14.530	106.2	12.2
3.20	0.1351	0.0422	0.2146	13.622	102.7	12.0
3.40	0.1556	0.0458	0.2372	12.820	98.6	11.7
3.60	0.1757	0.0488	0.2593	12.108	93.8	11.4
3.80	0.1951	0.0513	0.2810	11.471	88.5	11.1
4.00	0.2140	0.0535	0.3023	10.897	83.3	10.8
4.20	0.2310	0.0550	0.3224	10.378	77.7	10.4
4.40	0.2474	0.0562	0.3420	9.907	72.3	10.1
4.60	0.2621	0.0570	0.3606	9.476	67.0	9.7
4.80	0.2759	0.0575	0.3789	9.081	62.1	9.4
5.00	0.2884	0.0577	0.3959	8.718	57.5	9.0
5.20	0.2997	0.0576	0.4122	8.383	53.1	8.7
5.40	0.3104	0.0575	0.4282	8.072	49.1	8.4
5.60	0.3200	0.0571	0.4434	7.784	45.4	8.1
5.80	0.3286	0.0567	0.4577	7.515	41.9	7.8
6.00	0.3365	0.0561	0.4717	7.265	38.8	7.5
6.20	0.3439	0.0555	0.4855	7.031	35.9	7.2
6.40	0.3505	0.0548	0.4985	6.811	33.3	7.0
6.60	0.3564	0.0540	0.5111	6.604	30.9	6.7
6.80	0.3618	0.0532	0.5234	6.410	28.7	6.5
7.00	0.3669	0.0524	0.5356	6.227	26.6	6.2
7.20	0.3712	0.0516	0.5472	6.054	24.8	6.0
7.40	0.3749	0.0507	0.5584	5.890	23.0	5.8
7.60	0.3781	0.0498	0.5693	5.735	21.4	5.6
7.80	0.3809	0.0488	0.5800	5.588	20.0	5.4
8.00	0.3831	0.0479	0.5903	5.449	18.6	5.3
8.20	0.3848	0.0469	0.6004	5.316	17.4	5.1
8.40	0.3861	0.0460	0.6102	5.189	16.2	4.9
8.60	0.3870	0.0450	0.6198	5.069	15.2	4.8
8.80	0.3876	0.0440	0.6293	4.953	14.2	4.6
9.00	0.3878	0.0431	0.6385	4.843	13.2	4.5
9.20	0.3876	0.0421	0.6476	4.738	12.4	4.4
9.40	0.3870	0.0412	0.6564	4.637	11.6	4.2
9.60	0.3858	0.0402	0.6649	4.541	10.9	4.1
9.80	0.3839	0.0392	0.6730	4.448	10.2	4.0
10.00	0.3814	0.0381	0.6808	4.359	9.5	3.9
10.20	0.3785	0.0371	0.6884	4.273	8.9	3.8
10.40	0.3752	0.0361	0.6958	4.191	8.3	3.7
10.60	0.3715	0.0351	0.7031	4.112	7.8	3.6
10.80	0.3675	0.0340	0.7101	4.036	7.3	3.5
11.00	0.3631	0.0330	0.7170	3.963	6.8	3.4
11.20	0.3582	0.0320	0.7237	3.892	6.3	3.3
11.40	0.3530	0.0310	0.7303	3.824	5.9	3.2
11.60	0.3475	0.0300	0.7366	3.758	5.5	3.1
11.80	0.3415	0.0289	0.7428	3.694	5.2	3.0
12.00	0.3352	0.0279	0.7489	3.632	4.8	3.0
12.20	0.3285	0.0269	0.7548	3.573	4.5	2.9
12.40	0.3214	0.0259	0.7605	3.515	4.2	2.8
12.60	0.3140	0.0249	0.7661	3.459	3.9	2.8
12.80	0.3062	0.0239	0.7715	3.405	3.6	2.7
13.00	0.2977	0.0229	0.7767	3.353	3.4	2.6
13.20	0.2887	0.0219	0.7817	3.302	3.1	2.6
13.40	0.2791	0.0208	0.7865	3.253	2.9	2.5
13.60	0.2689	0.0198	0.7911	3.205	2.7	2.4
13.80	0.2579	0.0187	0.7956	3.159	2.4	2.4
14.00	0.2466	0.0176	0.7998	3.114	2.2	2.3
14.20	0.2347	0.0165	0.8039	3.070	2.0	2.3
14.40	0.2225	0.0154	0.8079	3.027	1.9	2.2
14.60	0.2098	0.0144	0.8117	2.986	1.7	2.2
14.80	0.1966	0.0133	0.8154	2.945	1.5	2.1
15.00	0.1829	0.0122	0.8189	2.906	1.3	2.1
15.20	0.1688	0.0111	0.8223	2.868	1.2	2.0
15.40	0.1542	0.0100	0.8255	2.830	1.1	2.0
15.60	0.1392	0.0089	0.8286	2.794	0.9	1.9
15.80	0.1237	0.0078	0.8315	2.759	0.8	1.9
16.00	0.1077	0.0067	0.8343	2.724	0.7	1.9
16.20	0.0912	0.0056	0.8370	2.691	0.5	1.8
16.40	0.0742	0.0045	0.8395	2.658	0.4	1.8
16.60	0.0568	0.0034	0.8419	2.626	0.3	1.7
16.80	0.0389	0.0023	0.8441	2.595	0.2	1.7
17.00	0.0204	0.0012	0.8462	-2.564	0.1	1.7
17.20	0.0015	0.0001	0.8481	2.534	0.0	1.6
17.40	-.0179	-.0010	0.8499	2.505	-0.1	1.6

Er is   0 maal geen convergentie bereikt.

Numerieke uitkomsten van de berekeningen aan de DEBRA 25   molen.
Pitchhoek   4.0 graden.
Virerna & Corrigan korrektie.
Slankheid = 26.1
Het gebruikte profiel is NACA 4418
De straal van de rotor is   12.500 meter.
De rotor heeft 3 bladen.
Het toerental bedraagt   50.0 toeren per minuut.
Bij de berekeningen wordt lambda telkens met 0.2 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct	V (m/s)	P(aero) (kW)	T(aero) (kN)
0.10	0.0003	0.0031	0.0570	654.498	26435.6	7346.0
0.20	0.0007	0.0033	0.0570	327.249	6949.1	1836.7
0.40	0.0015	0.0038	0.0578	163.625	2022.7	464.9
0.60	0.0028	0.0047	0.0594	109.083	1094.3	212.7
0.80	0.0046	0.0058	0.0622	81.812	764.8	125.1
1.00	0.0072	0.0072	0.0659	65.450	609.7	84.9
1.20	0.0108	0.0090	0.0709	54.542	525.1	63.4
1.40	0.0154	0.0110	0.0772	46.750	474.0	50.8
1.60	0.0214	0.0134	0.0850	40.906	441.2	42.7
1.80	0.0290	0.0161	0.0943	36.361	418.8	37.5
2.00	0.0383	0.0191	0.1054	32.725	403.3	34.0
2.20	0.0496	0.0225	0.1185	29.750	392.4	31.5
2.40	0.0631	0.0263	0.1339	27.271	384.5	30.0
2.60	0.0787	0.0303	0.1518	25.173	377.6	28.9
2.80	0.0963	0.0344	0.1716	23.375	369.7	28.2
3.00	0.1151	0.0384	0.1927	21.817	359.5	27.6
3.20	0.1351	0.0422	0.2146	20.453	347.6	27.0
3.40	0.1556	0.0458	0.2372	19.250	333.7	26.4
3.60	0.1757	0.0488	0.2593	18.181	317.4	25.8
3.80	0.1951	0.0513	0.2810	17.224	299.7	25.1
4.00	0.2140	0.0535	0.3023	16.362	281.8	24.3
4.20	0.2310	0.0550	0.3224	15.583	262.9	23.5
4.40	0.2474	0.0562	0.3420	14.875	244.8	22.8
4.60	0.2621	0.0570	0.3606	14.228	227.0	22.0
4.80	0.2759	0.0575	0.3789	13.635	210.3	21.2
5.00	0.2884	0.0577	0.3959	13.090	194.5	20.4
5.20	0.2997	0.0576	0.4122	12.587	179.7	19.6
5.40	0.3104	0.0575	0.4282	12.120	166.2	18.9
5.60	0.3200	0.0571	0.4434	11.687	153.6	18.2
5.80	0.3286	0.0567	0.4577	11.284	142.0	17.5
6.00	0.3365	0.0561	0.4717	10.908	131.3	16.9
6.20	0.3439	0.0555	0.4855	10.556	121.6	16.3
6.40	0.3505	0.0548	0.4985	10.227	112.7	15.7
6.60	0.3564	0.0540	0.5111	9.917	104.5	15.1
6.80	0.3618	0.0532	0.5234	9.625	97.0	14.6
7.00	0.3669	0.0524	0.5356	9.350	90.2	14.1
7.20	0.3712	0.0516	0.5472	9.090	83.8	13.6
7.40	0.3749	0.0507	0.5584	8.845	78.0	13.1
7.60	0.3781	0.0498	0.5693	8.612	72.6	12.7
7.80	0.3809	0.0488	0.5800	8.391	67.7	12.3
8.00	0.3831	0.0479	0.5903	8.181	63.1	11.9
8.20	0.3848	0.0469	0.6004	7.982	58.8	11.5
8.40	0.3861	0.0460	0.6102	7.792	54.9	11.1
8.60	0.3870	0.0450	0.6198	7.610	51.3	10.8
8.80	0.3876	0.0440	0.6293	7.437	47.9	10.5
9.00	0.3878	0.0431	0.6385	7.272	44.8	10.2
9.20	0.3876	0.0421	0.6476	7.114	42.0	9.9
9.40	0.3870	0.0412	0.6564	6.963	39.3	9.6
9.60	0.3858	0.0402	0.6649	6.818	36.8	9.3
9.80	0.3839	0.0392	0.6730	6.679	34.4	9.0
10.00	0.3814	0.0381	0.6808	6.545	32.2	8.8
10.20	0.3785	0.0371	0.6884	6.417	30.1	8.5
10.40	0.3752	0.0361	0.6958	6.293	28.1	8.3
10.60	0.3715	0.0351	0.7031	6.175	26.3	8.1
10.80	0.3675	0.0340	0.7101	6.060	24.6	7.8
11.00	0.3631	0.0330	0.7170	5.950	23.0	7.6
11.20	0.3582	0.0320	0.7237	5.844	21.5	7.4
11.40	0.3530	0.0310	0.7303	5.741	20.1	7.2
11.60	0.3475	0.0300	0.7366	5.642	18.8	7.1
11.80	0.3415	0.0289	0.7428	5.547	17.5	6.9
12.00	0.3352	0.0279	0.7489	5.454	16.4	6.7
12.20	0.3285	0.0269	0.7548	5.365	15.2	6.5
12.40	0.3214	0.0259	0.7605	5.278	14.2	6.4
12.60	0.3140	0.0249	0.7661	5.194	13.2	6.2
12.80	0.3062	0.0239	0.7715	5.113	12.3	6.1
13.00	0.2977	0.0229	0.7767	5.035	11.4	5.9
13.20	0.2887	0.0219	0.7817	4.958	10.6	5.8
13.40	0.2791	0.0208	0.7865	4.884	9.8	5.6
13.60	0.2689	0.0198	0.7911	4.812	9.0	5.5
13.80	0.2579	0.0187	0.7956	4.743	8.3	5.4
14.00	0.2466	0.0176	0.7998	4.675	7.6	5.3
14.20	0.2347	0.0165	0.8039	4.609	6.9	5.1
14.40	0.2225	0.0154	0.8079	4.545	6.3	5.0
14.60	0.2098	0.0144	0.8117	4.483	5.7	4.9
14.80	0.1966	0.0133	0.8154	4.422	5.1	4.8
15.00	0.1829	0.0122	0.8189	4.363	4.6	4.7
15.20	0.1688	0.0111	0.8223	4.306	4.1	4.6
15.40	0.1542	0.0100	0.8255	4.250	3.6	4.5
15.60	0.1392	0.0089	0.8286	4.196	3.1	4.4
15.80	0.1237	0.0078	0.8315	4.142	2.6	4.3
16.00	0.1077	0.0067	0.8343	4.091	2.2	4.2
16.20	0.0912	0.0056	0.8370	4.040	1.8	4.1
16.40	0.0742	0.0045	0.8395	3.991	1.4	4.0
16.60	0.0568	0.0034	0.8419	3.943	1.0	3.9
16.80	0.0389	0.0023	0.8441	3.896	0.7	3.9
17.00	0.0204	0.0012	0.8462	3.850	0.4	3.8
17.20	0.0015	0.0001	0.8481	3.805	0.0	3.7
17.40	-.0179	-.0010	0.8499	3.761	-0.3	3.6

Er is   0 maal geen convergentie bereikt.

II.4   25 m HAT PETTEN

task A.2.c

PETTEN.

Slankheid = 17.2   NACA 23018

Viterna & Corrigan korrektie.

ALFA

PETTEN

Slankheid = 17.2   NACA 23018

Viterna & Corrigan korrektie.

ALFA
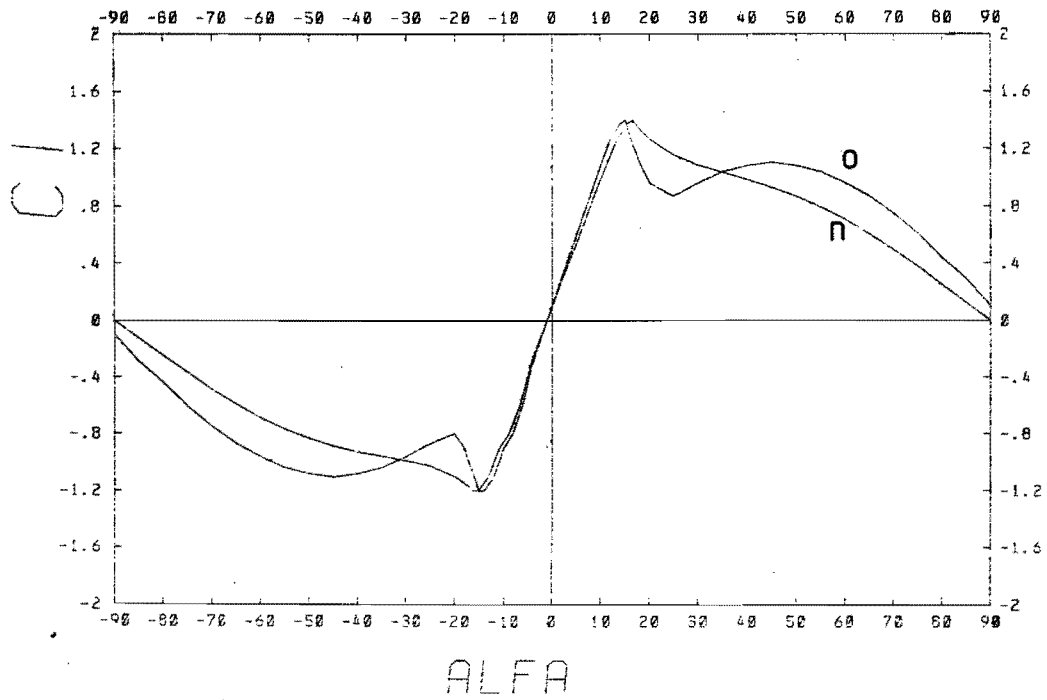
PETTEN Pitchhoek = 0.0 graden
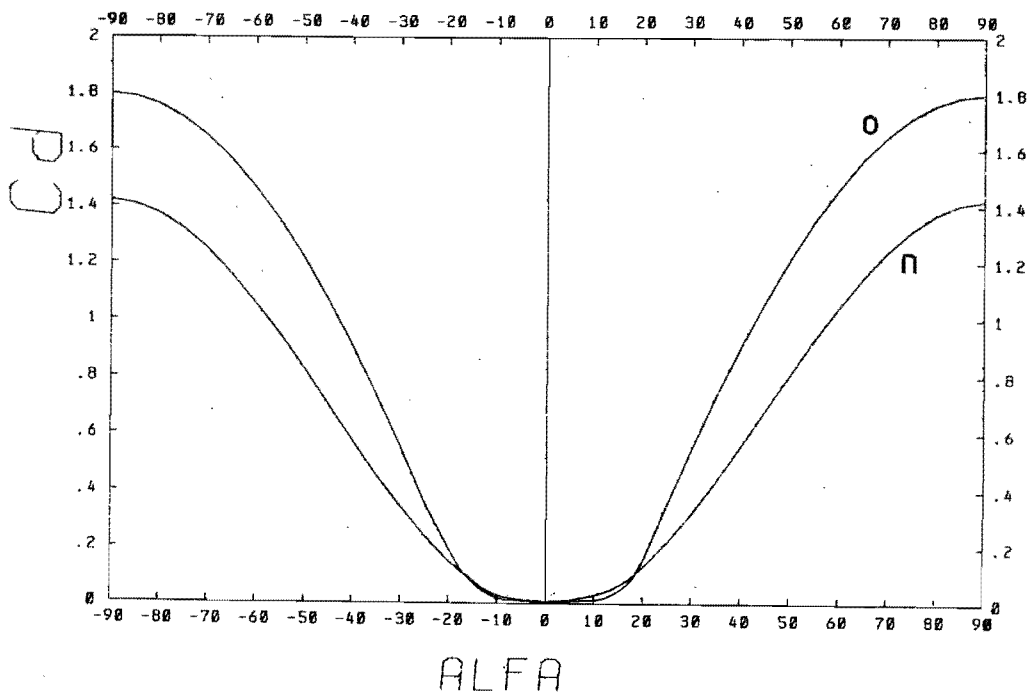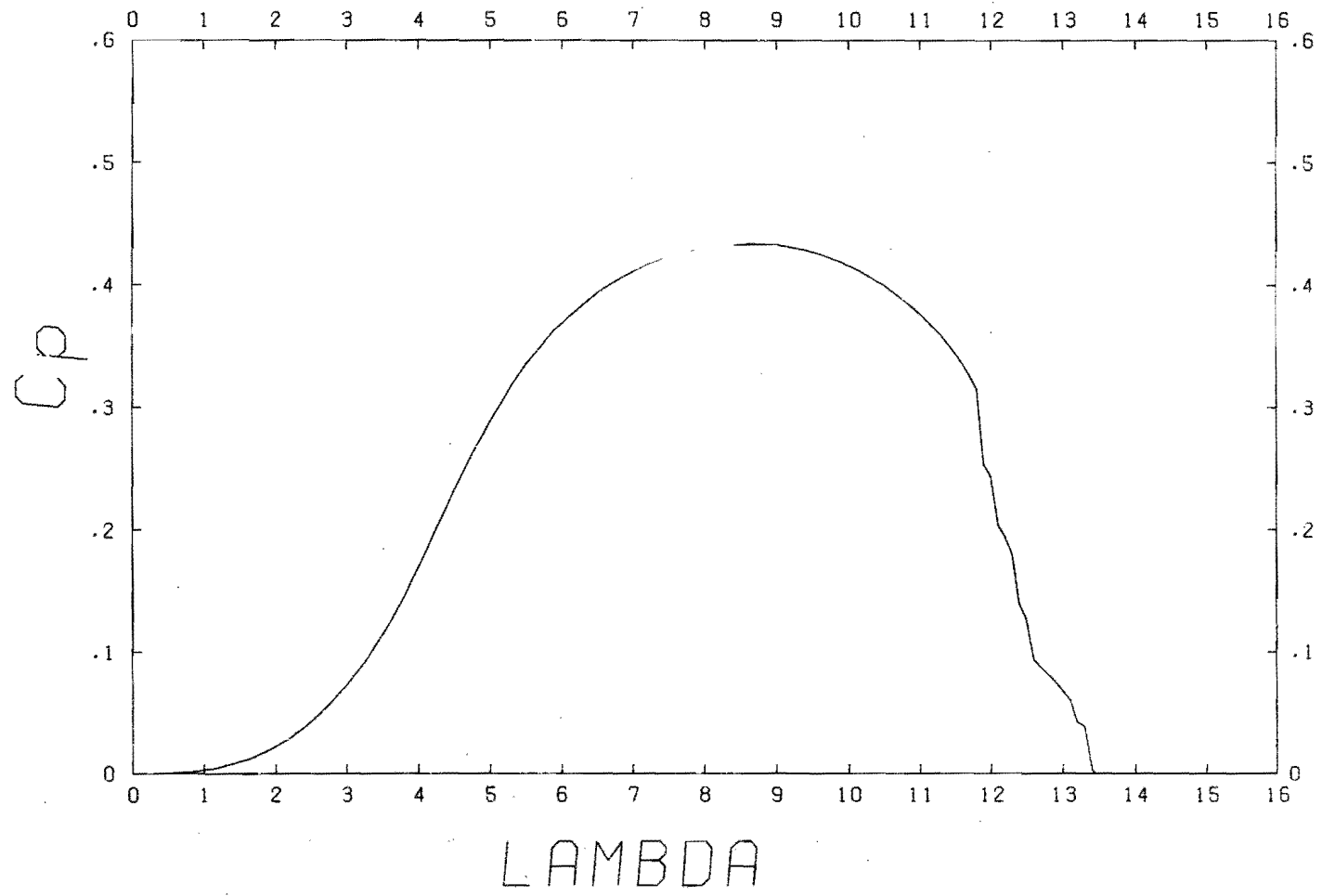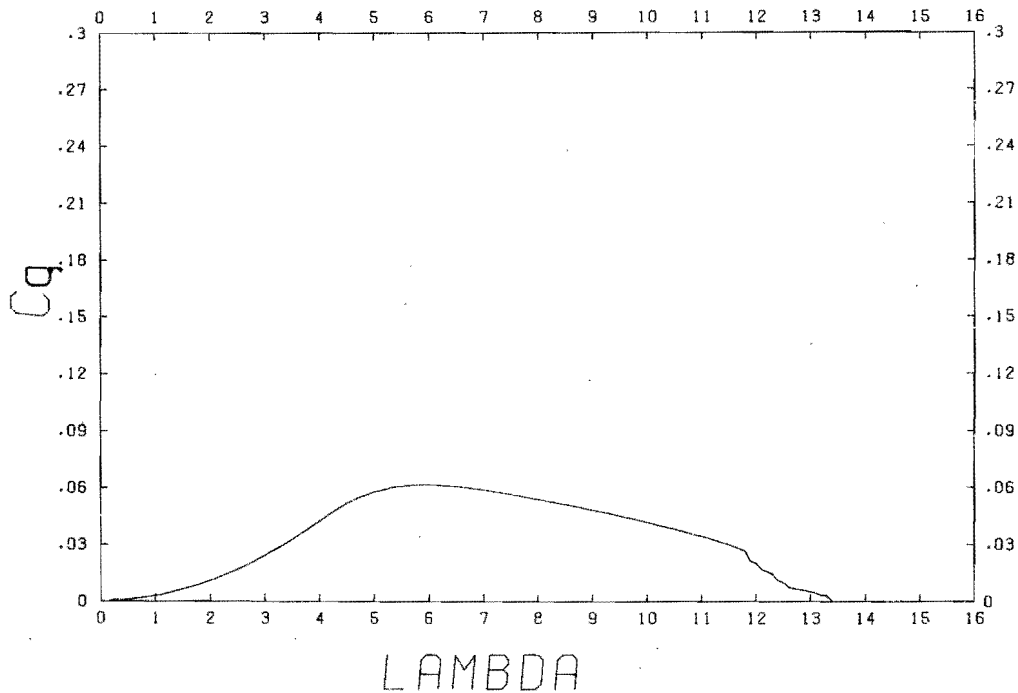Slankheid = 17.2   NACA 23018
Viterna & Corrigan korrektie.

PETTEN Pitchhoek = 0.0 graden

Slankheid = 17.2   NACA 23018
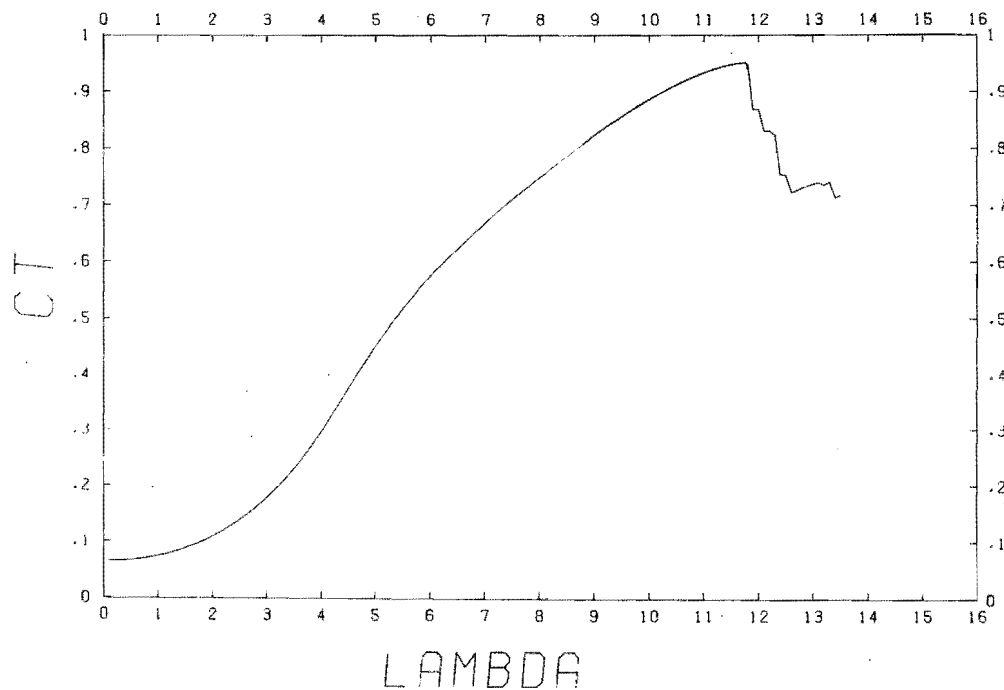
Viterna & Corrigan korrektie.

LAMBDA

PETTEN Pitchhoek = 0.0 graden

Slankheid = 17.2   NACA 23018

Viterna & Corrigan korrektie.

LAMBDA

Numerieke uitkomsten van de berekeningen aan de PETTEN molen.
Pitchhoek -5.0 graden.
Viterna & Corrigan korrektie.
Slankheid = 17.2
Het gebruikte profiel is NACA 23018
De straal van de rotor is 12.500 meter.
De rotor heeft 2 bladen.
Bij de berekeningen wordt lambda telkens met 0.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct		Lambda	Cp	Cq	Ct
0.10	-.0002	-.0016	0.0660		4.80	0.1690	0.0352	0.3952
0.10	-.0002	-.0016	0.0660		4.90	0.1797	0.0367	0.4121
0.20	-.0006	-.0031	0.0662		5.00	0.1908	0.0382	0.4297
0.30	-.0008	-.0027	0.0667		5.10	0.2022	0.0396	0.4479
0.40	-.0008	-.0020	0.0675		5.20	0.2140	0.0412	0.4668
0.50	-.0010	-.0019	0.0685		5.30	0.2262	0.0427	0.4862
0.60	-.0011	-.0018	0.0697		5.40	0.2386	0.0442	0.5063
0.70	-.0011	-.0016	0.0711		5.50	0.2515	0.0457	0.5272
0.80	-.0011	-.0014	0.0727		5.60	0.2647	0.0473	0.5492
0.90	-.0010	-.0011	0.0746		5.70	0.2783	0.0488	0.5721
1.00	-.0009	-.0009	0.0767		5.80	0.2921	0.0504	0.5960
1.10	-.0006	-.0005	0.0791		5.90	0.3055	0.0518	0.6211
1.20	-.0002	-.0001	0.0816		6.00	0.3174	0.0529	0.6473
1.30	0.0003	0.0003	0.0845		6.10	0.3271	0.0536	0.6703
1.40	0.0010	0.0007	0.0876		6.20	0.3357	0.0541	0.6908
1.50	0.0018	0.0012	0.0909		6.30	0.3437	0.0546	0.7111
1.60	0.0027	0.0017	0.0945		6.40	0.3502	0.0547	0.7295
1.70	0.0039	0.0023	0.0985		6.50	0.3557	0.0547	0.7468
1.80	0.0052	0.0029	0.1026		6.60	0.3607	0.0547	0.7640
1.90	0.0066	0.0035	0.1071		6.70	0.3651	0.0545	0.7811
2.00	0.0083	0.0042	0.1119		6.80	0.3688	0.0542	0.7991
2.10	0.0102	0.0049	0.1169		6.90	0.3708	0.0537	0.8141
2.20	0.0123	0.0056	0.1222		7.00	0.3721	0.0532	0.8284
2.30	0.0146	0.0064	0.1279		7.10	0.3724	0.0524	0.8418
2.40	0.0172	0.0072	0.1339		7.20	0.3716	0.0516	0.8542
2.50	0.0200	0.0080	0.1402		7.30	0.3701	0.0507	0.8661
2.60	0.0231	0.0089	0.1468		7.40	0.3676	0.0497	0.8772
2.70	0.0264	0.0098	0.1538		7.50	0.3643	0.0486	0.8879
2.80	0.0300	0.0107	0.1612		7.60	0.3601	0.0474	0.8979
2.90	0.0338	0.0117	0.1689		7.70	0.3544	0.0460	0.9065
3.00	0.0380	0.0127	0.1769		7.80	0.3470	0.0445	0.9141
3.10	0.0424	0.0137	0.1854		7.90	0.3360	0.0425	0.9195
3.20	0.0472	0.0147	0.1942		8.00	0.2779	0.0347	0.8623
3.30	0.0522	0.0158	0.2034		8.10	0.2553	0.0315	0.8540
3.40	0.0576	0.0169	0.2130		8.20	0.1724	0.0210	0.7033
3.50	0.0633	0.0181	0.2230		8.30	0.1567	0.0189	0.7578
3.60	0.0693	0.0193	0.2334		8.40	0.1500	0.0179	0.7661
3.70	0.0757	0.0205	0.2443		8.50	0.1410	0.0166	0.7730
3.80	0.0824	0.0217	0.2557		8.60	0.0994	0.0116	0.7494
3.90	0.0894	0.0229	0.2675		8.70	0.0905	0.0104	0.7557
4.00	0.0968	0.0242	0.2798		8.80	0.0788	0.0090	0.7578
4.10	0.1046	0.0255	0.2926		8.90	0.0638	0.0072	0.6665
4.20	0.1127	0.0268	0.3059		9.00	0.0379	0.0042	0.7250
4.30	0.1211	0.0282	0.3195		9.10	0.0011	0.0001	0.7089
4.40	0.1300	0.0295	0.3337		9.20	-.0051	-.0005	0.7192
4.50	0.1392	0.0309	0.3484					
4.60	0.1487	0.0323	0.3635					
4.70	0.1587	0.0338	0.3790					

Er is 2 maal geen convergentie bereikt.

Pitchhoek -2.5 graden.
Viterna & Corrigan korrektie.
Slankheid = 17.2
Het gebruikte profiel is NACA 23018
De straal van de rotor is   12.500 meter.
De rotor heeft 2 bladen.
Bij de berekeningen wordt lambda telkens met 0.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct
0.10	-.0001	-.0013	0.0658
0.10	-.0001	-.0013	0.0658
0.20	-.0005	-.0023	0.0659
0.30	-.0002	-.0007	0.0664
0.40	-.0002	-.0006	0.0671
0.50	-.0002	-.0004	0.0679
0.60	-.0001	-.0002	0.0690
0.70	0.0001	0.0001	0.0704
0.80	0.0003	0.0004	0.0719
0.90	0.0007	0.0007	0.0737
1.00	0.0011	0.0011	0.0757
1.10	0.0018	0.0016	0.0779
1.20	0.0025	0.0021	0.0805
1.30	0.0034	0.0026	0.0832
1.40	0.0045	0.0032	0.0862
1.50	0.0057	0.0038	0.0896
1.60	0.0072	0.0045	0.0931
1.70	0.0089	0.0052	0.0970
1.80	0.0108	0.0060	0.1011
1.90	0.0129	0.0068	0.1056
2.00	0.0153	0.0076	0.1104
2.10	0.0179	0.0085	0.1154
2.20	0.0208	0.0095	0.1208
2.30	0.0240	0.0104	0.1266
2.40	0.0275	0.0115	0.1326
2.50	0.0313	0.0125	0.1391
2.60	0.0354	0.0136	0.1459
2.70	0.0399	0.0148	0.1531
2.80	0.0446	0.0159	0.1607
2.90	0.0498	0.0172	0.1686
3.00	0.0553	0.0184	0.1770
3.10	0.0612	0.0198	0.1858
3.20	0.0675	0.0211	0.1951
3.30	0.0742	0.0225	0.2048
3.40	0.0813	0.0239	0.2150
3.50	0.0888	0.0254	0.2257
3.60	0.0967	0.0269	0.2368
3.70	0.1051	0.0284	0.2484
3.80	0.1138	0.0300	0.2606
3.90	0.1230	0.0315	0.2731
4.00	0.1327	0.0332	0.2863
4.10	0.1429	0.0348	0.3000
4.20	0.1535	0.0365	0.3143
4.30	0.1645	0.0383	0.3291
4.40	0.1761	0.0400	0.3447
4.50	0.1882	0.0418	0.3609
4.60	0.2007	0.0436	0.3779
4.70	0.2138	0.0455	0.3955
4.80	0.2273	0.0474	0.4138
4.90	0.2412	0.0492	0.4330
5.00	0.2550	0.0510	0.4530
5.10	0.2686	0.0527	0.4734
5.20	0.2812	0.0541	0.4927
5.30	0.2932	0.0553	0.5118
5.40	0.3048	0.0564	0.5298
5.50	0.3160	0.0574	0.5482
5.60	0.3256	0.0581	0.5647
5.70	0.3347	0.0587	0.5809
5.80	0.3435	0.0592	0.5974
5.90	0.3513	0.0595	0.6123
6.00	0.3591	0.0599	0.6274
6.10	0.3669	0.0601	0.6426
6.20	0.3745	0.0604	0.6579
6.30	0.3822	0.0607	0.6737
6.40	0.3888	0.0608	0.6890
6.50	0.3937	0.0606	0.7015
6.60	0.3980	0.0603	0.7137
6.70	0.4015	0.0599	0.7252
6.80	0.4045	0.0595	0.7362
6.90	0.4073	0.0590	0.7472
7.00	0.4099	0.0586	0.7582
7.10	0.4124	0.0581	0.7691
7.20	0.4147	0.0576	0.7799
7.30	0.4166	0.0571	0.7904
7.40	0.4185	0.0566	0.8011
7.50	0.4197	0.0560	0.8117
7.60	0.4206	0.0553	0.8228
7.70	0.4203	0.0546	0.8326
7.80	0.4197	0.0538	0.8418
7.90	0.4187	0.0530	0.8508
8.00	0.4173	0.0522	0.8595
8.10	0.4154	0.0513	0.8681
8.20	0.4130	0.0504	0.8765
8.30	0.4103	0.0494	0.8846
8.40	0.4071	0.0485	0.8925
8.50	0.4034	0.0475	0.9001
8.60	0.3991	0.0464	0.9072
8.70	0.3940	0.0453	0.9141
8.80	0.3882	0.0441	0.9205
8.90	0.3818	0.0429	0.9264
9.00	0.3742	0.0416	0.9317
9.10	0.3656	0.0402	0.9361
9.20	0.3552	0.0386	0.9391
9.30	0.3416	0.0367	0.9393
9.40	0.2837	0.0302	0.8692
9.50	0.2217	0.0233	0.8059
9.60	0.2137	0.0223	0.8104
9.70	0.2042	0.0211	0.8137
9.80	0.1873	0.0191	0.8105
9.90	0.1227	0.0124	0.7214
10.00	0.1167	0.0117	0.7281
10.10	0.1100	0.0109	0.7344
10.20	0.1017	0.0100	0.7398
10.30	0.0913	0.0089	0.7436
10.40	0.0542	0.0052	0.7191
10.50	0.0480	0.0046	0.7259
10.60	0.0414	0.0039	0.7326
10.70	0.0342	0.0032	0.7389
10.80	0.0260	0.0024	0.7448
10.90	0.0055	0.0005	0.7428

Numerieke uitkomsten van de berekeningen aan de PETTEN molen.
Pit.hoek 0.0 graden.
Viterna & Corrigan korrektie.
Slankheid = 17.2
Het gebruikte profiel is NACA 23018
De straal van de rotor is 12.500 meter.
De rotor heeft 2 bladen.
Bij de berekeningen wordt lambda telkens met 0.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct
0.10	-.0001	-.0006	0.0654
0.10	-.0001	-.0006	0.0654
0.20	0.0001	0.0006	0.0654
0.30	0.0002	0.0007	0.0658
0.40	0.0004	0.0009	0.0664
0.50	0.0006	0.0012	0.0672
0.60	0.0009	0.0014	0.0681
0.70	0.0012	0.0018	0.0693
0.80	0.0017	0.0022	0.0708
0.90	0.0024	0.0026	0.0725
1.00	0.0031	0.0031	0.0744
1.10	0.0040	0.0037	0.0766
1.20	0.0051	0.0043	0.0790
1.30	0.0064	0.0049	0.0817
1.40	0.0079	0.0057	0.0847
1.50	0.0096	0.0064	0.0879
1.60	0.0116	0.0072	0.0915
1.70	0.0138	0.0081	0.0953
1.80	0.0163	0.0090	0.0995
1.90	0.0190	0.0100	0.1039
2.00	0.0221	0.0110	0.1087
2.10	0.0255	0.0121	0.1139
2.20	0.0292	0.0133	0.1194
2.30	0.0332	0.0144	0.1253
2.40	0.0377	0.0157	0.1315
2.50	0.0424	0.0170	0.1382
2.60	0.0476	0.0183	0.1452
2.70	0.0532	0.0197	0.1527
2.80	0.0593	0.0212	0.1606
2.90	0.0658	0.0227	0.1690
3.00	0.0727	0.0242	0.1779
3.10	0.0801	0.0258	0.1874
3.20	0.0879	0.0275	0.1972
3.30	0.0963	0.0292	0.2075
3.40	0.1051	0.0309	0.2184
3.50	0.1145	0.0327	0.2298
3.60	0.1244	0.0345	0.2419
3.70	0.1348	0.0364	0.2545
3.80	0.1458	0.0384	0.2678
3.90	0.1574	0.0404	0.2817
4.00	0.1695	0.0424	0.2962
4.10	0.1822	0.0444	0.3118
4.20	0.1951	0.0465	0.3279
4.30	0.2080	0.0484	0.3440
4.40	0.2206	0.0501	0.3601
4.50	0.2332	0.0518	0.3763
4.60	0.2451	0.0533	0.3916
4.70	0.2566	0.0546	0.4072
4.80	0.2676	0.0557	0.4219
4.90	0.2784	0.0568	0.4369
5.00	0.2886	0.0577	0.4513
5.10	0.2983	0.0585	0.4650
5.20	0.3083	0.0593	0.4791
5.30	0.3178	0.0600	0.4932
5.40	0.3266	0.0605	0.5059
5.50	0.3347	0.0609	0.5184
5.60	0.3422	0.0611	0.5304
5.70	0.3492	0.0613	0.5421
5.80	0.3564	0.0614	0.5542
5.90	0.3630	0.0615	0.5663
6.00	0.3684	0.0614	0.5763
6.10	0.3739	0.0613	0.5863
6.20	0.3788	0.0611	0.5958
6.30	0.3836	0.0609	0.6051
6.40	0.3884	0.0607	0.6144
6.50	0.3931	0.0605	0.6237
6.60	0.3973	0.0602	0.6330
6.70	0.4011	0.0599	0.6421
6.80	0.4043	0.0595	0.6509
6.90	0.4076	0.0591	0.6598
7.00	0.4106	0.0587	0.6688
7.10	0.4136	0.0583	0.6780
7.20	0.4166	0.0579	0.6874
7.30	0.4188	0.0574	0.6955
7.40	0.4209	0.0569	0.7036
7.50	0.4229	0.0564	0.7115
7.60	0.4246	0.0559	0.7194
7.70	0.4263	0.0554	0.7271
7.80	0.4278	0.0548	0.7349
7.90	0.4291	0.0543	0.7426
8.00	0.4302	0.0538	0.7502
8.10	0.4311	0.0532	0.7577
8.20	0.4318	0.0527	0.7651
8.30	0.43'4	0.0521	0.7726
8.40	0.43 9	0.0515	0.7800
8.50	0.4333	0.0510	0.7873
8.60	0.4334	0.0504	0.7946
8.70	0.4334	0.0498	0.8019
8.80	0.4333	0.0492	0.8091
8.90	0.4331	0.0487	0.8163
9.00	0.4328	0.0481	0.8243
9.10	0.4321	0.0475	0.8310
9.20	0.4311	0.0469	0.8376
9.30	0.4300	0.0462	0.8442
9.40	0.4287	0.0456	0.8505
9.50	0.4271	0.0450	0.8568
9.60	0.4253	0.0443	0.8629
9.70	0.4234	0.0436	0.8689
9.80	0.4212	0.0430	0.8749
9.90	0.4188	0.0423	0.8806
10.00	0.4161	0.0416	0.8863
10.10	0.4133	0.0409	0.8918
10.20	0.4102	0.0402	0.8971
10.30	0.4069	0.0395	0.9024
10.40	0.4033	0.0388	0.9074
10.50	0.3996	0.0381	0.9124
10.60	0.3955	0.0373	0.9171
10.70	0.3912	0.0366	0.9217
10.80	0.3866	0.0358	0.9260
10.90	0.3817	0.0350	0.9302
11.00	0.3765	0.0342	0.9341
11.10	0.3710	0.0334	0.9377
11.20	0.3651	0.0326	0.9411
11.30	0.3587	0.0317	0.9440
11.40	0.3519	0.0309	0.9466
11.50	0.3444	0.0300	0.9487
11.60	0.3360	0.0290	0.9501
11.70	0.3264	0.0279	0.9506
11.80	0.3149	0.0267	0.9492
11.90	0.2529	0.0213	0.8687
12.00	0.2434	0.0203	0.8693
12.10	0.2035	0.0168	0.8302
12.20	0.1942	0.0159	0.8306
12.30	0.1792	0.0146	0.8240
12.40	0.1399	0.0113	0.7546
12.50	0.1266	0.0101	0.7523
12.60	0.0932	0.0074	0.7227
12.70	0.0873	0.0069	0.7266
12.80	0.0811	0.0063	0.7305
12.90	0.0747	0.0058	0.7341
13.00	0.0677	0.0052	0.7375
13.10	0.0600	0.0046	0.7403
13.20	0.0420	0.0032	0.7352
13.30	0.0382	0.0029	0.7410
13.40	0.0026	0.0002	0.7133
13.50	-.0038	-.0003	0.7171

Er is 0 maal geen convergentie bereikt.

Numerieke uitkomsten van de berekeningen aan de PETTEN molen.
Pitchhoek 2.5 graden.
Viterna & Corrigan korrektie.
Slankheid = 17.2
Het gebruikte profiel is NACA 23018
De straal van de rotor is 12.500 meter.
De rotor heeft 2 bladen.
Bij de berekeningen wordt lambda telkens met 0.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct
0.10	0.0001	0.0010	0.0647
0.10	0.0001	0.0010	0.0647
0.20	0.0004	0.0020	0.0648
0.30	0.0007	0.0022	0.0650
0.40	0.0010	0.0024	0.0655
0.50	0.0013	0.0027	0.0661
0.60	0.0018	0.0030	0.0670
0.70	0.0024	0.0035	0.0681
0.80	0.0031	0.0039	0.0695
0.90	0.0040	0.0045	0.0711
1.00	0.0051	0.0051	0.0729
1.10	0.0063	0.0057	0.0750
1.20	0.0077	0.0064	0.0774
1.30	0.0094	0.0072	0.0800
1.40	0.0113	0.0080	0.0829
1.50	0.0134	0.0090	0.0862
1.60	0.0159	0.0099	0.0897
1.70	0.0186	0.0109	0.0935
1.80	0.0217	0.0120	0.0977
1.90	0.0251	0.0132	0.1022
2.00	0.0288	0.0144	0.1071
2.10	0.0329	0.0157	0.1124
2.20	0.0374	0.0170	0.1180
2.30	0.0424	0.0184	0.1241
2.40	0.0477	0.0199	0.1306
2.50	0.0536	0.0214	0.1376
2.60	0.0599	0.0230	0.1451
2.70	0.0667	0.0247	0.1530
2.80	0.0740	0.0264	0.1615
2.90	0.0818	0.0282	0.1704
3.00	0.0902	0.0301	0.1799
3.10	0.0992	0.0320	0.1900
3.20	0.1087	0.0340	0.2007
3.30	0.1188	0.0360	0.2121
3.40	0.1297	0.0381	0.2241
3.50	0.1410	0.0403	0.2368
3.60	0.1527	0.0424	0.2500
3.70	0.1645	0.0444	0.2635
3.80	0.1762	0.0464	0.2770
3.90	0.1877	0.0481	0.2905
4.00	0.1989	0.0497	0.3035
4.10	0.2099	0.0512	0.3166
4.20	0.2205	0.0525	0.3293
4.30	0.2308	0.0537	0.3415
4.40	0.2414	0.0549	0.3544
4.50	0.2510	0.0558	0.3664
4.60	0.2601	0.0565	0.3777
4.70	0.2690	0.0572	0.3890
4.90	0.2849	0.0581	0.4099
5.00	0.2921	0.0584	0.4195
5.10	0.2992	0.0587	0.4291
5.20	0.3062	0.0589	0.4387
5.30	0.3131	0.0591	0.4481
5.40	0.3198	0.0592	0.4578
5.50	0.3258	0.0592	0.4668
5.60	0.3307	0.0591	0.4745
5.70	0.3354	0.0588	0.4820
5.80	0.3397	0.0586	0.4891
5.90	0.3440	0.0583	0.4963
6.00	0.3481	0.0580	0.5034
6.10	0.3522	0.0577	0.5106
6.20	0.3562	0.0575	0.5176
6.30	0.3599	0.0571	0.5243
6.40	0.3636	0.0568	0.5311
6.50	0.3672	0.0565	0.5380
6.60	0.3708	0.0562	0.5449
6.70	0.3744	0.0559	0.5520
6.80	0.3775	0.0555	0.5590
6.90	0.3803	0.0551	0.5651
7.00	0.3829	0.0547	0.5711
7.10	0.3853	0.0543	0.5769
7.20	0.3877	0.0538	0.5828
7.30	0.3899	0.0534	0.5885
7.40	0.3922	0.0530	0.5943
7.50	0.3944	0.0526	0.6000
7.60	0.3965	0.0522	0.6056
7.70	0.3986	0.0518	0.6112
7.80	0.4005	0.0514	0.6167
7.90	0.4025	0.0509	0.6222
8.00	0.4044	0.0505	0.6277
8.10	0.4062	0.0501	0.6331
8.20	0.4079	0.0497	0.6384
8.30	0.4094	0.0493	0.6437
8.40	0.4108	0.0489	0.6489
8.50	0.4121	0.0485	0.6543
8.60	0.4133	0.0481	0.6599
8.70	0.4142	0.0476	0.6647
8.80	0.4150	0.0472	0.6694
8.90	0.4157	0.0467	0.6740
9.00	0.4163	0.0463	0.6786
9.10	0.4168	0.0458	0.6831
9.20	0.4173	0.0454	0.6875
9.30	0.4177	0.0449	0.6919
9.40	0.4180	0.0445	0.6962
9.50	0.4183	0.0440	0.7005
9.60	0.4185	0.0436	0.7048
9.70	0.4187	0.0432	0.7090
9.80	0.4188	0.0427	0.7131
9.90	0.4188	0.0423	0.7172
10.00	0.4188	0.0419	0.7213
10.10	0.4187	0.0415	0.7253
10.20	0.4186	0.0410	0.7293
10.30	0.4184	0.0406	0.7333
10.40	0.4180	0.0402	0.7373
10.50	0.4175	0.0398	0.7412
10.60	0.4169	0.0393	0.7452
10.70	0.4163	0.0389	0.7490
10.80	0.4155	0.0385	0.7529
10.90	0.4146	0.0380	0.7568

11.10	0.4125	0.0372	0.7644
11.20	0.4114	0.0367	0.7682
11.30	0.4101	0.0363	0.7719
11.40	0.4088	0.0359	0.7756
11.50	0.4074	0.0354	0.7792
11.60	0.4059	0.0350	0.7828
11.70	0.4043	0.0346	0.7864
11.80	0.4026	0.0341	0.7900
11.90	0.4009	0.0337	0.7935
12.00	0.3990	0.0333	0.7970
12.10	0.3971	0.0328	0.8004
12.20	0.3951	0.0324	0.8038
12.30	0.3929	0.0319	0.8071
12.40	0.3907	0.0315	0.8105
12.50	0.3885	0.0311	0.8137
12.60	0.3861	0.0306	0.8170
12.70	0.3836	0.0302	0.8202
12.80	0.3811	0.0298	0.8234
12.90	0.3784	0.0293	0.8265
13.00	0.3757	0.0289	0.8296
13.10	0.3729	0.0285	0.8326
13.20	0.3699	0.0280	0.8356
13.30	0.3669	0.0276	0.8386
13.40	0.3638	0.0272	0.8415
13.50	0.3606	0.0267	0.8444
13.60	0.3573	0.0263	0.8472
13.70	0.3539	0.0258	0.8499
13.80	0.3502	0.0254	0.8526
13.90	0.3465	0.0249	0.8552
14.00	0.3426	0.0245	0.8578
14.10	0.3387	0.0240	0.8603
14.20	0.3346	0.0236	0.8628
14.30	0.3304	0.0231	0.8652
14.40	0.3260	0.0226	0.8675
14.50	0.3216	0.0222	0.8698
14.60	0.3170	0.0217	0.8721
14.70	0.3124	0.0212	0.8742
14.80	0.3076	0.0208	0.8764
14.90	0.3027	0.0203	0.8784
15.00	0.2977	0.0198	0.8805
15.10	0.2926	0.0194	0.8824
15.20	0.2872	0.0189	0.8843
15.30	0.2817	0.0184	0.8861
15.40	0.2762	0.0179	0.8878
15.50	0.2705	0.0174	0.8895
15.60	0.2646	0.0170	0.8911
15.70	0.2587	0.0165	0.8926
15.80	0.2526	0.0160	0.8941
15.90	0.2464	0.0155	0.8955
16.00	0.2400	0.0150	0.8968
16.10	0.2335	0.0145	0.8981
16.20	0.2268	0.0140	0.8992
16.30	0.2199	0.0135	0.9002
16.40	0.2129	0.0130	0.9012
16.50	0.2057	0.0125	0.9021
16.60	0.1984	0.0120	0.9028
16.70	0.1909	0.0114	0.9035
16.80	0.1832	0.0109	0.9040
16.90	0.1753	0.0104	0.9044
17.00	0.1672	0.0098	0.9047
17.10	0.1588	0.0093	0.9048

17.20	0.1502	0.0087	0.9047
17.30	0.1414	0.0082	0.9045
17.40	0.1324	0.0076	0.9041
17.50	0.1230	0.0070	0.9034
17.60	0.1133	0.0064	0.9024
17.70	0.1032	0.0058	0.9010
17.80	0.0925	0.0052	0.8991
17.90	0.0808	0.0045	0.8963
18.00	0.0416	0.0023	0.8447
18.10	0.0307	0.0017	0.8425
18.20	-.0035	-.0002	0.7910

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Pitchhoek 5.0 graden.
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Bij de berekeningen wordt lambda telkens met 0.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct
0.10	0.0003	0.0032	0.0639
0.10	0.0003	0.0032	0.0639
0.20	0.0007	0.0034	0.0638
0.30	0.0011	0.0036	0.0640
0.40	0.0015	0.0039	0.0643
0.50	0.0021	0.0042	0.0649
0.60	0.0028	0.0046	0.0657
0.70	0.0036	0.0051	0.0667
0.80	0.0045	0.0057	0.0680
0.90	0.0056	0.0063	0.0695
1.00	0.0070	0.0070	0.0712
1.10	0.0085	0.0077	0.0733
1.20	0.0102	0.0085	0.0756
1.30	0.0123	0.0094	0.0782
1.40	0.0146	0.0104	0.0811
1.50	0.0171	0.0114	0.0843
1.60	0.0201	0.0125	0.0878
1.70	0.0233	0.0137	0.0917
1.80	0.0270	0.0150	0.0959
1.90	0.0310	0.0163	0.1005
2.00	0.0354	0.0177	0.1056
2.10	0.0403	0.0192	0.1110
2.20	0.0457	0.0208	0.1170
2.30	0.0515	0.0224	0.1234
2.40	0.0579	0.0241	0.1303
2.50	0.0648	0.0259	0.1377
2.60	0.0723	0.0278	0.1457
2.70	0.0803	0.0298	0.1542
2.80	0.0890	0.0318	0.1634
2.90	0.0984	0.0339	0.1732
3.00	0.1084	0.0361	0.1837
3.10	0.1189	0.0383	0.1949
3.20	0.1294	0.0405	0.2061
3.30	0.1401	0.0425	0.2175
3.40	0.1507	0.0443	0.2289
3.50	0.1610	0.0460	0.2402
3.60	0.1712	0.0476	0.2512
3.70	0.1814	0.0490	0.2626
3.80	0.1907	0.0502	0.2727
3.90	0.2000	0.0513	0.2829
4.00	0.2090	0.0522	0.2933
4.10	0.2171	0.0530	0.3026
4.20	0.2250	0.0536	0.3115
4.30	0.2327	0.0541	0.3205
4.40	0.2400	0.0546	0.3293
4.50	0.2464	0.0547	0.3367
4.60	0.2527	0.0549	0.3443
4.70	0.2586	0.0550	0.3517
4.80	0.2643	0.0551	0.3589
4.90	0.2702	0.0551	0.3664
5.00	0.2760	0.0552	0.3740
5.10	0.2806	0.0550	0.3804
5.20	0.2848	0.0548	0.3860
5.30	0.2887	0.0545	0.3913
5.40	0.2923	0.0541	0.3965
5.50	0.2960	0.0538	0.4017
5.60	0.2995	0.0535	0.4069
5.70	0.3030	0.0532	0.4120
5.80	0.3061	0.0528	0.4166
5.90	0.3091	0.0524	0.4213
6.00	0.3121	0.0520	0.4261
6.10	0.3152	0.0517	0.4308
6.20	0.3182	0.0513	0.4356
6.30	0.3213	0.0510	0.4406
6.40	0.3238	0.0506	0.4449
6.50	0.3261	0.0502	0.4488
6.60	0.3282	0.0497	0.4526
6.70	0.3301	0.0493	0.4561
6.80	0.3319	0.0488	0.4596
6.90	0.3336	0.0483	0.4630
7.00	0.3352	0.0479	0.4662
7.10	0.3368	0.0474	0.4694
7.20	0.3381	0.0470	0.4725
7.30	0.3394	0.0465	0.4755
7.40	0.3406	0.0460	0.4784
7.50	0.3418	0.0456	0.4812
7.60	0.3429	0.0451	0.4840
7.70	0.3440	0.0447	0.4867
7.80	0.3450	0.0442	0.4894
7.90	0.3460	0.0438	0.4921
8.00	0.3470	0.0434	0.4948
8.10	0.3480	0.0430	0.4976
8.20	0.3488	0.0425	0.5002
8.30	0.3493	0.0421	0.5024
8.40	0.3499	0.0417	0.5044
8.50	0.3503	0.0412	0.5064
8.60	0.3506	0.0408	0.5085
8.70	0.3508	0.0403	0.5105
8.80	0.3509	0.0399	0.5125
8.90	0.3509	0.0394	0.5144
9.00	0.3508	0.0390	0.5163
9.10	0.3507	0.0385	0.5182
9.20	0.3505	0.0381	0.5200
9.30	0.3502	0.0377	0.5218
9.40	0.3499	0.0372	0.5235
9.50	0.3495	0.0368	0.5251
9.60	0.3491	0.0364	0.5267
9.70	0.3486	0.0359	0.5283
9.80	0.3481	0.0355	0.5298
9.90	0.3475	0.0351	0.5313
10.00	0.3468	0.0347	0.5327
10.10	0.3461	0.0343	0.5341
10.20	0.3453	0.0339	0.5354
10.30	0.3444	0.0334	0.5367
10.40	0.3435	0.0330	0.5379
10.50	0.3426	0.0326	0.5391
10.60	0.3416	0.0322	0.5402
10.70	0.3405	0.0318	0.5413
10.80	0.3394	0.0314	0.5423
10.90	0.3382	0.0310	0.5433

11.00	0.3370	0.0306	0.5442
11.10	0.3357	0.0302	0.5451
11.20	0.3343	0.0298	0.5460
11.30	0.3328	0.0294	0.5467
11.40	0.3311	0.0290	0.5474
11.50	0.3293	0.0286	0.5480
11.60	0.3274	0.0282	0.5485
11.70	0.3254	0.0278	0.5490
11.80	0.3233	0.0274	0.5495
11.90	0.3211	0.0270	0.5499
12.00	0.3188	0.0266	0.5502
12.10	0.3164	0.0262	0.5505
12.20	0.3139	0.0257	0.5507
12.30	0.3114	0.0253	0.5509
12.40	0.3087	0.0249	0.5510
12.50	0.3060	0.0245	0.5511
12.60	0.3032	0.0241	0.5511
12.70	0.3003	0.0236	0.5511
12.80	0.2973	0.0232	0.5510
12.90	0.2942	0.0228	0.5509
13.00	0.2910	0.0224	0.5508
13.10	0.2878	0.0220	0.5506
13.20	0.2844	0.0215	0.5504
13.30	0.2810	0.0211	0.5501
13.40	0.2775	0.0207	0.5497
13.50	0.2739	0.0203	0.5494
13.60	0.2703	0.0199	0.5490
13.70	0.2665	0.0195	0.5485
13.80	0.2627	0.0190	0.5480
13.90	0.2588	0.0186	0.5475
14.00	0.2548	0.0182	0.5469
14.10	0.2508	0.0178	0.5463
14.20	0.2467	0.0174	0.5456
14.30	0.2425	0.0170	0.5449
14.40	0.2382	0.0165	0.5442
14.50	0.2338	0.0161	0.5434
14.60	0.2293	0.0157	0.5426
14.70	0.2248	0.0153	0.5417
14.80	0.2202	0.0149	0.5408
14.90	0.2155	0.0145	0.5399
15.00	0.2107	0.0140	0.5389
15.10	0.2059	0.0136	0.5379
15.20	0.2009	0.0132	0.5368
15.30	0.1959	0.0128	0.5357
15.40	0.1908	0.0124	0.5346
15.50	0.1856	0.0120	0.5334
15.60	0.1803	0.0116	0.5322
15.70	0.1750	0.0111	0.5310
15.80	0.1695	0.0107	0.5297
15.90	0.1640	0.0103	0.5284
16.00	0.1583	0.0099	0.5270
16.10	0.1525	0.0095	0.5256
16.20	0.1466	0.0090	0.5241
16.30	0.1405	0.0086	0.5226
16.40	0.1344	0.0082	0.5211
16.50	0.1282	0.0078	0.5195
16.60	0.1219	0.0073	0.5179
16.70	0.1155	0.0069	0.5162
16.80	0.1090	0.0065	0.5145
16.90	0.1023	0.0061	0.5128
17.00	0.0955	0.0056	0.5110
17.10	0.0887	0.0052	0.5091
17.20	0.0817	0.0048	0.5073
17.30	0.0747	0.0043	0.5054
17.40	0.0675	0.0039	0.5035
17.50	0.0603	0.0034	0.5015
17.60	0.0529	0.0030	0.4995
17.70	0.0455	0.0026	0.4975
17.80	0.0379	0.0021	0.4954
17.90	0.0302	0.0017	0.4932
18.00	0.0223	0.0012	0.4911
18.10	0.0143	0.0008	0.4889
18.20	0.0062	0.0003	0.4866
18.30	-.0019	-.0001	0.4844

Er is   0 maal geen convergentie bereikt.

Numerieke uitkomsten van de berekeningen aan de PETTEN molen.
Pitchhoek 10.0 graden.
Viterna & Corrigan korrektie.
Slankheid = 17.2
Het gebruikte profiel is NACA 23018
De straal van de rotor is 12.500 meter.
De rotor heeft 2 bladen.
Bij de berekeningen wordt lambda telkens met 0.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct
0.10	0.0006	0.0059	0.0615
0.10	0.0006	0.0059	0.0615
0.20	0.0012	0.0061	0.0613
0.30	0.0019	0.0064	0.0612
0.40	0.0027	0.0067	0.0614
0.50	0.0036	0.0072	0.0618
0.60	0.0046	0.0077	0.0624
0.70	0.0058	0.0083	0.0632
0.80	0.0072	0.0090	0.0644
0.90	0.0088	0.0098	0.0657
1.00	0.0106	0.0106	0.0673
1.10	0.0127	0.0116	0.0693
1.20	0.0151	0.0126	0.0715
1.30	0.0178	0.0137	0.0741
1.40	0.0209	0.0149	0.0770
1.50	0.0244	0.0162	0.0802
1.60	0.0282	0.0177	0.0839
1.70	0.0326	0.0192	0.0880
1.80	0.0374	0.0208	0.0926
1.90	0.0428	0.0225	0.0977
2.00	0.0488	0.0244	0.1034
2.10	0.0553	0.0264	0.1096
2.20	0.0626	0.0284	0.1164
2.30	0.0705	0.0307	0.1240
2.40	0.0790	0.0329	0.1321
2.50	0.0878	0.0351	0.1406
2.60	0.0965	0.0371	0.1490
2.70	0.1053	0.0390	0.1575
2.80	0.1139	0.0407	0.1658
2.90	0.1221	0.0421	0.1737
3.00	0.1302	0.0434	0.1818
3.10	0.1374	0.0443	0.1888
3.20	0.1445	0.0452	0.1957
3.30	0.1511	0.0458	0.2024
3.40	0.1571	0.0462	0.2084
3.50	0.1628	0.0465	0.2140
3.60	0.1682	0.0467	0.2196
3.70	0.1732	0.0468	0.2248
3.80	0.1775	0.0467	0.2291
3.90	0.1813	0.0465	0.2330
4.00	0.1851	0.0463	0.2370
4.10	0.1890	0.0461	0.2410
4.20	0.1928	0.0459	0.2451
4.30	0.1960	0.0456	0.2489
4.40	0.1982	0.0450	0.2512
4.50	0.2001	0.0445	0.2532
4.60	0.2018	0.0439	0.2550
4.70	0.2033	0.0433	0.2567
4.80	0.2047	0.0426	0.2582
4.90	0.2057	0.0420	0.2593
5.00	0.2066	0.0413	0.2602
5.10	0.2073	0.0406	0.2610
5.20	0.2080	0.0400	0.2618
5.30	0.2086	0.0394	0.2626
5.40	0.2091	0.0387	0.2633
5.50	0.2094	0.0381	0.2641
5.60	0.2091	0.0373	0.2640
5.70	0.2087	0.0366	0.2637
5.80	0.2081	0.0359	0.2632
5.90	0.2074	0.0351	0.2625
6.00	0.2065	0.0344	0.2617
6.10	0.2055	0.0337	0.2608
6.20	0.2044	0.0330	0.2598
6.30	0.2030	0.0322	0.2586
6.40	0.2016	0.0315	0.2573
6.50	0.2001	0.0308	0.2559
6.60	0.1984	0.0301	0.2543
6.70	0.1965	0.0293	0.2526
6.80	0.1944	0.0286	0.2507
6.90	0.1921	0.0278	0.2487
7.00	0.1897	0.0271	0.2467
7.10	0.1872	0.0264	0.2445
7.20	0.1846	0.0256	0.2424
7.30	0.1816	0.0249	0.2398
7.40	0.1785	0.0241	0.2370
7.50	0.1752	0.0234	0.2339
7.60	0.1717	0.0226	0.2307
7.70	0.1680	0.0218	0.2274
7.80	0.1642	0.0211	0.2240
7.90	0.1603	0.0203	0.2205
8.00	0.1562	0.0195	0.2168
8.10	0.1520	0.0188	0.2130
8.20	0.1476	0.0180	0.2091
8.30	0.1430	0.0172	0.2050
8.40	0.1383	0.0165	0.2008
8.50	0.1335	0.0157	0.1964
8.60	0.1285	0.0149	0.1920
8.70	0.1234	0.0142	0.1874
8.80	0.1180	0.0134	0.1826
8.90	0.1124	0.0126	0.1777
9.00	0.1065	0.0118	0.1727
9.10	0.1004	0.0110	0.1674
9.20	0.0941	0.0102	0.1621
9.30	0.0875	0.0094	0.1566
9.40	0.0808	0.0086	0.1510
9.50	0.0739	0.0078	0.1452
9.60	0.0668	0.0070	0.1393
9.70	0.0595	0.0061	0.1333
9.80	0.0520	0.0053	0.1272
9.90	0.0443	0.0045	0.1210
10.00	0.0365	0.0037	0.1146
10.10	0.0285	0.0028	0.1081
10.20	0.0202	0.0020	0.1015
10.30	0.0118	0.0011	0.0948
10.40	0.0032	0.0003	0.0879
10.50	-.0056	-.0005	0.0810

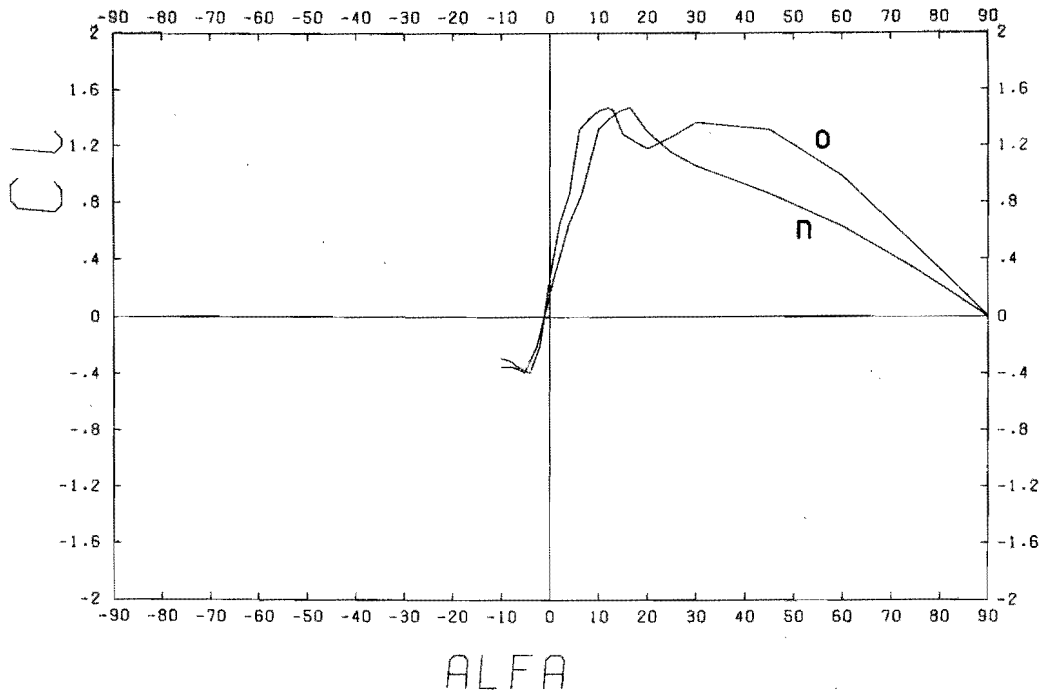# Er is 0 maal geen convergentie bereikt.

II.5   DEMPSTER 14'

task A.3.a
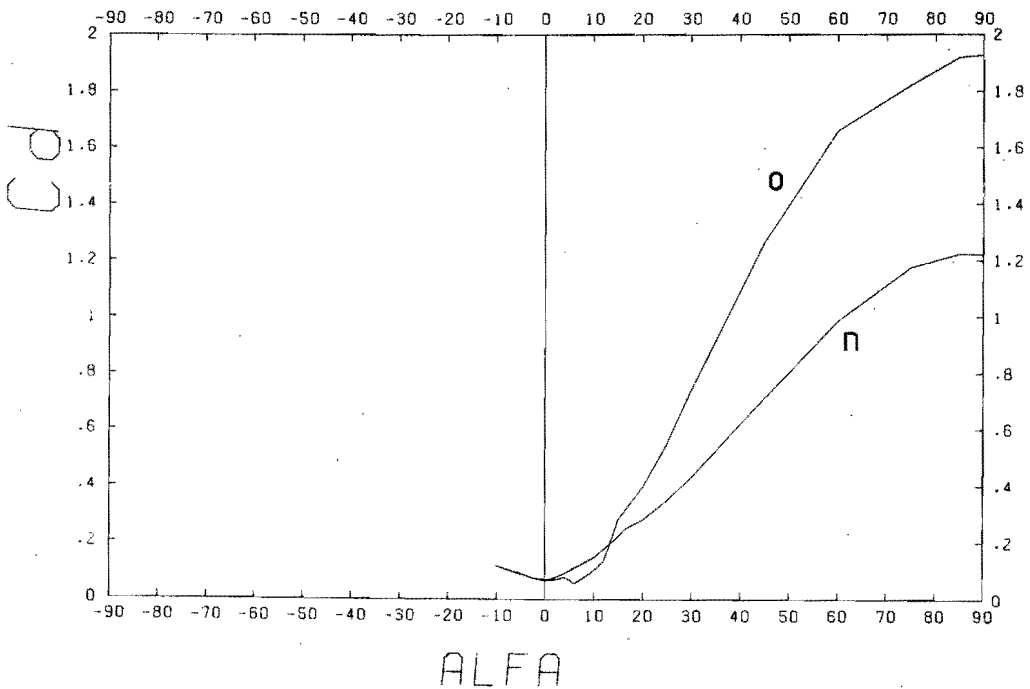
DEMPSTER

Slankheid = 6.1   GebPlaat

Viterna & Corrigan korrektie.

ALFA

DEMPSTER

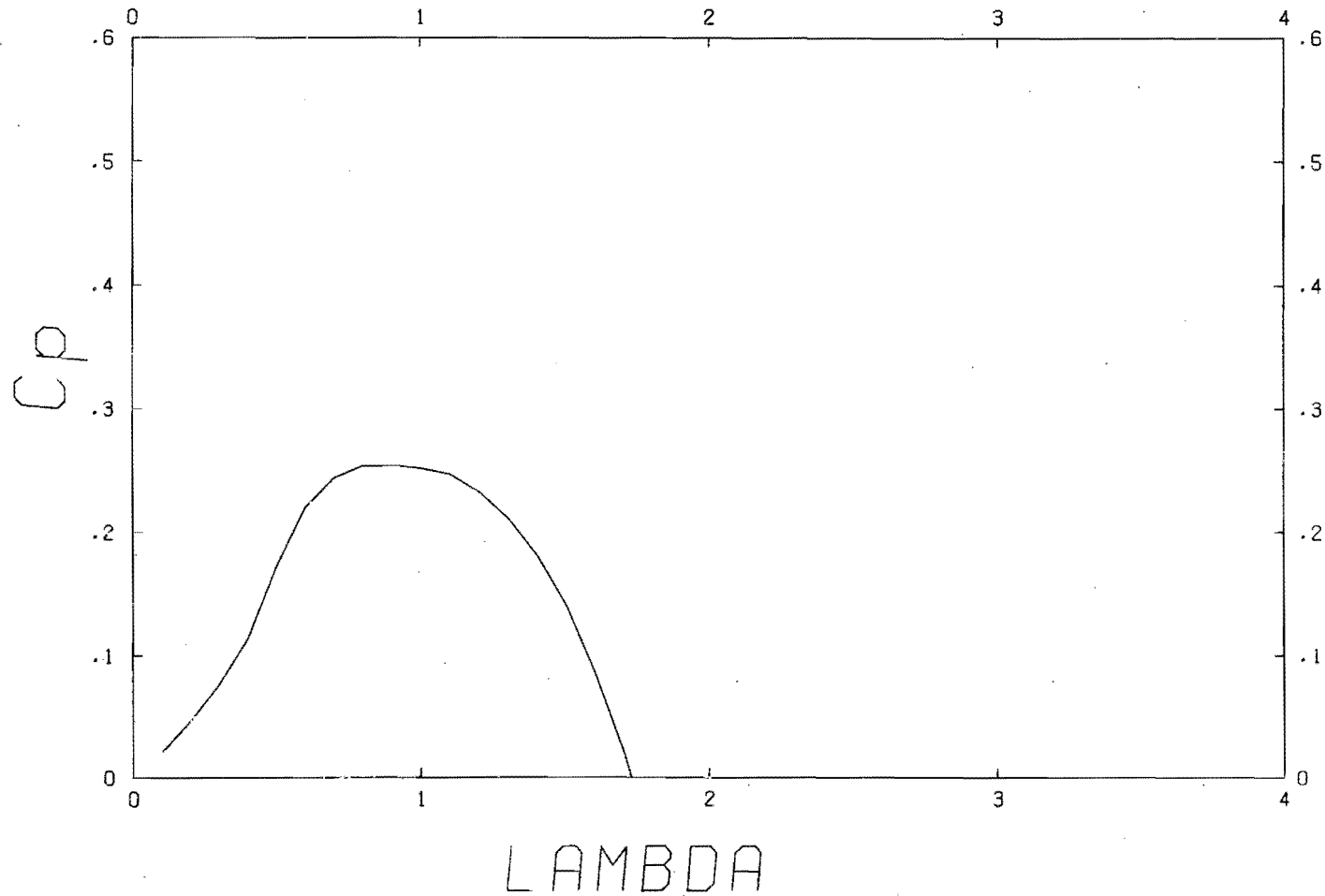Slankheid = 6.1   GebPlaat

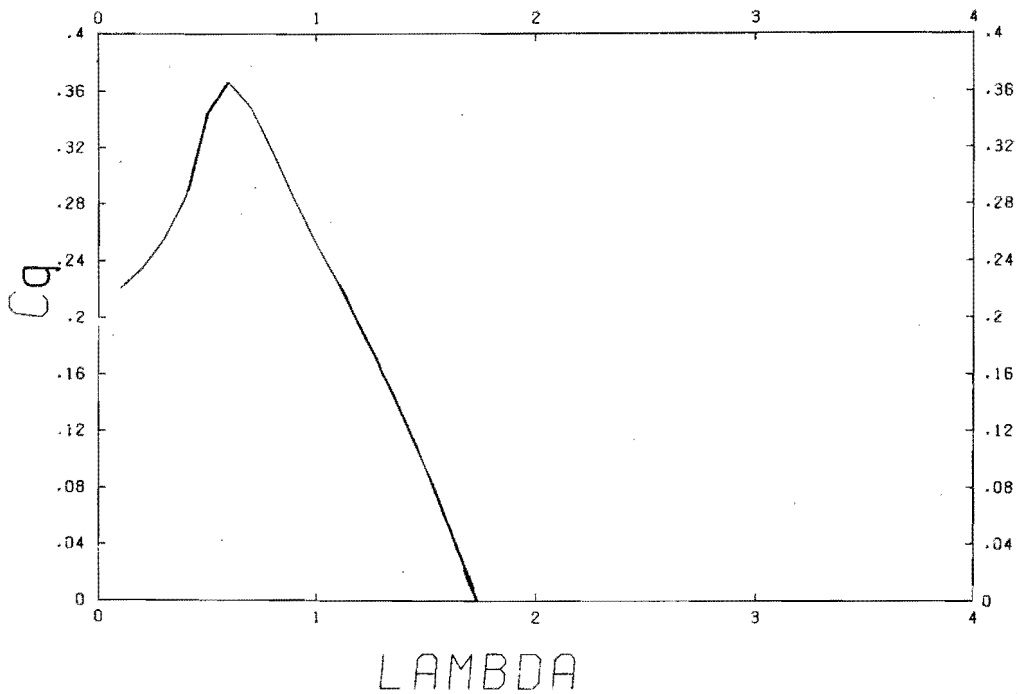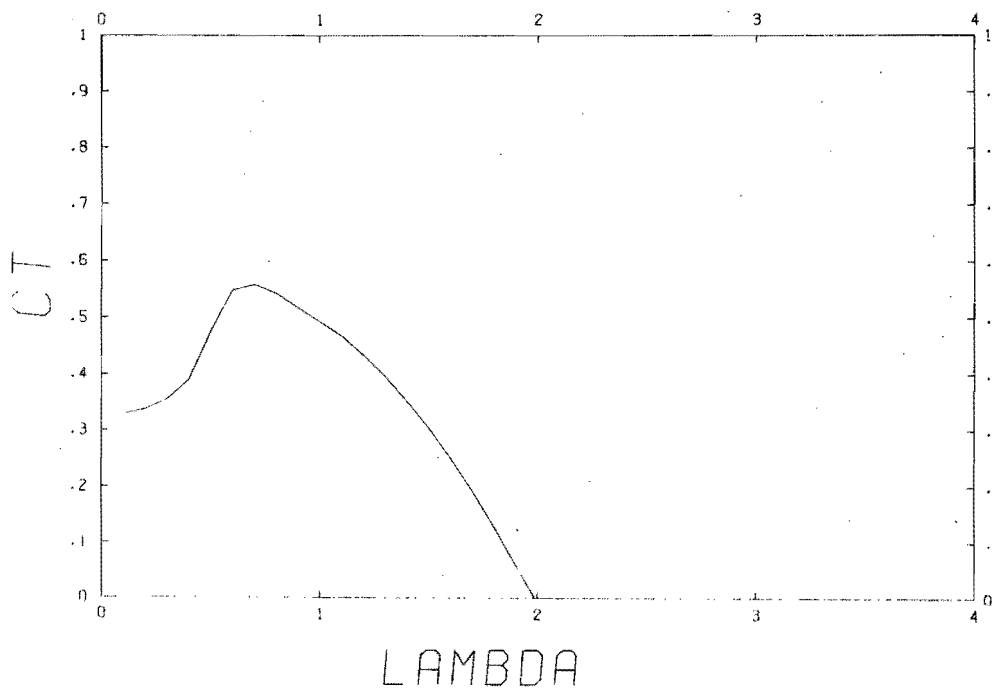Viterna & Corrigan korrektie.

ALFA

DEMPSTER Pitchhoek = 0.0 graden

Slankheid = 6.1   GebPlaat

Viterna & Corrigan korrektie.

DEMPSTER Pitchhoek = 0.0 graden

Slankheid = 6.1   GebPlaat

Viterna & Corrigan korrektie.

LAMBDA

DEMPSTER Pitchhoek = 0.0 graden

Slankheid = 6.1   GebPlaat

Viterna & Corrigan korrektie.

LAMBDA

Numerieke uitkomsten van de berekeningen aan de DEMPSTER   molen.
Pitchhoek   0.0 graden.
Viterna & Corrigan korrektie.
Slankheid =   6.1
Het gebruikte profiel is GebPlaat
De straal van de rotor is   2.230 meter.
De rotor heeft 18 bladen.
Bij de berekeningen wordt lambda telkens met 0.1 opgehoogd.

Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct
0.10	0.0221	0.2209	0.3288
0.10	0.0221	0.2209	0.3288
0.20	0.0469	0.2346	0.3376
0.30	0.0763	0.2544	0.3551
0.40	0.1138	0.2845	0.3894
0.50	0.1718	0.3436	0.4753
0.60	0.2196	0.3661	0.5480
0.70	0.2440	0.3485	0.5585
0.80	0.2536	0.3170	0.5429
0.90	0.2539	0.2822	0.5170
1.00	0.2517	0.2517	0.4924
1.10	0.2463	0.2239	0.4671
1.20	0.2323	0.1936	0.4347
1.30	0.2105	0.1619	0.3966
1.40	0.1807	0.1291	0.3531
1.50	0.1404	0.0936	0.3042
1.60	0.0870	0.0544	0.2506
1.70	0.0222	0.0131	0.1923
1.80	-.0540	-.0300	0.1293
1.90	-.1348	-.0710	0.0604
2.00	-.2103	-.1051	-.0075

Er is 3 maal geen convergentie bereikt.

II.6   WEU I-4

task A.3.b

WEU I4

Slankheid = 2.0   GebPla+ buis
Viterna & Corrigan korrektie.

ALFA

WEU I4

Slankheid = 2.0   GebPla+ buis
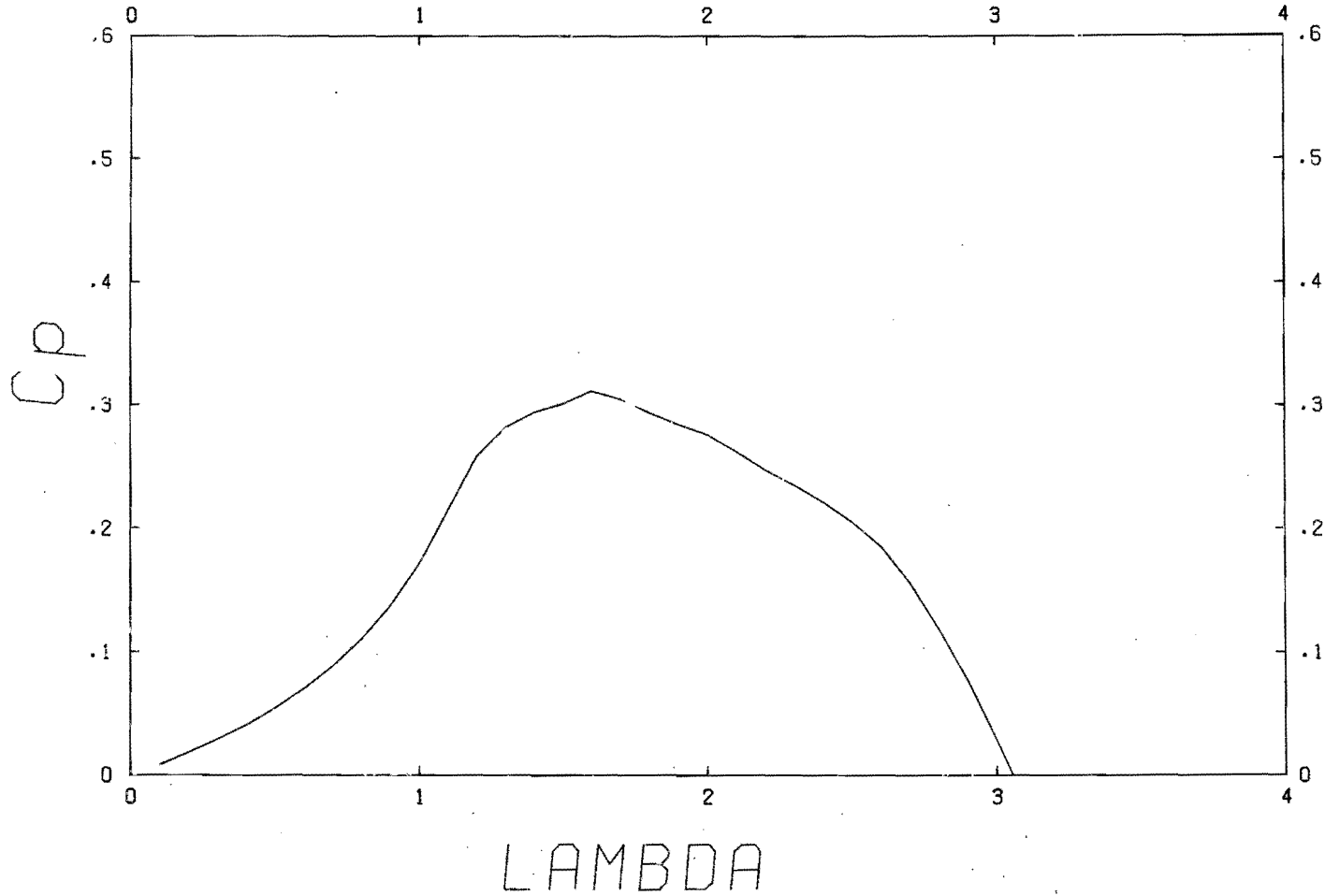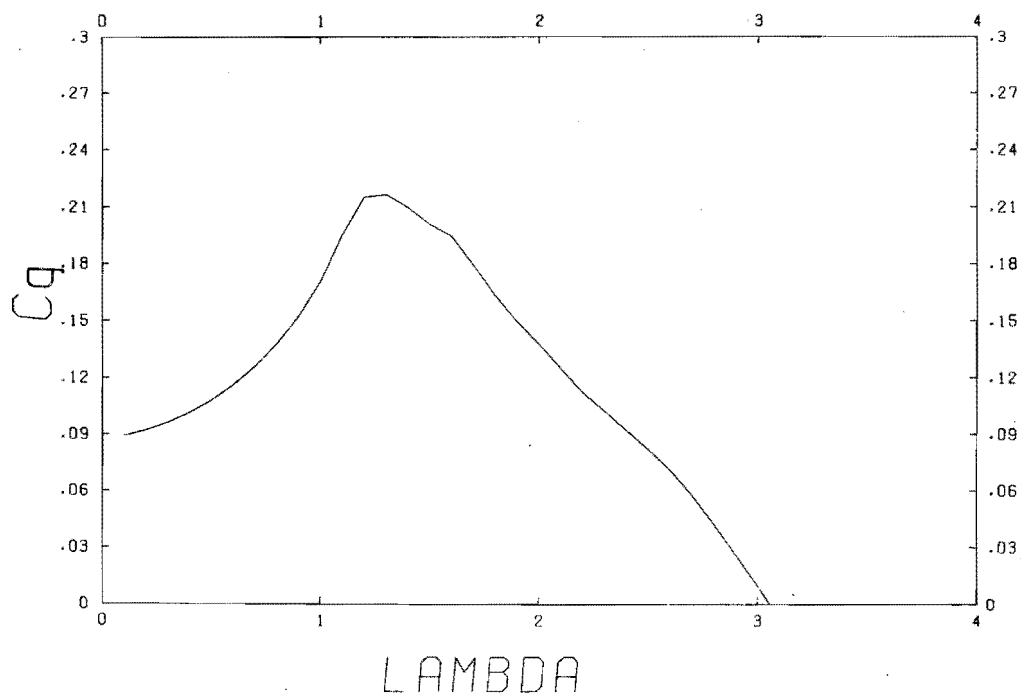### Viterna & Corrigan korrektie.

ALFA
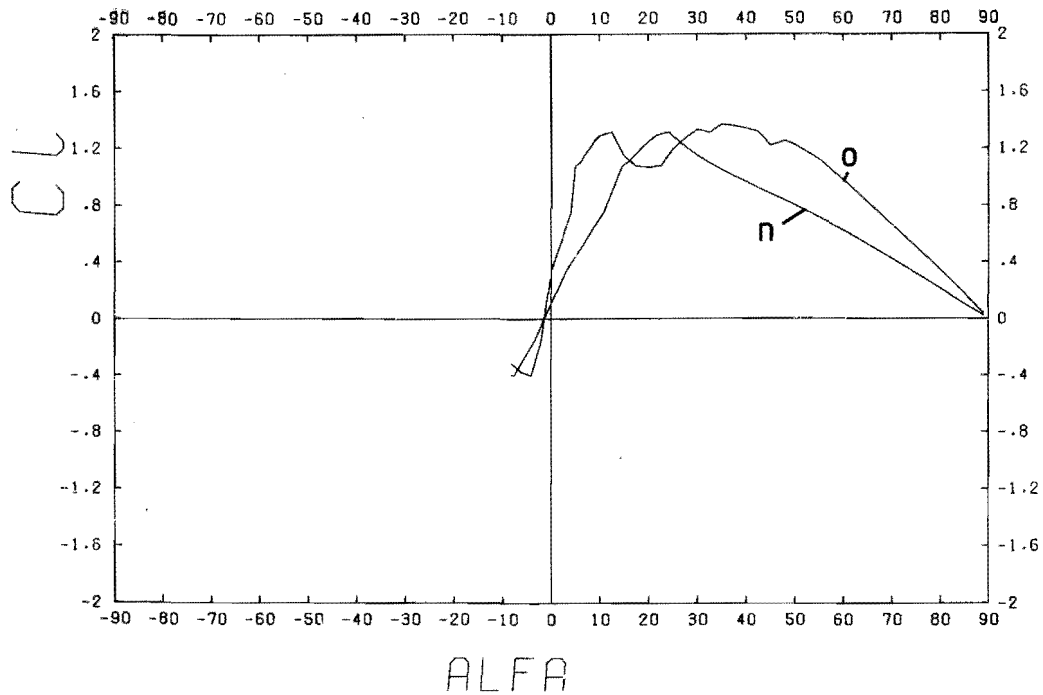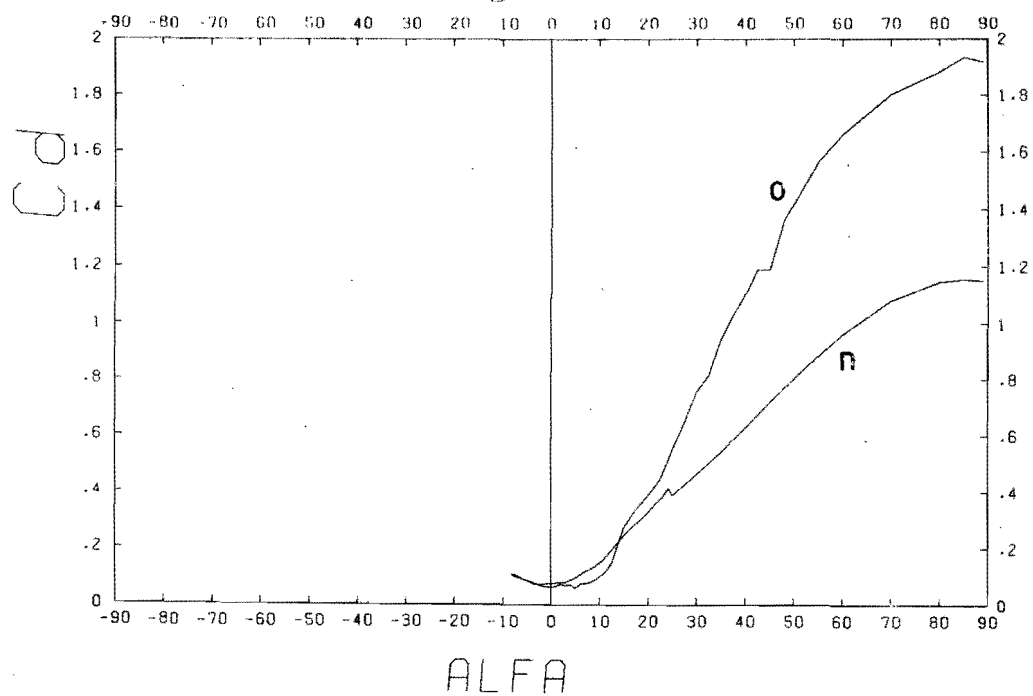
WEU 14 Pitchhoek = 0.0 graden
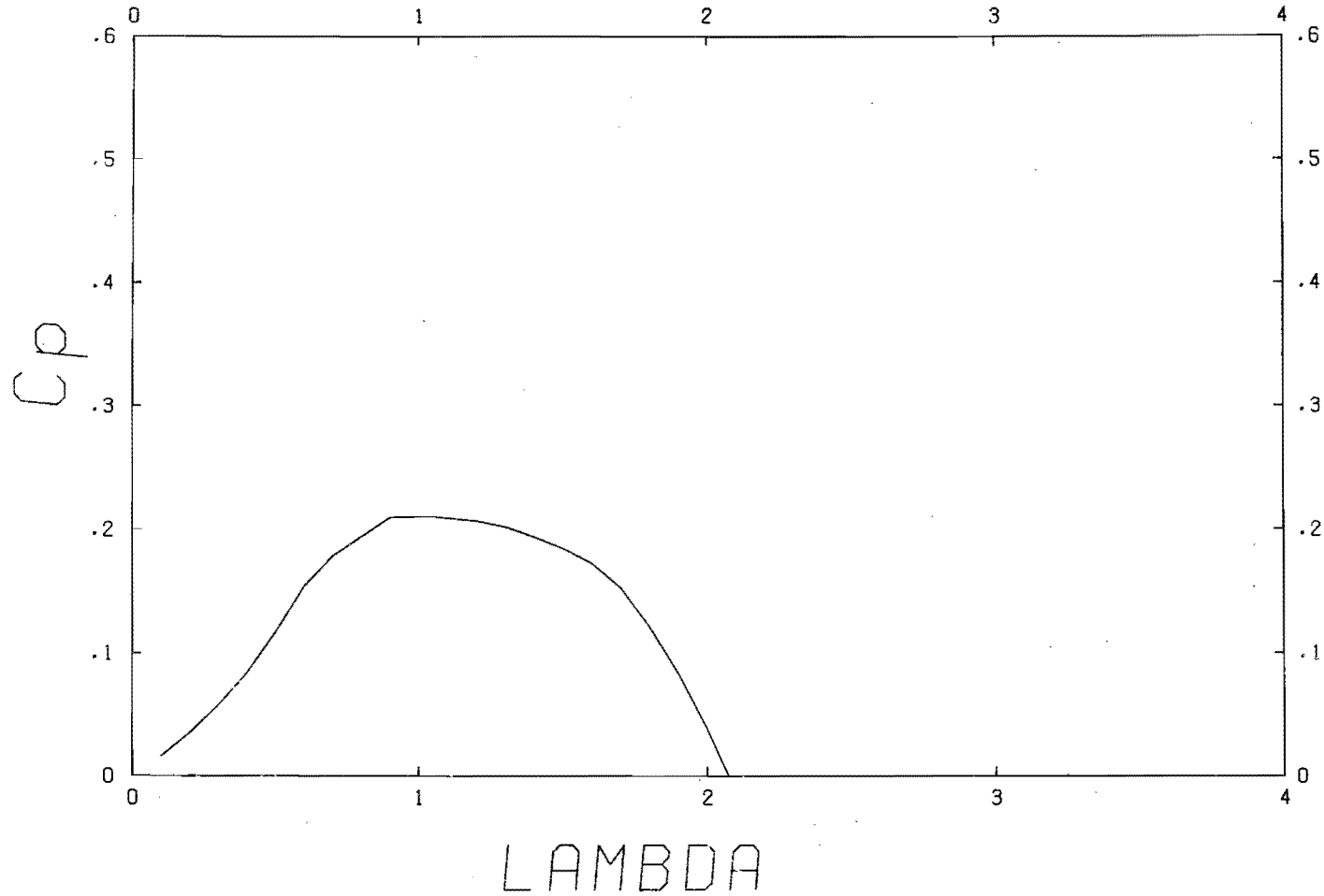
Slankheid = 2.0 GebPlat buis

Viterna & Corrigan korrektie.

WEU I4 Pitchhoek = 0.0 graden
Slankheid = 2.0 . GebPla+ buis
Viterna & Corrigan korrektie.
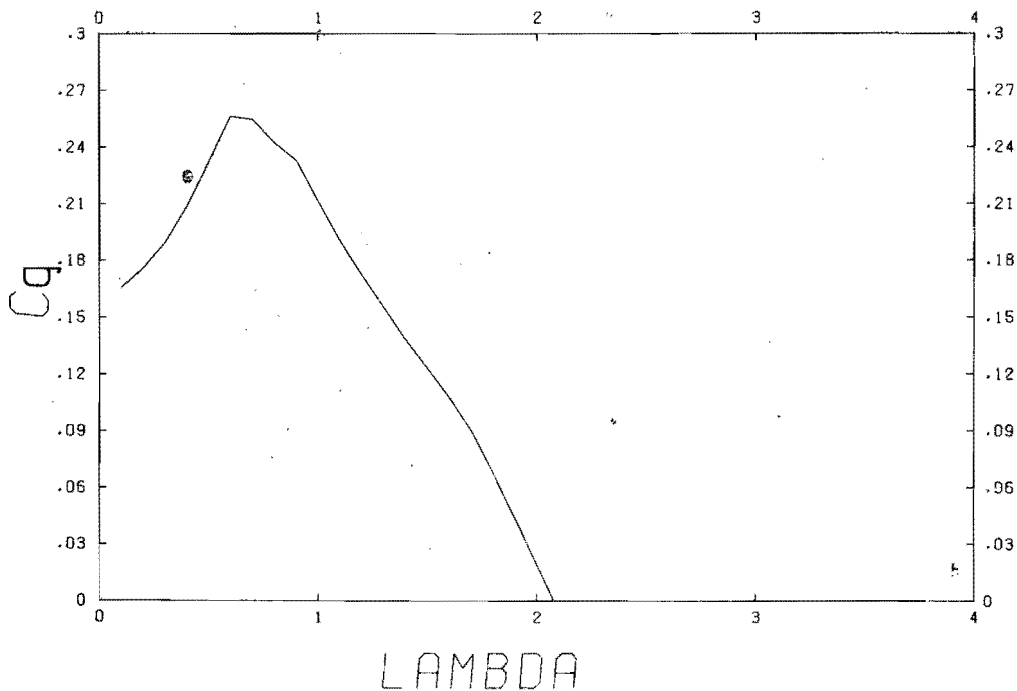
LAMBDA

WEU ·I4 Pitchhoek = 0.0 graden
Slankheid = 2.0 GebPla+ buis
Viterna & Corrigan korrektie.

LAMBDA
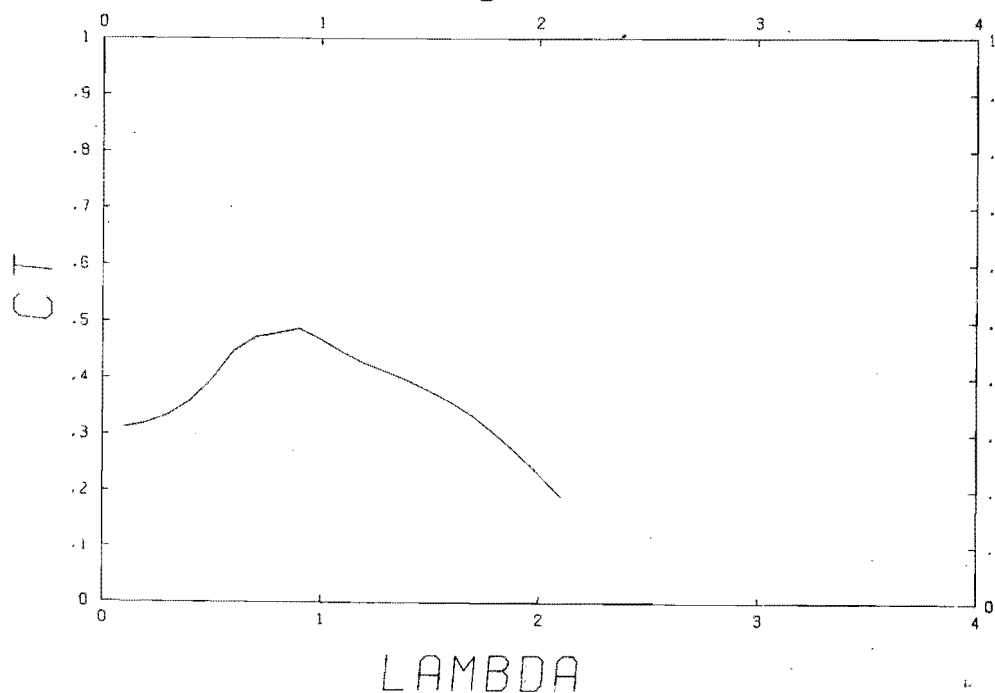
Numerieke uitkomsten van de berekeningen aan de WEU I4   molen.
Pitchhoek   0.0 graden.
Viterna & Corrigan korrektie.
Slankheid =   2.0
Het gebruikte profiel is GebPla+ buis
De straal van de rotor is   1.525 meter.
De rotor heeft 8 bladen.
Bij de berekeningen wordt lambda telkens met 0.1 opgehoogd.

Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct
0.10	0.0166	0.1659	0.3115
0.10	0.0166	0.1659	0.3115
0.20	0.0352	0.1759	0.3192
0.30	0.0569	0.1897	0.3338
0.40	0.0835	0.2086	0.3583
0.50	0.1162	0.2323	0.3968
0.60	0.1537	0.2562	0.4472
0.70	0.1784	0.2548	0.4728
0.80	0.1939	0.2423	0.4804
0.90	0.2097	0.2330	0.4883
1.00	0.2113	0.2113	0.4695
1.10	0.2091	0.1901	0.4455
1.20	0.2068	0.1723	0.4264
1.30	0.2018	0.1552	0.4119
1.40	0.1934	0.1382	0.3961
1.50	0.1846	0.1231	0.3777
1.60	0.1723	0.1077	0.3573
1.70	0.1529	0.0900	0.3327
1.80	0.1216	0.0676	0.3023
1.90	0.0832	0.0438	0.2682
2.00	0.0387	0.0193	0.2311
2.10	-.0121	-.0058	0.1909

Er is   0 maal geen convergentie bereikt.

II.7   CWD 5000

task A.3.c

CWD 5000

Slankheid = 4.1   GebPla+ buis

Viterna & Corrigan korrektie.

ALFA

CWD 5000

Slankheid = 4.1   GebPla+ buis

Viterna & Corrigan korrektie.

ALFA
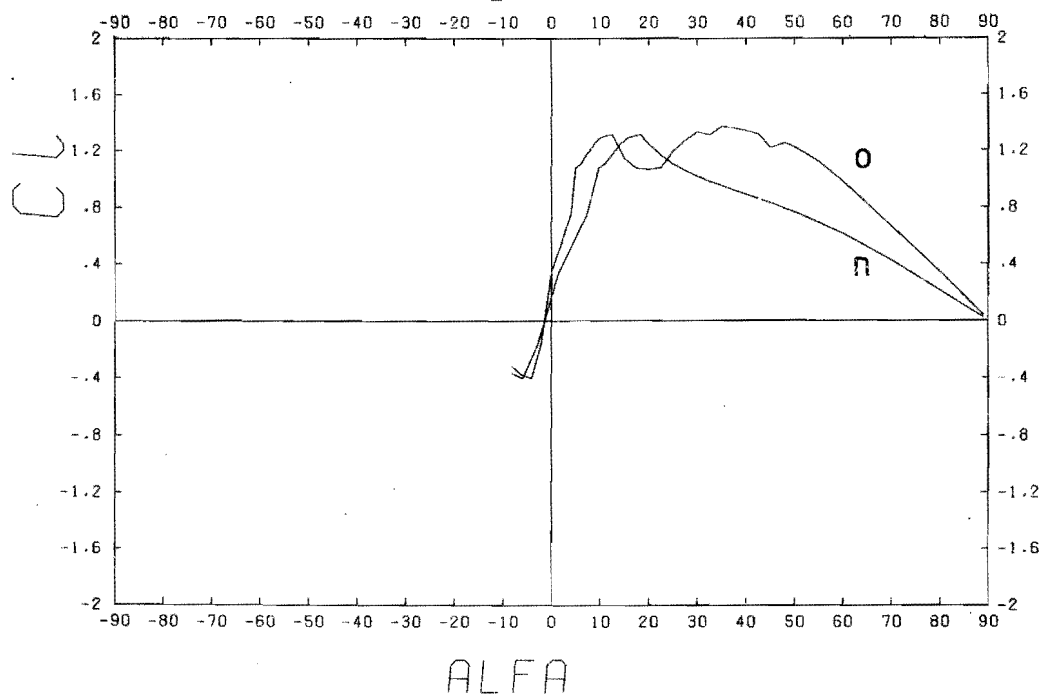
CWD 5000 Pitchhoek = 0.0 graden
Slankheid = 4.1   GebPlat buis
Viterna & Corrigan korrektie.
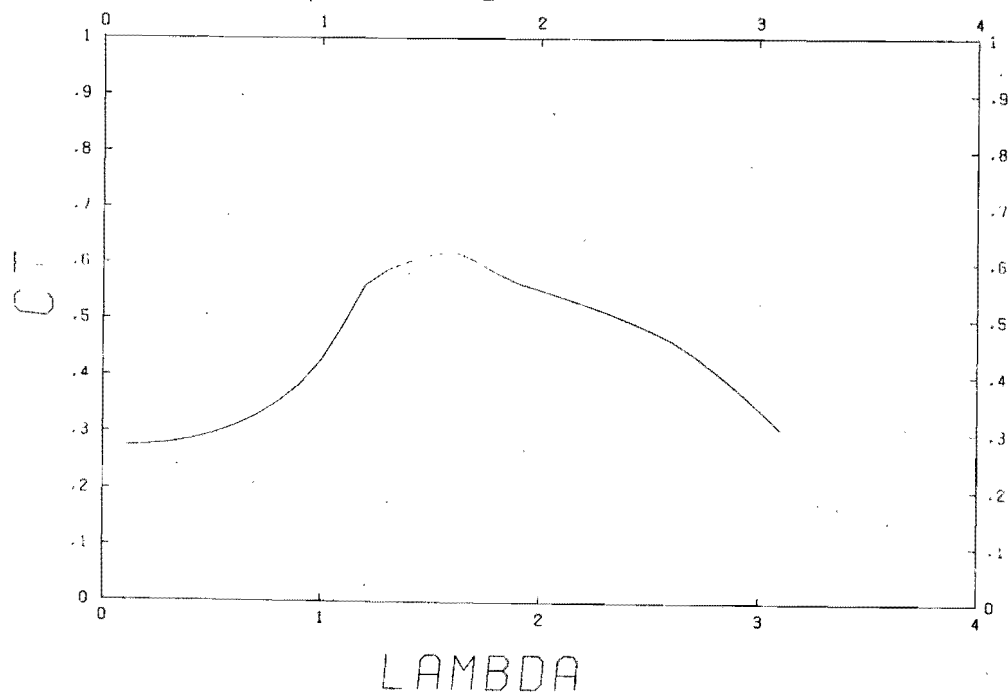
CWD 5000 Pitchhoek = 0.0 graden
Slankheid = 4.1 GebPla+ buis
Viterna & Corrigan korrektie.

LAMBDA

CWD 5000 Pitchhoek = 0.0 graden
Slankheid = 4.1 GebPla+ buis
Viterna & Corrigan korrektie.

LAMBDA

Numerieke uitkomsten van de berekeningen aan de CWD 5000   molen.
Pitchhoek   0.0 graden.
Viterna & Corrigan korrektie.
Slankheid =   4.1
Het gebruikte profiel is GebPla+ buis
De straal van de rotor is   2.500 meter.
De rotor heeft 8 bladen.
Bij de berekeningen wordt lambda telkens met 0.1 opgehoogd.

#Cp- ,Cq- EN Ct-lambda-karakteristieken voor deze rotor:

Lambda	Cp	Cq	Ct
0.10	0.0089	0.0891	0.2750
0.10	0.0089	0.0891	0.2750
0.20	0.0184	0.0921	0.2764
0.30	0.0289	0.0962	0.2801
0.40	0.0406	0.1015	0.2866
0.50	0.0540	0.1080	0.2963
0.60	0.0697	0.1161	0.3098
0.70	0.0882	0.1260	0.3280
0.80	0.1103	0.1379	0.3521
0.90	0.1373	0.1526	0.3841
1.00	0.1711	0.1711	0.4276
1.10	0.2153	0.1957	0.4906
1.20	0.2585	0.2155	0.5607
1.30	0.2819	0.2168	0.5874
1.40	0.2940	0.2100	0.6025
1.50	0.3013	0.2009	0.6149
1.60	0.3115	0.1947	0.6219
1.70	0.3047	0.1792	0.6047
1.80	0.2938	0.1632	0.5823
1.90	0.2840	0.1495	0.5644
2.00	0.2758	0.1379	0.5524
2.10	0.2623	0.1249	0.5404
2.20	0.2475	0.1125	0.5276
2.30	0.2351	0.1022	0.5136
2.40	0.2215	0.0923	0.4985
2.50	0.2052	0.0821	0.4822
2.60	0.1853	0.0713	0.4637
2.70	0.1556	0.0576	0.4389
2.80	0.1185	0.0423	0.4097
2.90	0.0762	0.0263	0.3777
3.00	0.0291	0.0097	0.3434
3.10	-.0222	-.0072	0.3073

Er is   0 maal geen convergentie bereikt.

II.8 CONCLUDING REMARKS

This section is not called conclusions, because conclusions
can only be drawn after comparison with other methods and with
measurements. This will be done in the final report of the
Benchmark test by Risø.
Nevertheless, some remarks can be made here.
As described in the incomplete draft of this final report,
called: "Benchmark test on power curve computations on wind
turbines - a compendium; incomplete draft, Nov. '86" by Helge
Petersen, Risø, the given profile characteristics of the
Windmatic WM 17 S are already converted from 2-D data to 3-D
data, in approximately the same waty. Therefore the old ("o")
and new ("n") curves are about the same, which is definitely
different in all other calculation cases.

REFERENCES

1. J. v. Meel, A. Kragten, G. v. Kuik
   "Benchmark test of power curve computations, specification
   of three multiblade rotors", June 1986, R 793 D,
   CWD, Wind Energy Group, TU Eindhoven.

2. A. Hageman
   "Catalogue of aerodynamic characteristics of airfoils in
   the Reynolds number range 10^4-10^6",
   July 1980, R 443 D, Wind Energy Group, TU Eindhoven.

3. J.W.J. Brouwer, J.A. Peters
   "14' Dempster windmill; a report of the alternative ON 70
   task", in Dutch, August 1984, R 674 D,
   CWD, Wind Energy Group, TU Eindhoven.

4. A. Kragten
   "Windtunnel measurements on a scale model of the WEU I-4
   rotor to determine $C_P-\lambda$ and $C_Q-\lambda$ curves",
   April 1985, R 715 D, CWD, Wind Energy Group, TU Eindhoven.

5. C.A. Buskes
   "Scale model of the CWD 5000 LW rotor windtunnel tests for
   different blade setting angles", november 1983, WM-074,
   CWD, Wind Energy Group, TU Twente.

6. K. Heil
   "Theoretical and experimental determination of the
   performance of horizontal axis wind turbine rotors",
   in Dutch, February 1979, R 365 A, Dept. of Physics,
   Wind Energy Group, TU Eindhoven.

7. W. v. Helden
   "Adjusting the blade element/momentum theory, using the
   Viterna & Corrigan tip correction method", in Dutch,
   December 1986, R 825 S, Dept. of Physics,
   Wind Energy Group, TU Eindhoven.

APPENDIX A: PROFILE CHARACTERISTICS OF THE MULTIBLADED ROTORS

Figures a.1 to a.8 and tables a.1 to a.7 shows the aerodynamics characteristics of curved plates, with and without spar. No data are available for plates with a spar at 1/3 chord position. In that case the data of the plate with a 1/4 chord position spar can be used.
If data are necessary which cannot be derived from the given data, one is free to interpolate or extrapolate.
The given data are taken from [ref. 2].

curved plate

camber: 7.14%

plate thickness: 1.63 mm

Re:

□ : 1.2×10^5

+ : 1.7×10^5

△ : 2.5×10^5

× : 3.4×10^5

C_L

1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0

-0.2
-0.4

-4 -2 0 2 4 6 8 10 12 14 16 18 20 α

C_L

1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0

-0.2
-0.4

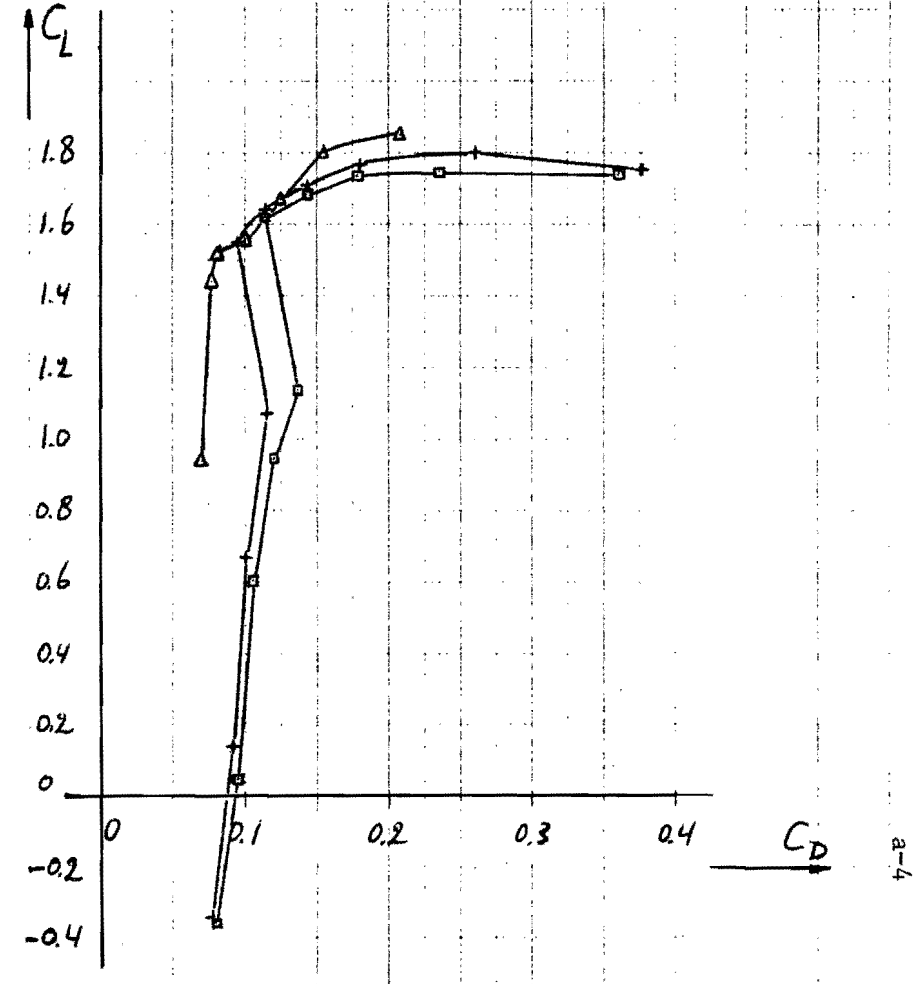0 0.1 0.2 0.3 0.4 C_D
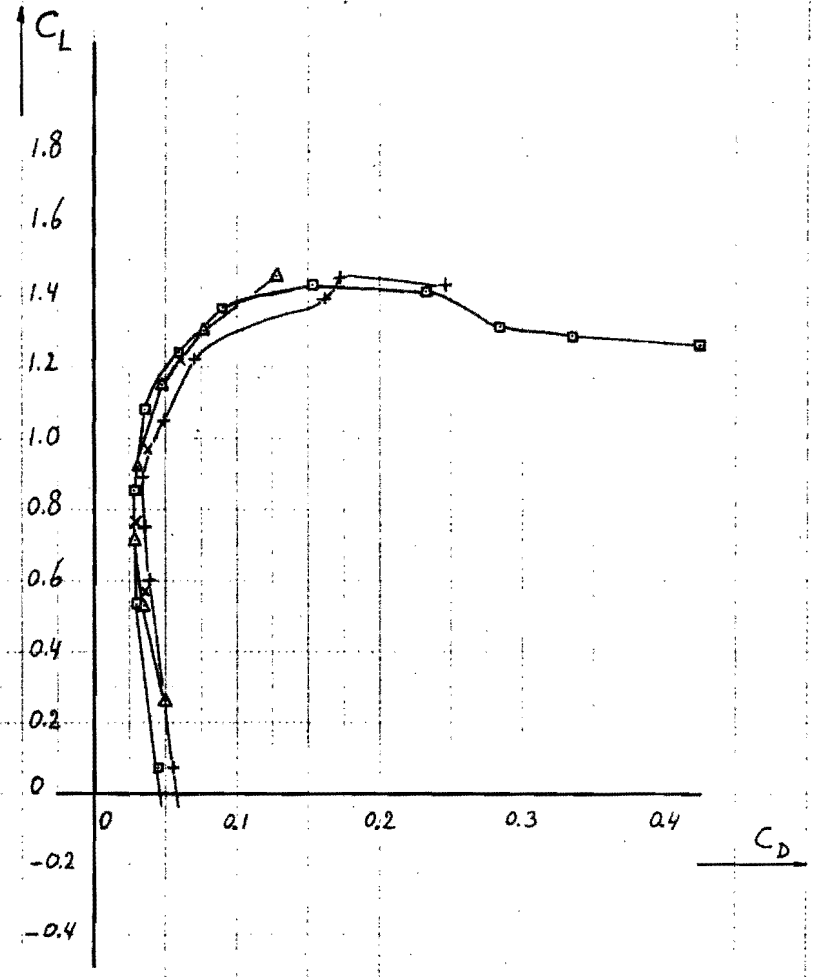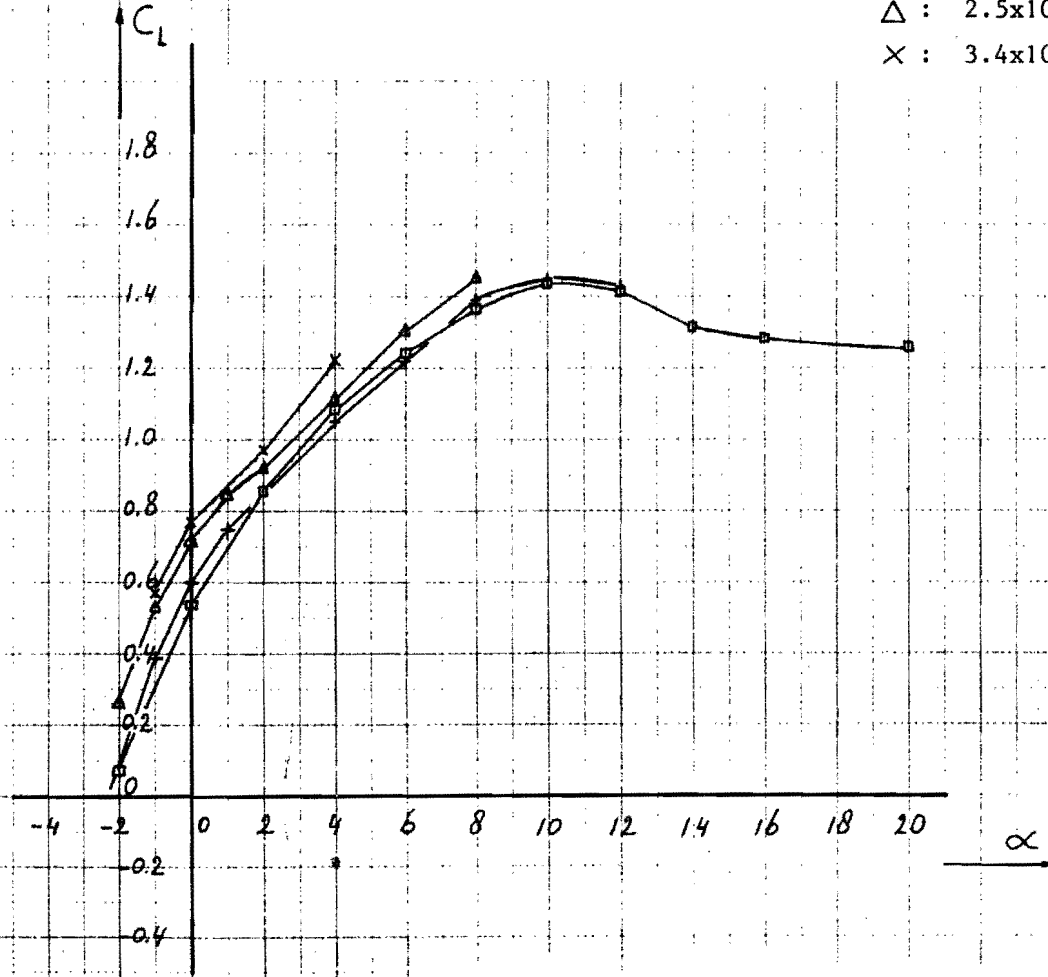
Fig. a-1   curved plates (Imperial College)
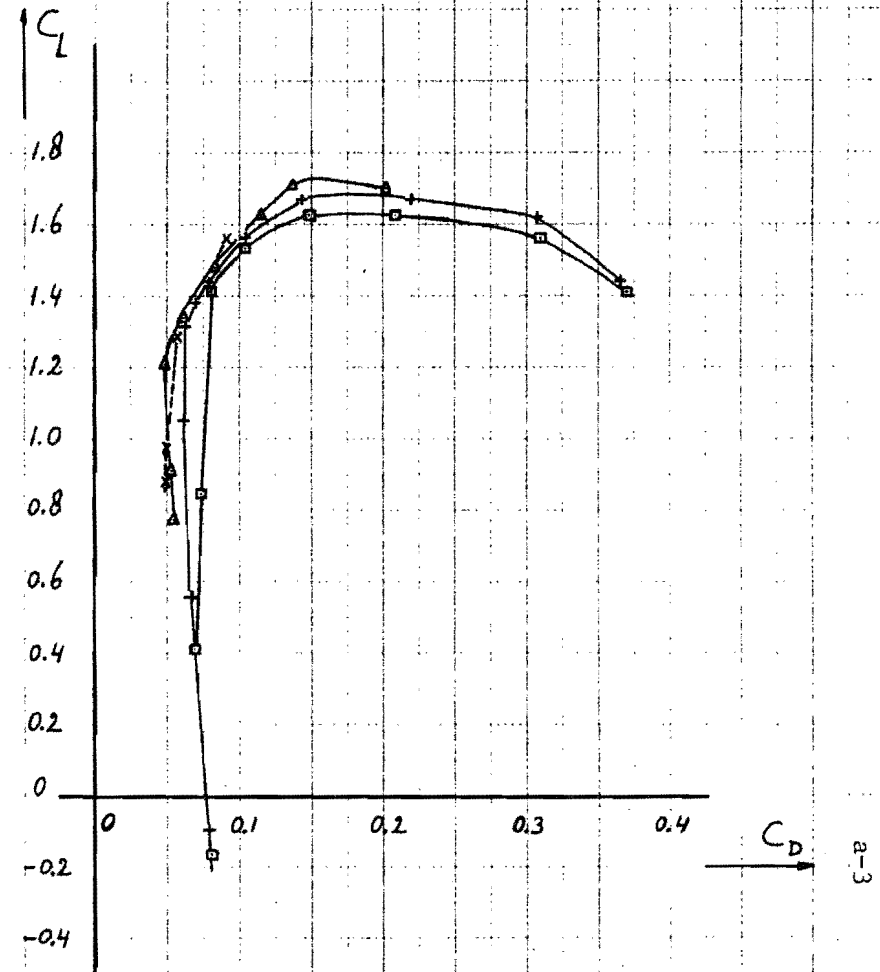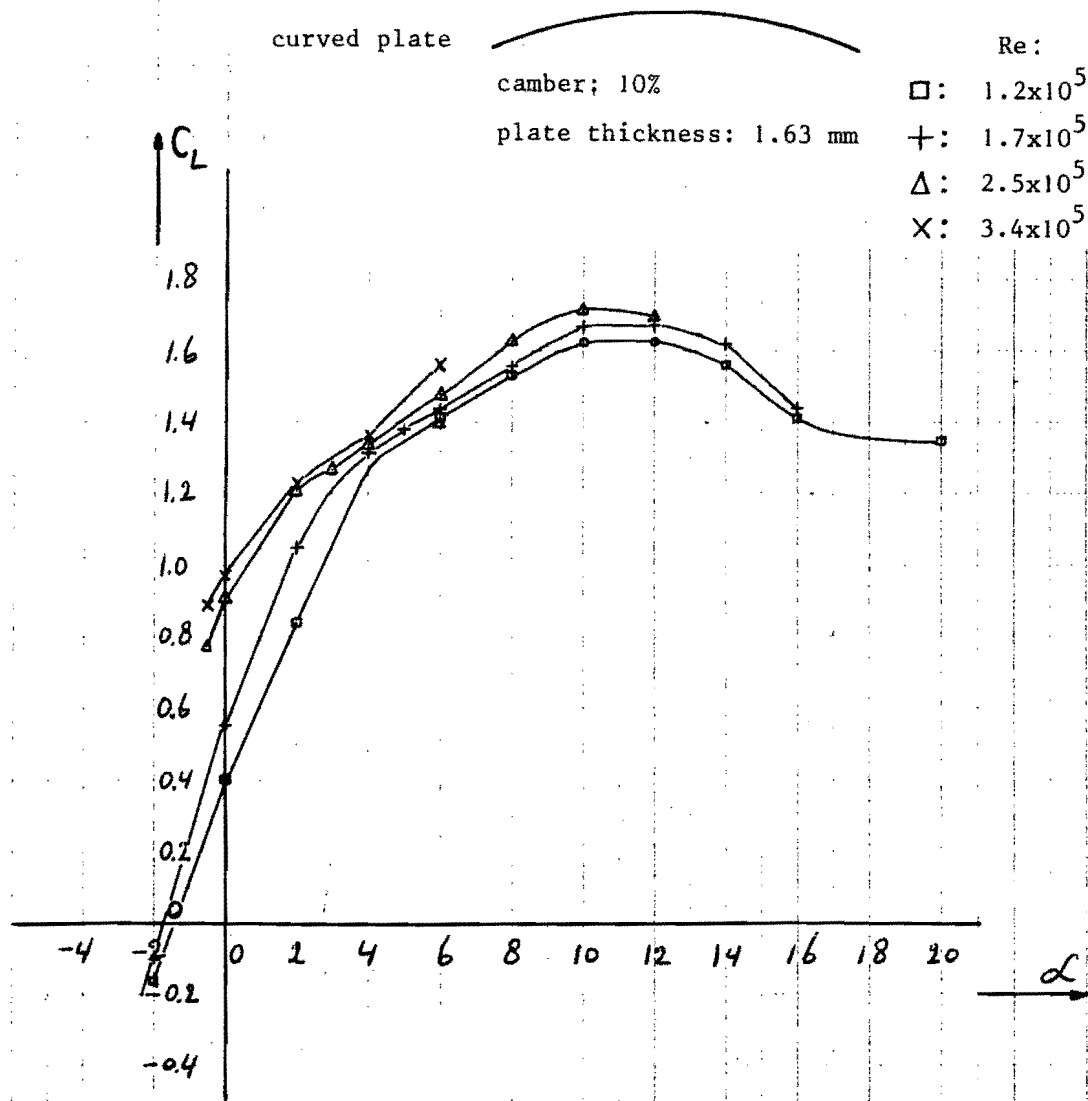
Fig. α-2 curved plates (Imperial college)

curved plate

camber: 12.5%

plate thickness: 1.63 mm

Re:

$\square$: 1.2×10^5

$+$: 1.7×10^5

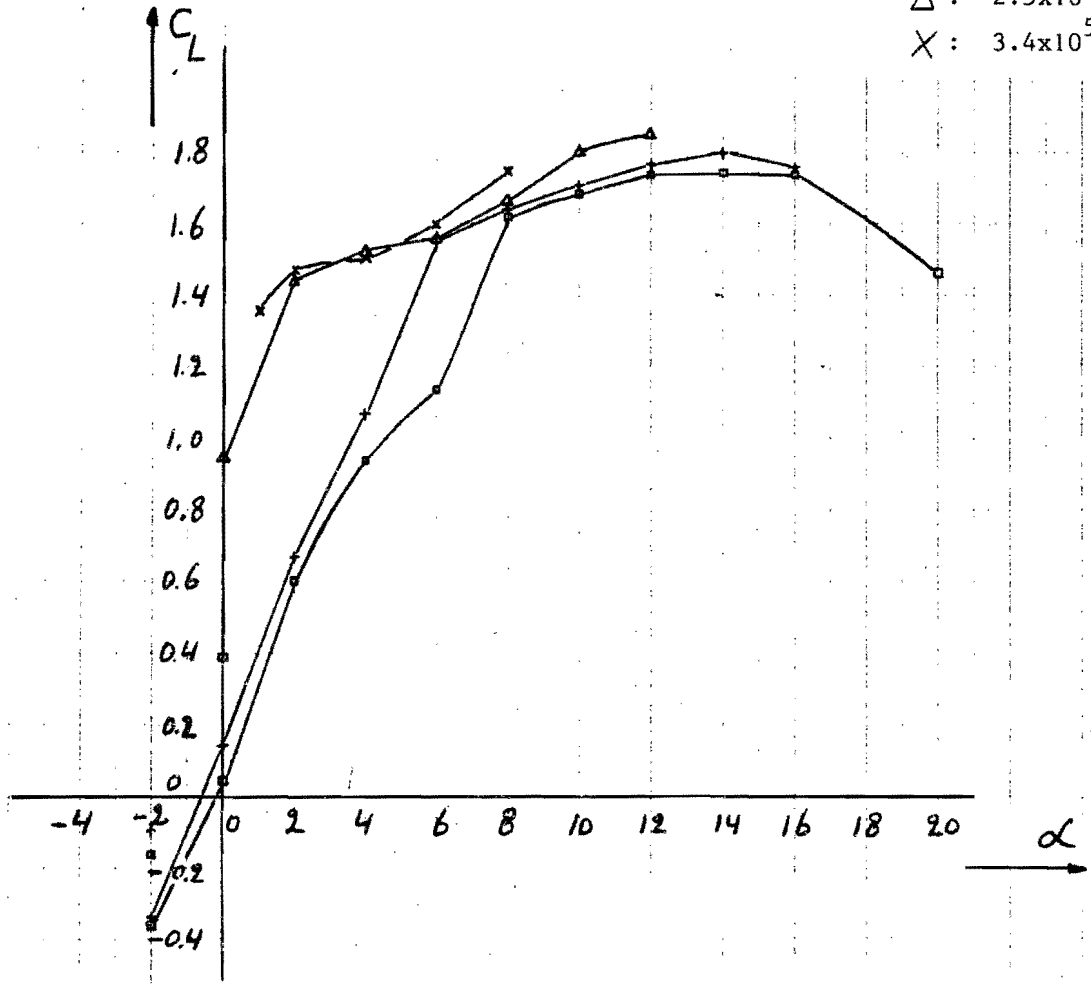$\triangle$: 2.5×10^5

$\times$: 3.4×10^5
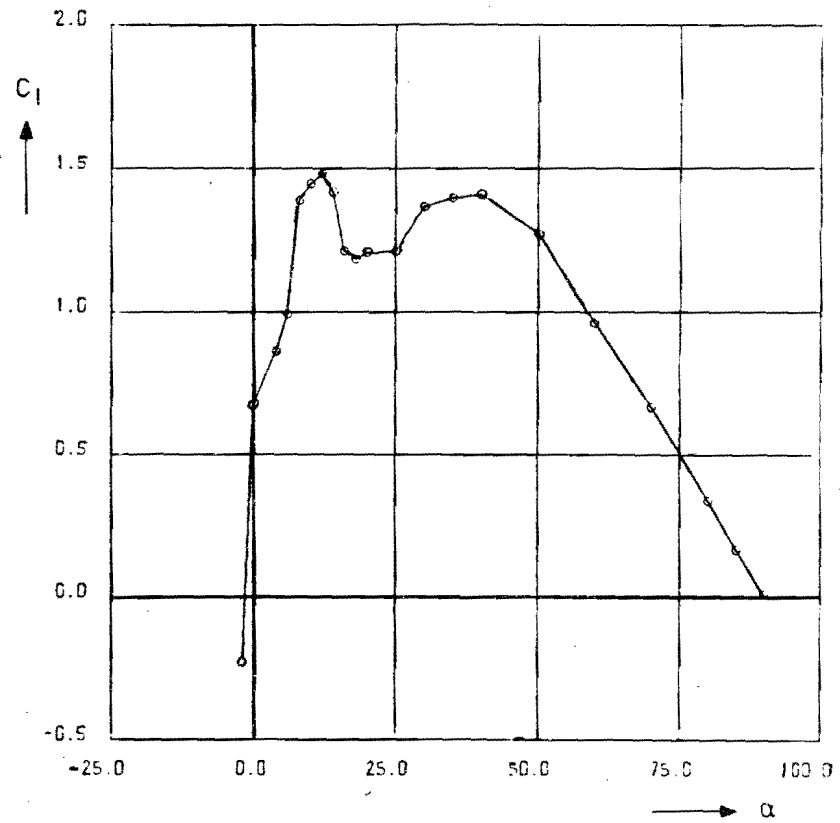
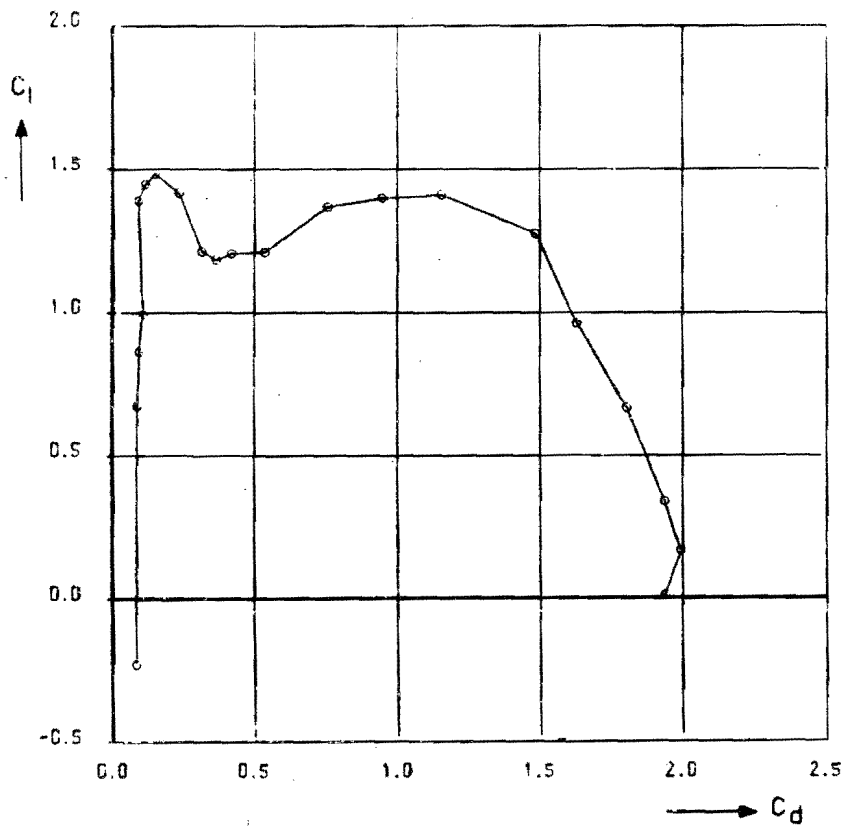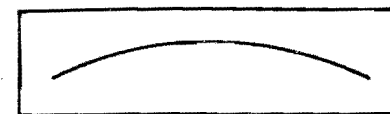Fig. a-3 curved plates (Imperial college)

fig. α-4   Section characteristics of curved plate.

Reynolds number: 60.000

camber: 10%

curved plates (Bruining)

fig. a-5   Section characteristics of curved plate.
Reynolds number: 100.000
camber: 10%

curved plates (Bruining)

fig. α-6   Section characteristics of curved plate.
Reynolds number: 200.000
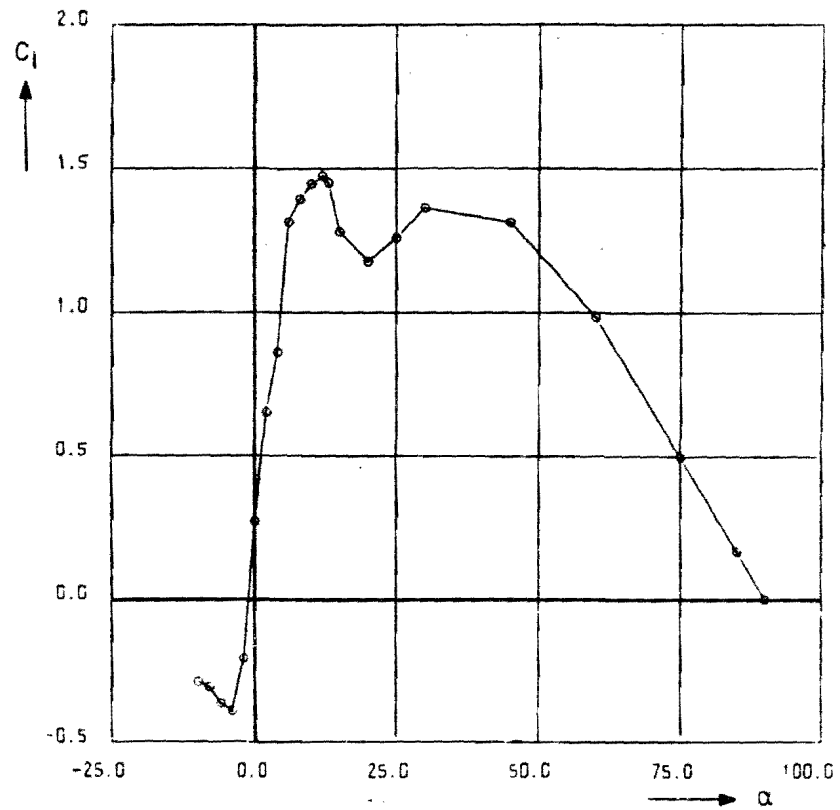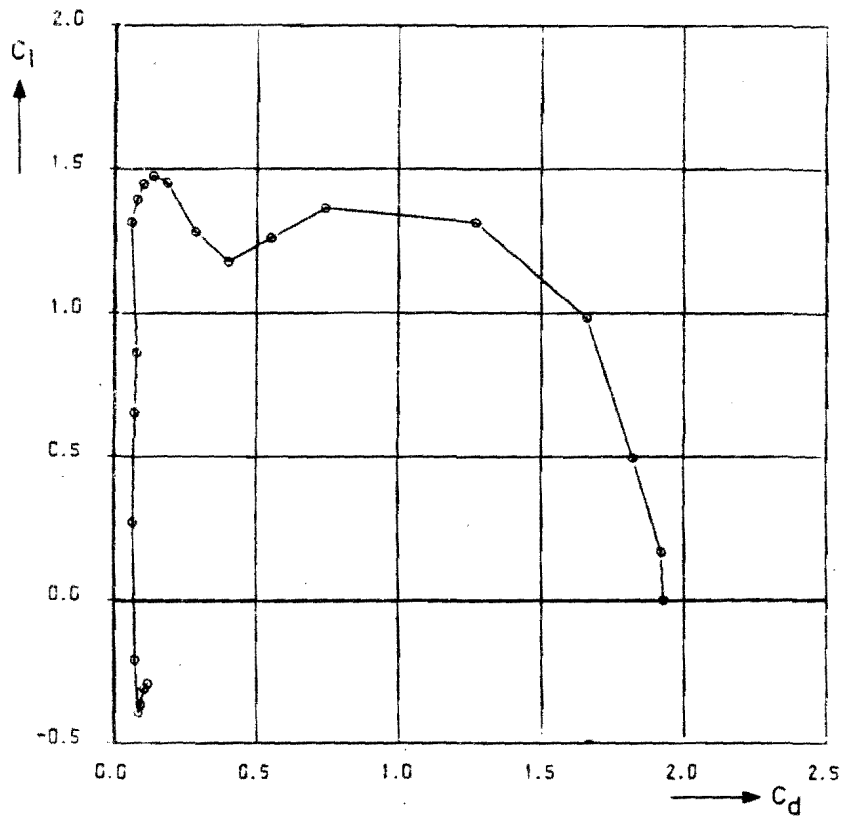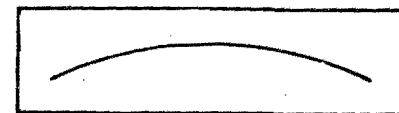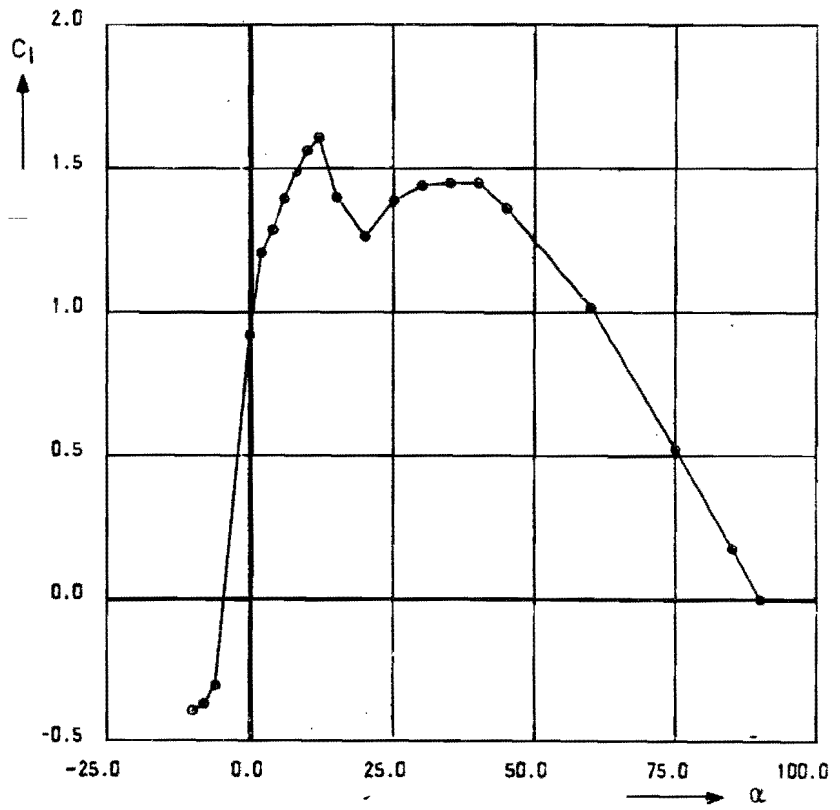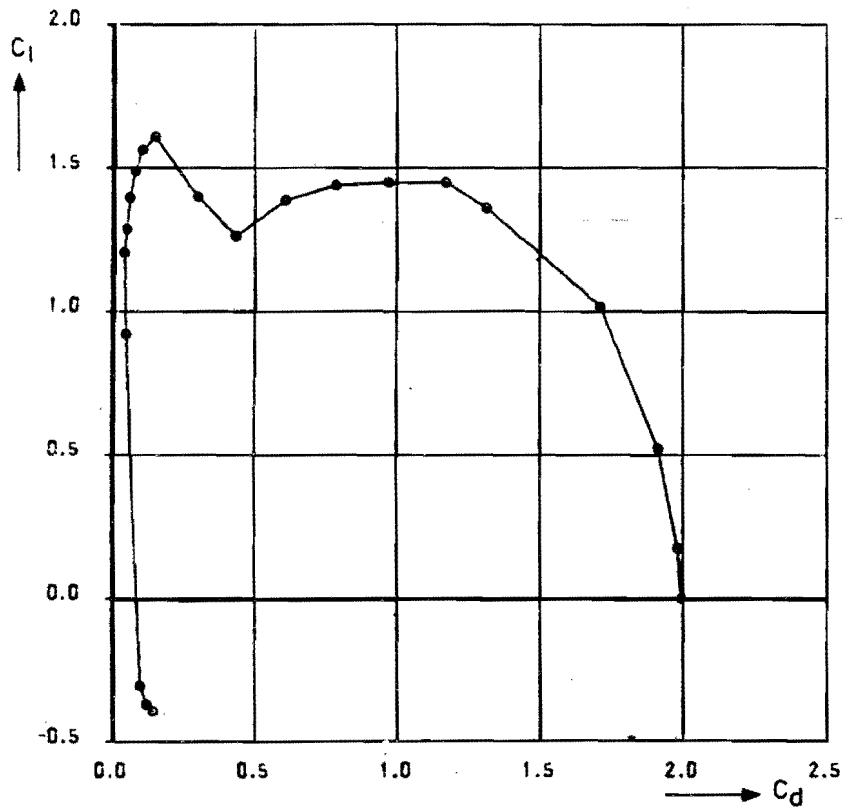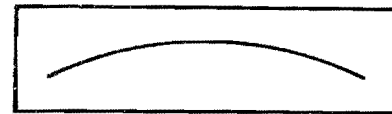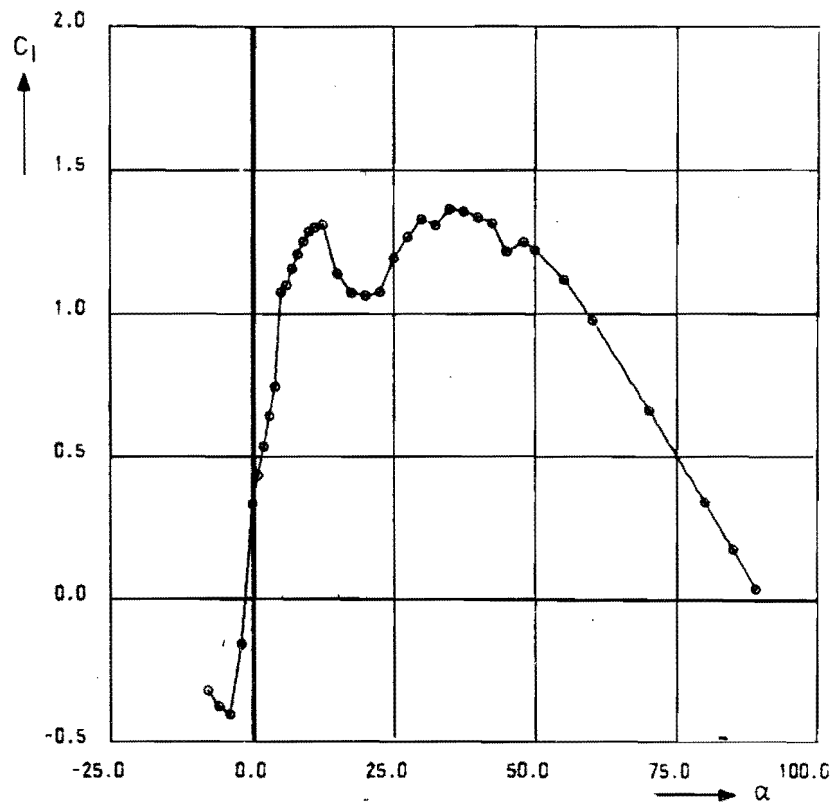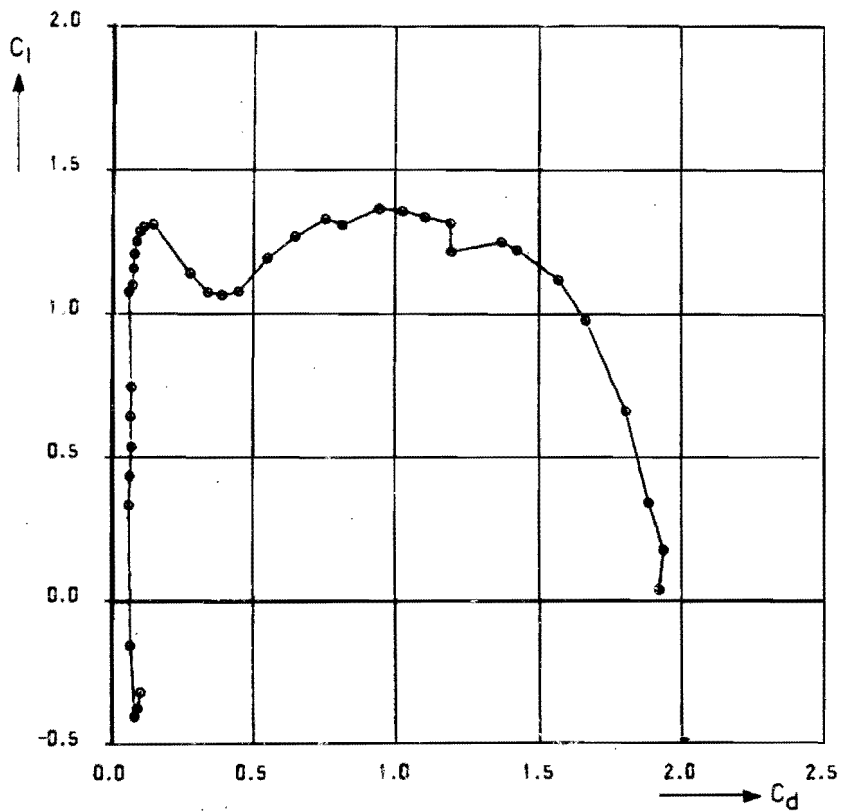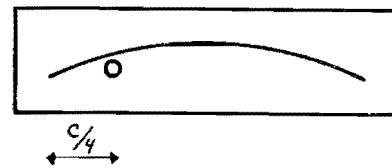camber: 10%

curved plates (Bruining)

fig. a-7   Section characteristics of curved plate.
Reynolds number: 100.000
camber: 10%

curved plates (Bruining)
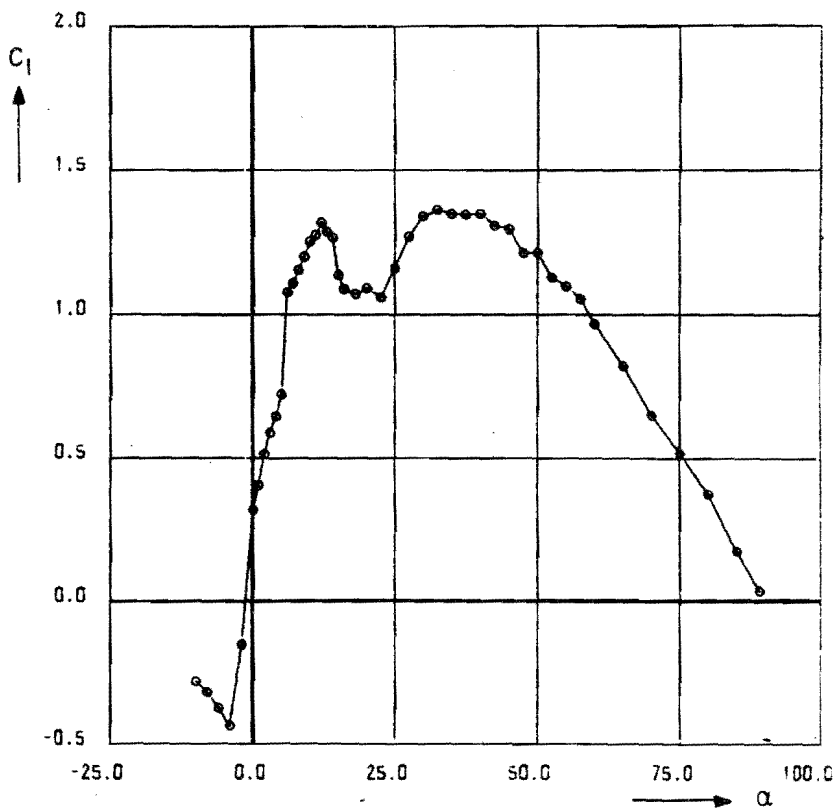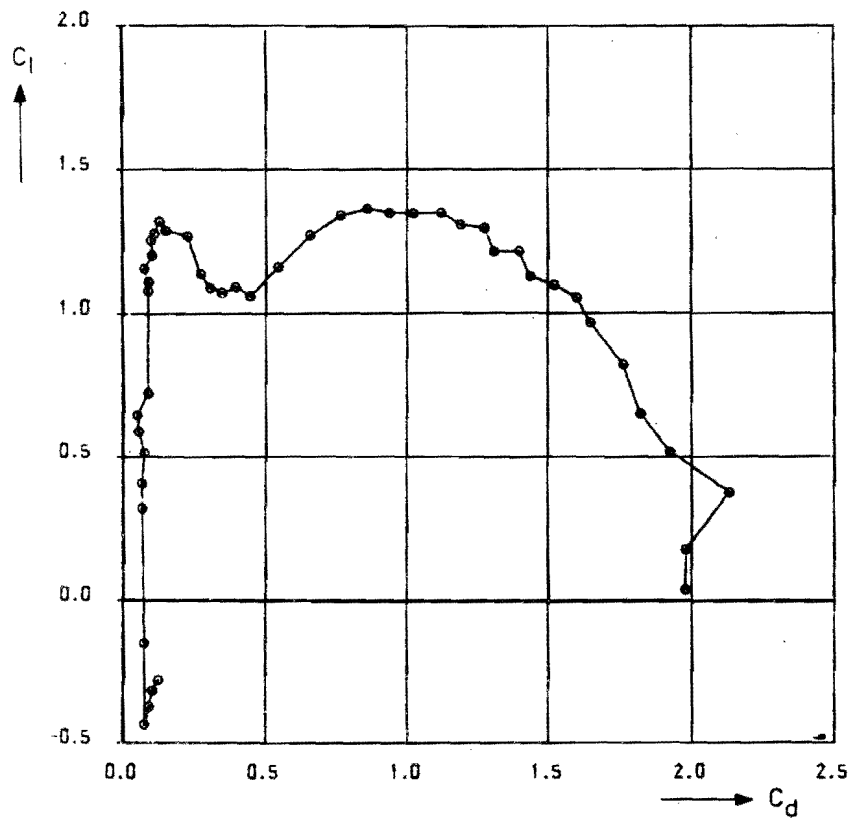
fig. α-8   Section characteristics of curved plate.
Reynolds number: 60.000
camber:10%
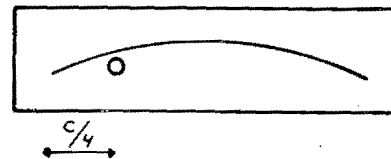
curved plates (Bruining)

Table   a-1

RE = 60,000
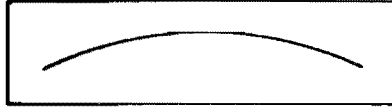
camber: 10%

ALFA	CL	CD	CL/CD
-4.000	-0.394	0.087	-4.513
-2.000	-0.228	0.083	-2.741
0.000	0.675	0.087	7.734
4.000	0.863	0.093	9.285
6.000	0.993	0.126	9.353
8.000	1.389	0.091	15.193
10.000	1.448	0.115	12.547
12.300	1.484	0.151	9.839
14.300	1.417	0.235	6.020
16.000	1.212	0.317	3.823
18.000	1.184	0.366	3.232
20.000	1.207	0.421	2.849
25.000	1.210	0.537	2.255
30.000	1.368	0.756	1.809
35.200	1.399	0.946	1.478
40.000	1.410	1.153	1.223
50.000	1.275	1.484	0.859
60.000	0.961	1.630	0.590
70.000	0.667	1.805	0.369
80.000	0.339	1.937	0.175
85.000	0.168	1.992	0.084
90.000	0.011	1.938	0.005
85.000	0.171	1.953	0.088
80.000	0.355	1.986	0.179
75.000	0.512	1.864	0.275
70.000	0.685	1.813	0.378
60.000	1.015	1.702	0.597
50.000	1.272	1.440	0.883
40.000	1.410	1.124	1.255
30.000	1.421	0.761	1.866
25.000	1.267	0.538	2.354
20.000	1.219	0.409	2.981
18.000	1.234	0.366	3.347
16.300	1.257	0.310	4.054
14.000	1.427	0.222	6.430
12.000	1.495	0.137	10.885
10.000	1.467	0.111	13.223
8.200	1.436	0.082	17.138
6.000	1.351	0.070	19.343
4.000	0.878	0.086	10.182
2.000	0.693	0.080	8.626
0.000	0.198	0.064	3.120

curved plates (Bruining)

Table α-2

RE = 130,000

camber: 10%
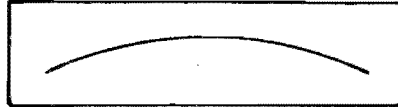
ALFA	CL	CD	CL/CD
0.000	0.281	0.266	4.248
-2.000	-0.218	0.372	-3.028
-4.005	-0.392	0.085	-4.618
-6.005	-0.362	0.093	-3.899
-7.005	-0.337	0.100	-3.357
-8.005	-0.319	0.107	-2.990
-10.300	-0.291	0.119	-2.446
-8.005	-0.309	0.107	-2.897
-6.005	-0.365	0.093	-3.917
-4.005	-0.393	0.085	-4.672
-2.005	-0.208	0.073	-2.853
0.300	0.271	0.066	4.122
2.000	0.652	0.069	9.411
4.000	0.861	0.078	11.067
5.995	1.315	0.057	23.056
8.000	1.394	0.078	17.983
9.995	1.448	0.101	14.399
11.995	1.474	0.135	10.929
13.060	1.452	0.182	7.983
15.005	1.281	0.283	4.523
20.000	1.177	0.399	2.948
25.300	1.260	0.550	2.290
30.300	1.364	0.741	1.840
45.000	1.313	1.268	1.035
60.000	0.983	1.663	0.592
74.995	0.496	1.822	0.272
84.995	0.169	1.920	0.088
89.995	0.000	1.927	0.000
84.995	0.172	1.954	0.088
74.995	0.513	1.870	0.274
60.005	1.205	1.226	1.048
29.995	1.361	0.733	1.856
19.995	1.181	0.393	3.002
14.995	1.286	0.276	4.663
11.995	1.472	0.131	11.246
9.995	1.457	0.097	14.989
8.005	1.395	0.074	18.853
5.995	1.315	0.057	23.042
3.995	1.274	0.046	27.944
1.995	0.657	0.069	9.464
0.000	0.261	0.266	3.977

curved plates (Bruining)

Table a-2 (cont.)

RE = 200,000

camber: 10%

ALFA	CL	CD	CL/CD
-2.000	0.350	0.055	6.319
-4.005	-0.096	0.072	-1.337
-6.005	-0.295	0.098	-3.009
-8.005	-0.376	0.122	-3.089
-10.000	-0.394	0.143	-2.764
-8.005	-0.371	0.121	-3.074
-6.000	-0.305	0.098	-3.102
0.000	0.922	0.047	19.529
1.995	1.206	0.042	28.752
3.995	1.288	0.050	25.767
6.005	1.396	0.061	22.845
8.005	1.489	0.079	18.856
10.000	1.562	0.105	14.837
12.005	1.609	0.150	10.747
15.005	1.400	0.299	4.682
20.000	1.263	0.433	2.916
24.995	1.348	0.608	2.243
30.000	1.441	0.787	1.831
34.995	1.450	0.973	1.495
39.995	1.450	1.170	1.240
45.000	1.361	1.312	1.037
60.005	1.015	1.711	0.593
75.000	0.522	1.912	0.273
85.000	0.175	1.979	0.088
90.000	-0.003	1.992	-0.002
85.000	0.173	1.969	0.088
74.995	0.530	1.934	0.274
59.995	1.010	1.699	0.595
45.005	1.355	1.306	1.037
39.995	1.453	1.170	1.242
29.995	1.416	0.771	1.837
20.000	1.263	0.431	2.934
14.995	1.403	0.298	4.707
9.995	1.570	0.104	15.099
0.005	0.920	0.047	19.549

curved plates (Bruining)

Table α-3

RE = 60,000
BUIS 1/4

camber: 10%

ALFA	CL	CO	CL/CO
0.000	0.300	0.058	5.156
-1.005	0.145	0.064	2.263
-2.005	-0.133	0.076	-1.753
-3.000	-0.356	0.081	-4.414
-4.200	-0.417	0.080	-5.212
-5.005	-0.422	0.088	-4.806
-6.005	-0.368	0.097	-3.787
-7.005	-0.336	0.104	-3.239
-8.000	-0.319	0.106	-3.018
-9.000	-0.294	0.120	-2.458
-9.995	-0.282	0.123	-2.283
-8.010	-0.318	0.102	-3.122
-6.005	-0.374	0.090	-4.144
-4.005	-0.437	0.374	-5.918
-2.000	-0.151	0.073	-2.081
0.000	0.320	0.066	4.863
0.995	0.407	0.065	6.314
2.000	0.514	0.075	6.897
2.995	0.589	0.054	10.839
4.000	0.646	0.048	13.365
5.030	0.722	0.088	8.235
6.000	1.078	0.089	12.167
7.000	1.110	0.091	12.255
8.005	1.157	0.075	15.444
9.000	1.202	0.102	11.758
10.000	1.255	0.098	12.824
11.000	1.278	0.110	11.639
12.005	1.320	0.128	10.286
13.000	1.288	0.151	8.541
13.995	1.269	0.225	5.632
15.005	1.138	0.272	4.183
15.995	1.089	0.305	3.548
18.005	1.072	0.346	3.095
20.003	1.093	0.393	2.779
22.505	1.060	0.444	2.386
25.000	1.162	0.545	2.133
27.500	1.272	0.656	1.938
29.995	1.342	0.766	1.752
32.495	1.364	0.859	1.587
34.990	1.349	0.937	1.440
37.505	1.347	1.024	1.315
40.305	1.350	1.121	1.204
42.495	1.308	1.190	1.099
44.995	1.296	1.276	1.016
47.495	1.214	1.310	0.927
49.995	1.215	1.399	0.868
52.500	1.129	1.439	0.784
55.000	1.097	1.522	0.721
57.495	1.054	1.601	0.658

curved plates (Bruining)

Table a-3(cont.)

RE = 60,000
BUIS 1/4
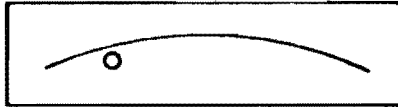
camber: 10%

ALFA	CL	CD	CL/CD
60.005	0.967	1.649	0.587
64.995	0.821	1.763	0.446
69.995	0.650	1.823	0.357
75.005	0.517	1.924	0.269
79.995	0.376	2.133	0.176
85.005	0.177	1.979	0.089
89.000	0.037	1.978	0.019
85.005	0.178	1.909	0.093
79.995	0.349	1.905	0.183
74.995	0.503	1.844	0.273
69.995	0.656	1.797	0.365
64.995	0.817	1.729	0.472
59.995	1.050	1.764	0.596
55.000	1.100	1.494	0.736
50.005	1.192	1.350	0.883
45.000	1.302	1.261	1.032
39.995	1.383	1.115	1.240
34.995	1.390	0.948	1.467
30.000	1.348	0.748	1.802
27.505	1.258	0.620	2.030
25.000	1.155	0.513	2.252
22.505	1.071	0.425	2.524
20.000	1.099	0.384	2.866
17.505	1.114	0.337	3.304
15.000	1.163	0.263	4.423
14.000	1.246	0.209	5.963
13.000	1.297	0.141	9.185
12.000	1.302	0.118	11.003
11.000	1.282	0.099	12.956
10.000	1.265	0.088	14.363
8.995	1.207	0.080	15.091
8.000	1.182	0.071	16.699
7.005	1.108	0.071	15.539
5.995	1.090	0.082	13.245
4.995	1.088	0.059	18.477
4.000	0.652	0.049	13.374
2.995	0.576	0.054	10.733
1.995	0.490	0.062	7.925
0.995	0.403	0.053	7.581
0.000	0.285	0.058	4.963

curved plates (Bruining)

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-------------------------------------------------------------------------------
RE = 100,000
BUIS 1/4C
```


camber: 10%

ALFA	CL	CD	CL/CD
0.000	0.322	0.063	5.148
-1.005	0.181	0.061	2.944
-2.000	-0.165	0.069	-2.383
-3.005	-0.342	0.078	-4.378
-4.000	-0.410	0.082	-4.989
-5.000	-0.413	0.087	-4.753
-6.005	-0.381	0.094	-4.067
-8.005	-0.320	0.104	-3.090
-6.005	-0.377	0.092	-4.102
-4.000	-0.405	0.082	-4.952
-2.005	-0.197	0.368	-2.328
0.000	0.334	0.062	5.419
1.005	0.435	0.066	6.589
1.995	0.536	0.072	7.479
2.995	0.642	0.068	9.440
3.995	0.745	0.071	10.442
4.995	1.075	0.059	18.072
5.995	1.100	0.074	14.815
6.995	1.157	0.077	15.045
7.995	1.207	0.080	15.303
9.000	1.253	0.088	14.204
9.995	1.287	0.100	12.929
11.000	1.302	0.113	11.503
12.505	1.312	0.147	8.954
14.995	1.140	0.276	4.129
17.500	1.073	0.339	3.162
19.995	1.064	0.389	2.736
22.505	1.076	0.448	2.401
24.995	1.193	0.550	2.167
27.495	1.269	0.649	1.956
30.000	1.330	0.757	1.758
32.495	1.310	0.816	1.605
34.995	1.366	0.945	1.445
37.505	1.358	1.027	1.322
40.000	1.337	1.104	1.211
42.500	1.316	1.191	1.105
45.000	1.217	1.193	1.020
48.005	1.251	1.367	0.915
49.995	1.223	1.422	0.840
55.000	1.119	1.567	0.714
60.000	0.977	1.662	0.588
69.995	0.662	1.804	0.367
79.995	0.341	1.884	0.181
84.995	0.176	1.935	0.091
89.000	0.037	1.919	0.019
85.000	0.174	1.908	0.391
79.995	0.349	1.927	0.181
69.995	0.668	1.819	0.347
60.000	0.954	1.612	0.592

curved plates (Bruining)

Table *a-9* (cont.)

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--------------------------------------------------------------------------
RE = 100,000
SUIS 1/4C
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camber: 10%

ALFA	CL	CD	CL/CD
54.995	1.385	1.510	0.719
49.995	1.237	1.435	0.862
45.300	1.256	1.227	1.024
40.300	1.405	1.154	1.217
34.995	1.340	0.917	1.461
32.495	1.355	0.845	1.603
29.995	1.325	0.749	1.769
27.495	1.260	0.642	1.961
24.995	1.179	0.541	2.179
22.500	1.079	0.443	2.433
20.005	1.083	0.393	2.754
17.495	1.098	0.346	3.176
14.995	1.136	0.274	4.153
14.005	1.277	0.236	5.413
13.000	1.300	0.170	7.627
11.995	1.325	0.132	10.045
9.995	1.287	0.100	12.929
8.000	1.207	0.278	15.450
5.995	1.102	0.070	15.658
3.995	1.057	0.047	22.632
1.995	0.526	0.073	7.236
0.000	0.323	0.063	5.137

curved plates (Bruïning)

Gebruikte gegevens van de Wind Matic   rotor.

De slankheid bedraagt   13.1778.
Aantal bladen: 3
Het gebruikte profiel is   NACA 63215
De straal van de rotor is: 8.5

Het toerental bedraagt   55.0 toeren per minuut.
De pitch hoek is 1.3 graden.
De gevevens van de diverse stations op het blad zijn:

Xr	Cr	BETA
0.20000	0.12824	0.28449
0.30000	0.11824	0.18850
0.40000	0.10882	0.12915
0.50000	0.09941	0.09076
0.60000	0.09000	0.06458
0.70000	0.08059	0.04887
0.80000	0.07118	0.03840
0.85000	0.06648	0.03403
0.90000	0.06177	0.02967
0.95000	0.05706	0.02618
0.97500	0.05471	0.02443
0.99990	0.05235	0.02269

Gebruikte gegevens van de NIBE B   rotor.

De slankheid bedraagt   18.1818.
Aantal bladen: 3
Het gebruikte profiel is   NACA 4418
De straal van de rotor is: 20.0

Het toerental bedraagt   33.4 toeren per minuut.
De pitch hoek is -2.0 graden.
De gevevens van de diverse stations op het blad zijn:

Xr	Cr	BETA
0.10000	0.12000	0.15621
0.20000	0.11000	0.14120
0.30000	0.10000	0.12322
0.40000	0.09000	0.10123
0.50000	0.08000	0.07854
0.60000	0.07000	0.05585
0.70000	0.06000	0.03316
0.80000	0.05000	0.01047
0.85000	0.04500	-0.00087
0.90000	0.04000	-0.01222
0.95000	0.03500	-0.02356
0.97500	0.03250	-0.02923
0.99000	0.03100	-0.03264
0.99990	0.03000	-0.03488

Gebruikte gegevens van de DEBRA 25   rotor.

De slankheid bedraagt 26.0552.
Aantal bladen: 3
Het gebruikte profiel is   NACA 4418
De straal van de rotor is: 12.5

Het toerental bedraagt 33/50 toeren per minuut.
De pitch hoek is + 4.0 graden.
De gevevens van de diverse stations op het blad zijn:

Xr	Cr	BETA
0.16000	0.05368	0.17104
0.20000	0.06440	0.11310
0.24400	0.07168	0.08831
0.30000	0.06800	0.06981
0.38000	0.06272	0.04189
0.44000	0.05880	0.02182
0.55040	0.05152	-0.00908
0.70000	0.04168	-0.03491
0.82000	0.03376	-0.04730
0.90000	0.02840	-0.05166
0.98000	0.02424	-0.05222
0.99990	0.02320	-0.05236

Gebruikte gegevens van de PETTEN   rotor.

De slankheid bedraagt 17.2414.
Aantal bladen: 2
Het gebruikte profiel is   NACA 23018
De straal van de rotor is: 12.5

De pitch hoek is 0.0 graden.
De gevevens van de diverse stations op het blad zijn:

Xr	Cr	BETA
0.08000	0.14910	0.21049
0.15000	0.13960	0.17364
0.25000	0.12600	0.12099
0.40000	0.10560	0.04853
0.50000	0.09200	0.01657
0.60000	0.07840	-0.00708
0.70000	0.06480	-0.02550
0.80000	0.05120	-0.04038
0.85000	0.04440	-0.04682
0.90000	0.03760	-0.05272
0.95000	0.03080	-0.05816
0.97500	0.02740	-0.06072
0.99000	0.02540	-0.06221
0.99990	0.02400	-0.06317

Gebruikte gegevens van de DEMPSTER rotor.

De slankheid bedraagt 6.0764.
Aantal bladen: 18
Het gebruikte profiel is GebPlaat
De straal van de rotor is: 2.2

De pitch hoek is 0.0 graden.
De gevevens van de diverse stations op het blad zijn:

Xr	Cr	BETA
0.46480	0.09390	0.78540
0.55000	0.11501	0.74142
0.65000	0.13979	0.68975
0.75000	0.16457	0.63809
0.80000	0.17696	0.61226
0.85000	0.18935	0.58643
0.90000	0.20174	0.56060
0.95000	0.21413	0.53494
0.97000	0.21908	0.52447
0.99000	0.22404	0.51417
0.99990	0.22770	0.50911

Gebruikte gegevens van de WEU I4 rotor.

De slankheid bedraagt 2.0450.
Aantal bladen: 8
Het gebruikte profiel is GebPla+ buis
De straal van de rotor is: 1.5

De pitch hoek is 0.0 graden.
De gevevens van de diverse stations op het blad zijn:

Xr	Cr	BETA
0.41000	0.28900	0.70860
0.54100	0.28900	0.64577
0.65000	0.28900	0.59341
0.75000	0.28900	0.54629
0.86900	0.28900	0.48869
0.90000	0.28900	0.47473
0.95000	0.28900	0.45029
0.97000	0.28900	0.43982
0.98000	0.28900	0.43633
0.99000	0.28900	0.43110

Gebruikte gegevens van de CWD 5000 rotor.

De slankheid bedraagt 4.1120.
Aantal bladen: 8
Het gebruikte profiel is GebPla+ buis
De straal van de rotor is: 2.5

De pitch hoek is 0.0 graden.
De gevevens van de diverse stations op het blad zijn:

Xr	Cr	BETA
0.26800	0.17800	0.67195
0.37000	0.17800	0.61261
0.46400	0.17800	0.55851
0.55000	0.17800	0.50789
0.64400	0.17800	0.45379
0.73000	0.17800	0.40317
0.82400	0.17800	0.34907
0.90000	0.17800	0.30543
0.95000	0.17800	0.27576
0.97000	0.17800	0.26354
0.98000	0.17800	0.25831
0.99000	0.17800	0.25307