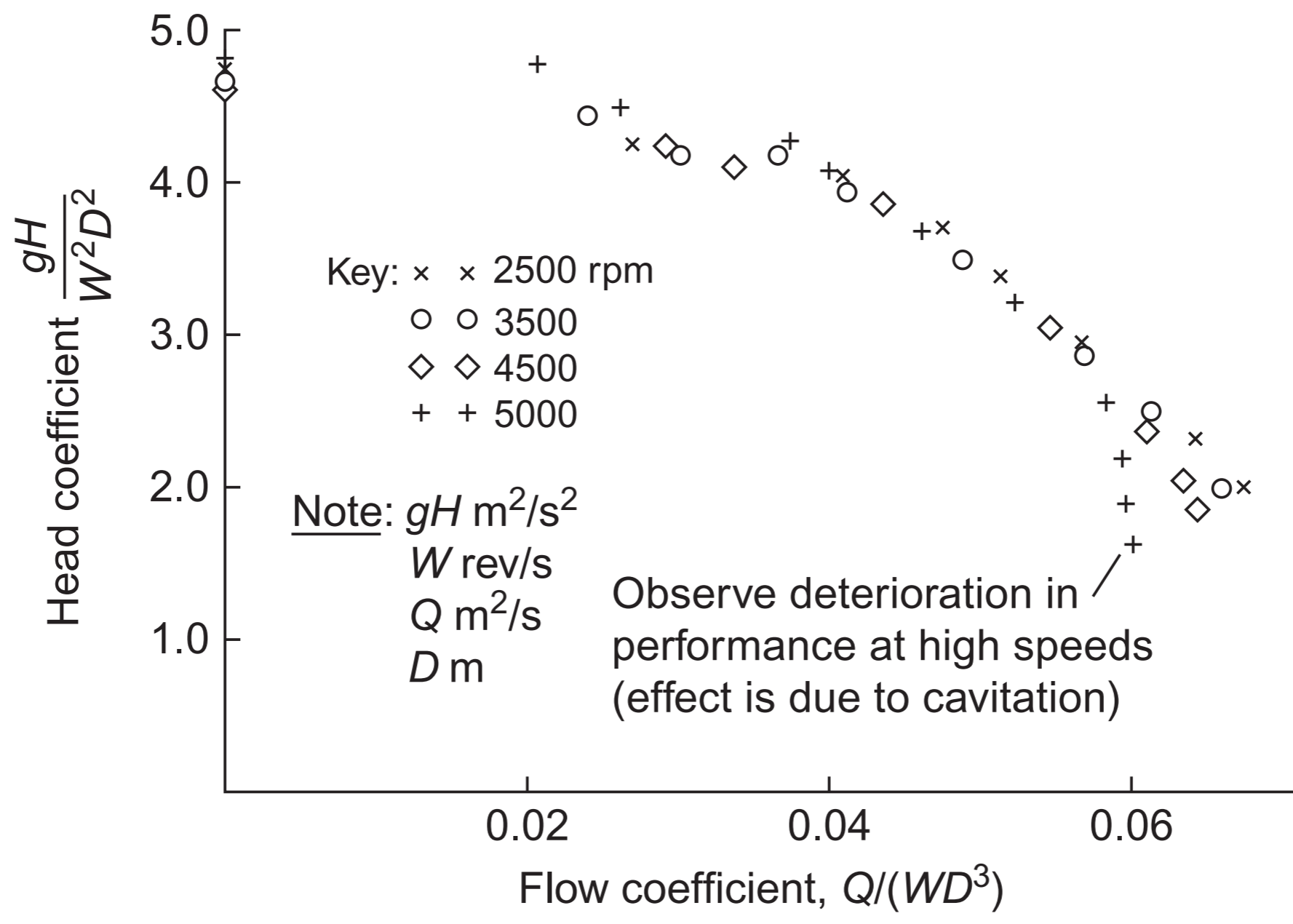
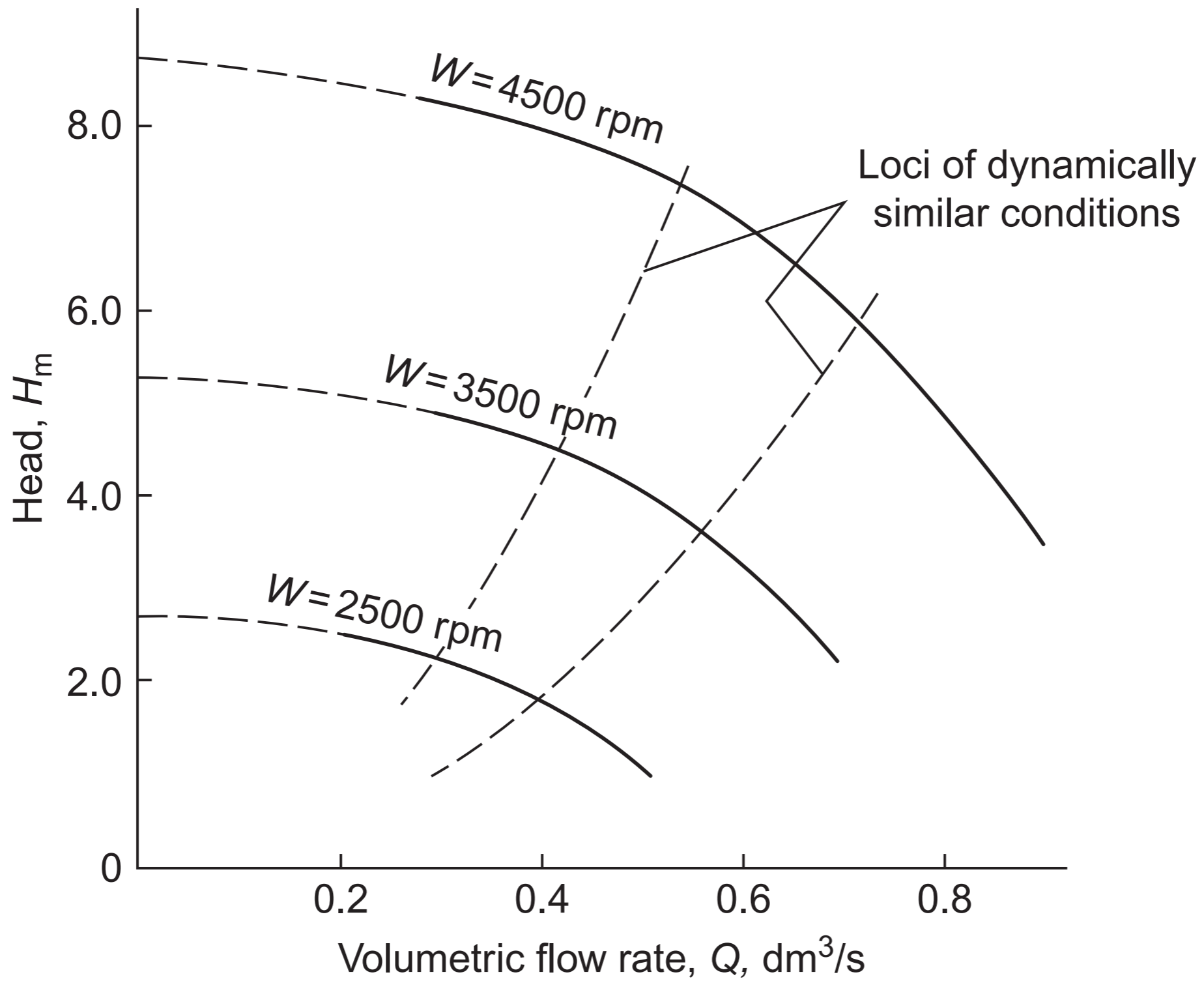
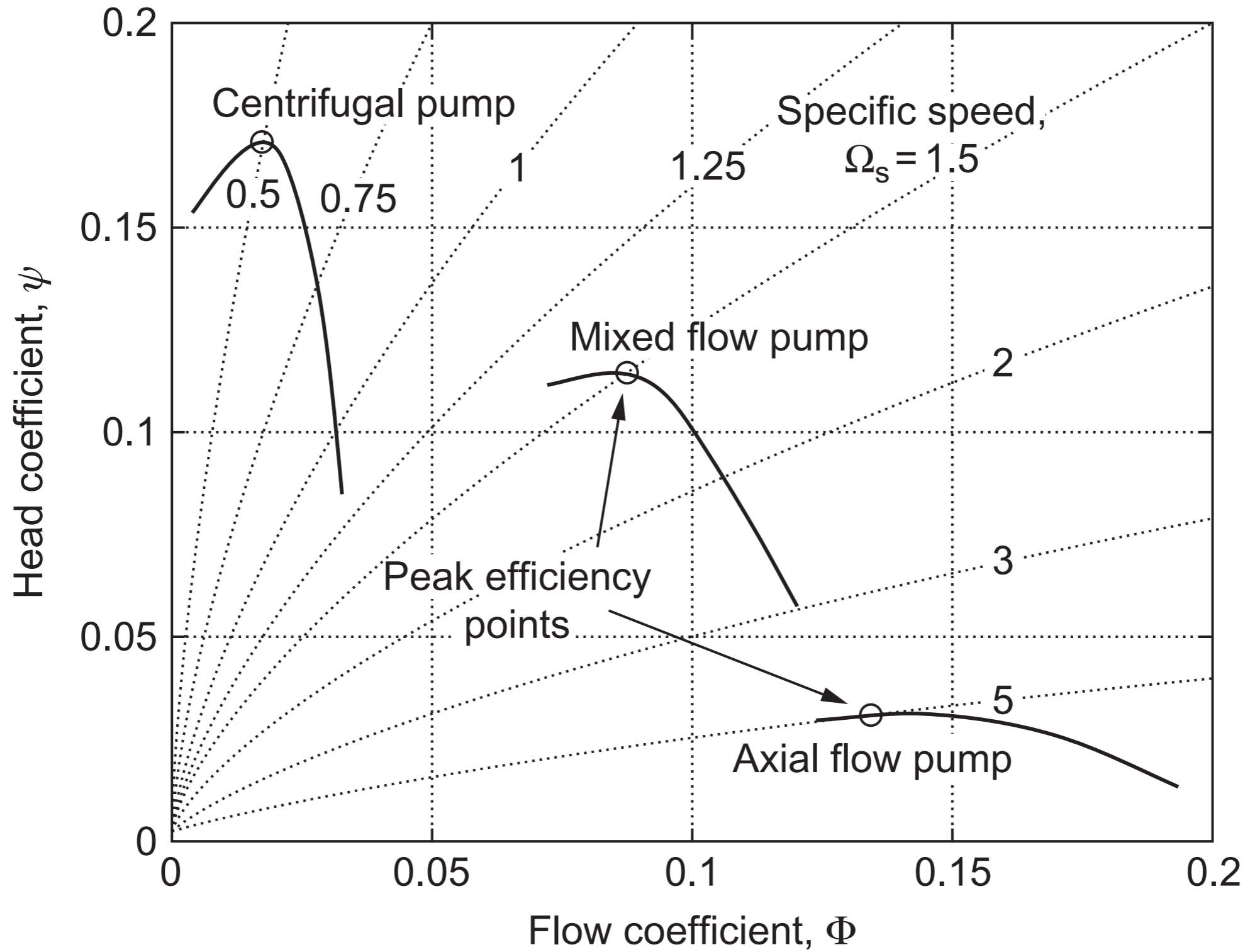


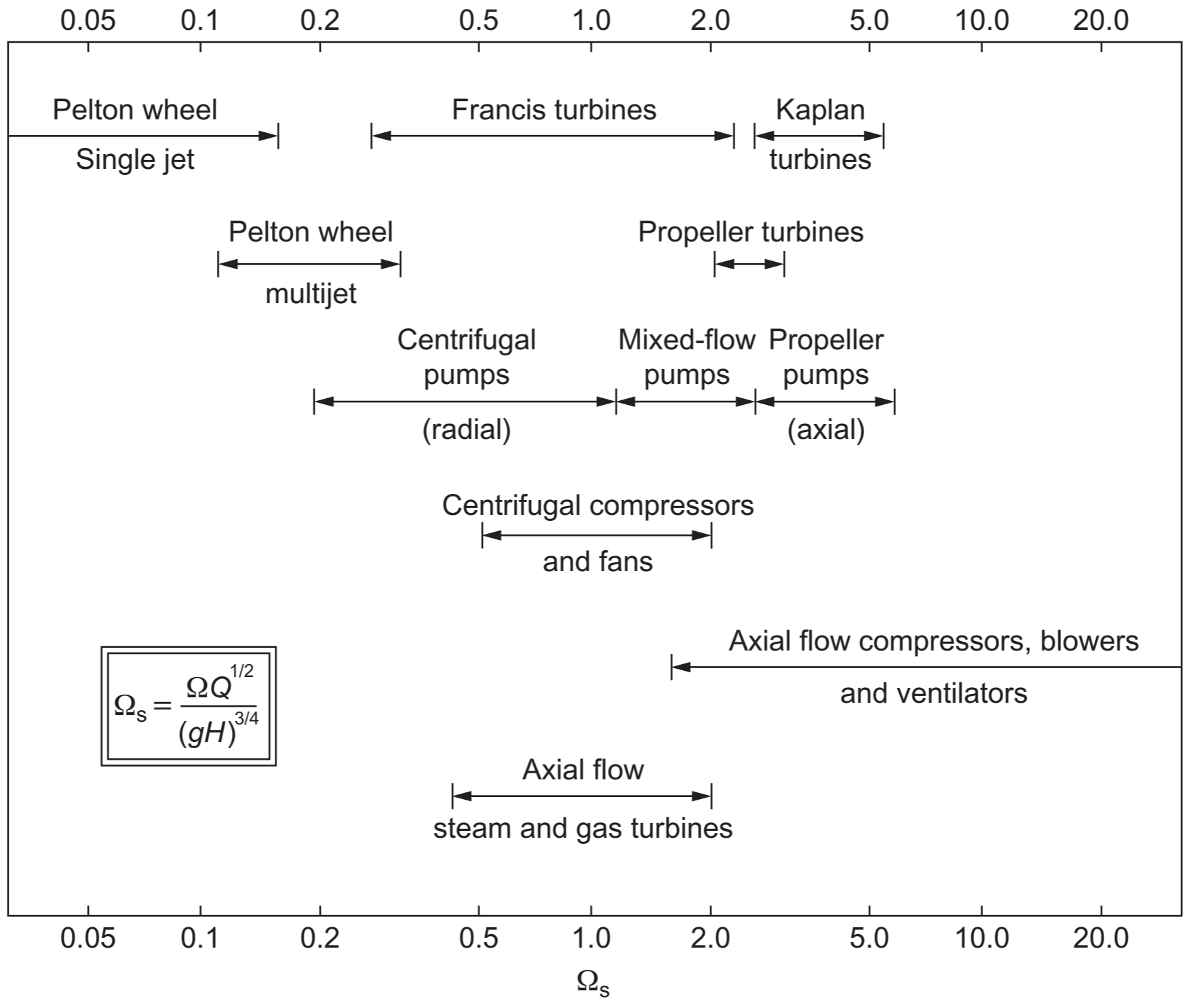
Compressore di media pressione

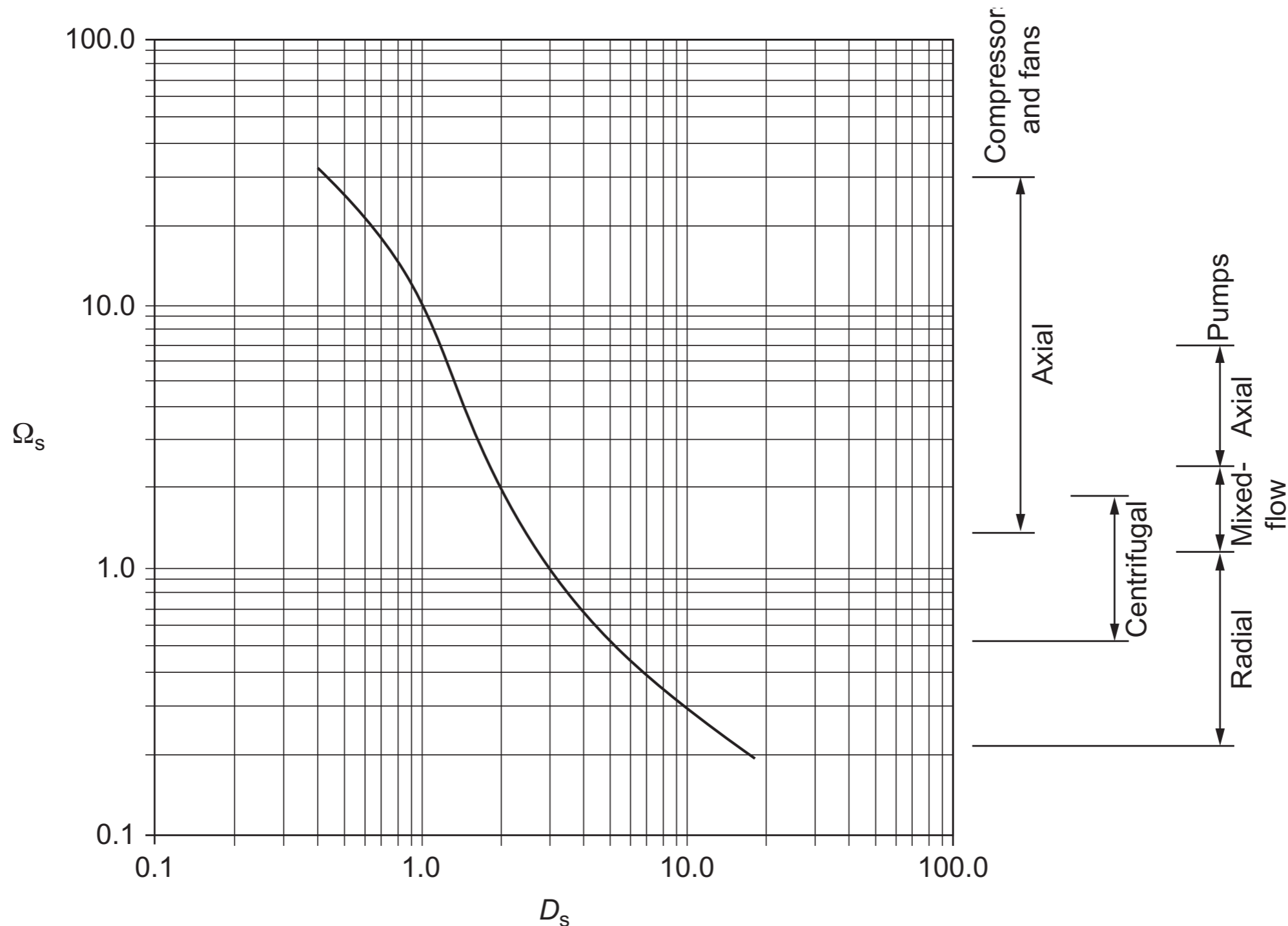
\dot{m}	31	[kg/s]	$p_{0,1}$	47	[kPa]
$T_{0,1}$	268.5	[K]	PR_{tot}	7	
n	8500	[rpm]	$D_{m,1}$	0.64	[m]
α_1	25	[°]	R	287	[J/kg K]
k	1.4		Φ	0.4÷0.45	
ψ^M	<0.4	(per stadio)	DF^M	<0.45	
$(AR_{rot})_{D_m}$	1.5		$(AR_{stat})_{D_m}$	2	





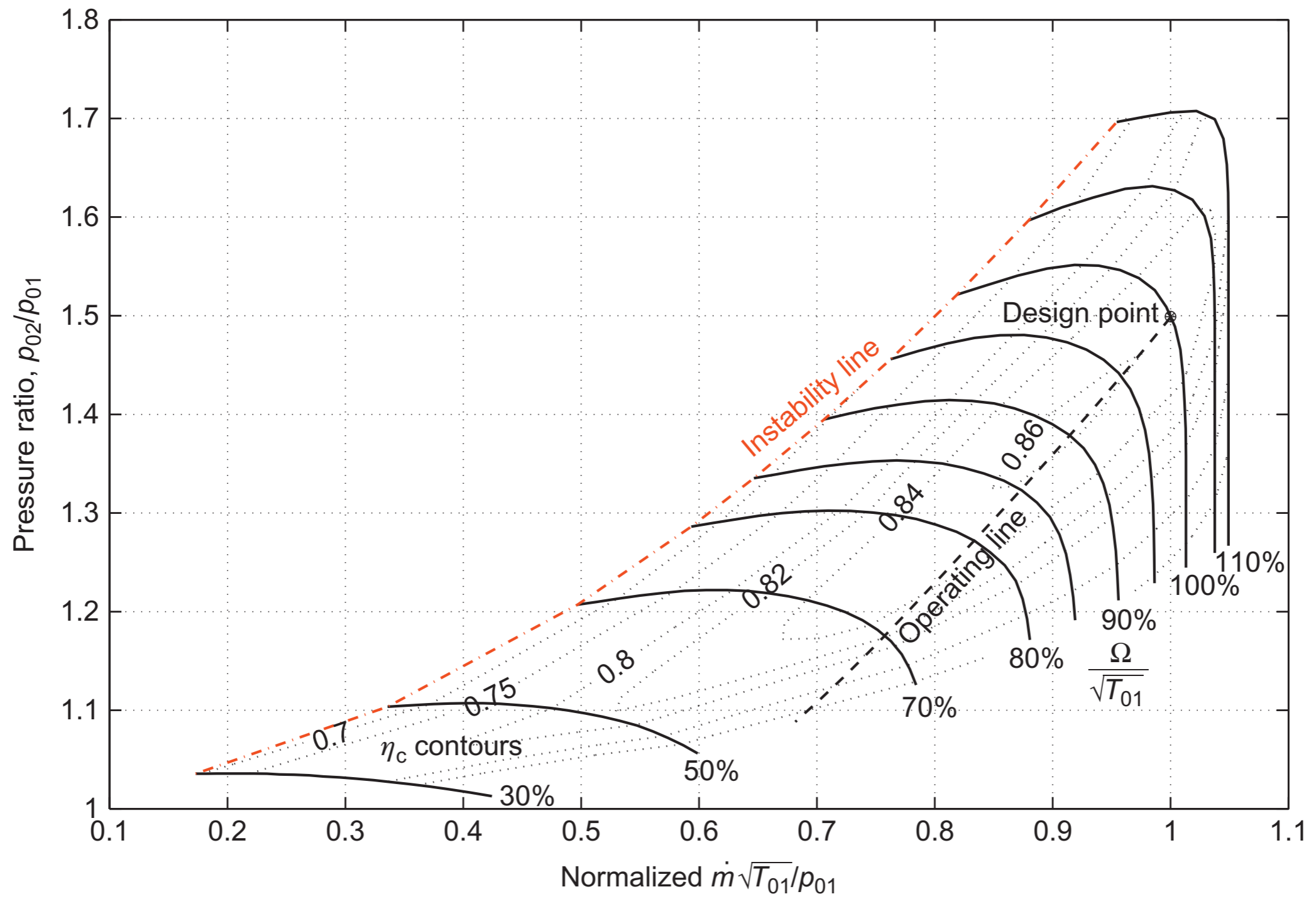


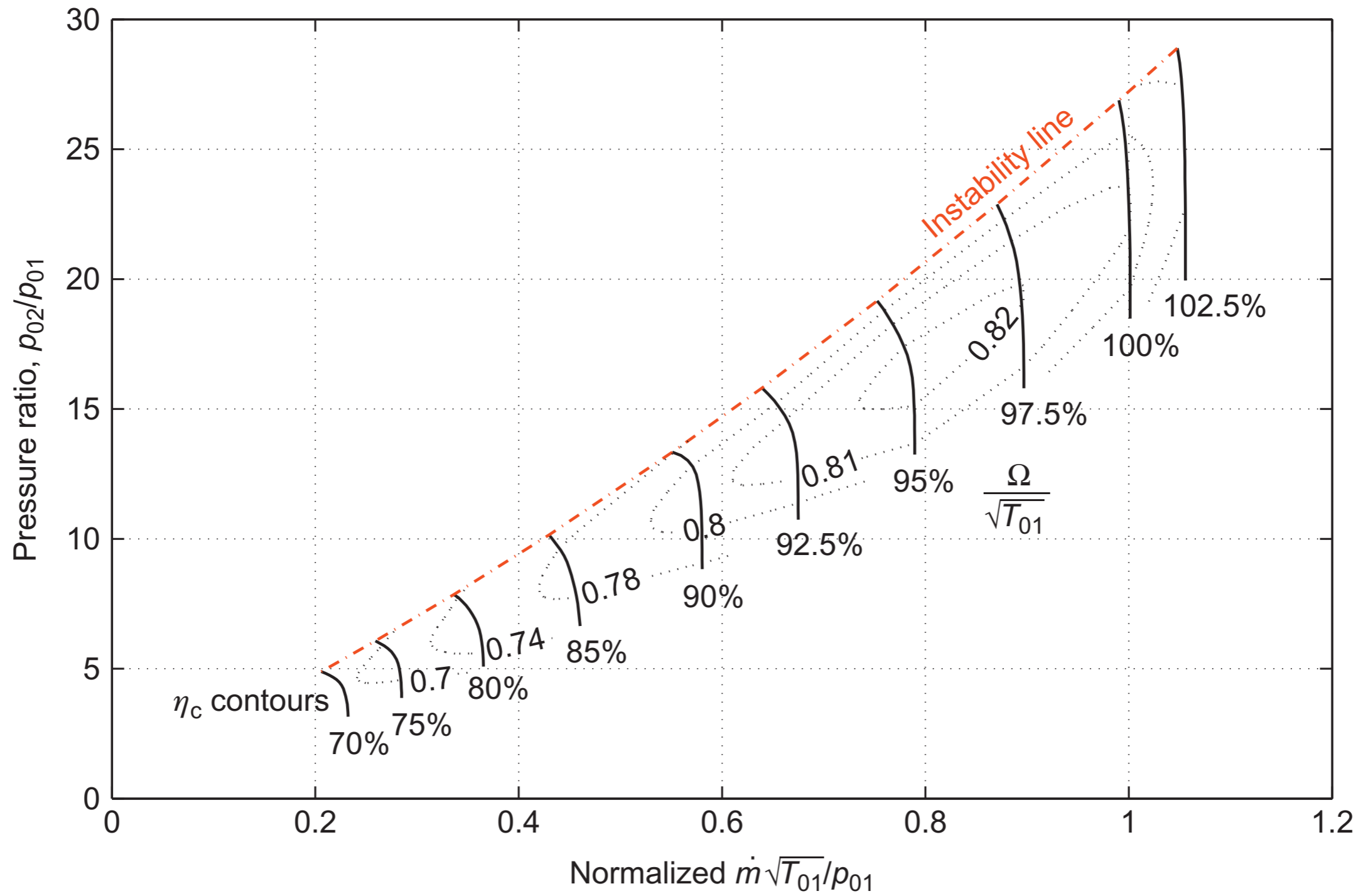




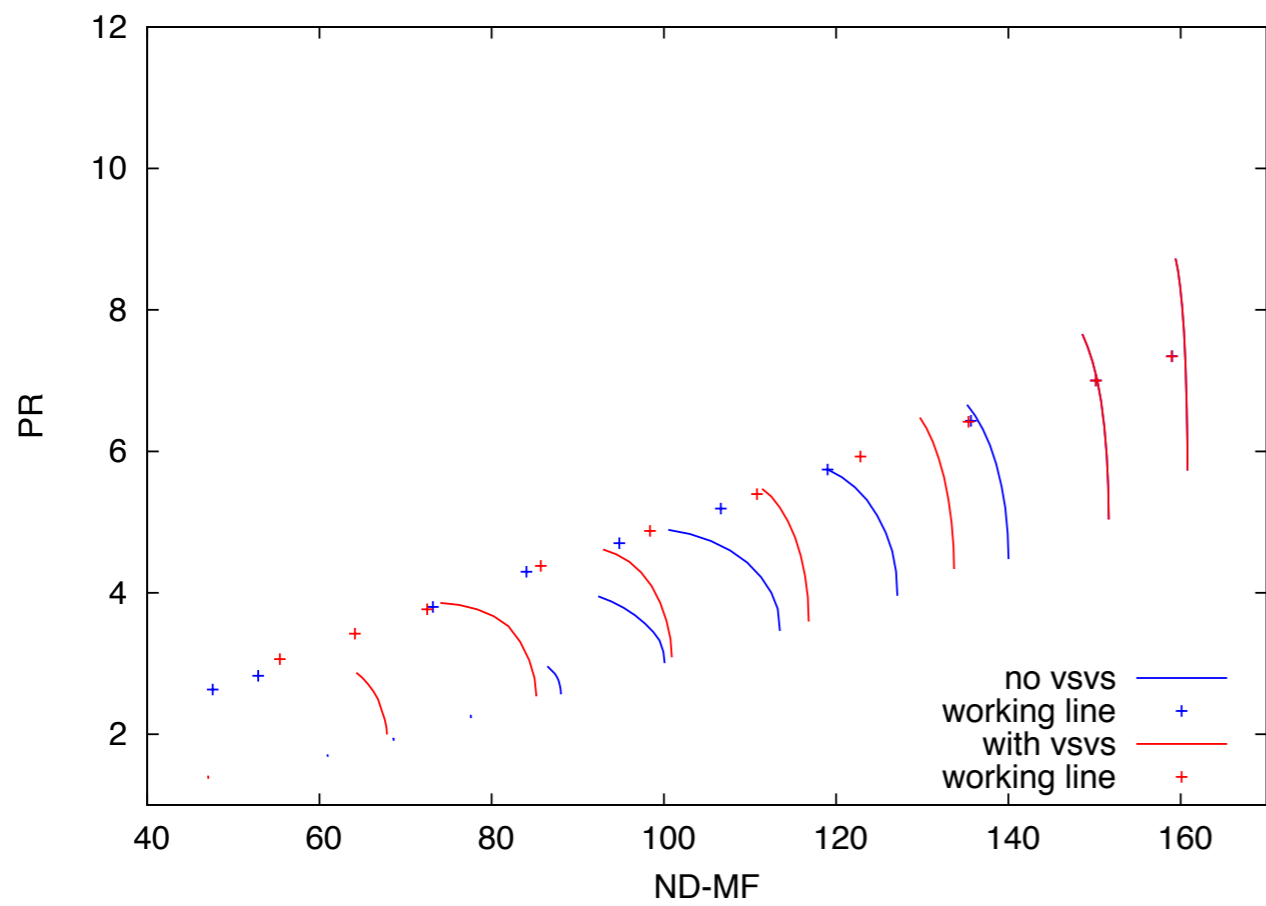
$$\Omega_s = \frac{\Phi_1^{1/2}}{\psi_1^{3/4}} = \frac{\Omega Q^{1/2}}{(gH)^{3/4}}$$

$$D_s = \frac{\psi_1^{1/4}}{\Phi_1^{1/2}} = \frac{D(gH)^{1/4}}{Q^{1/2}}$$

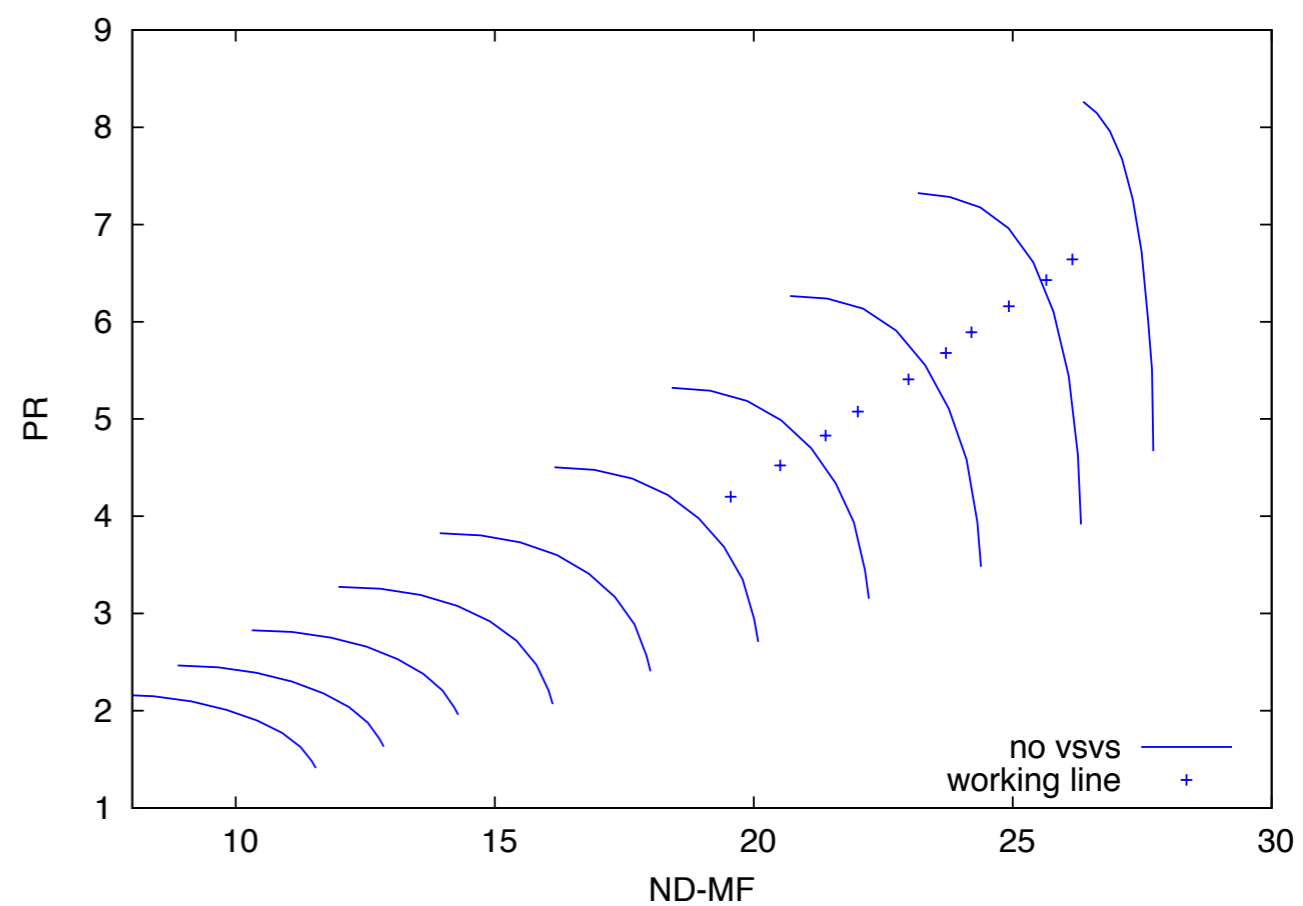




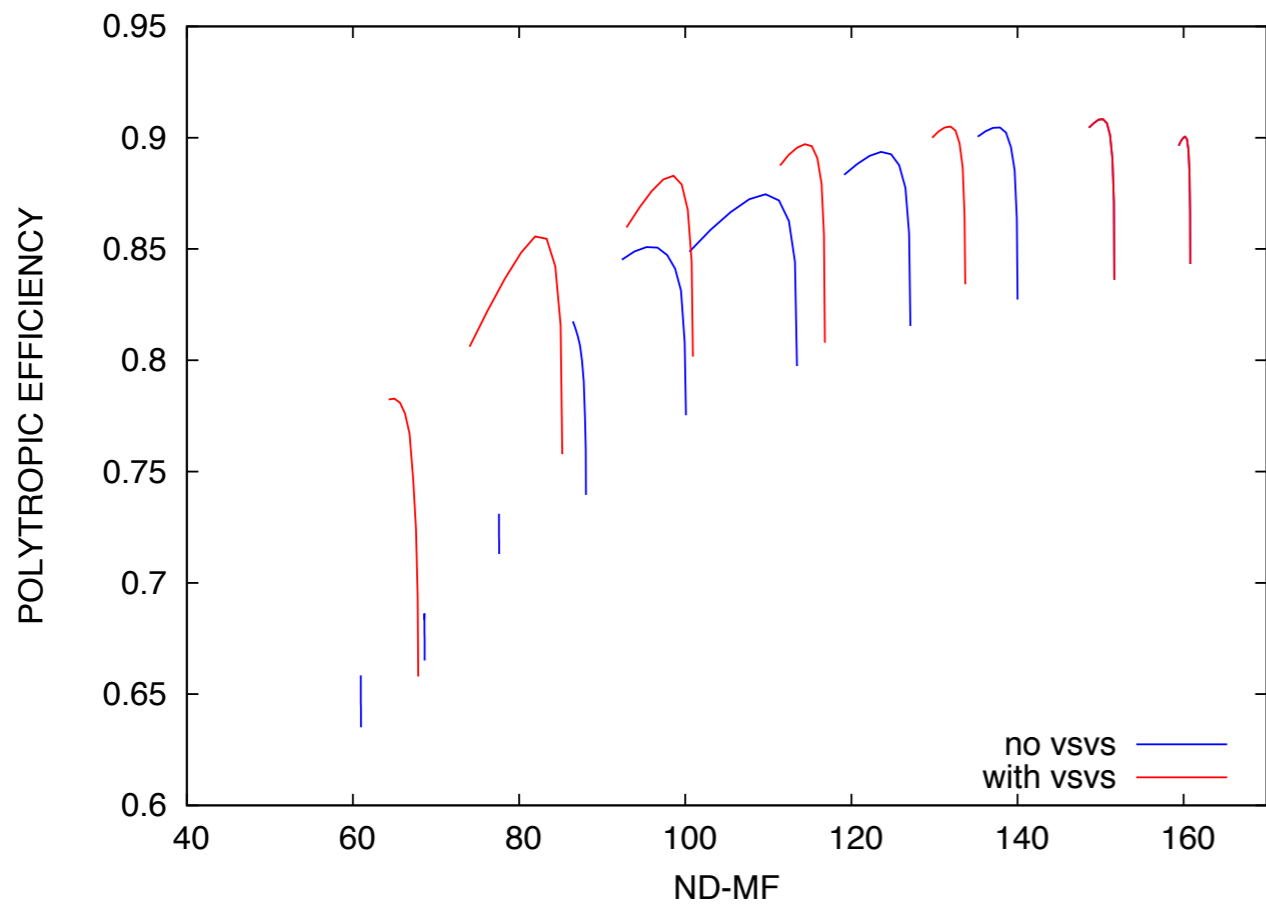
IPC



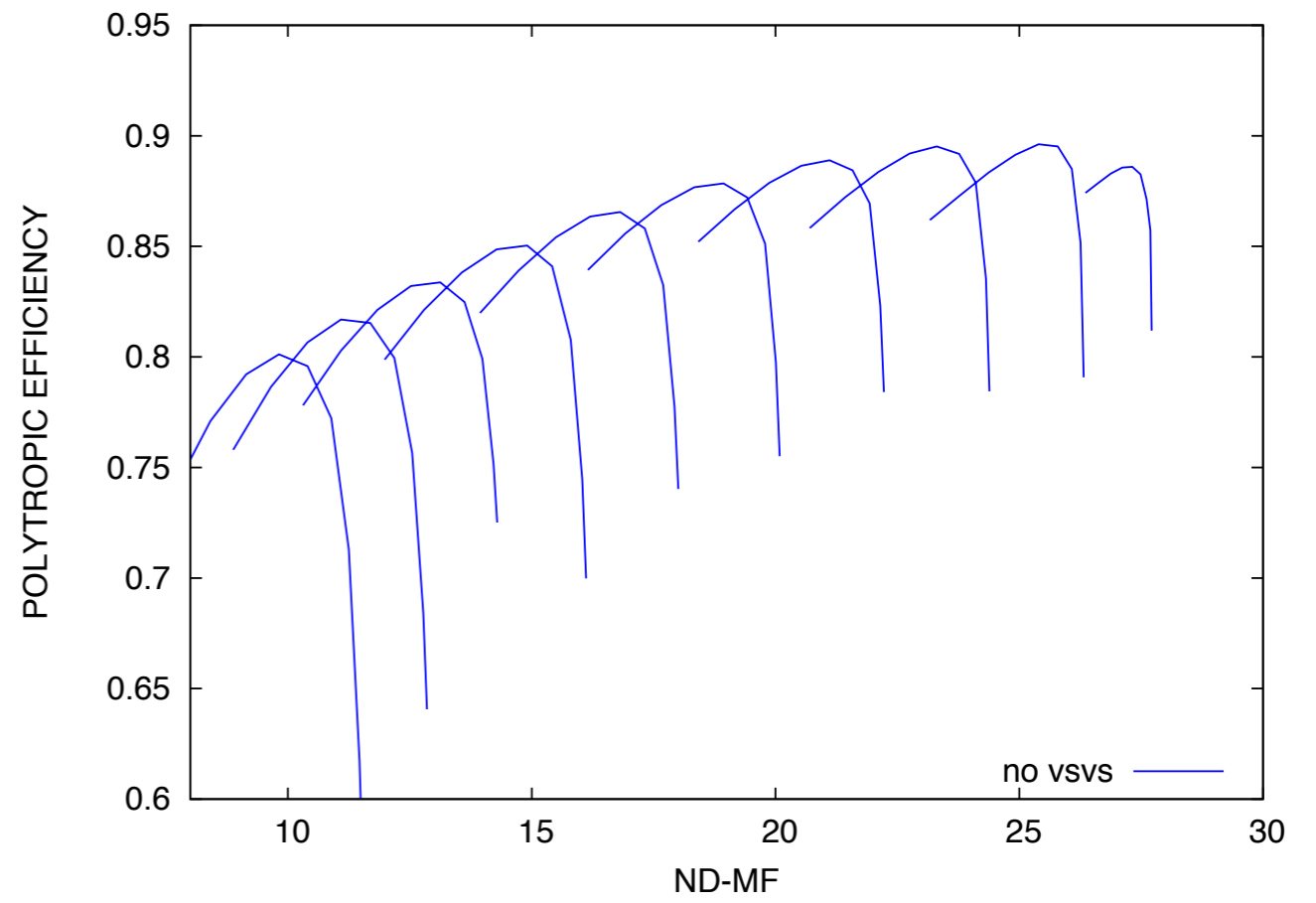
HPC

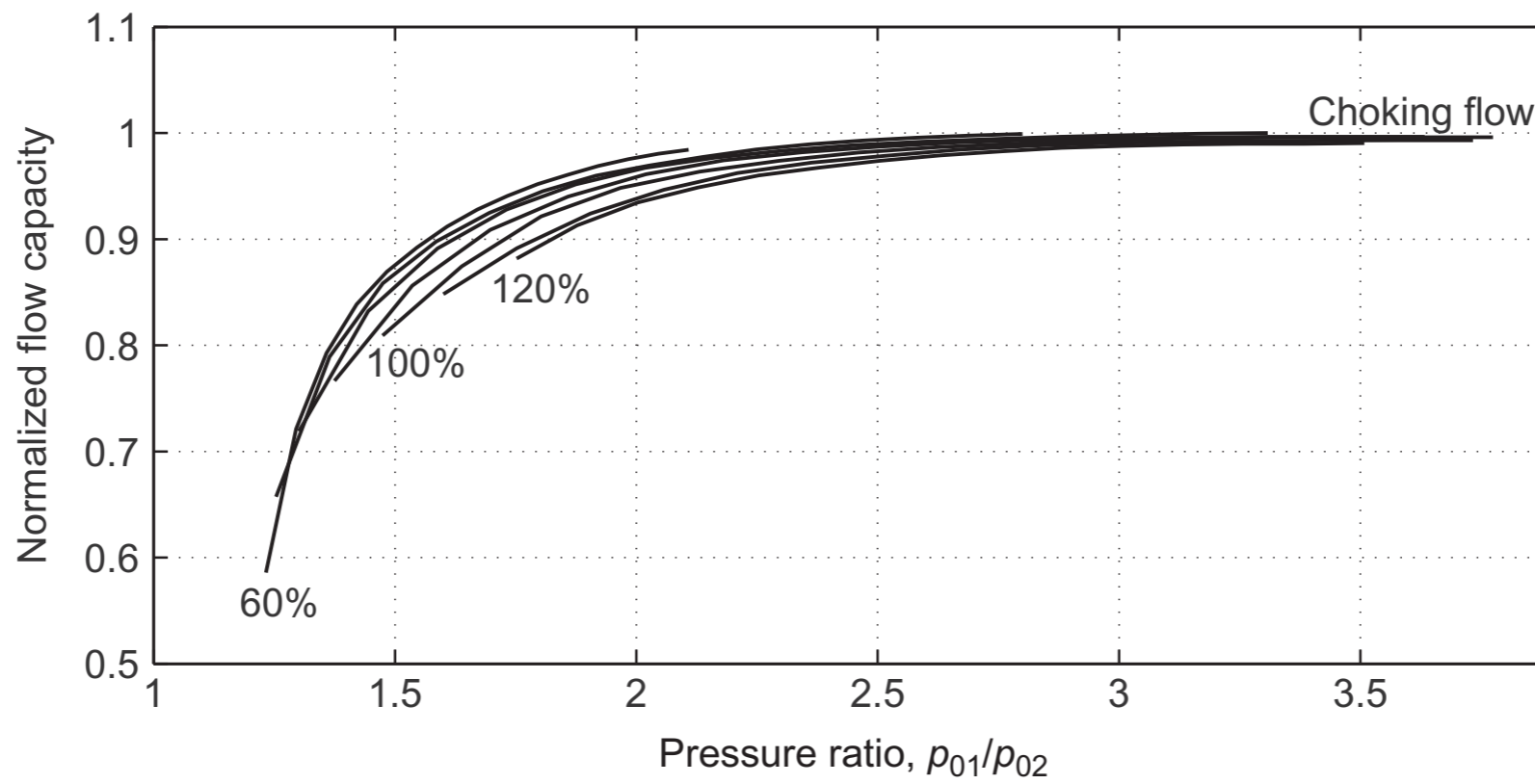
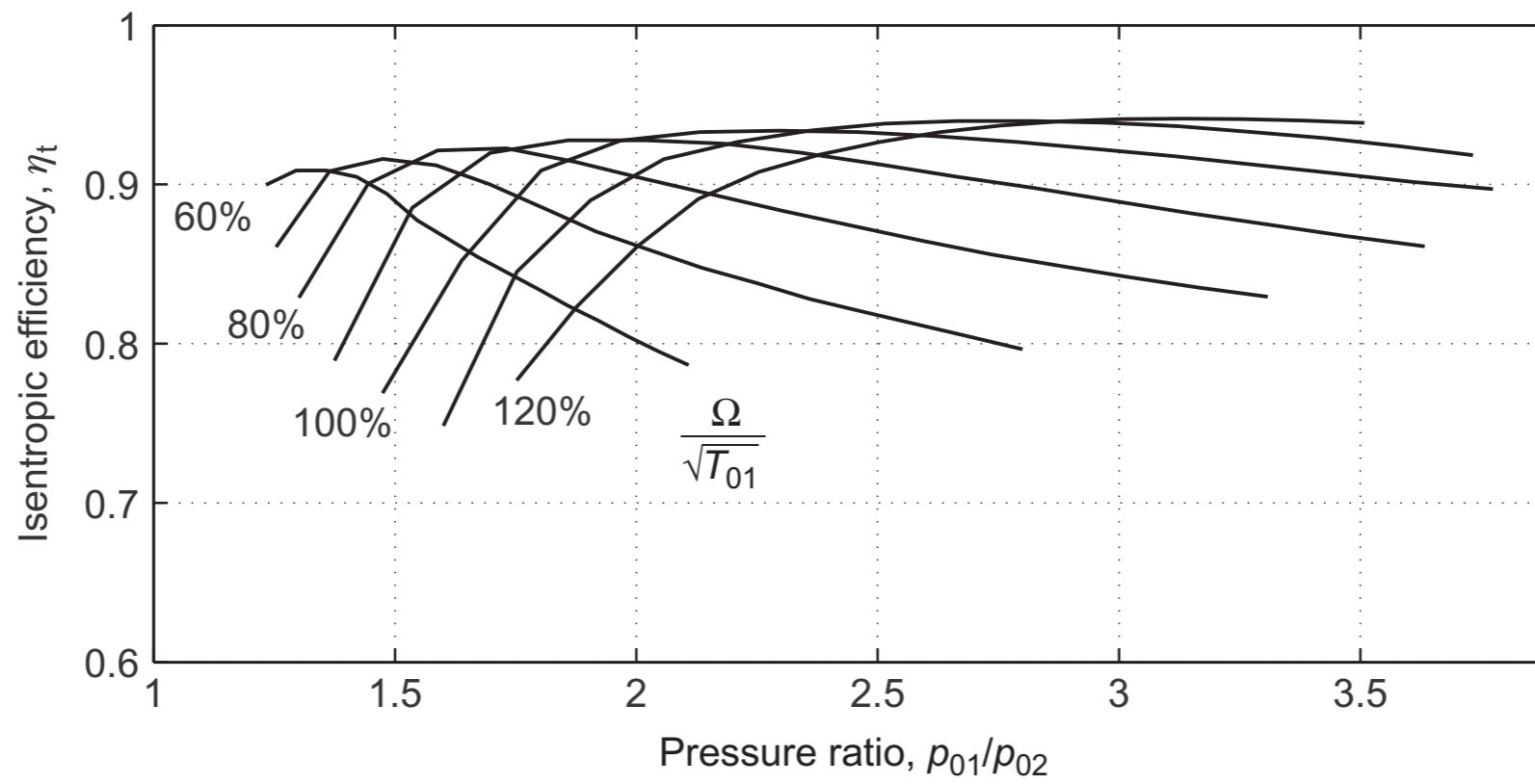


IPC



HPC





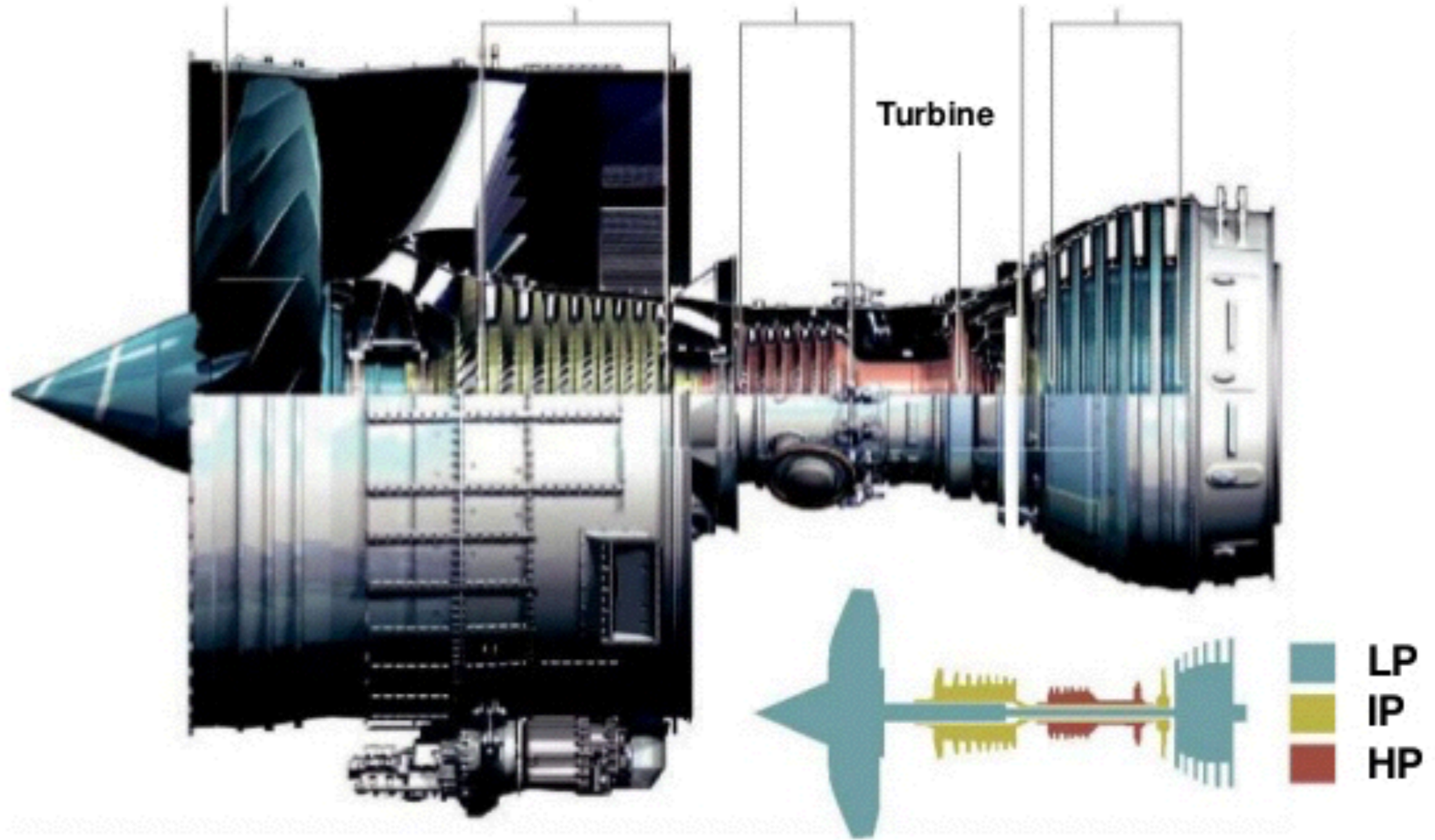
Fan (LP compressor)

IP compressor

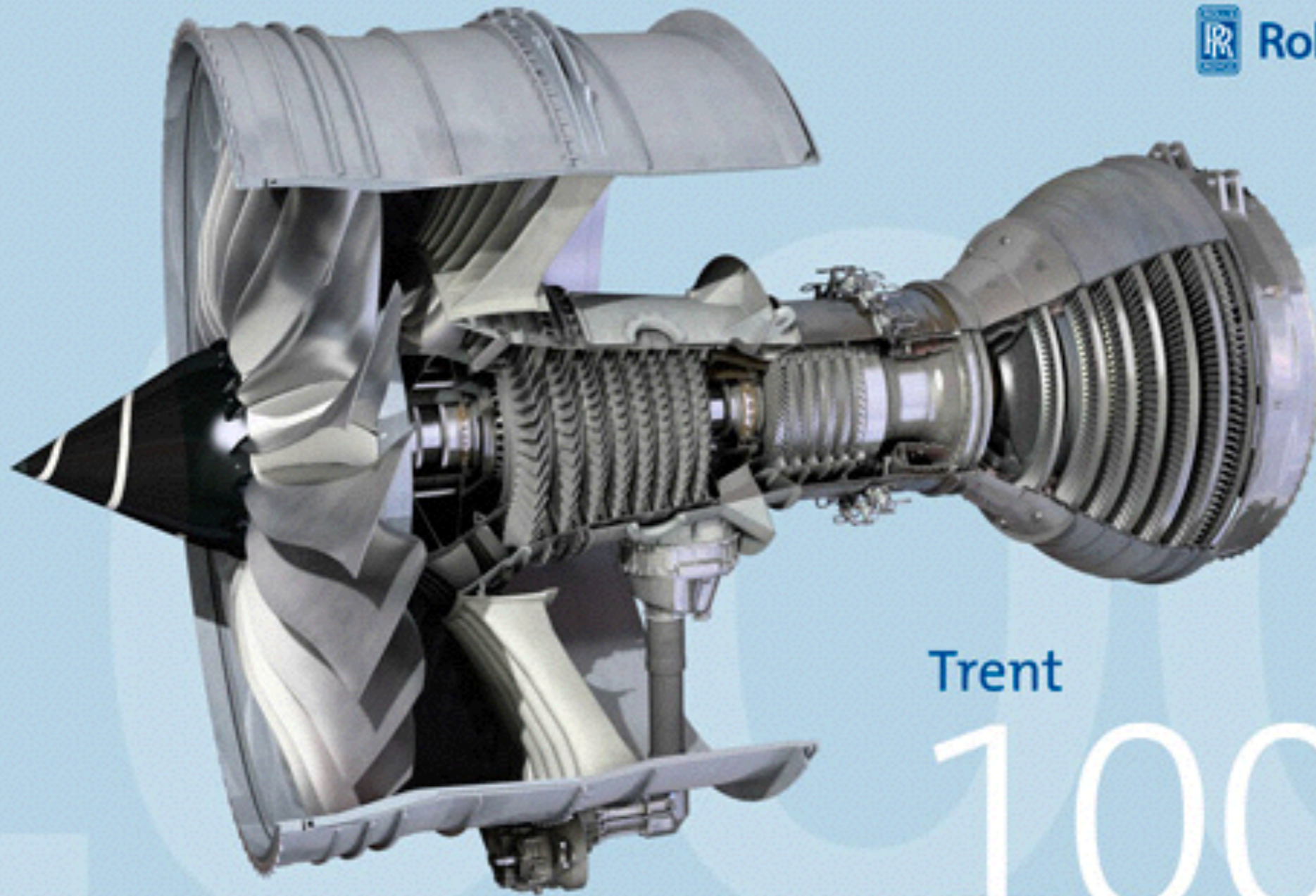
HP compressor

IP turbine

LP turbine



Trent 1000 – three shaft configuration



Trent 1000

1000 times better

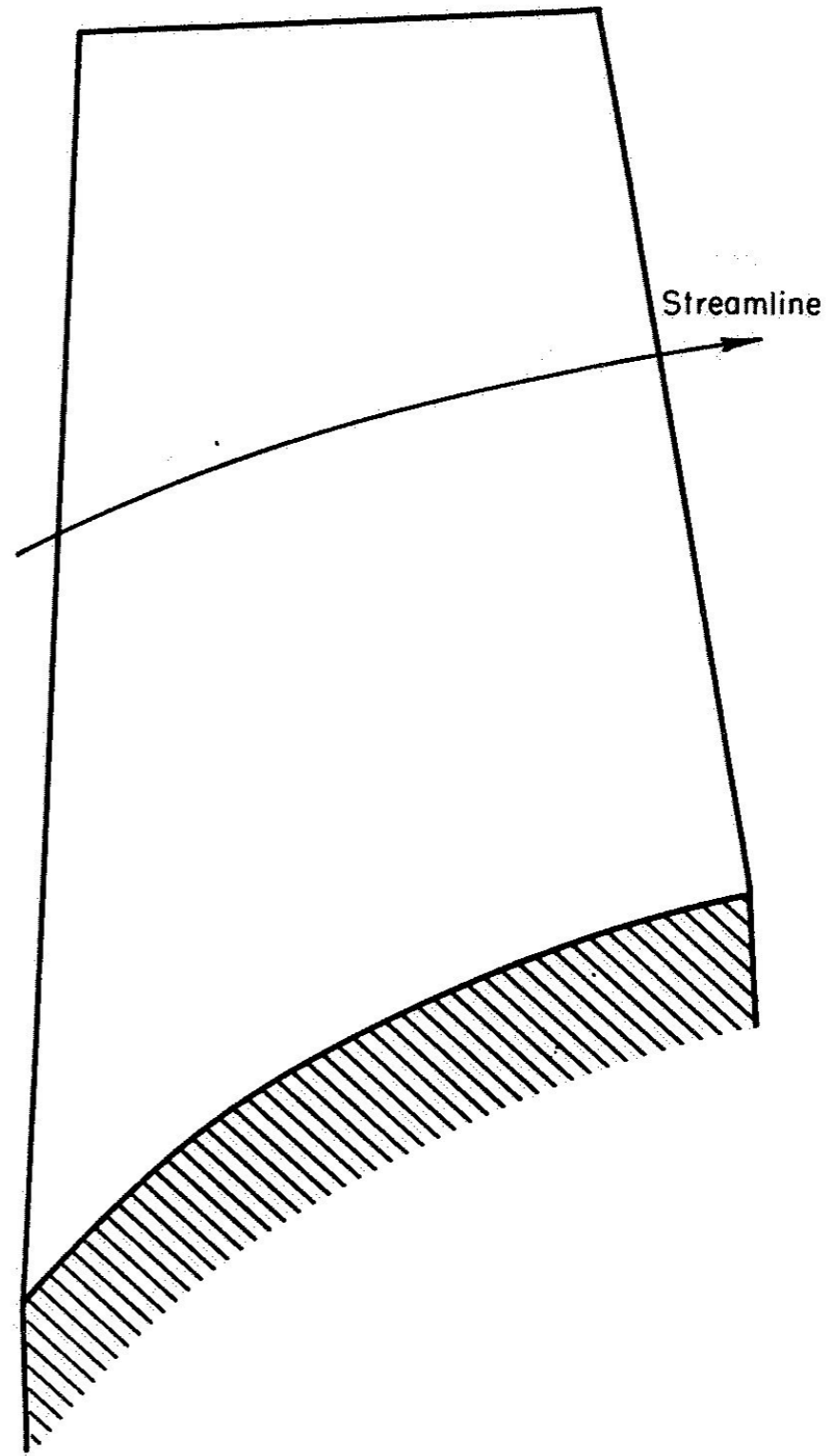
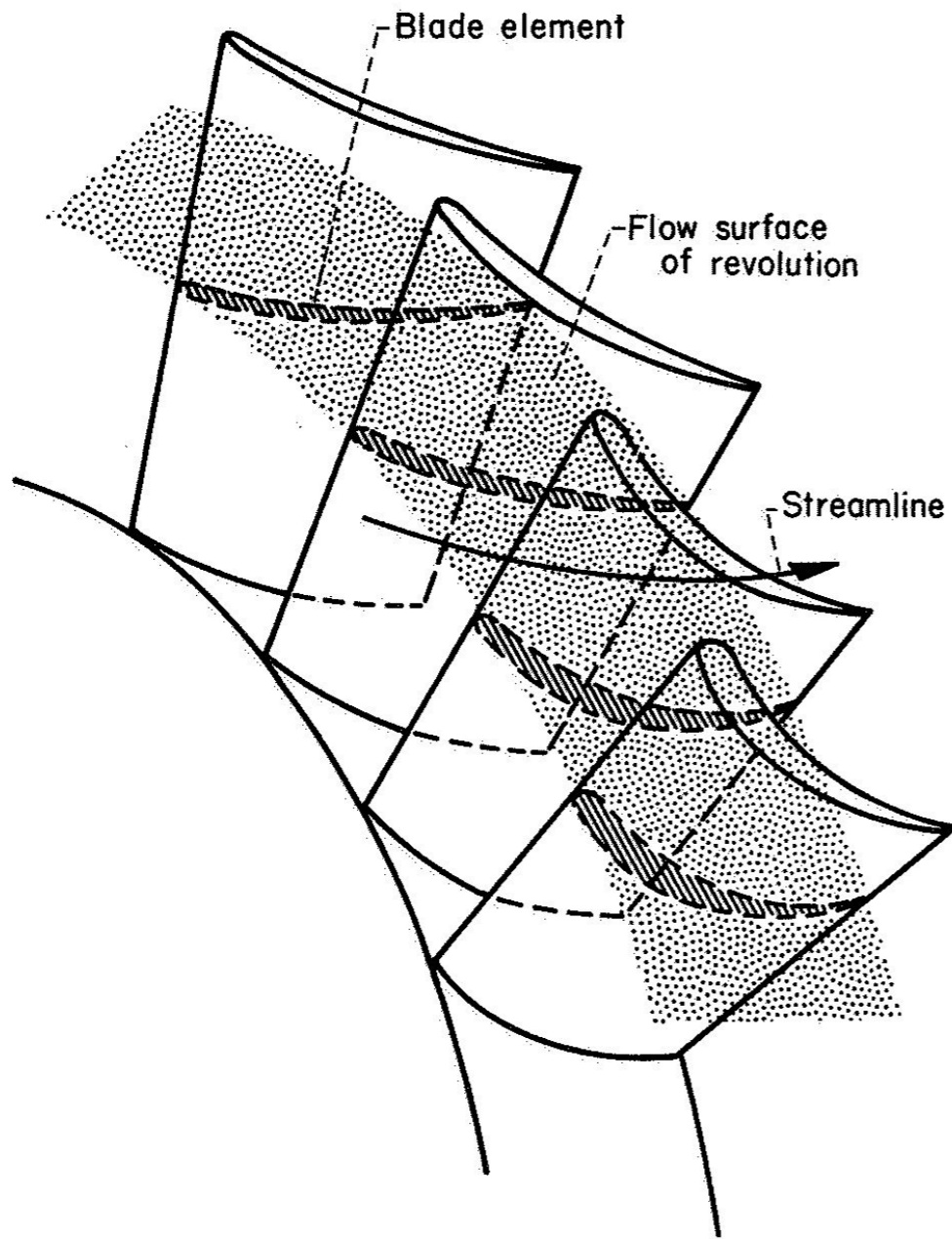
Entry into service 2011
Thrust 53,000–78,000 lbf
Boeing 787-8 Dreamliner
Boeing 787-9 Dreamliner
Boeing 787-10 Dreamliner

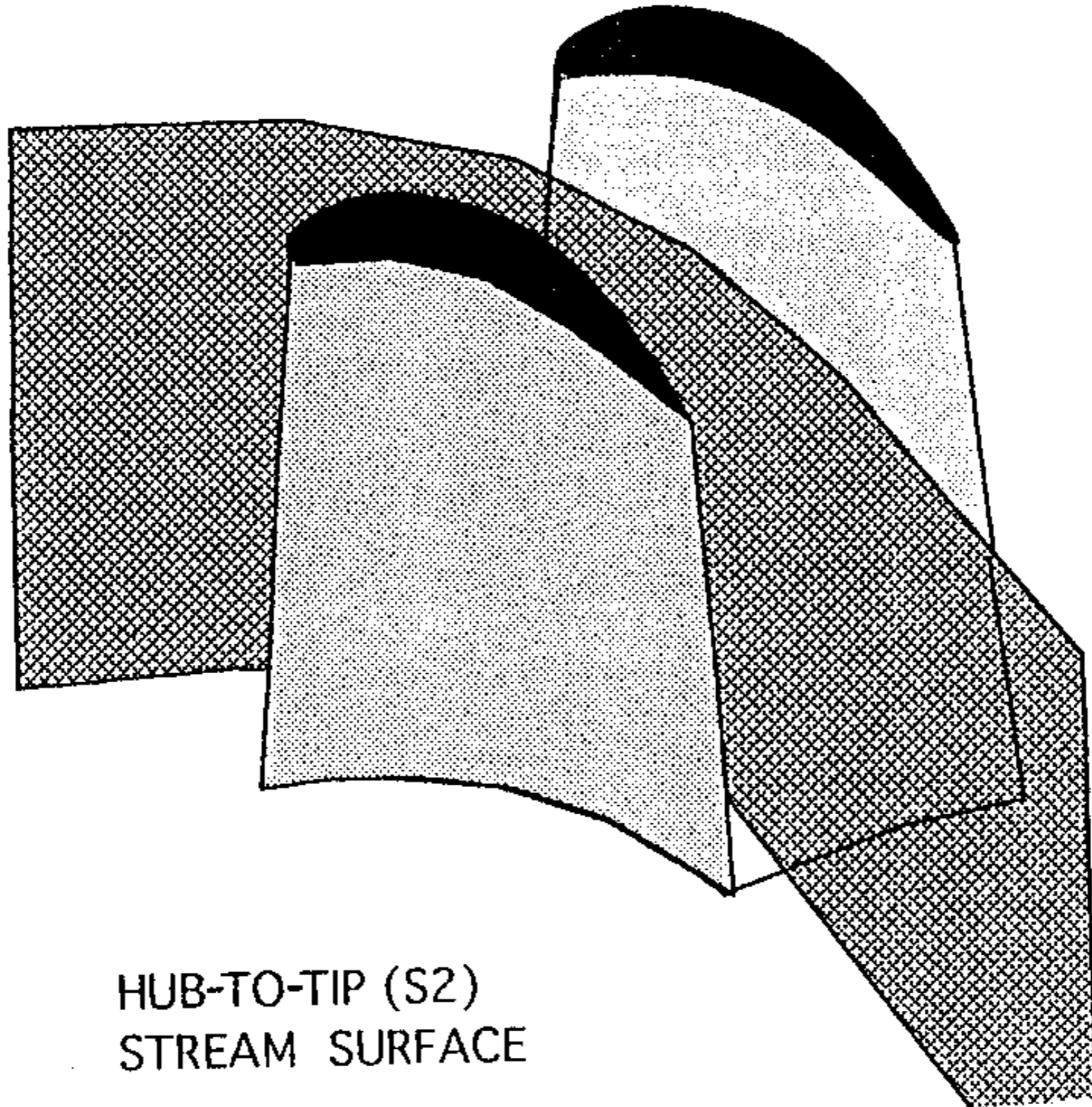
Technical Data

Configuration: Three shaft turbofan
Bypass Ratio: >10:1
Overall Pressure Ratio: 50:1
Fan: 20 blades, 112" diameter
Intermediate Pressure Compressor: 8 stages

High Pressure Compressor: 6 stages
Noise: OC 0.1 (departures) / OC 0.25 (arrivals)
High Pressure Turbine: Single stage
Intermediate Pressure Turbine: Single stage
Low Pressure Turbine: 6 stages







HUB-TO-TIP (S2)
STREAM SURFACE

Design Process

Strumenti

Mean-line design

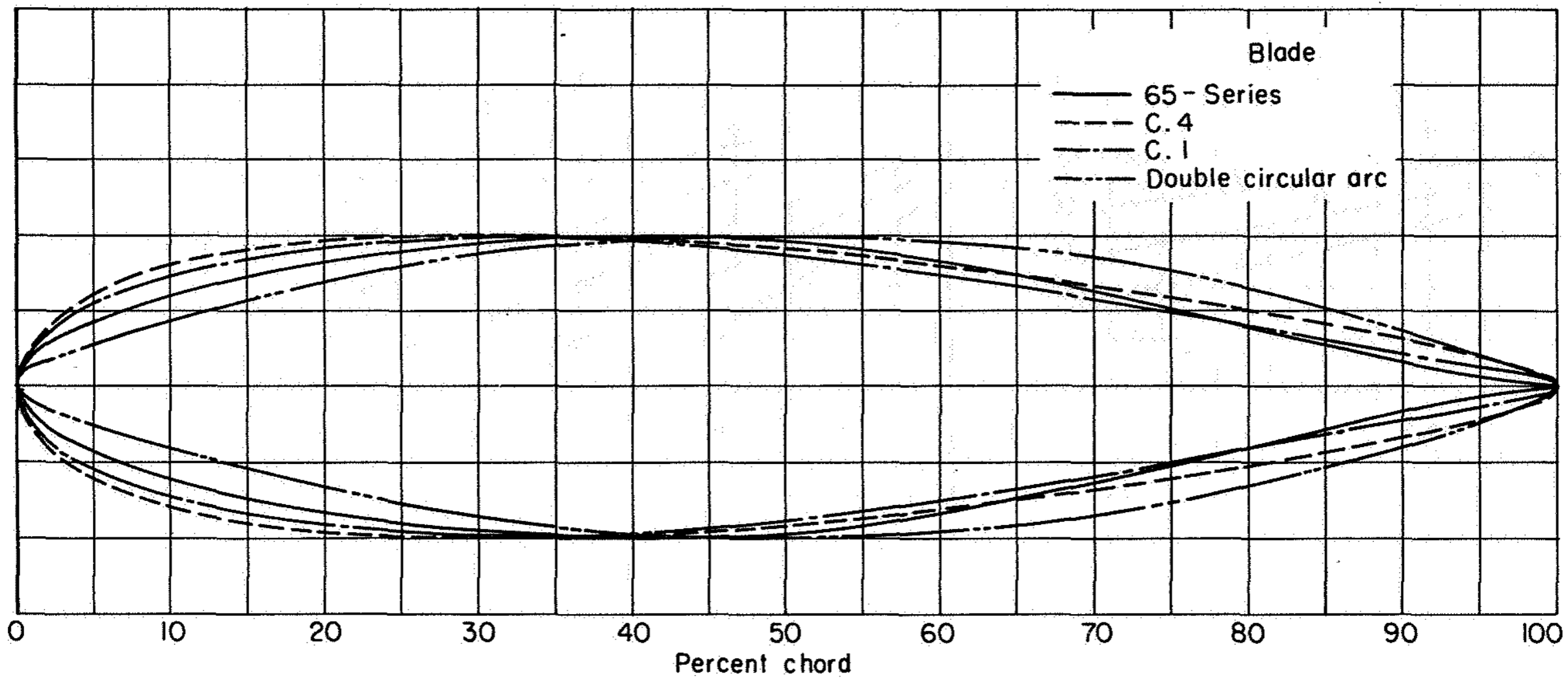
- leggi di conservazione
- correlazioni

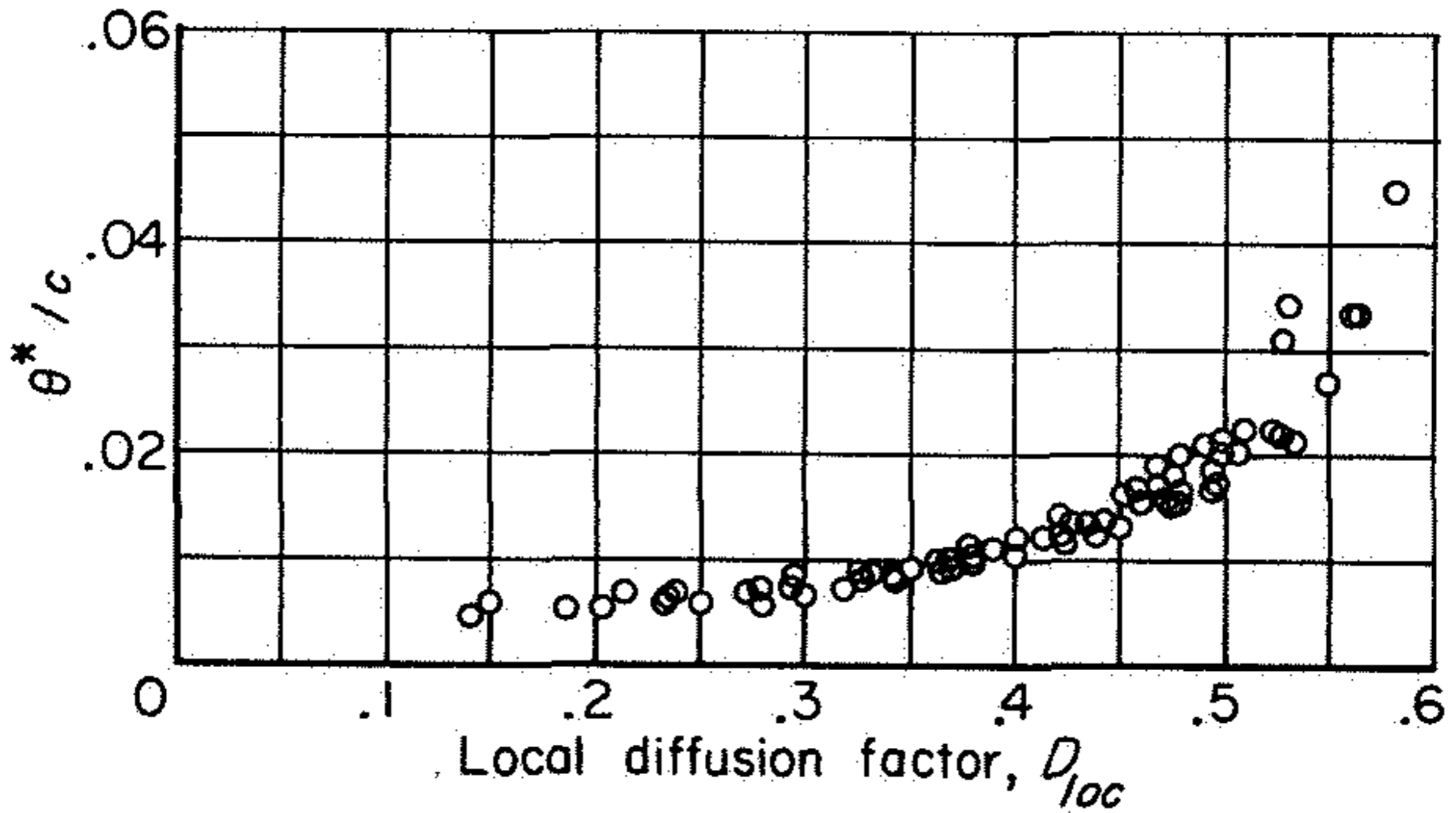
Through-flow design

- equazioni semplificate
- correlazioni
- 2D CFD

3D-design

- 3D CFD

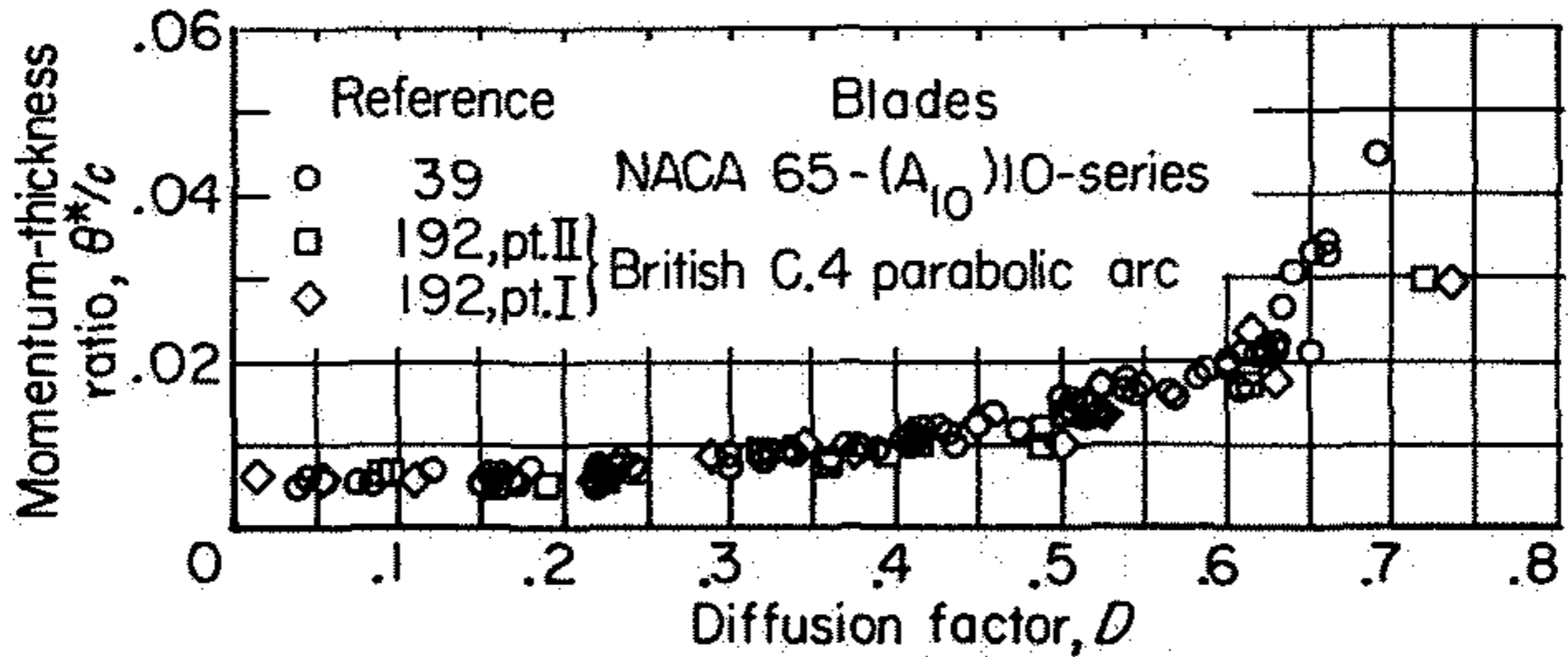




$$D_{loc} = \frac{V_{max} - V_2}{V_{max}}$$

$$D_{loc} = \left(1 - \frac{V_2}{V_1}\right) + \frac{\Delta V_\theta}{2\sigma V_1}$$

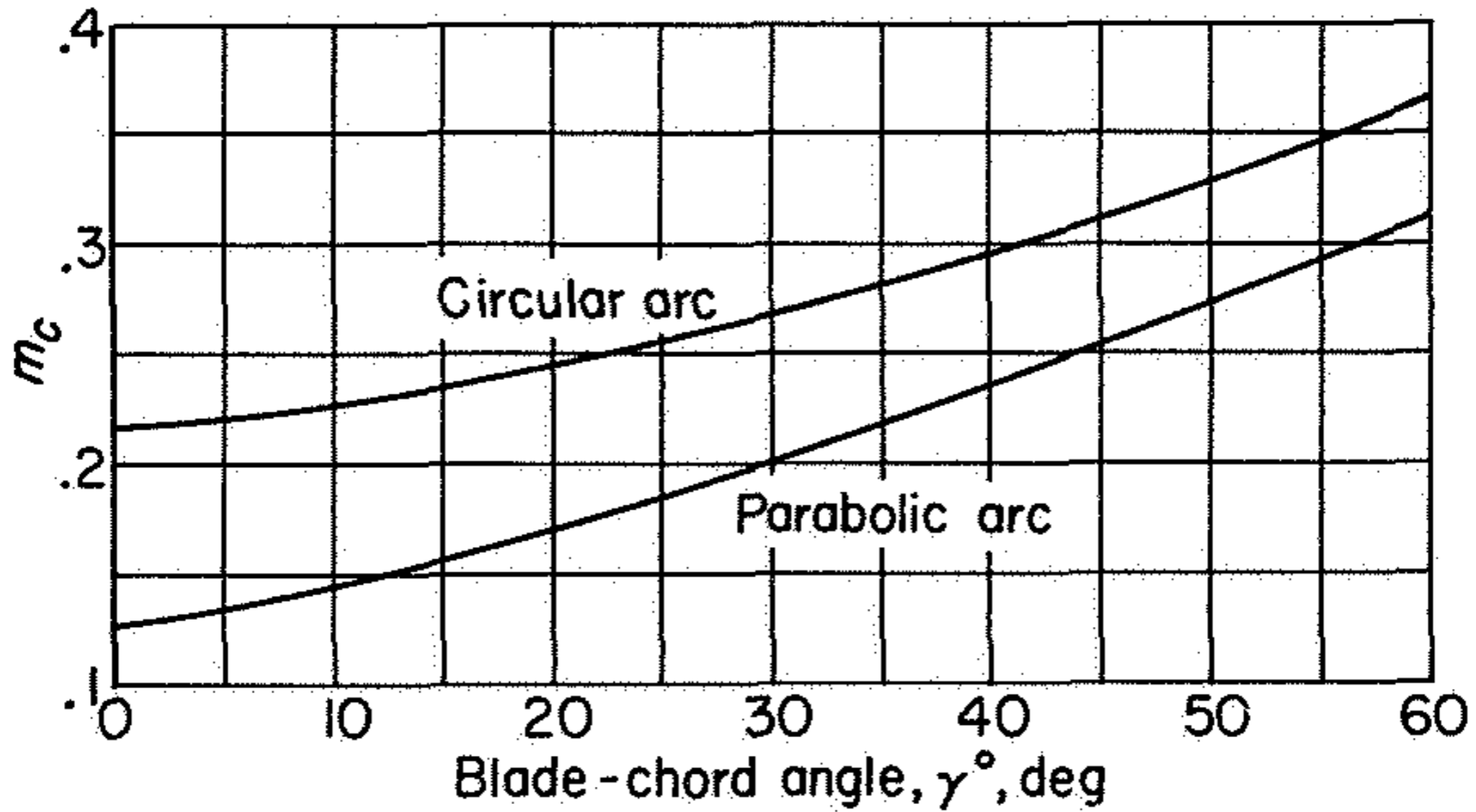
per NACA-65

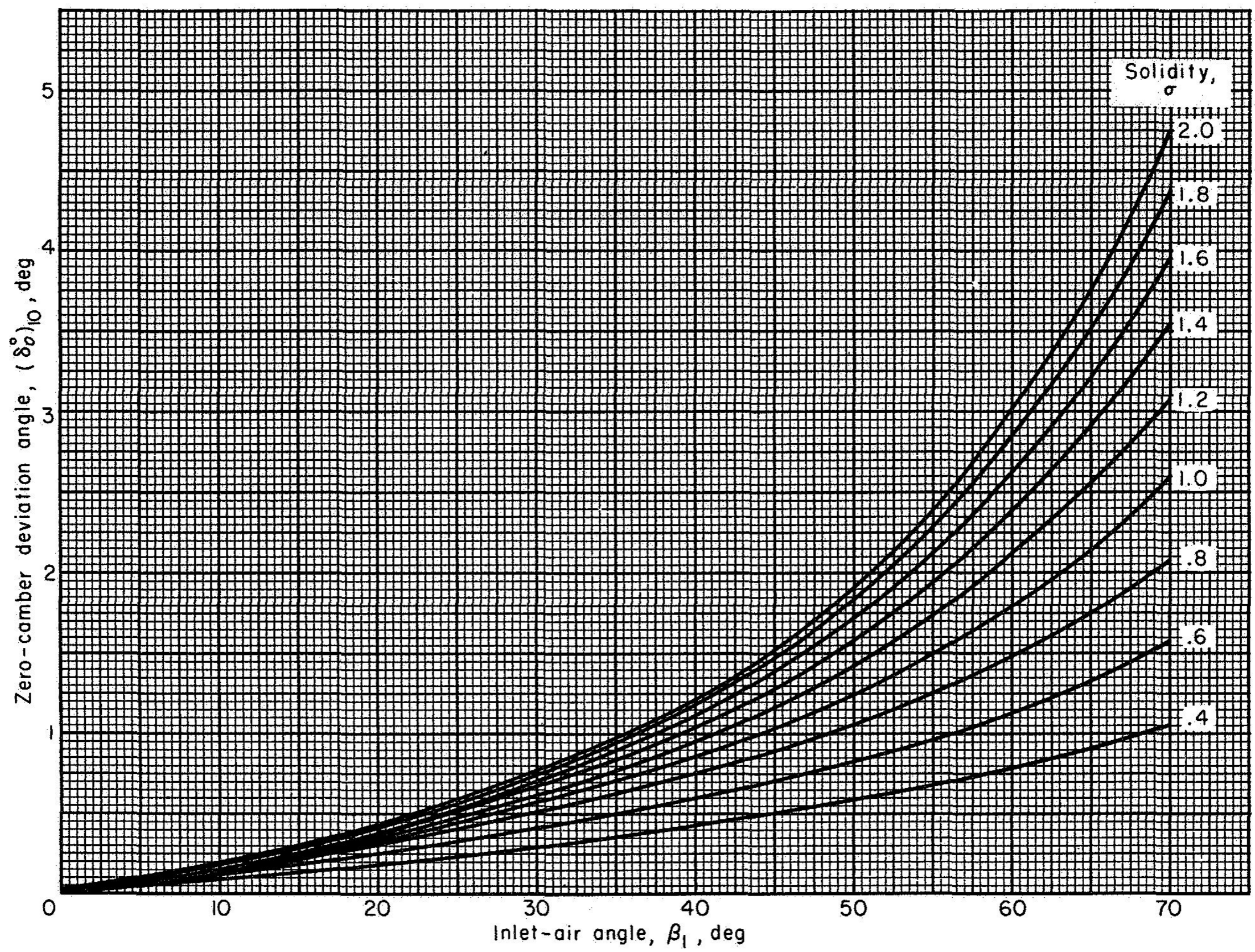


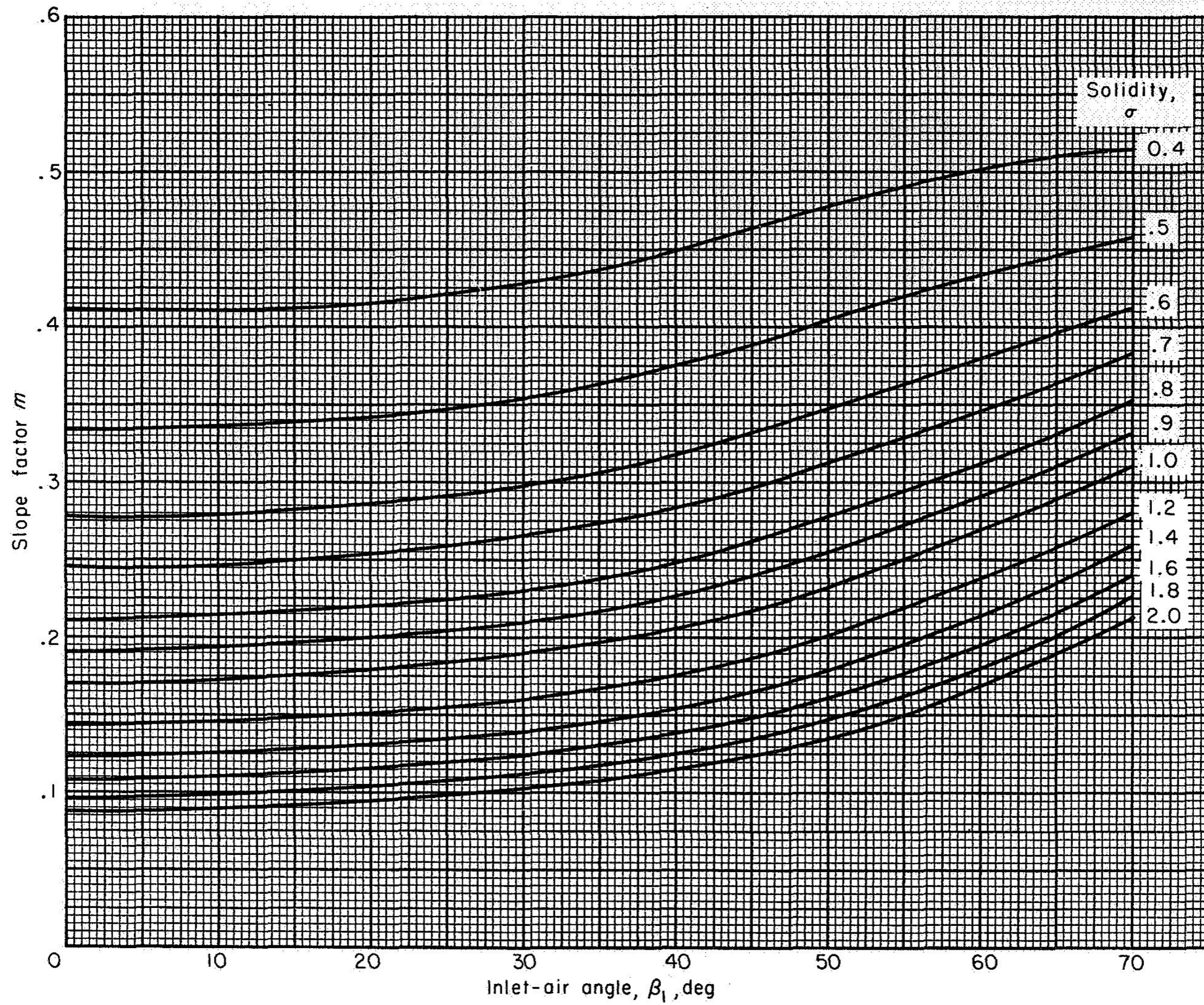
$$D_{loc} = \frac{V_{max} - V_2}{V_{max}}$$

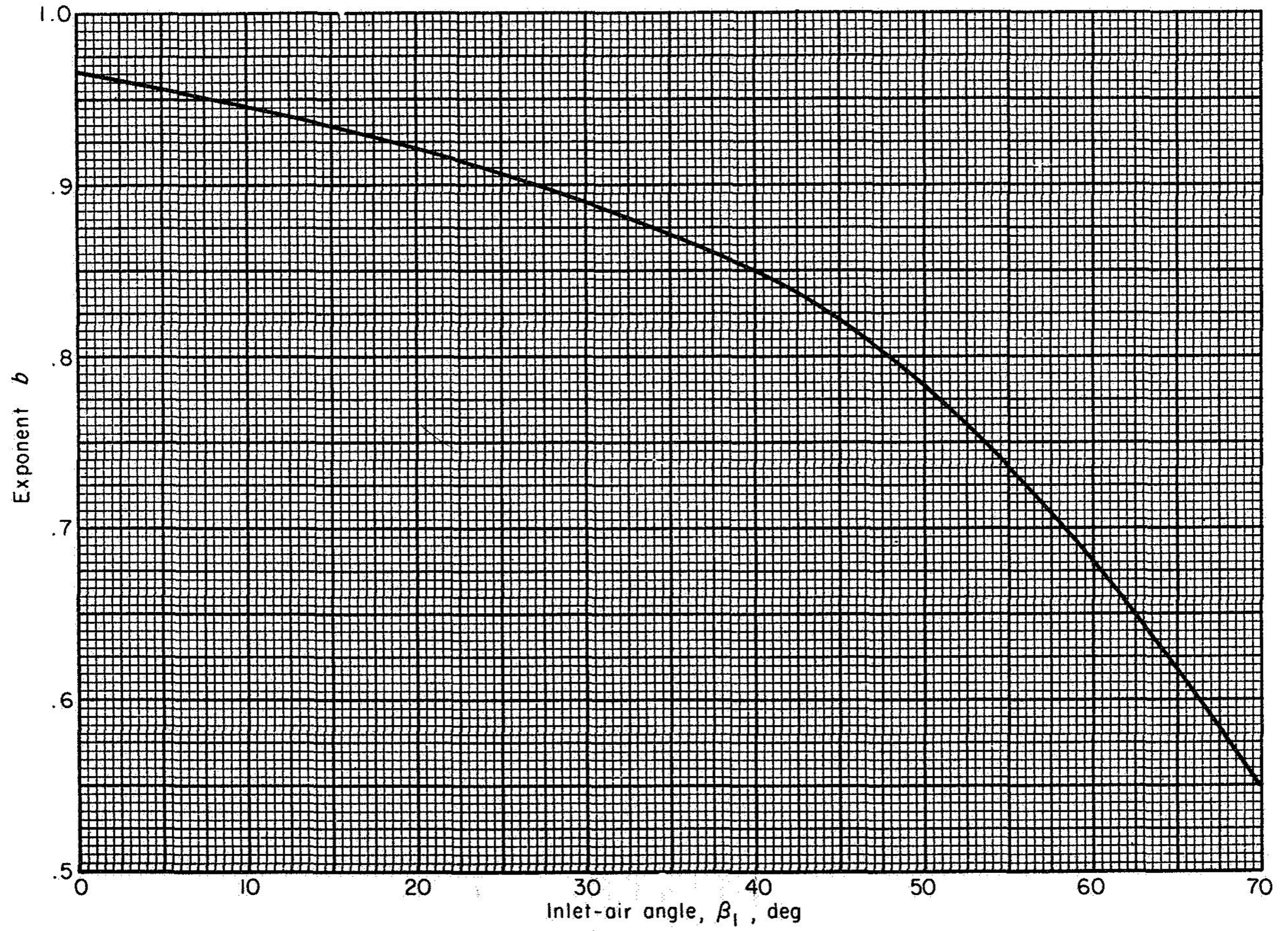
$$D_{loc} = \left(1 - \frac{V_2}{V_1}\right) + \frac{\Delta V_\theta}{2\sigma V_1}$$

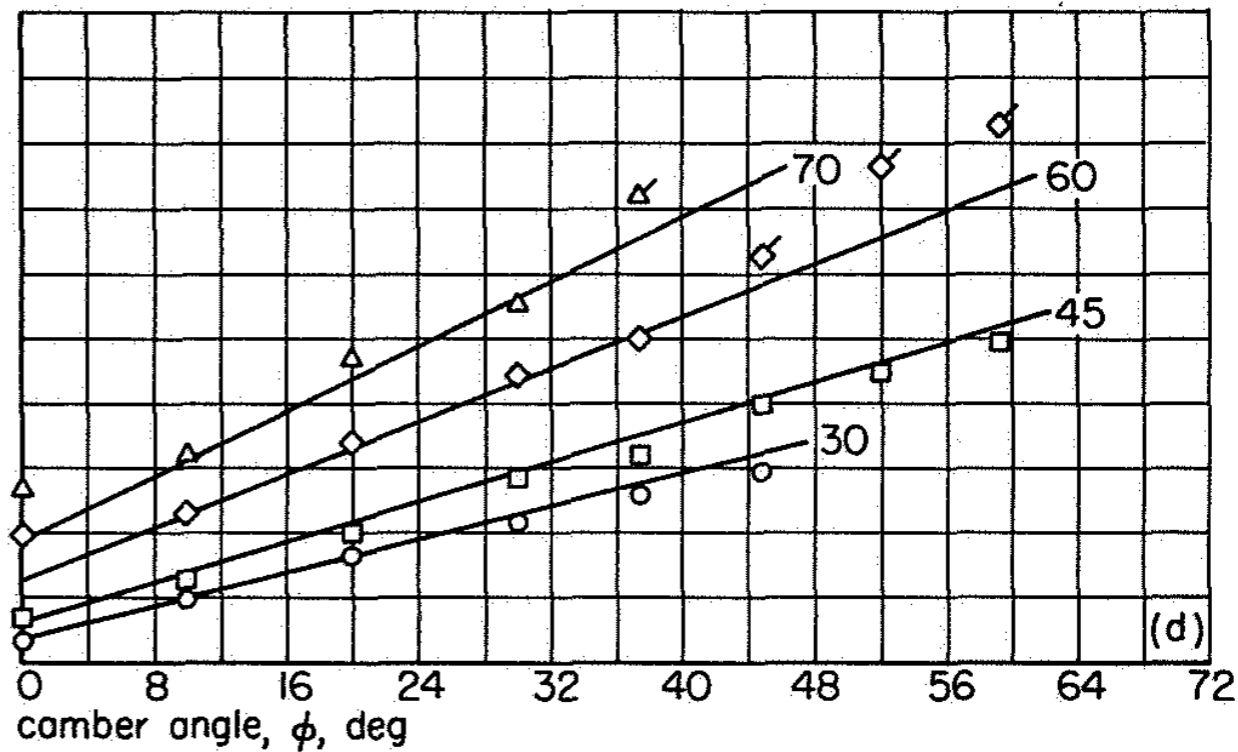
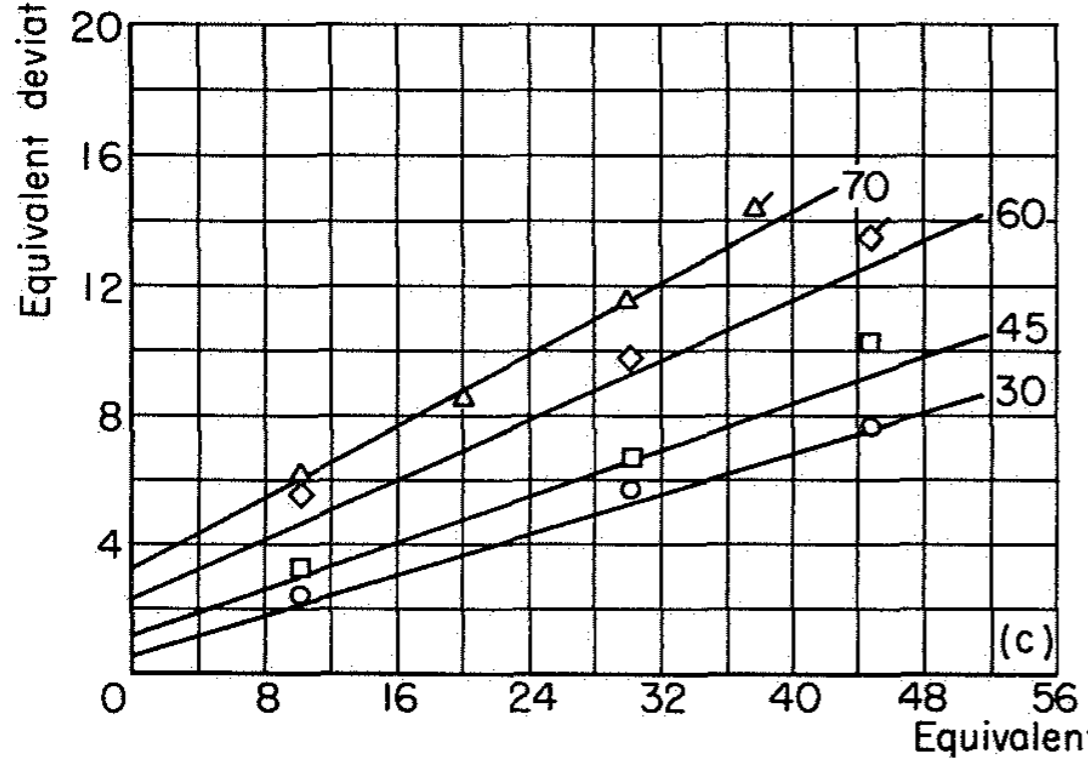
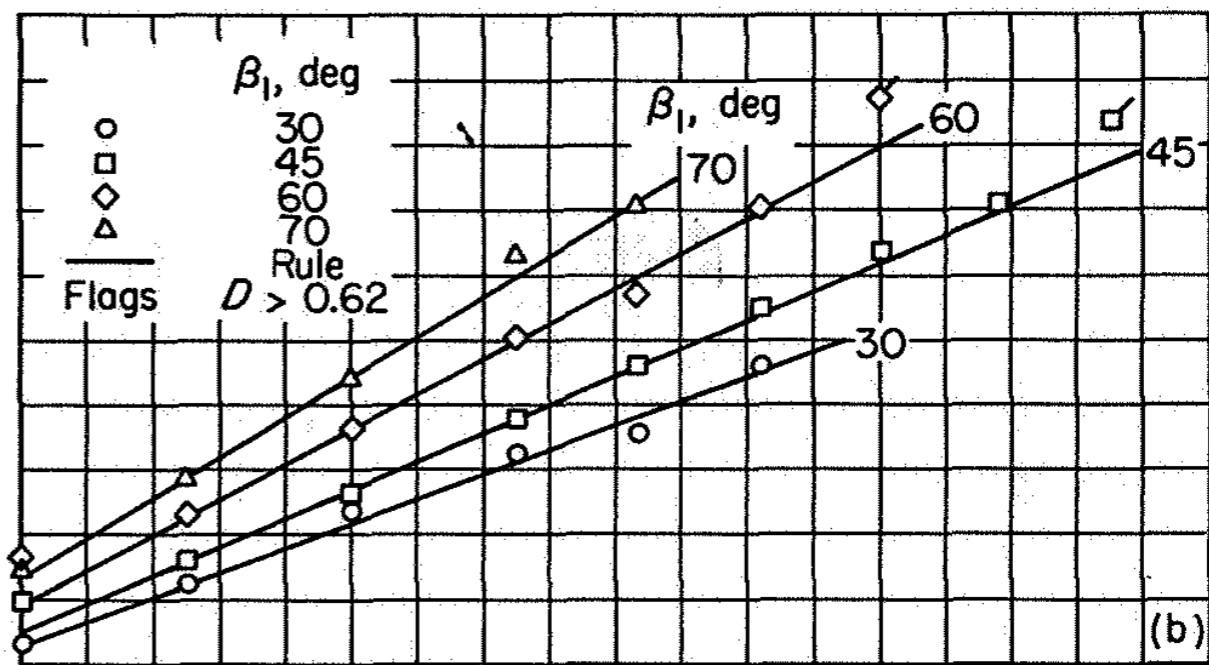
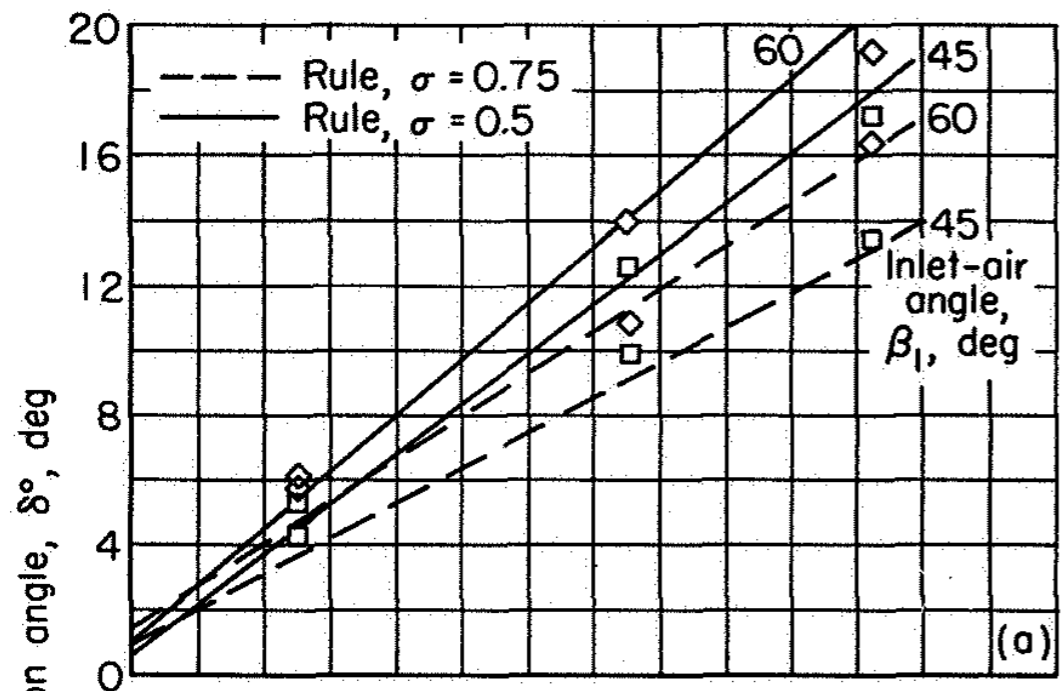
per NACA-65

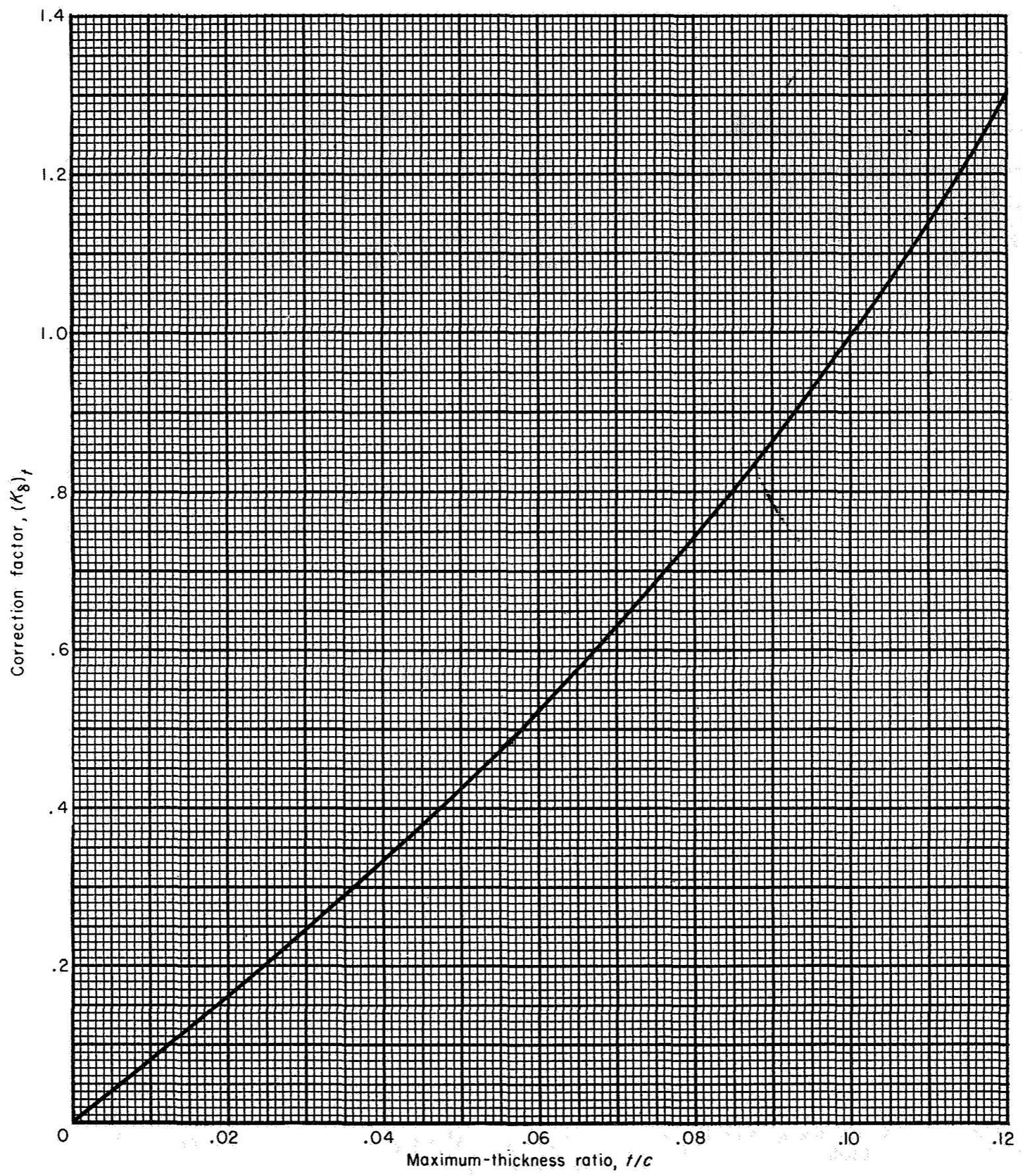




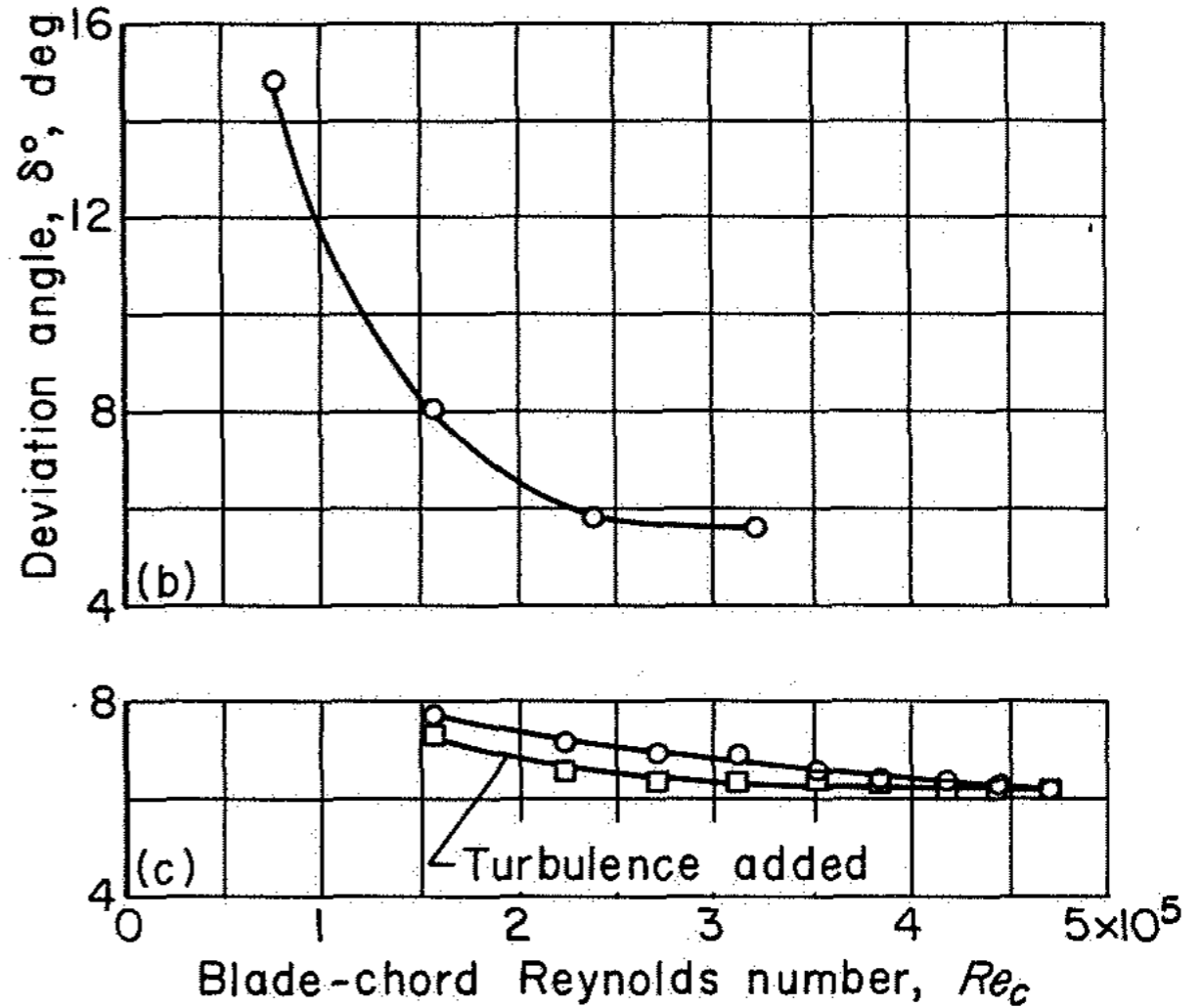
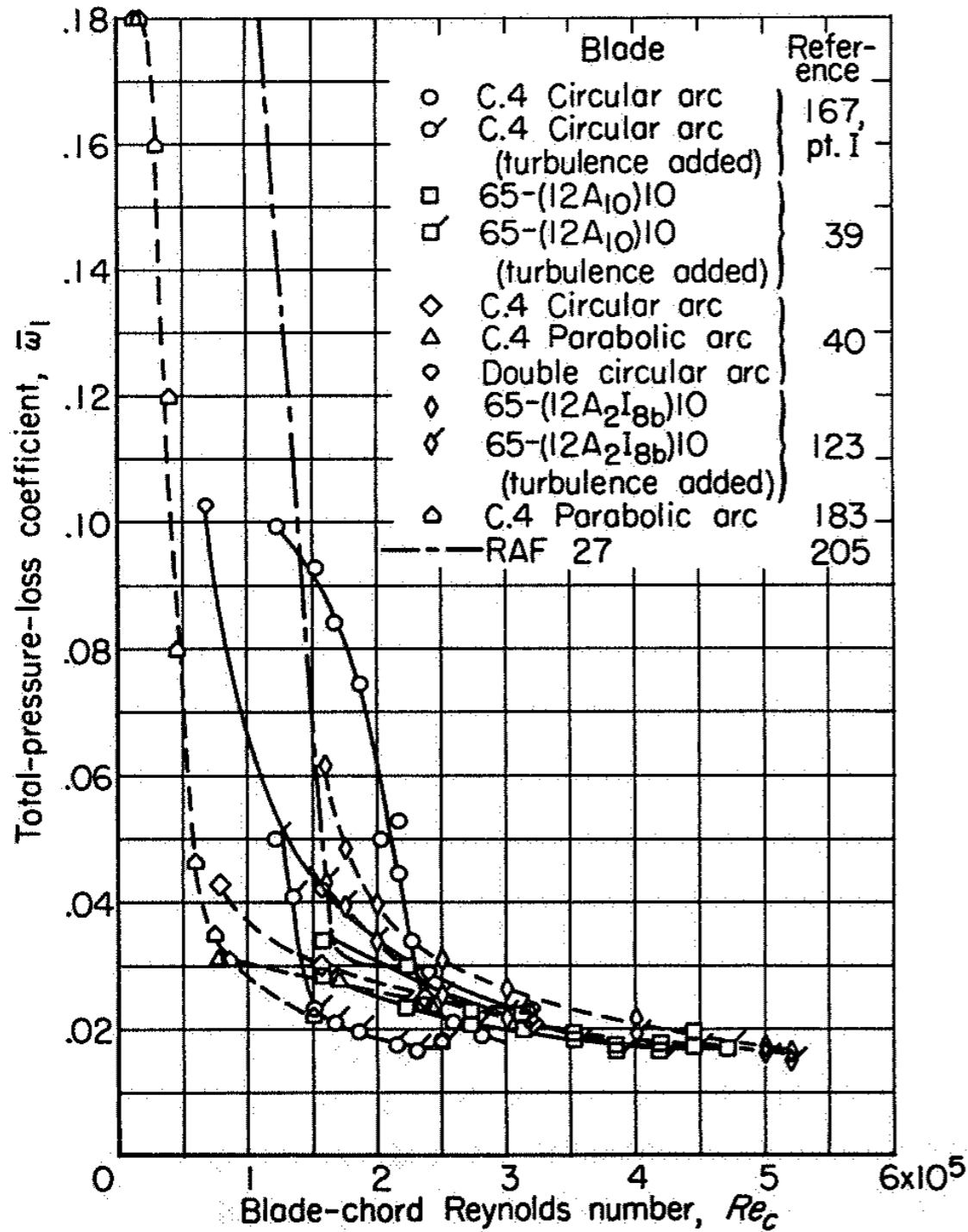




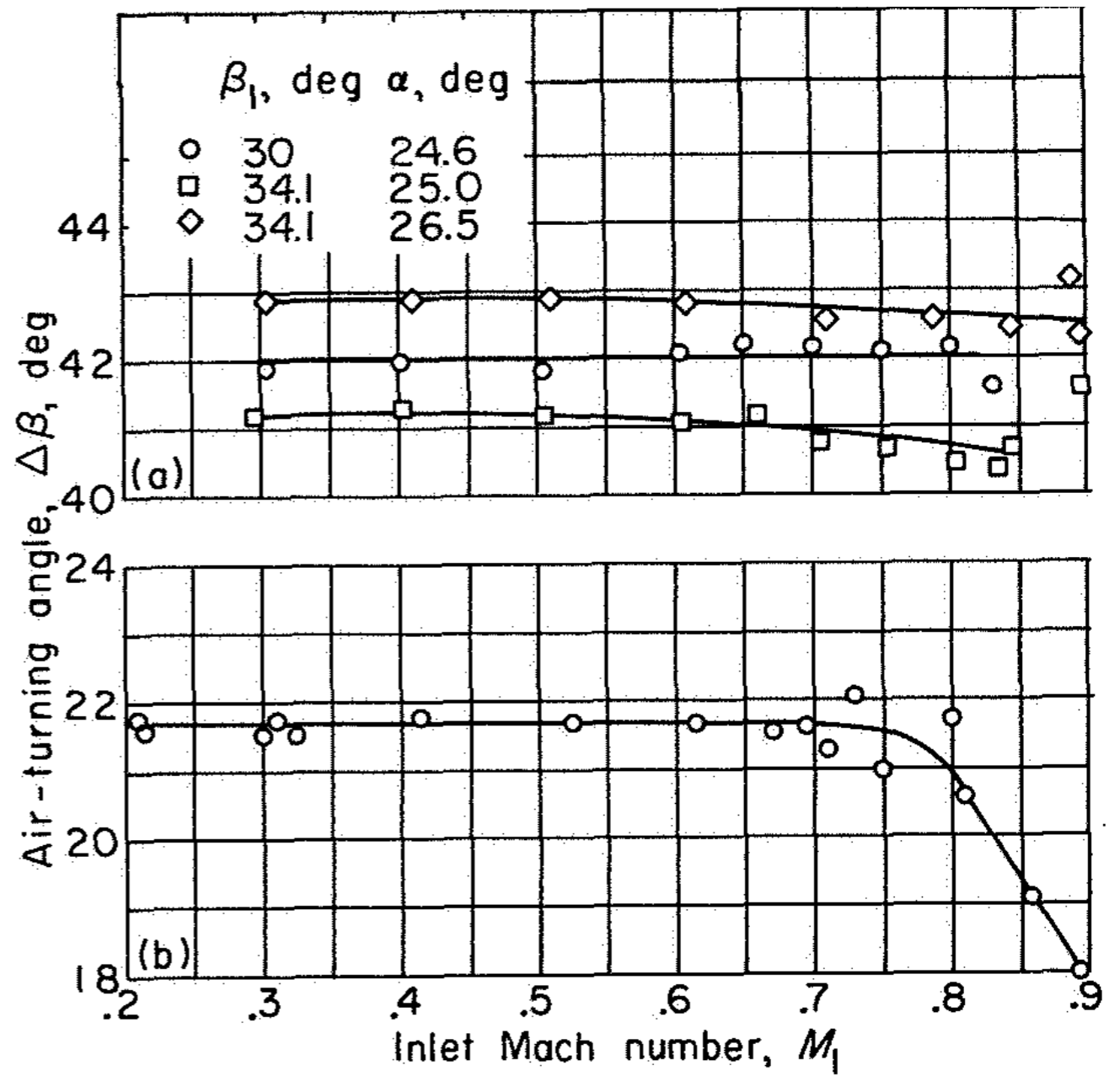
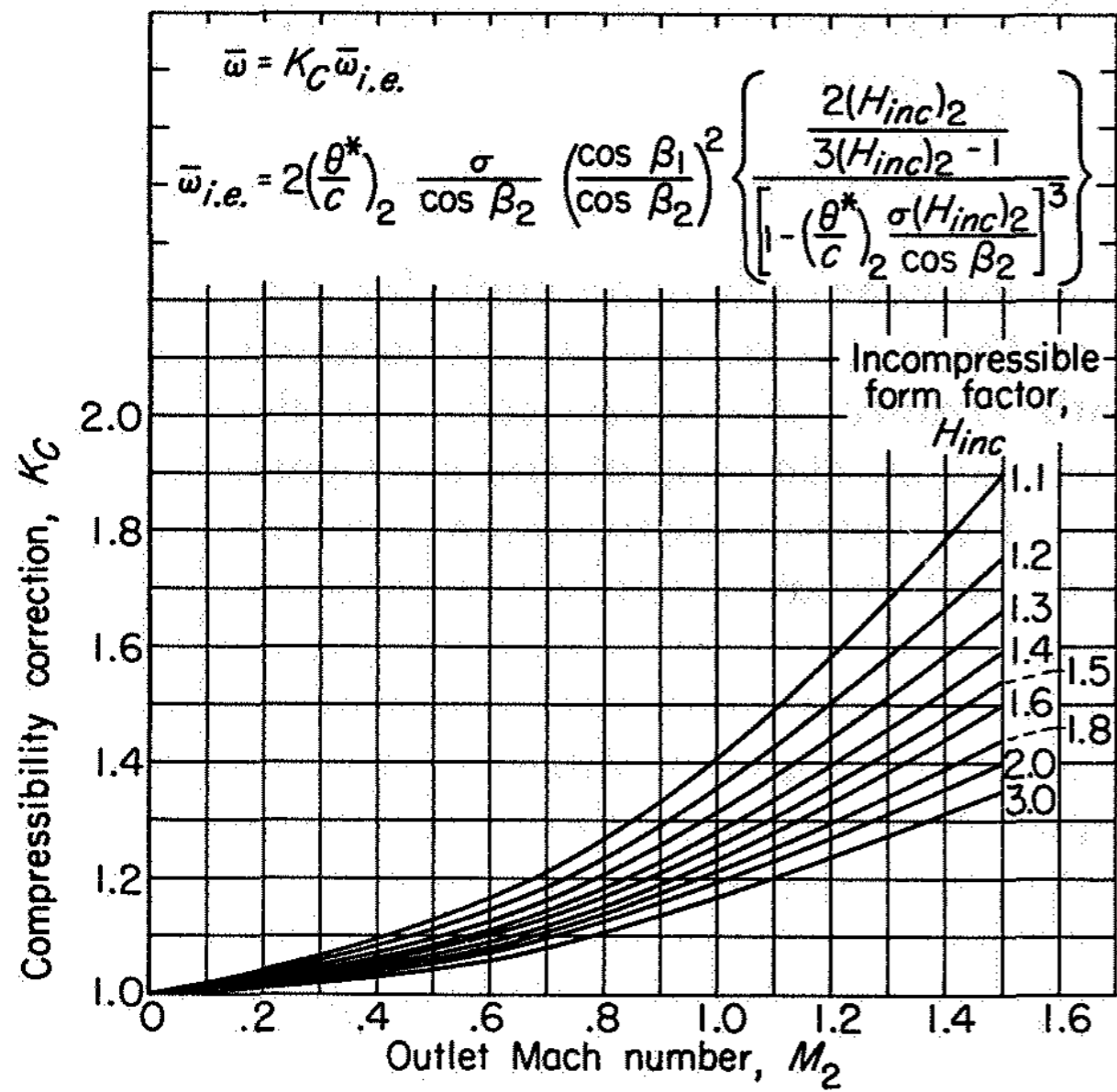




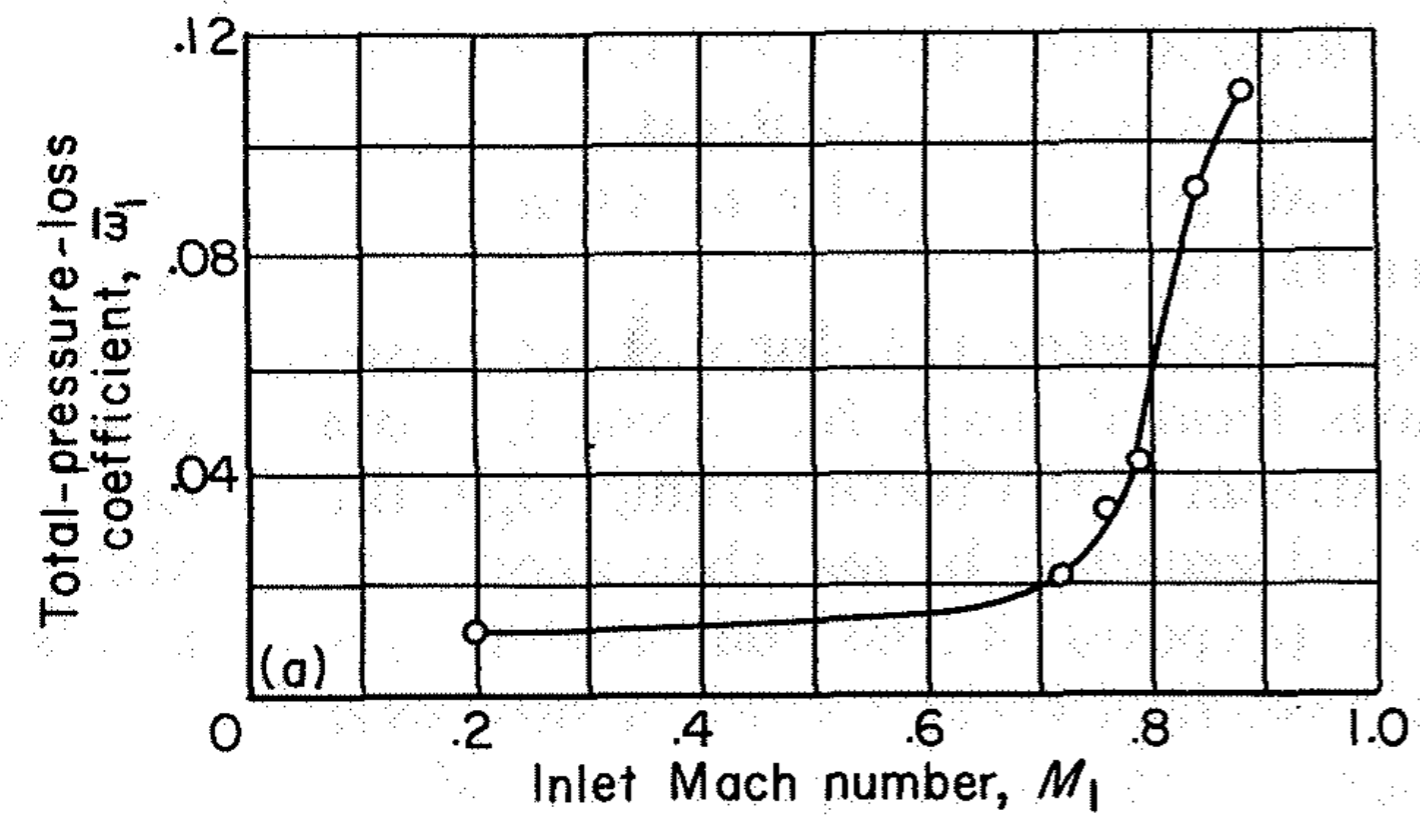
Effetto del Reynolds



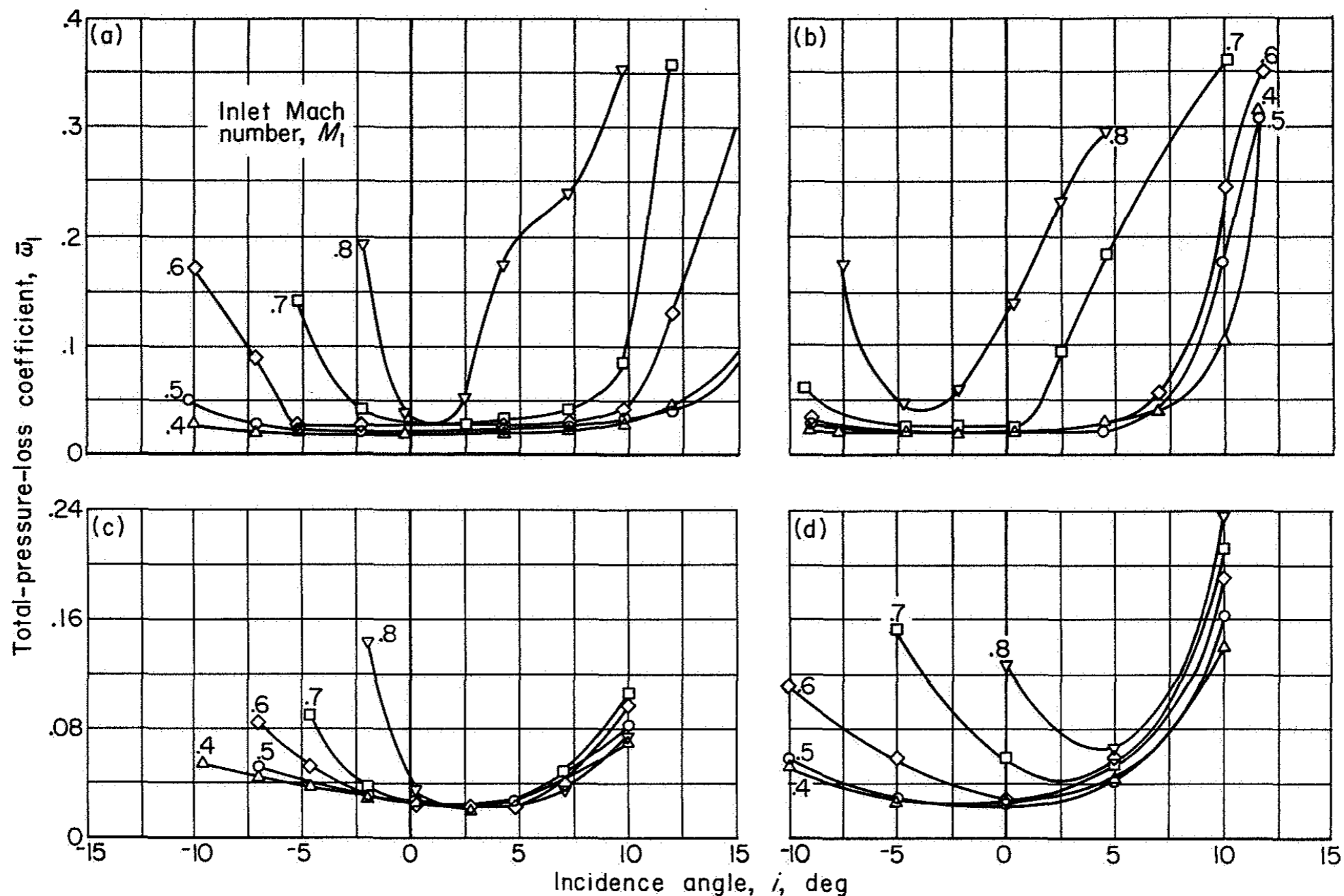
Effetto del Mach



Effetto del Mach



Effetto dell'incidenza



(a) C.4 Circular-arc blade. Camber angle, 25° ; maximum-thickness ratio, 0.10; solidity, 1.333; blade-chord angle, 42.5° (ref. 40). (b) C.4 Parabolic-arc blade. Camber angle, 25° ; maximum-thickness ratio, 0.10; solidity, 1.333; blade-chord angle, 37.6° (ref. 40).

(c) Double-circular-arc blade. Camber angle, 25° ; maximum-thickness ratio, 0.105; solidity, 1.333; blade-chord angle, 42.5° (ref. 40). (d) Sharp-nose blade. Camber angle, 27.5° ; maximum-thickness ratio, 0.08; solidity, 1.15; blade-chord angle, 30° (ref. 205).

FIGURE 130.—Effect of inlet Mach number on loss characteristics of cascade blade sections.

Blade Profiling

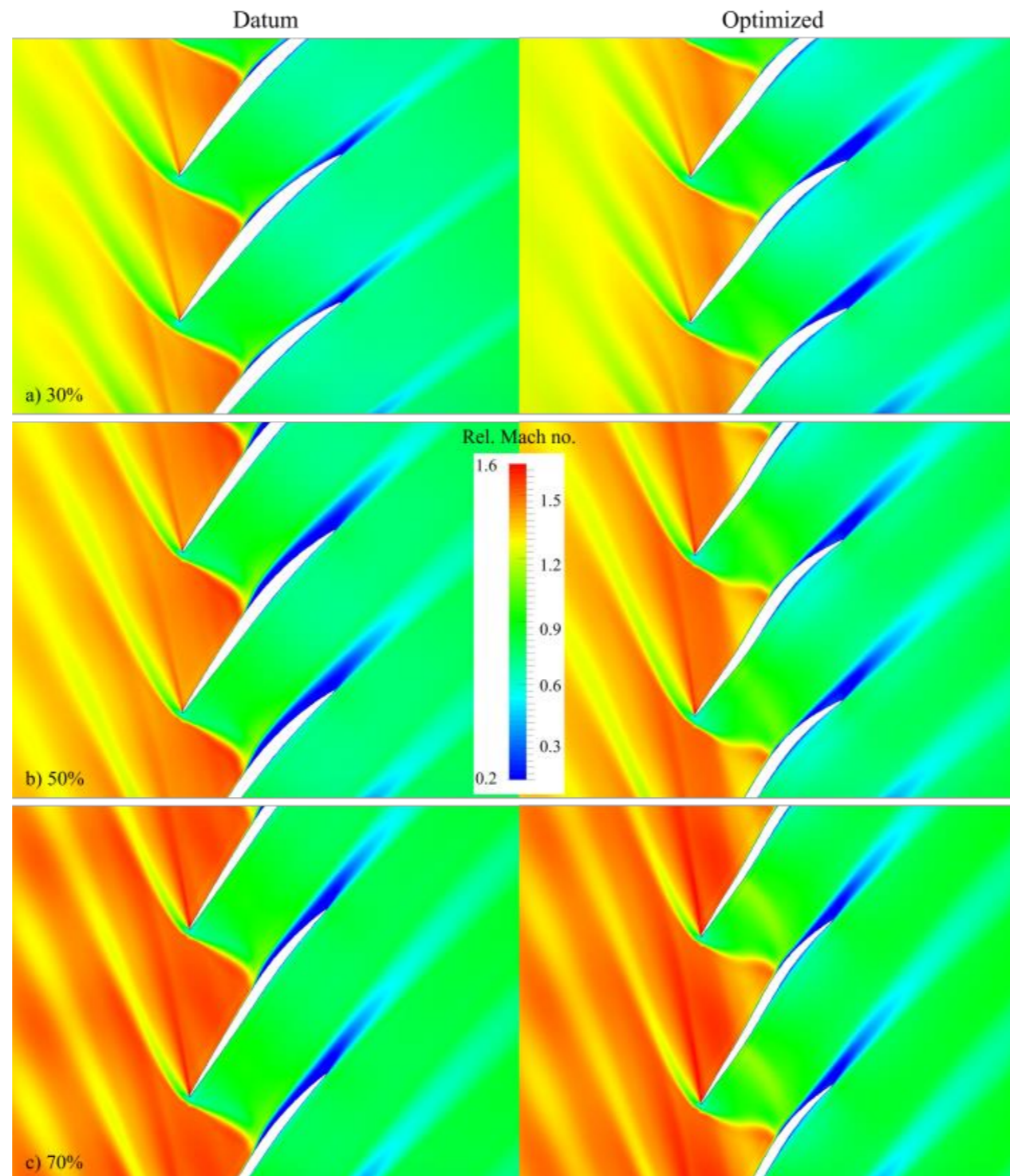
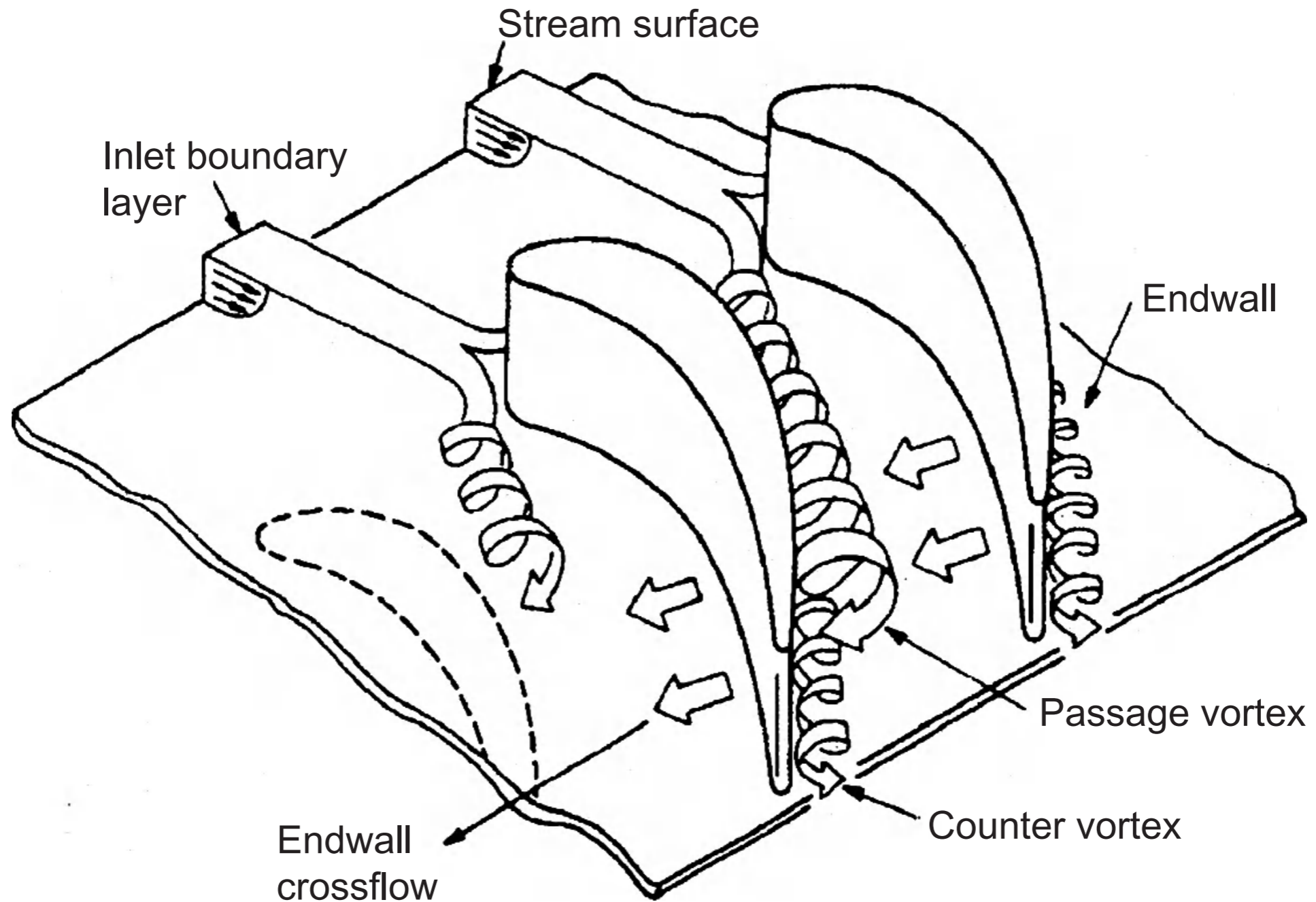
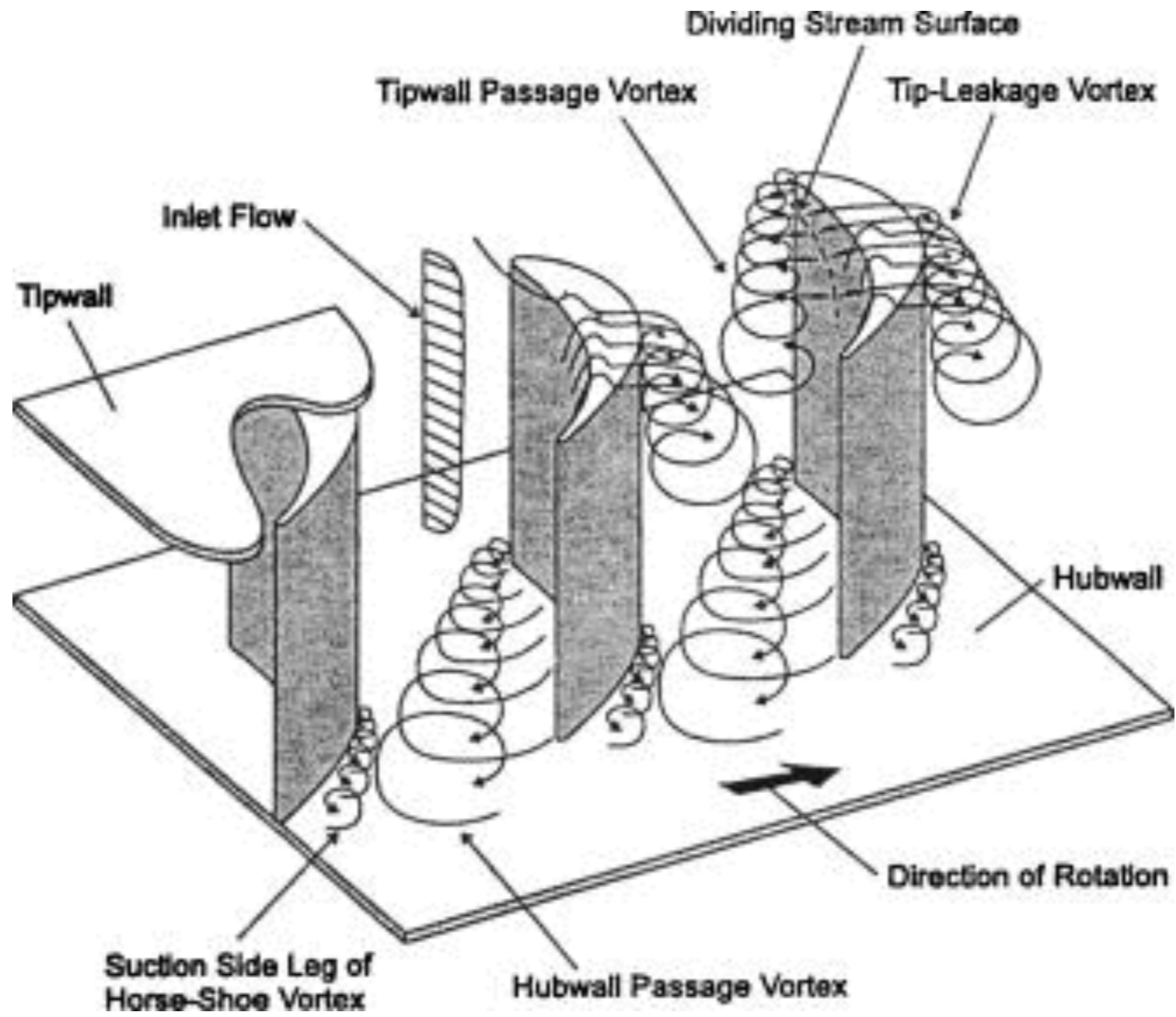


FIGURE 15. RELATIVE MACH NUMBER CONTOUR COMPARISON AT 30% (a), 50% (b) AND 70% (c) SPAN

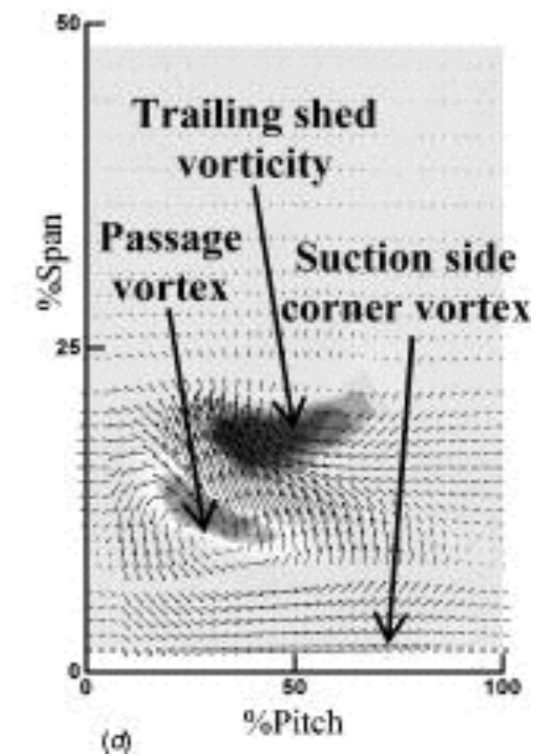
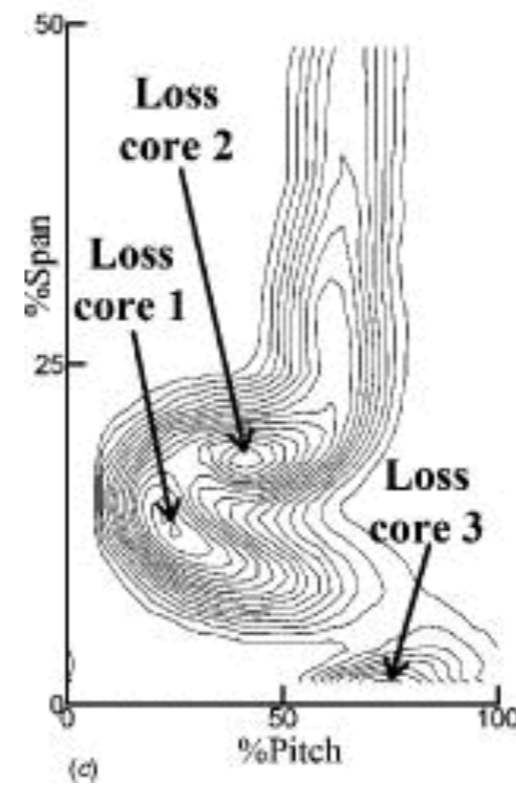
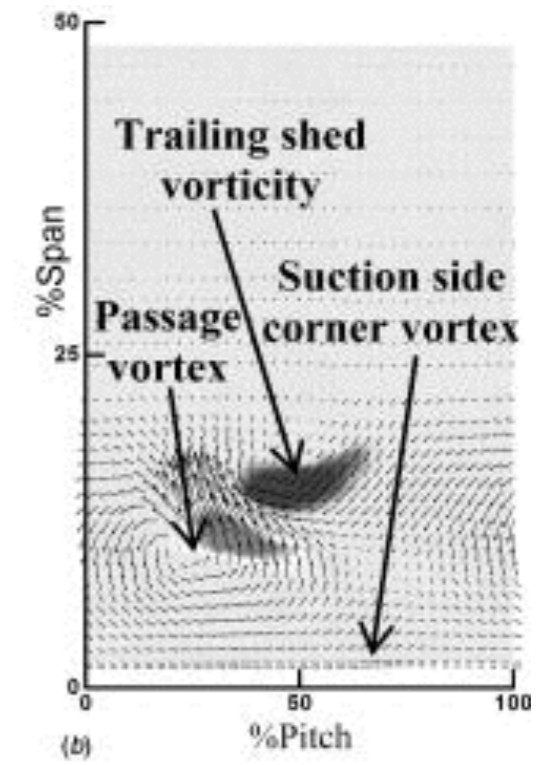
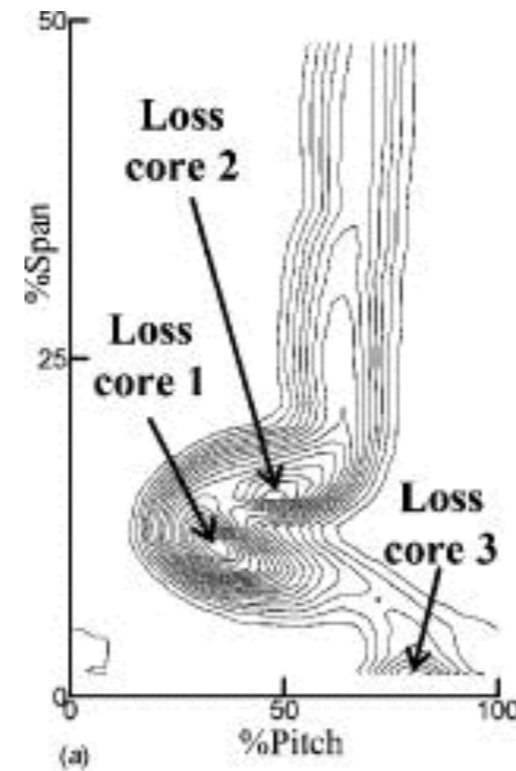
Secondary flows / 3D effects



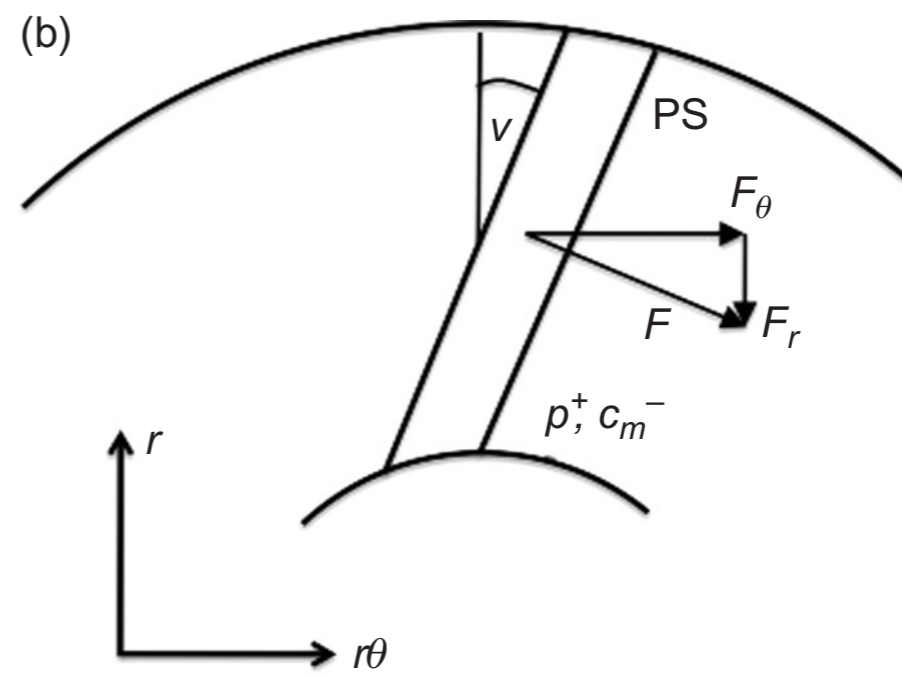
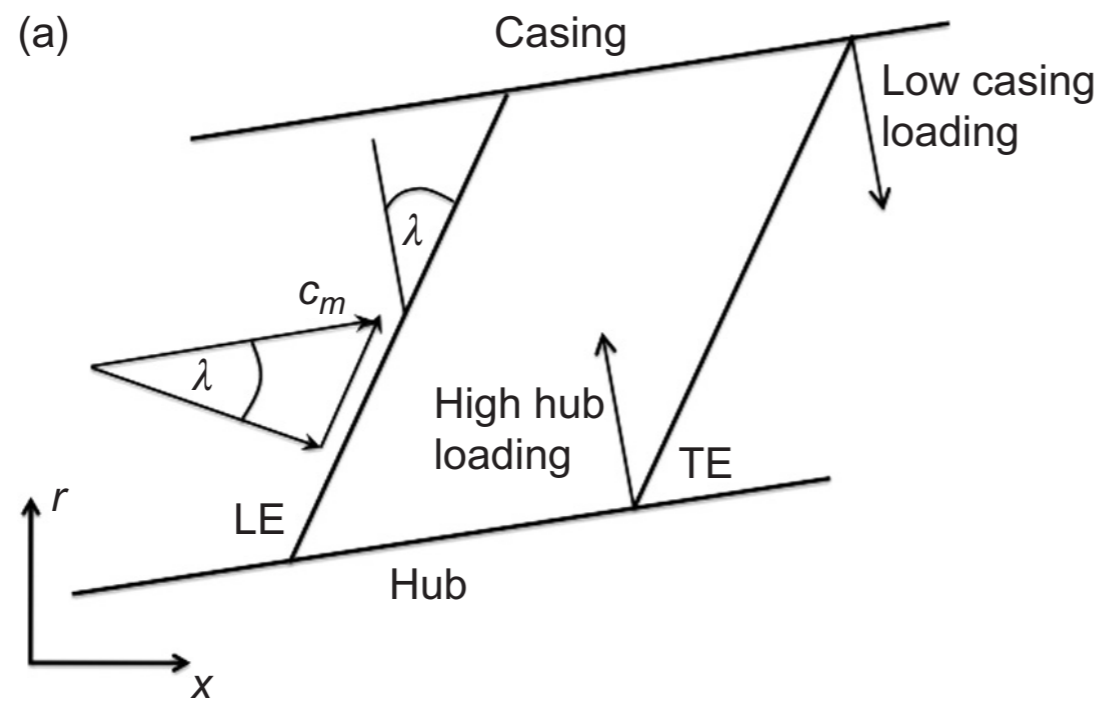
Secondary flows / 3D effects



Secondary flows / 3D effects



Sweep and Lean



Sweep and Lean



70s



80s



90s



2000-





TRENT 1000 FAN

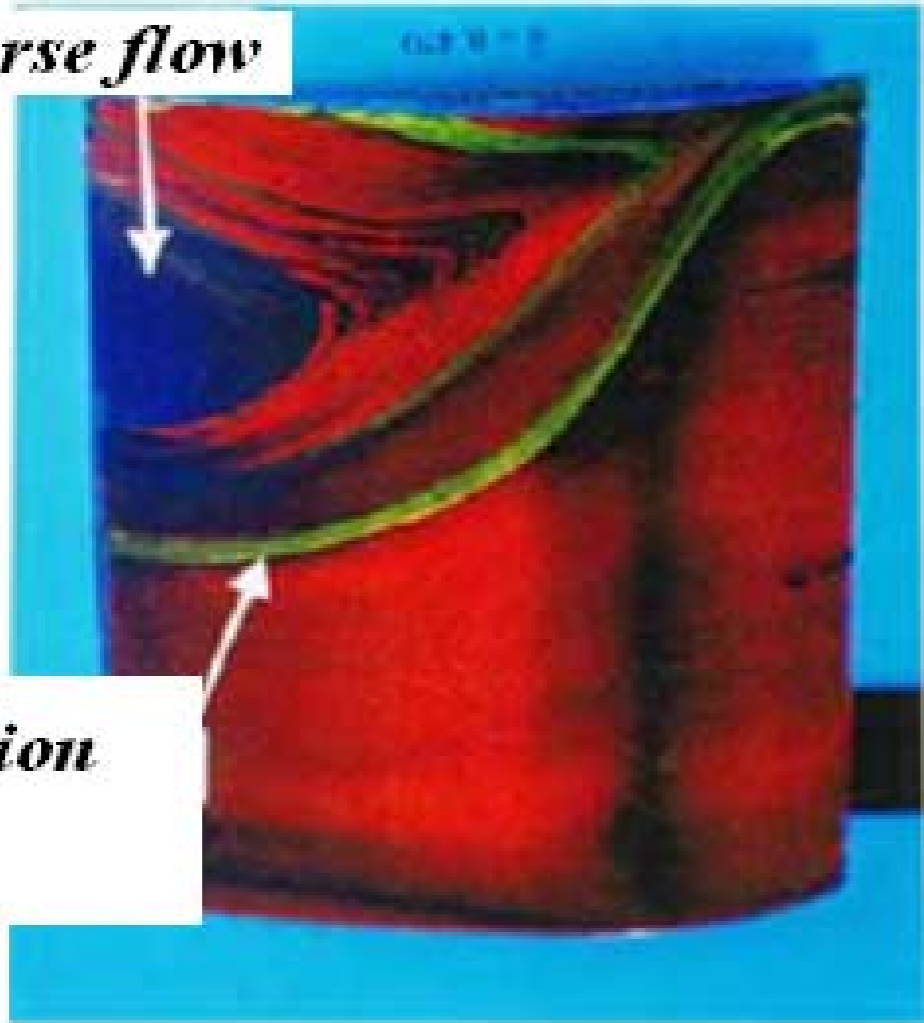
Rolls-Royce and ZF
Apprentice Exchange
2013/2014





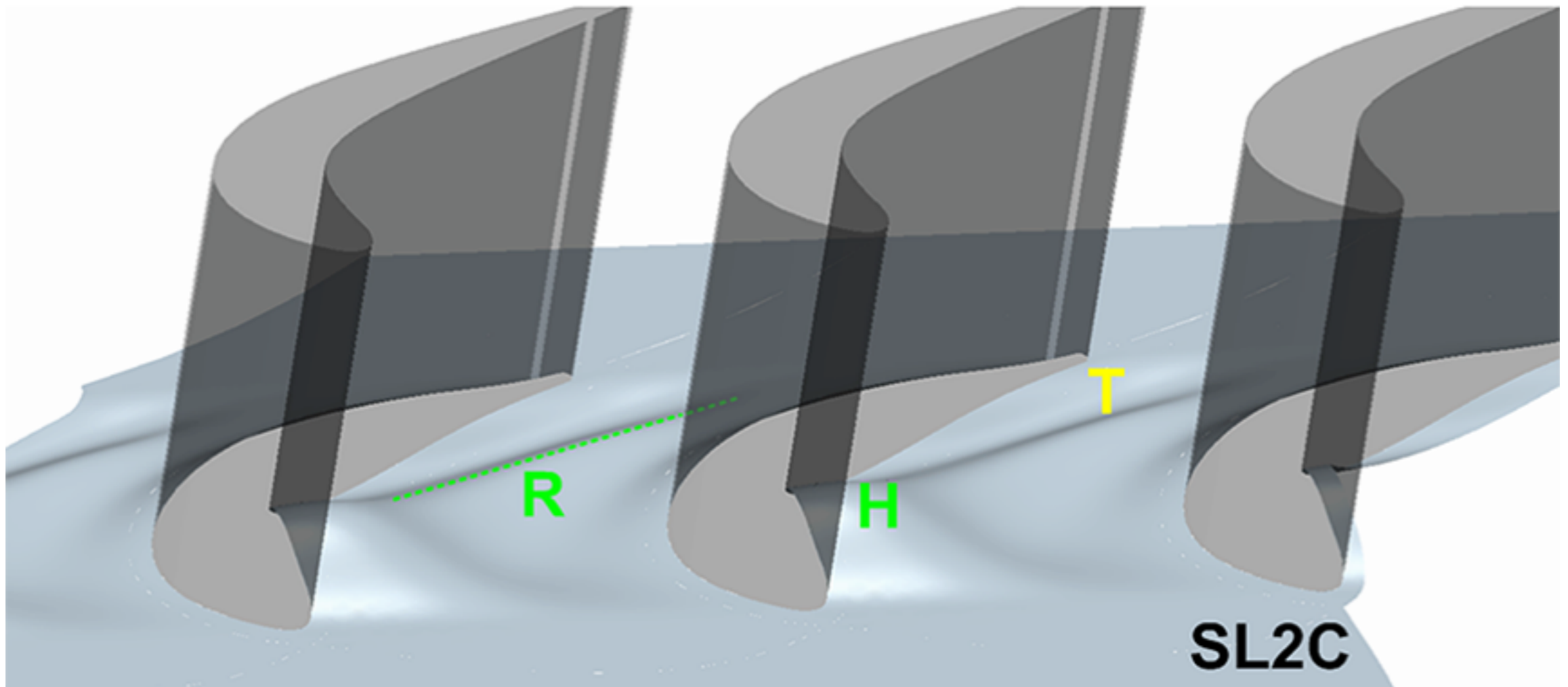
Sweep and Lean

Reverse flow

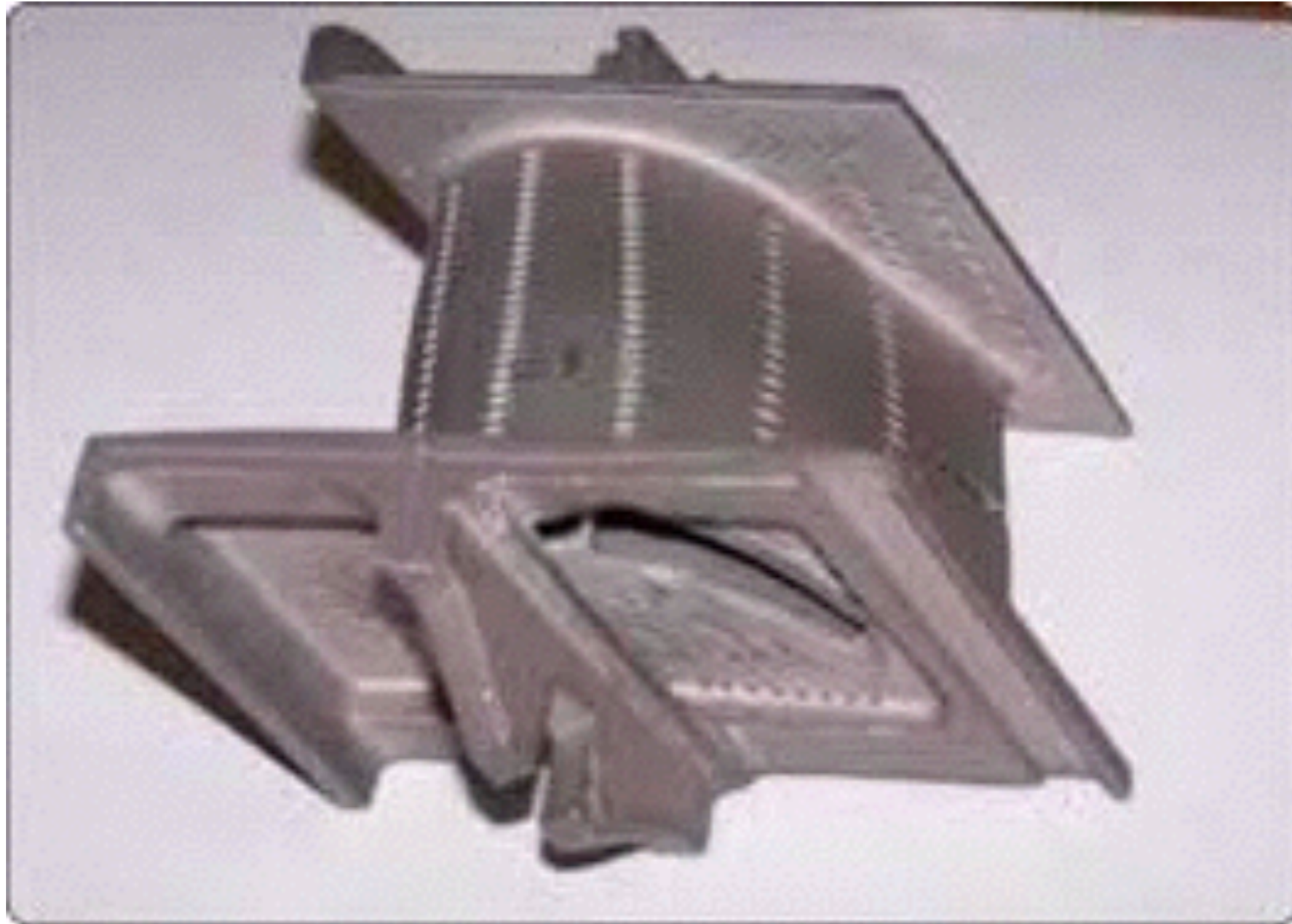


*Separation
line*

Endwall profiling



Tip treatments



Tip treatments

