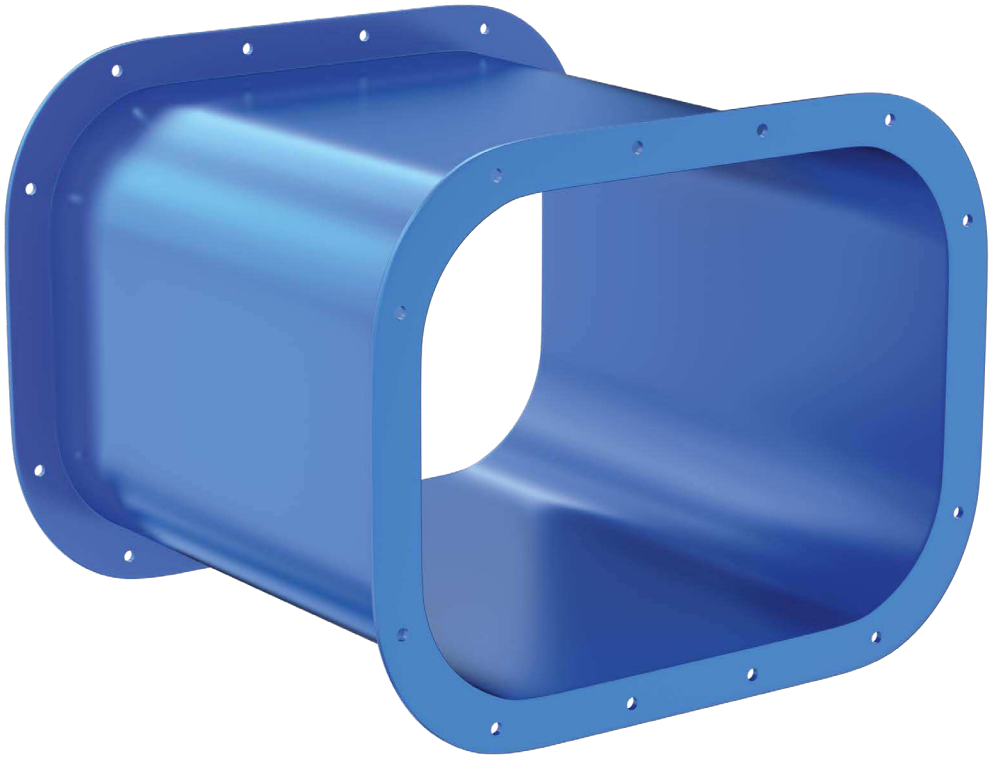
KATALOG WYNIKÓW WEDŁUG SUROWYCH DANYCH BADAWCZYCH PRZEWODÓW SQUOVAL SERII SQ100

RESULTS CATALOG ACC. TO RAW RESEARCH DATA OF SQUOVAL DUCTS SQ100 SERIES

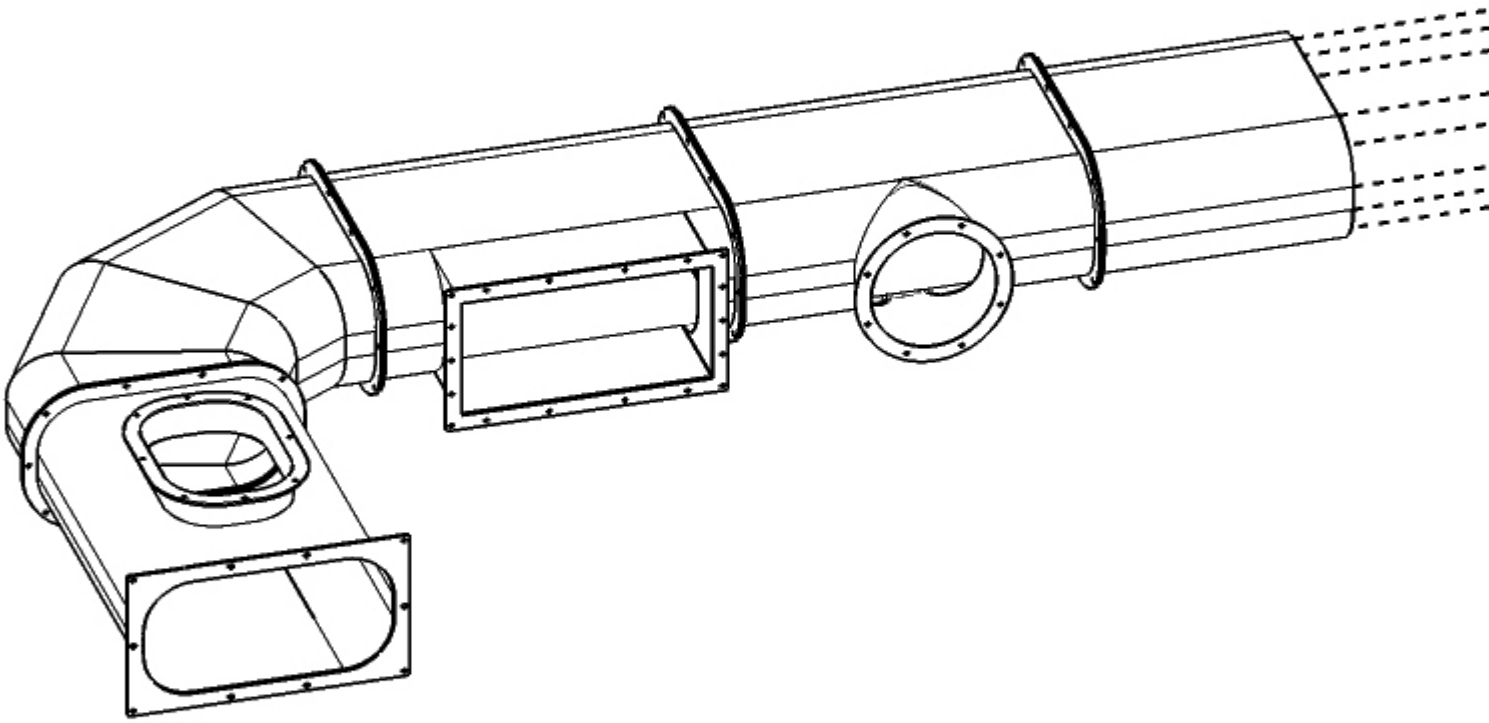
TYTUŁ TITLE	KATALOG WSPÓŁCZYNNIKÓW OPORÓW MIEJSCOWYCH PRZEWODÓW SQUOVAL SERII SQ100 CATALOG OF LOCAL RESISTANCE COEFFICIENTS OF SQUOVAL DUCTS SQ100 SERIES
PROJEKT PROJECT	PROJEKT POIR 01.01.01-1422/15 „Opracowanie innowacyjnych rozwiązań dedykowanych systemom wentylacyjnym elektrowni jądrowych” „Development of innovative solutions dedicated to the ventilation systems of nuclear power plants”
BADANIE RESEARCH	16/POIR
DATA DATE	03.2019
ZAMAWIAJĄCY ORDERING	Nucair Technologies Spółka z ograniczoną odpowiedzialnością z siedzibą w Solec Kujawski 86-050, Powstańców 8B NIP: 5542932702 REGON: 362931040
KONTRAHENT CONTRACTOR	UTP University of Science and Technology 85-796 Bydgoszcz, Poland, al. Kaliskiego 7
AUTORZY RAPORTU REPORT AUTHORS	dr hab.inż. Kazimierz Peszyński, prof. UTP dr inż. Sylwester Wawrzyniak

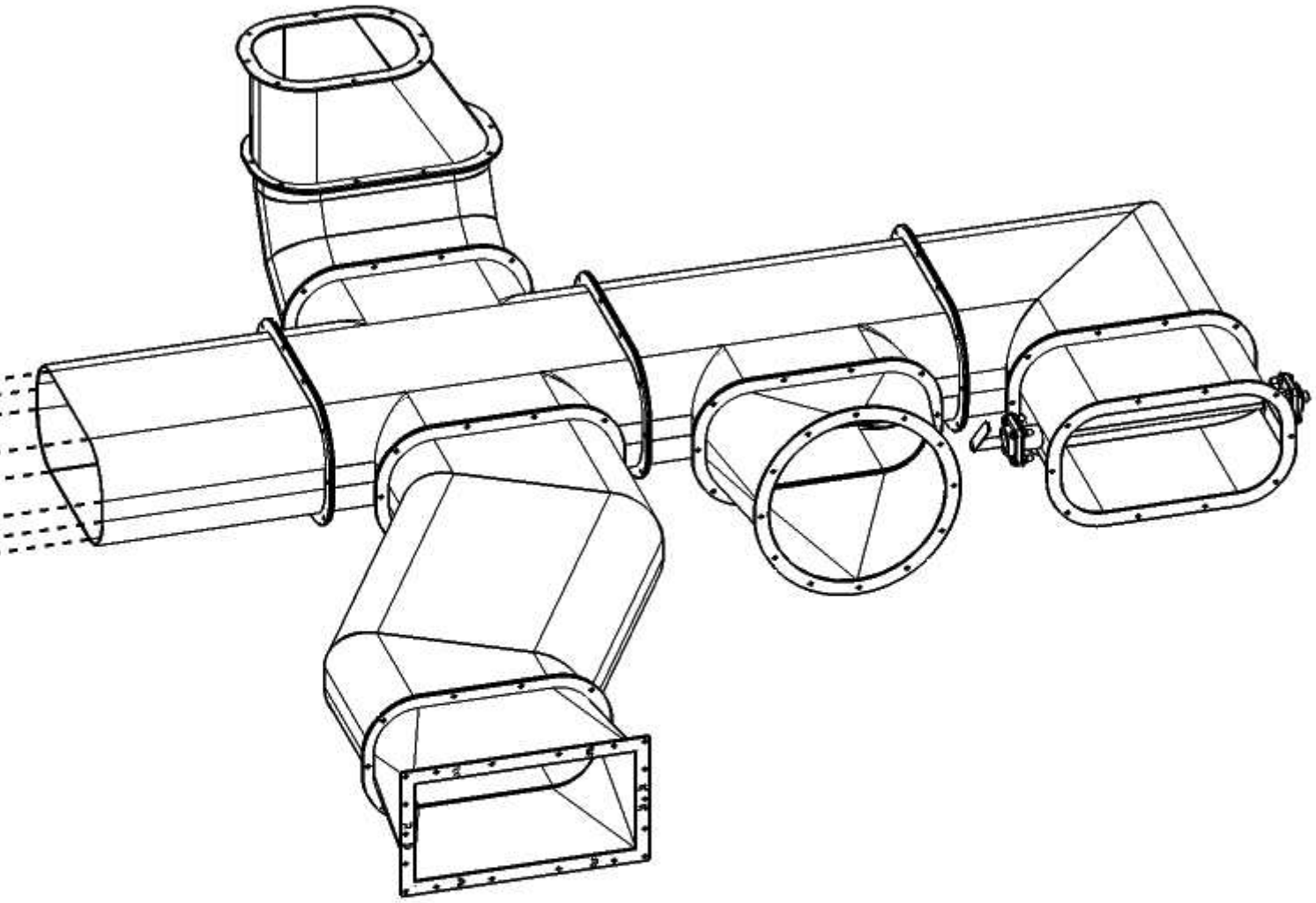
Fundusze Europejskie Inteligentny Rozwój
Narodowe Centrum Badań i Rozwoju
Unia Europejska Europejski Fundusz Rozwoju Regionalnego

NucAir TECHNOLOGIES

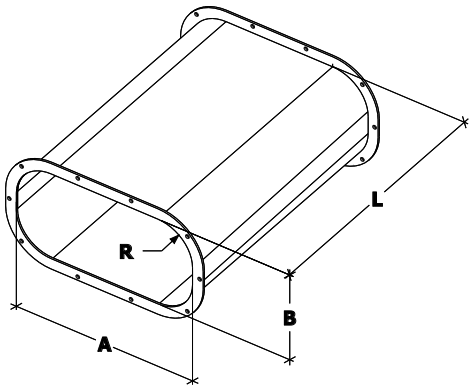


NucAir SQUOVAL® WELDED DUCTWORK





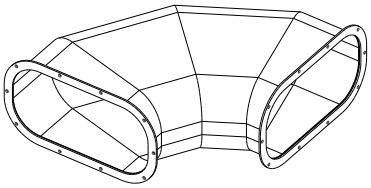
STRAIGHT DUCT



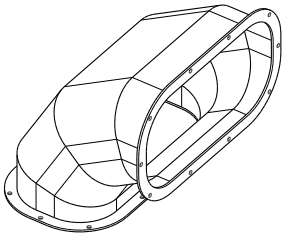
SIGN	STANDARD DIMENSIONS [mm]
A	400-2000
B	300-1000
L	300-2000
R	100

A, B, L and R are outer dimensions of Squoval® duct

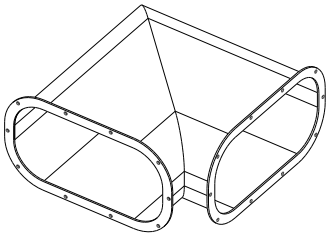
HORIZONTAL BEND 15°-90°



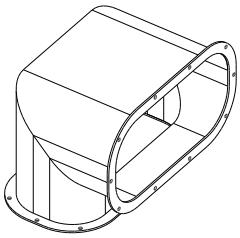
VERTICAL BEND 15°-90°



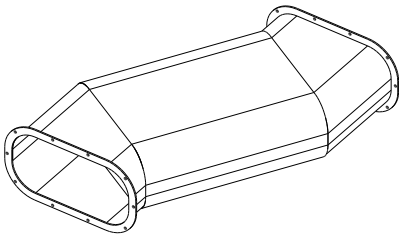
HORIZONTAL SQUARE BEND 45°-90°



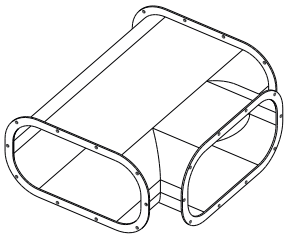
VERTICAL SQUARE BEND 45°-90°



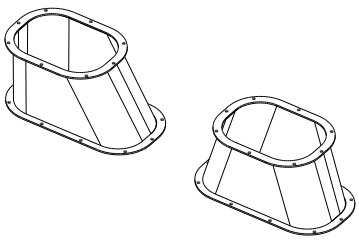
OFFSET



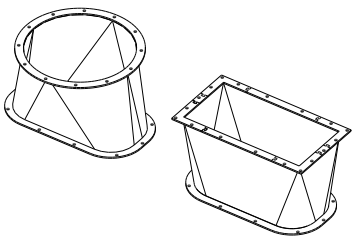
T-PIECE



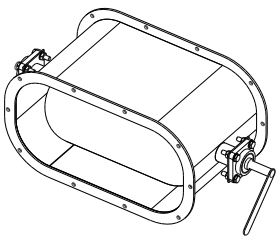
CONCENTRIC & NONCONCENTRIC TAPER



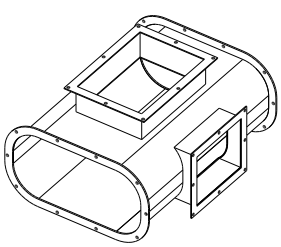
SQUOVAL® TO CIRCULAR AND RECTANGULAR ADAPTER



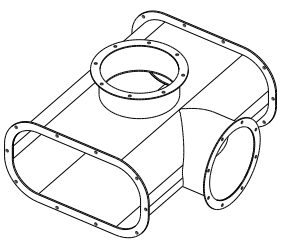
SINGLE BLADE DAMPER



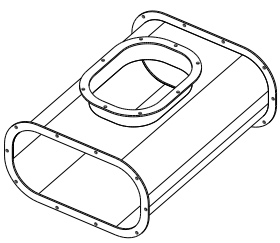
RECTANGULAR BRANCH



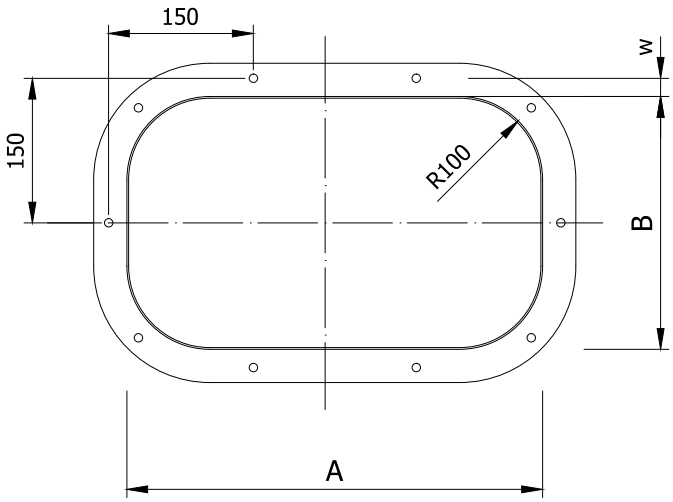
CIRCULAR BRANCH



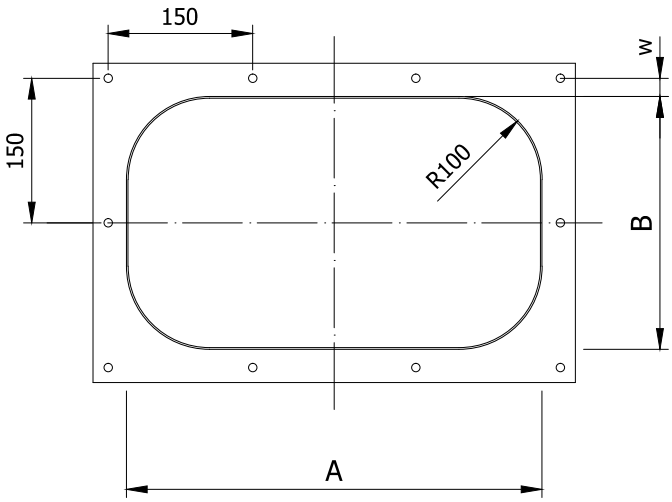
SQUOVAL® BRANCH



STANDARD



OPTIONAL



LARGER DIMENSION (A OR B)	FLANGE / FLAT BAR	W	SCREW CONNECTION
≤ 400	30 X 5	17	M8
≤ 700	40 X 5	22	M8
> 700	50 X 6	35	M10

All dimensions in mm.

RECOMMENDED DIMENSIONS

A (mm) / B (mm)	400	500	600	800	1000	1200	1400	1600	1800	2000
300										
400										
500										
600										
800										
1000										

STANDARDS

REV. 3.2019

DIMENSION	EN 1505
STRENGTH AND LEAKAGE	EN 1507
DUCTS SURFACE	DIN 18379
HOT ROLLED CARBON STEEL	EN 10025-4
COLD ROLLED CARBON STEEL	EN 10130
STAINLESS STEEL	EN 10088-1
PROTECTIVE PAINT SYSTEM	ISO 12944-5
HOT DIP GALVANIZATION	ISO 1461
PASSIVATION AND PICKLING	ASTM A380 AND ASTM A967

Squoval® welded ducts are classified as rectangular ducts. Rectangular corner replaced with an arc.

STANDARD MATERIALS

HOT ROLLED CARBON STEEL	S235JR
COLD ROLLED CARBON STEEL	DC01
STAINLESS STEEL	304, 304L, 316, 316L

Other materials on request.

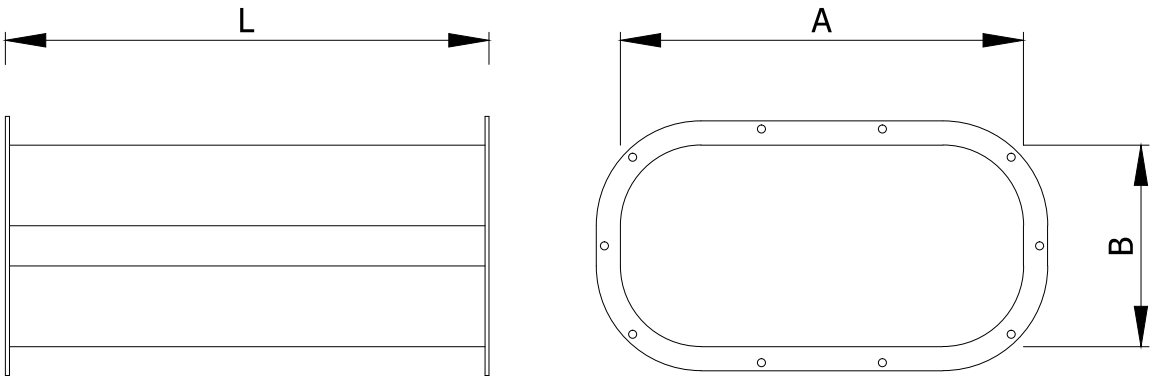
STRENGTH AND LEAKAGE

LEAKAGE CLASS	STRENGTH	
	UNDERPRESSURE	OVERPRESSURE
D	-2000 Pa	+3000 Pa

ANTI-CORROSION PROTECTION

SURFACE PROTECTION	STANDARD	MATERIAL	
		CARBON STEEL	STAINLESS STEEL
PROTECTIVE PAINT SYSTEM	ISO 12944-5	EPOXYD / POLYURETHANE	N/A
GALVANIZATION	ISO 1461	HOT DIP GALVANIZATION	N/A
PICKLING AND PASSIVATION	ASTM A 38 ASTM A 967	N/A	PICKLING AND PASSIVATION

Other coatings on request.

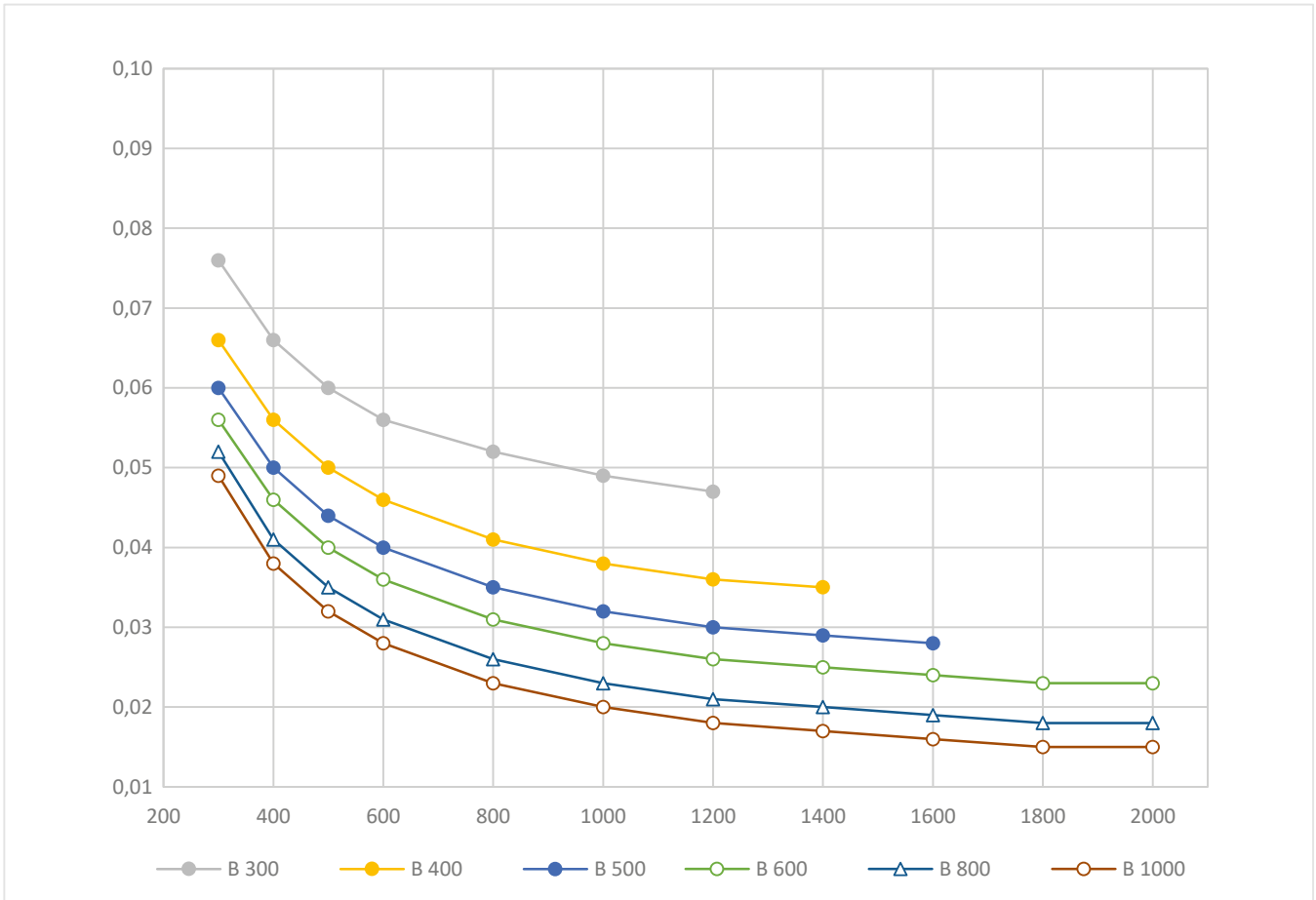


SURFACE ACC. TO DIN 18379

$$F = 2 \cdot (A + B) \cdot L$$

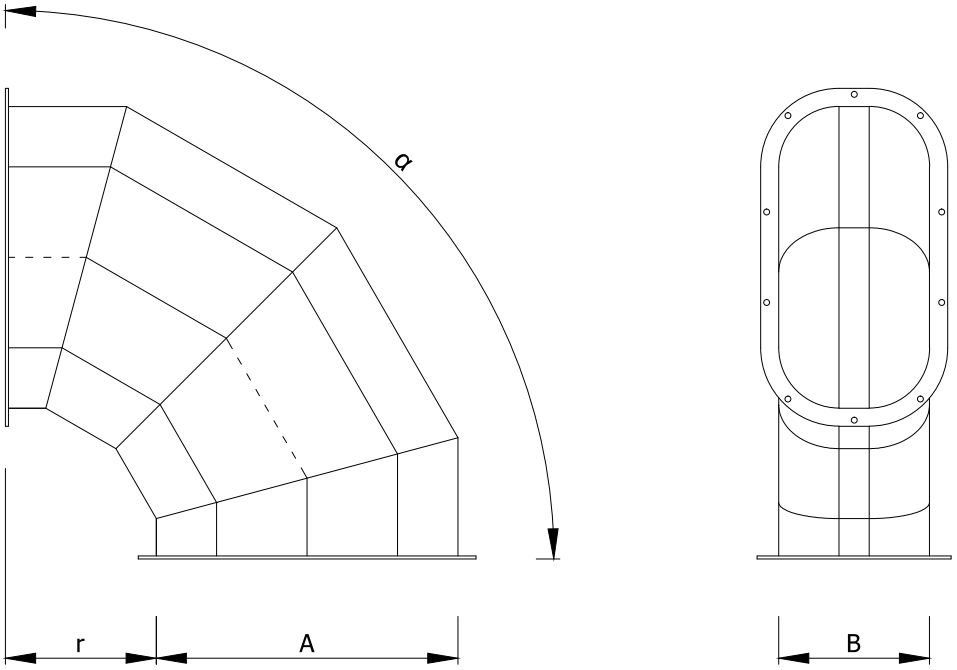
FRICTION COEFFICIENT FOR DUCT WITH 1 M LENGTH

ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.076	0.066	0.060	0.056	0.052					
	400	0.066	0.056	0.050	0.046	0.041	0.038	0.036			
	500	0.060	0.050	0.044	0.040	0.035	0.032	0.030	0.029		
	600	0.056	0.046	0.040	0.036	0.031	0.028	0.026	0.025	0.024	0.023
	800	0.052	0.041	0.035	0.031	0.026	0.023	0.021	0.020	0.019	0.018
	1000	0.049	0.038	0.032	0.028	0.023	0.020	0.019	0.017	0.016	0.016



HORIZONTAL BEND 15° - 90°

REV. 3.2019



SURFACE ACC. TO DIN 18379

$$F = 2 \cdot (A + B) \cdot \frac{\alpha \cdot \pi \cdot (r + B)}{180}$$

LOCAL FRICTION COEFFICIENTS

15° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.05	0.06	0.06	0.06	0.07					
	400	0.04	0.05	0.05	0.06	0.06	0.07	0.07			
	500	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.07		
	600	0.04	0.04	0.04	0.05	0.06	0.06	0.06	0.06	0.07	0.07
	800	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.06
	1000	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.06	0.06

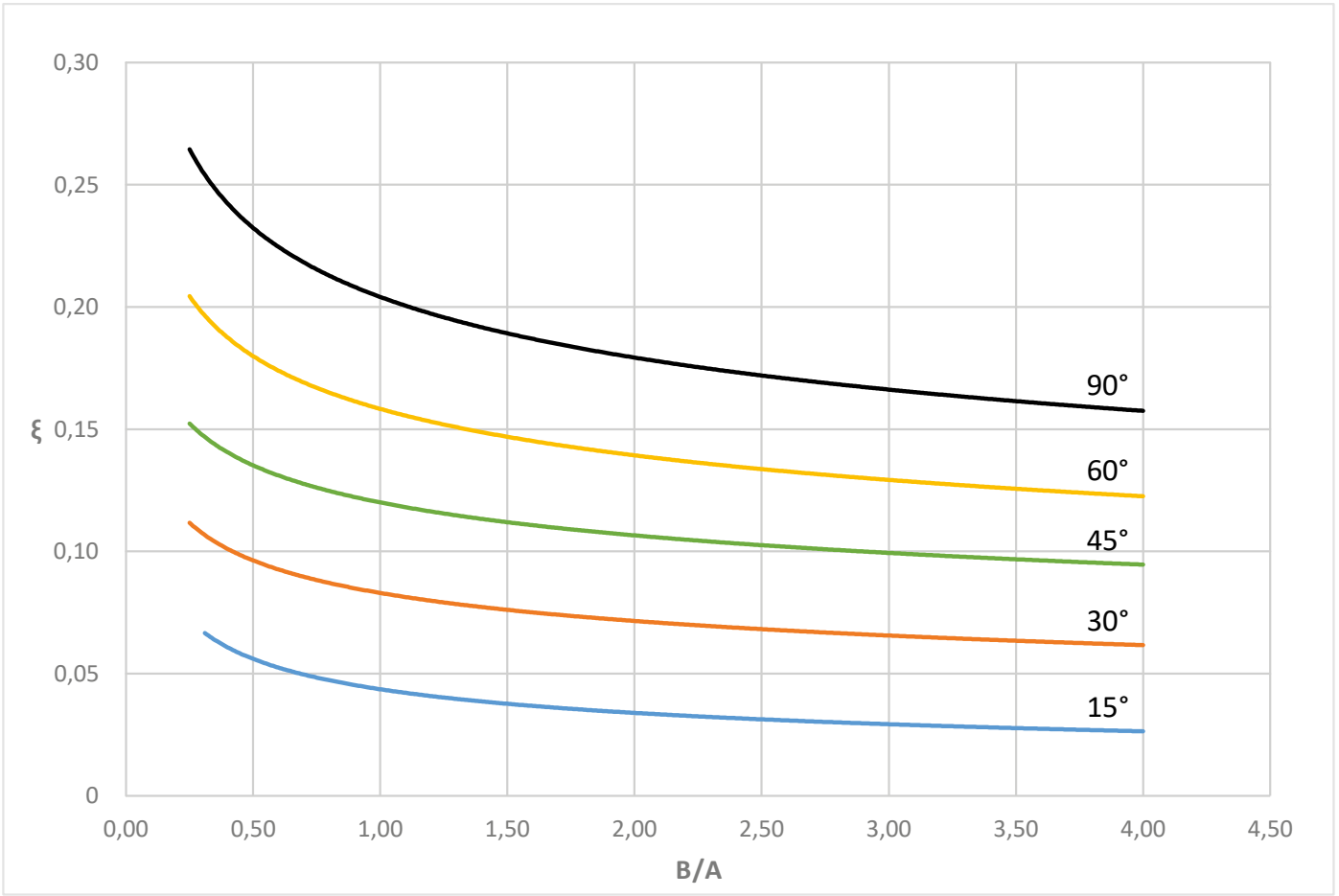
30° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.09	0.10	0.10	0.10	0.11					
	400	0.08	0.09	0.09	0.10	0.10	0.11	0.11			
	500	0.08	0.08	0.09	0.10	0.10	0.10	0.10	0.11		
	600	0.08	0.08	0.08	0.09	0.10	0.10	0.10	0.10	0.11	0.11
	800	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.10
	1000	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.10	0.10

45° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.13	0.13	0.14	0.14	0.15					
	400	0.12	0.13	0.13	0.14	0.14	0.15	0.15			
	500	0.11	0.12	0.12	0.13	0.14	0.14	0.15	0.15		
	600	0.11	0.11	0.12	0.13	0.13	0.14	0.14	0.14	0.15	0.15
	800	0.10	0.10	0.11	0.12	0.13	0.13	0.14	0.14	0.14	0.14
	1000	0.10	0.10	0.10	0.11	0.12	0.12	0.13	0.13	0.14	0.14

HORIZONTAL BEND 15° - 90°

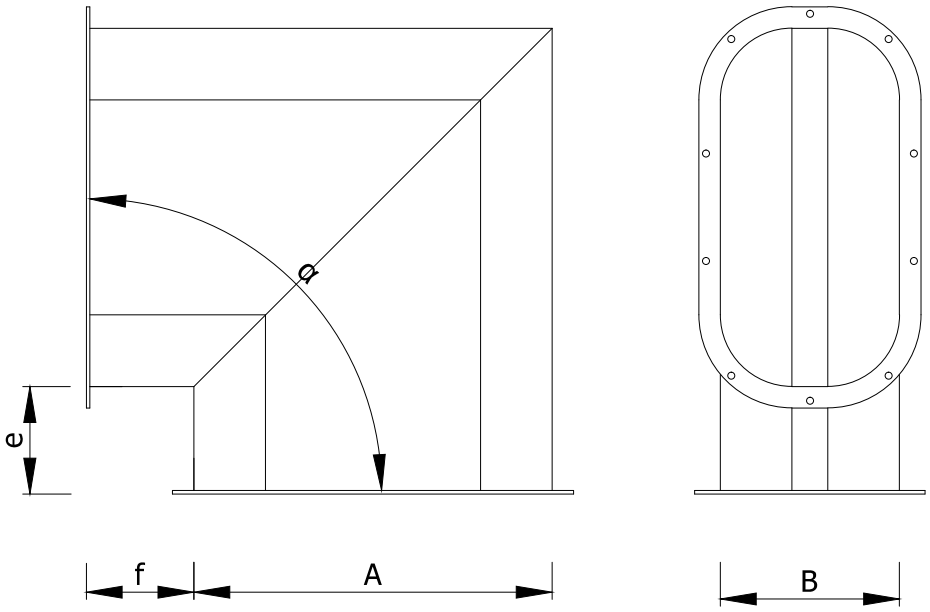
60° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.17	0.18	0.18	0.19	0.20					
	400	0.16	0.17	0.17	0.18	0.19	0.20	0.20			
	500	0.15	0.16	0.16	0.17	0.18	0.19	0.19	0.20		
	600	0.14	0.15	0.16	0.17	0.18	0.18	0.19	0.19	0.20	0.20
	800	0.13	0.14	0.14	0.16	0.17	0.17	0.18	0.18	0.19	0.19
	1000	0.13	0.13	0.13	0.15	0.16	0.16	0.17	0.18	0.18	0.18

90° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.22	0.23	0.24	0.25	0.26					
	400	0.20	0.21	0.22	0.24	0.25	0.25	0.26			
	500	0.19	0.20	0.21	0.23	0.24	0.25	0.25	0.26		
	600	0.18	0.19	0.20	0.22	0.23	0.24	0.24	0.25	0.25	0.26
	800	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.24	0.25
	1000	0.17	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.23	0.24



HORIZONTAL SQUARE BEND 45° - 90°

REV. 3.2019



SURFACE ACC. TO DIN 18379

$$F = 2 \cdot (A + B) \cdot (2 \cdot B + e + f)$$

LOCAL FRICTION COEFFICIENTS

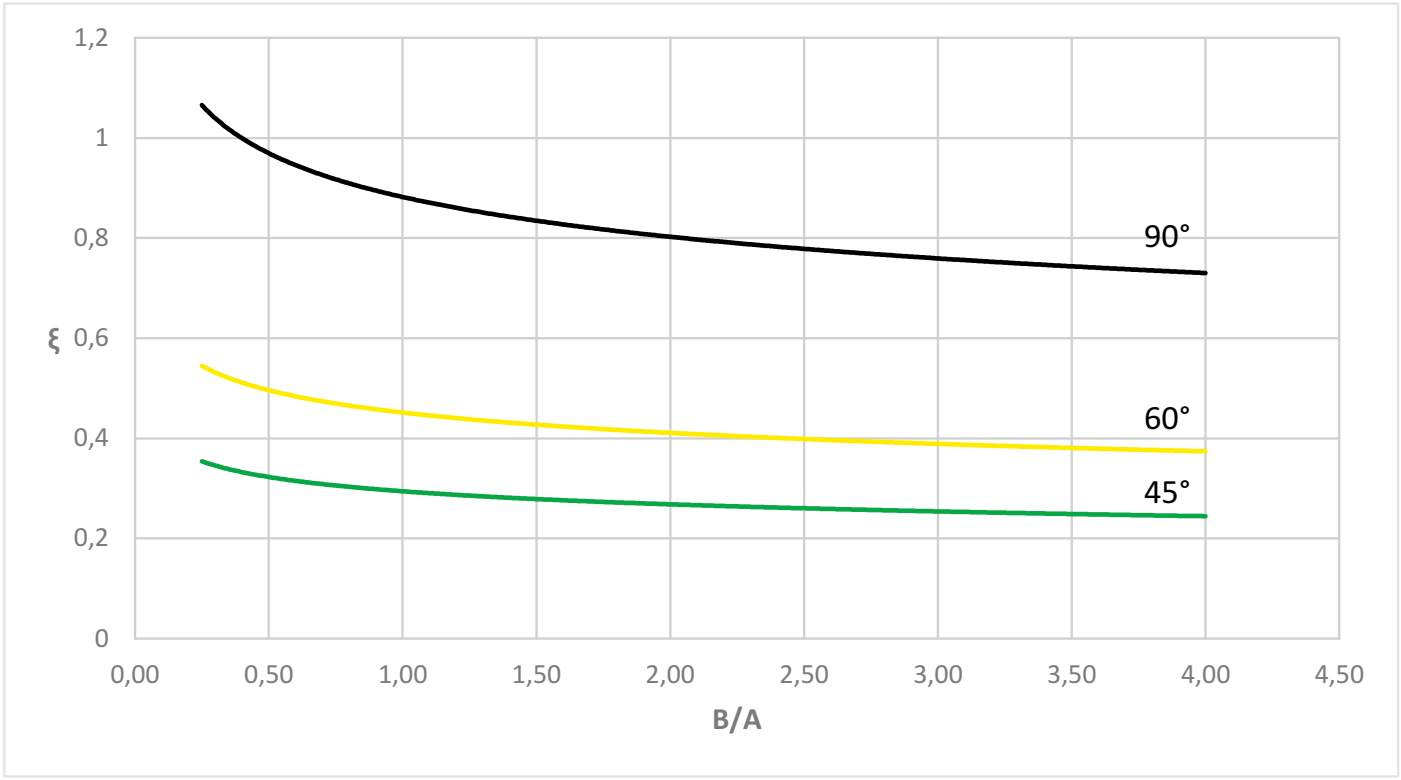
45° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.31	0.32	0.33	0.34	0.35					
	400	0.30	0.31	0.31	0.33	0.33	0.34	0.35			
	500	0.29	0.30	0.31	0.32	0.33	0.33	0.34	0.34		
	600	0.28	0.29	0.30	0.31	0.32	0.33	0.33	0.34	0.34	0.35
	800	0.27	0.28	0.29	0.30	0.31	0.31	0.32	0.33	0.33	0.33
	1000	0.26	0.27	0.28	0.29	0.30	0.31	0.31	0.32	0.32	0.33

60° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.47	0.49	0.50	0.52	0.53					
	400	0.46	0.47	0.48	0.50	0.51	0.52	0.53			
	500	0.44	0.46	0.47	0.47	0.50	0.51	0.52	0.53		
	600	0.43	0.44	0.46	0.47	0.49	0.50	0.51	0.52	0.52	0.53
	800	0.41	0.43	0.44	0.46	0.47	0.48	0.49	0.50	0.50	0.51
	1000	0.40	0.41	0.42	0.44	0.46	0.47	0.48	0.48	0.49	0.50

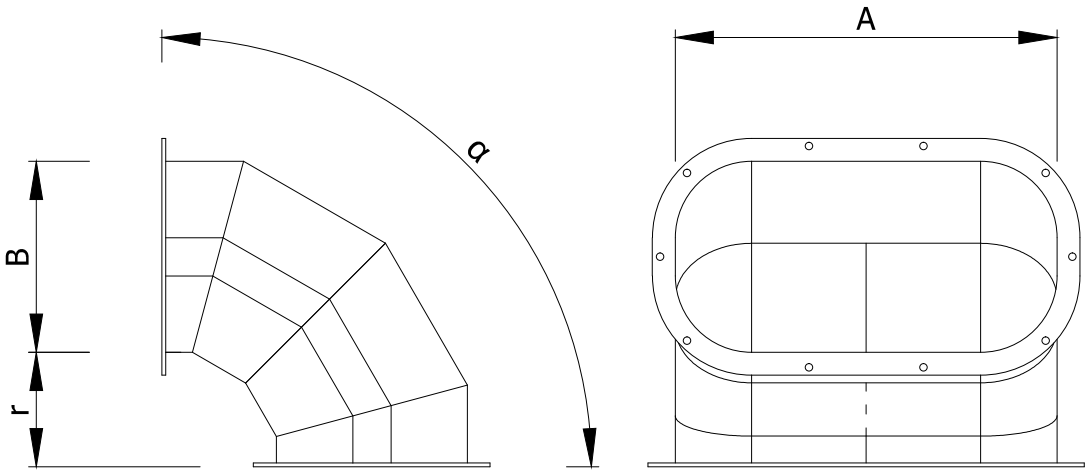
90° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.92	0.95	0.97	1.01	1.03					
	400	0.89	0.92	0.94	0.97	1.00	1.02	1.04			
	500	0.86	0.89	0.91	0.92	0.97	0.99	1.01	1.03		
	600	0.84	0.87	0.89	0.92	0.95	0.97	0.99	1.01	1.02	1.03
	800	0.81	0.83	0.86	0.89	0.92	0.94	0.96	0.97	0.99	1.00
	1000	0.78	0.81	0.83	0.86	0.89	0.91	0.93	0.95	0.96	0.97

HORIZONTAL SQUARE BEND 45° - 90°

REV. 3.2019



VERTICAL BEND 15° - 90°



SURFACE ACC. TO DIN 18379

$$F = 2 \cdot (A + B) \cdot \frac{\alpha \cdot \pi \cdot (r + B)}{180}$$

LOCAL FRICTION COEFFICIENTS

15° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.04	0.03	0.03	0.03	0.04					
	400	0.04	0.04	0.04	0.03	0.03	0.04	0.04			
	500	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.04		
	600	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.04	0.04
	800	0.06	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03	0.03
	1000	0.06	0.06	0.06	0.05	0.04	0.04	0.04	0.03	0.03	0.03

30° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.08	0.07	0.07	0.07	0.08					
	400	0.08	0.08	0.08	0.07	0.07	0.08	0.08			
	500	0.09	0.08	0.08	0.07	0.07	0.07	0.07	0.08		
	600	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.07	0.08	0.08
	800	0.10	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.07
	1000	0.10	0.10	0.10	0.09	0.08	0.08	0.08	0.07	0.07	0.07

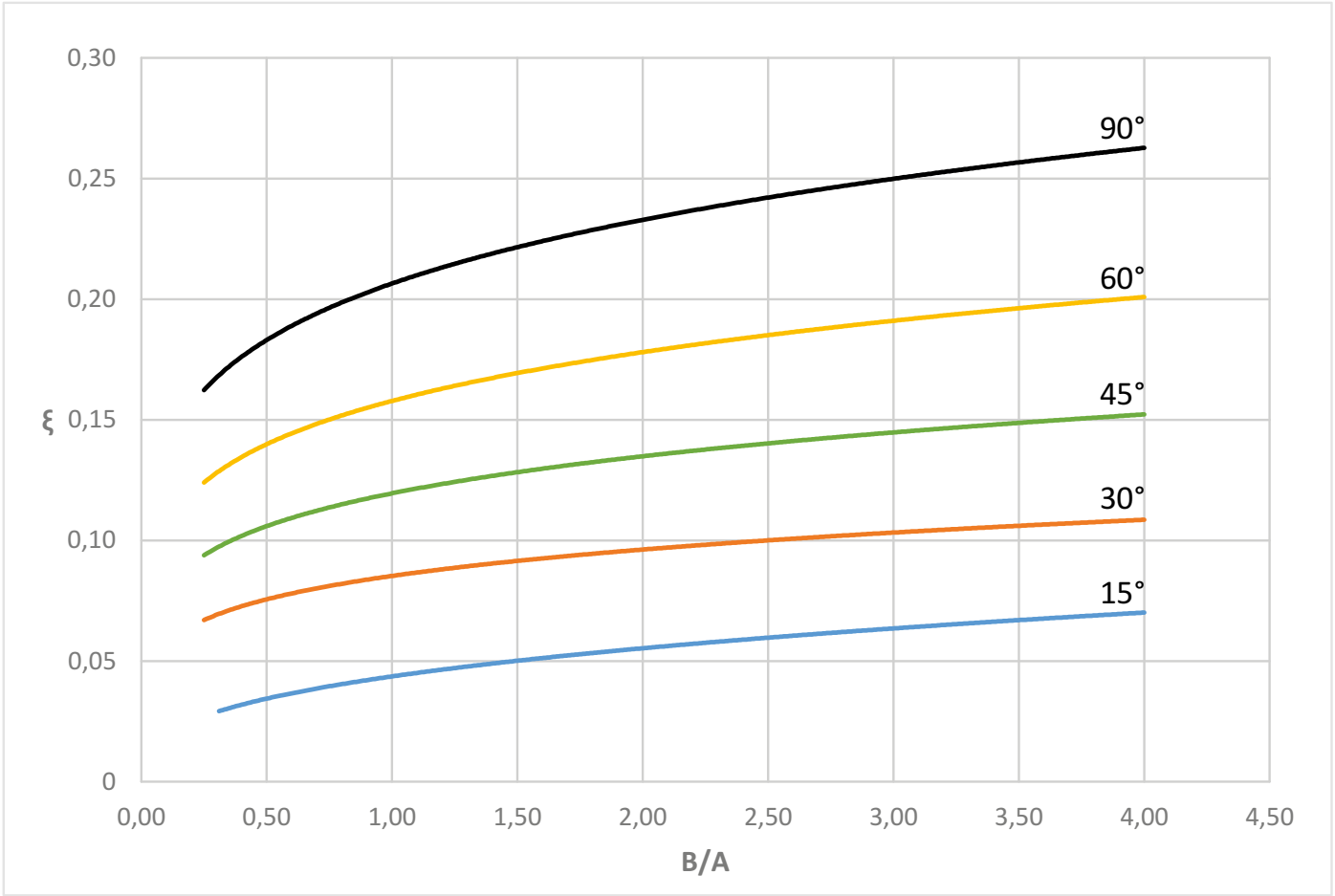
45° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.11	0.10	0.10	0.10	0.10					
	400	0.12	0.11	0.11	0.10	0.10	0.10	0.10			
	500	0.13	0.12	0.11	0.10	0.10	0.10	0.10	0.10		
	600	0.13	0.12	0.12	0.11	0.10	0.10	0.10	0.10	0.10	0.10
	800	0.14	0.13	0.13	0.12	0.11	0.11	0.10	0.10	0.10	0.10
	1000	0.14	0.14	0.13	0.13	0.12	0.11	0.11	0.10	0.10	0.10

VERTICAL BEND 15° - 90°

REV. 3.2019

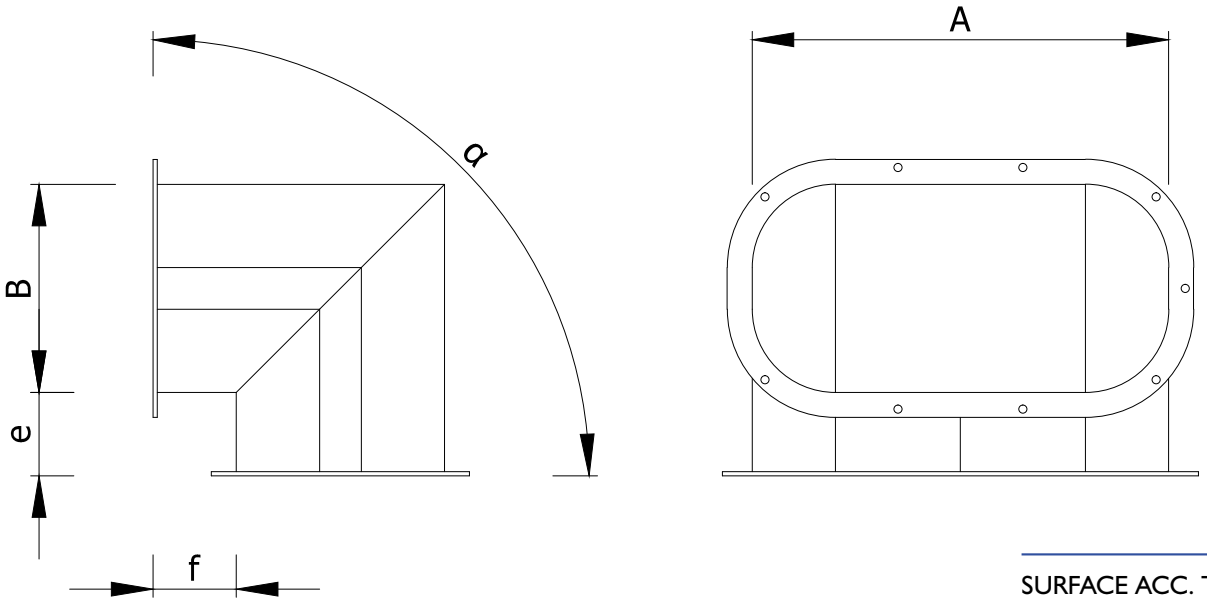
60° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.16	0.14	0.13	0.13	0.13					
	400	0.17	0.16	0.15	0.14	0.13	0.13	0.13			
	500	0.18	0.17	0.16	0.15	0.14	0.13	0.13	0.13		
	600	0.18	0.17	0.16	0.16	0.14	0.13	0.13	0.13	0.13	0.13
	800	0.19	0.18	0.18	0.17	0.16	0.15	0.14	0.13	0.13	0.13
	1000	0.20	0.19	0.18	0.18	0.17	0.16	0.15	0.14	0.14	0.13

90° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.19	0.18	0.17	0.17	0.17					
	400	0.20	0.19	0.18	0.17	0.17	0.17	0.17			
	500	0.21	0.20	0.19	0.18	0.17	0.17	0.17	0.17		
	600	0.22	0.21	0.20	0.19	0.18	0.17	0.17	0.17	0.17	0.17
	800	0.24	0.23	0.22	0.20	0.19	0.18	0.17	0.17	0.17	0.17
	1000	0.25	0.24	0.23	0.21	0.20	0.19	0.18	0.18	0.17	0.17



VERTICAL SQUARE BEND 45° - 90°

REV. 3.2019



SURFACE ACC. TO DIN 18379

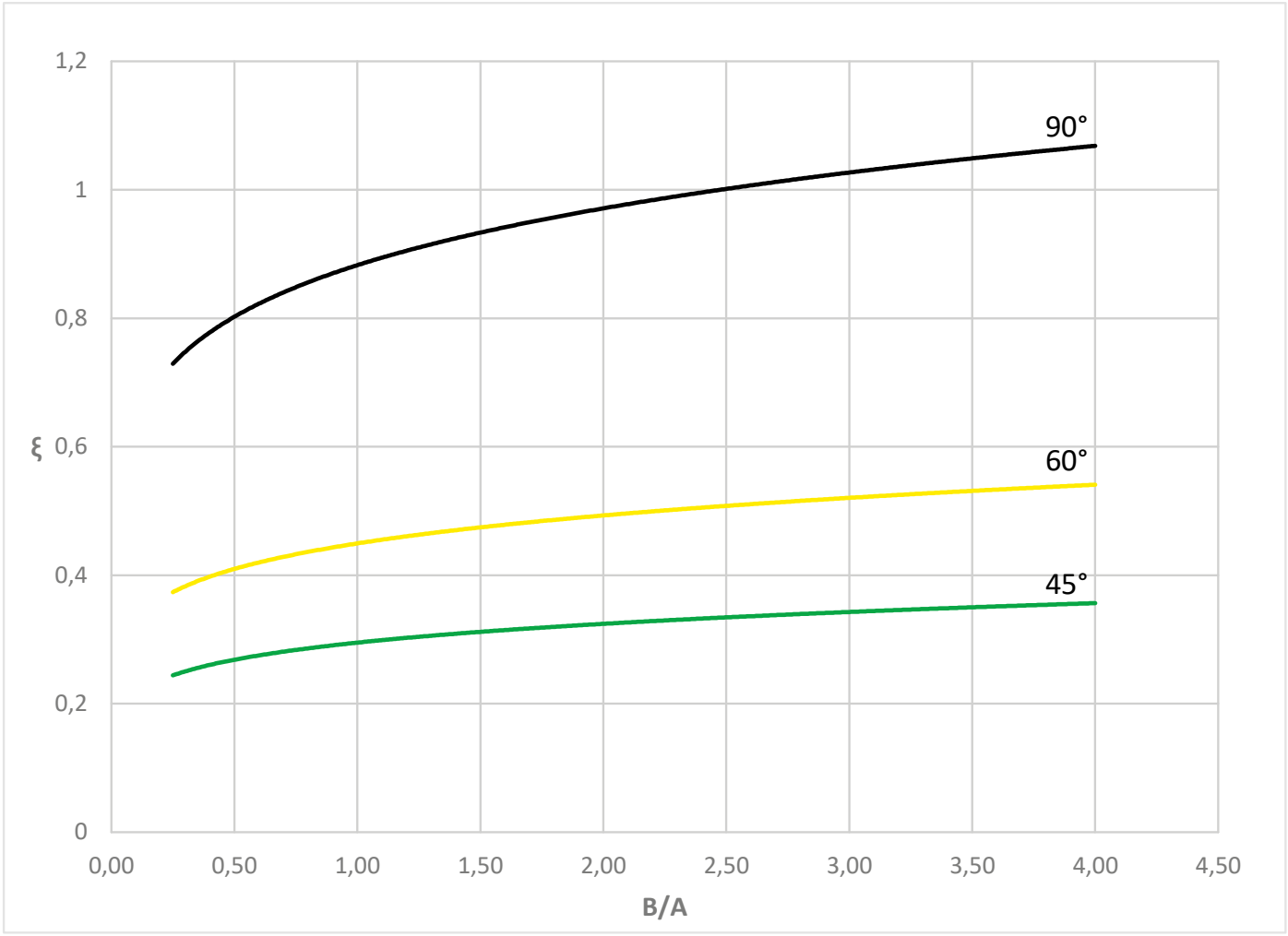
$$F = 2 \cdot (A + B) \cdot (2 \cdot B + e + f)$$

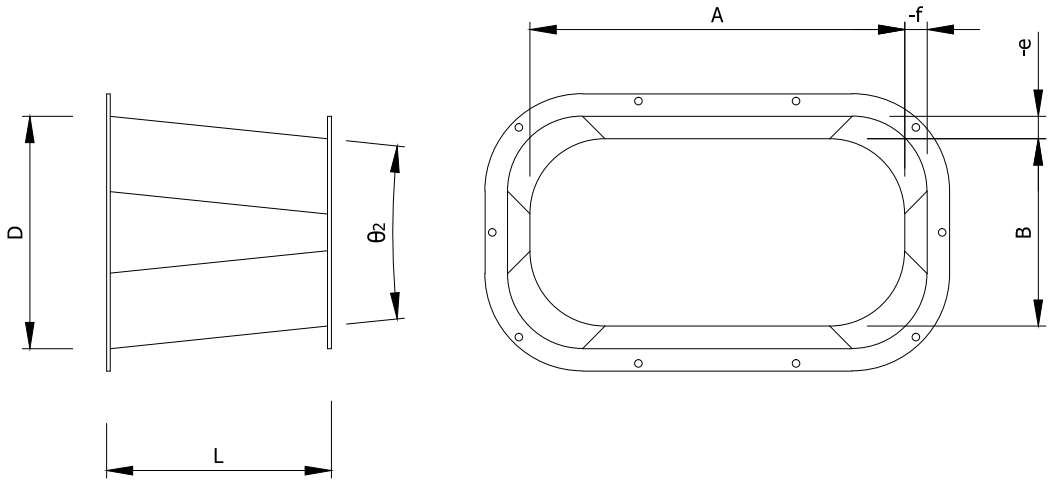
45° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.29	0.28	0.27	0.26	0.25					
	400	0.30	0.29	0.28	0.27	0.26	0.25	0.25			
	500	0.31	0.30	0.29	0.28	0.27	0.26	0.26	0.25		
	600	0.31	0.31	0.30	0.29	0.28	0.27	0.26	0.26	0.25	0.25
	800	0.33	0.32	0.31	0.30	0.29	0.28	0.28	0.27	0.27	0.26
	1000	0.33	0.33	0.32	0.31	0.30	0.29	0.28	0.28	0.27	0.27

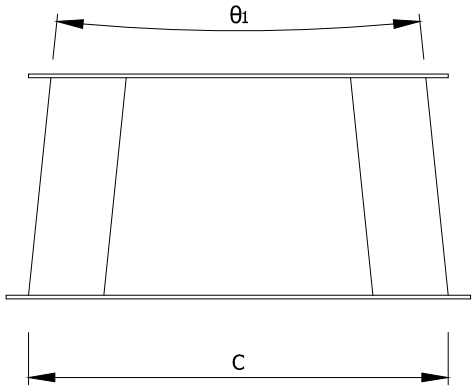
60° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.44	0.42	0.41	0.39	0.38					
	400	0.46	0.44	0.43	0.41	0.40	0.39	0.38			
	500	0.47	0.46	0.44	0.43	0.41	0.40	0.39	0.38		
	600	0.48	0.47	0.46	0.44	0.42	0.41	0.40	0.39	0.39	0.38
	800	0.50	0.48	0.47	0.46	0.44	0.43	0.42	0.41	0.41	0.40
	1000	0.51	0.50	0.49	0.47	0.46	0.44	0.43	0.43	0.42	0.41

90° ζ - COEFFICIENT		A mm									
		400	500	600	800	1000	1200	1400	1600	1800	2000
B mm	300	0.86	0.83	0.81	0.77	0.75					
	400	0.89	0.86	0.84	0.81	0.78	0.76	0.74			
	500	0.92	0.89	0.87	0.83	0.81	0.79	0.77	0.75		
	600	0.94	0.91	0.89	0.86	0.83	0.81	0.79	0.77	0.76	0.75
	800	0.97	0.95	0.92	0.89	0.86	0.84	0.82	0.81	0.79	0.78
	1000	1.00	0.97	0.95	0.92	0.89	0.87	0.85	0.83	0.82	0.81

VERTICAL SQUARE BEND 45° - 90°







SURFACE ACC. TO DIN 18379

$$F = 2 \cdot (A + B) \cdot (H)$$

CONCENTRIC
A+B ≥ C+D

e ≥ f $H = \sqrt{L^2 + e^2}$

e < f $H = \sqrt{L^2 + f^2}$

NONCONCENTRIC
B-D+e ≥ e

$H = \sqrt{L^2 + (B - D + e)^2}$

B-D+e < e

$H = \sqrt{L^2 + e^2}$

LOCAL FRICTION ζ COEFFICIENT FOR CONCENTRIC TAPER

ζ - COEFFICIENT		Θ									
		10	15	20	30	45	60	90	120	150	180
A_0/A_1	0.06	0.30	0.54	0.53	0.65	0.77	0.88	0.95	0.98	0.98	0.93
	0.10	0.30	0.50	0.53	0.64	0.75	0.84	0.89	0.91	0.91	0.88
	0.25	0.25	0.36	0.45	0.52	0.58	0.62	0.64	0.64	0.64	0.64
	0.50	0.15	0.21	0.25	0.30	0.33	0.33	0.33	0.32	0.31	0.30
	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.00	0.24	0.28	0.26	0.20	0.22	0.24	0.49	0.73	0.97	1.04
	4.00	0.89	0.78	0.79	0.70	0.88	1.12	2.72	4.33	5.62	6.58
	6.00	1.89	1.67	1.59	1.49	1.98	2.52	6.51	10.14	13.05	15.14
	10.00	5.09	5.32	5.15	5.05	6.50	8.05	19.06	29.07	37.08	43.05

A_0 - cross-sectional area at the inlet in m^2 **A_1** - cross-sectional area at the outlet in m^2 **θ** - the larger of dihedral angles

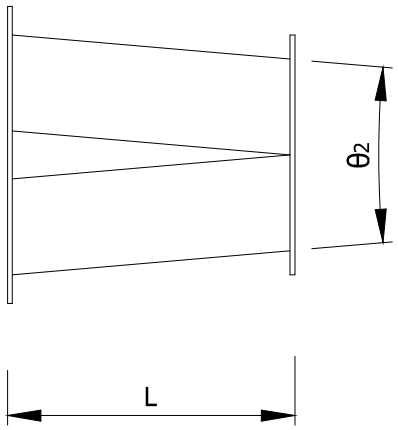
LOCAL FRICTION ζ COEFFICIENT FOR NONCONCENTRIC TAPER

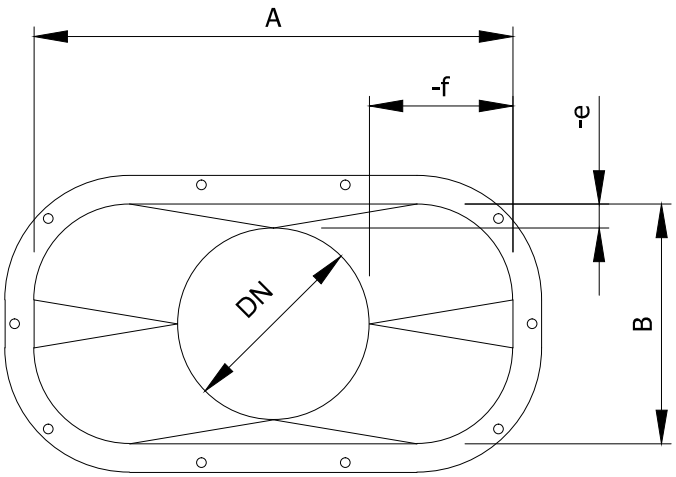
ζ - COEFFICIENT		Θ									
		10	15	20	30	45	60	90	120	150	180
A_0/A_1	0.06	0.35	0.62	0.61	0.75	0.89	1.01	1.09	1.13	1.13	1.07
	0.10	0.35	0.58	0.61	0.74	0.86	0.97	1.02	1.05	1.05	1.01
	0.25	0.29	0.41	0.52	0.60	0.67	0.71	0.74	0.74	0.74	0.74
	0.50	0.17	0.24	0.29	0.35	0.38	0.38	0.38	0.37	0.36	0.35
	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.00	0.28	0.32	0.30	0.23	0.25	0.28	0.56	0.84	1.12	1.20
	4.00	0.10	0.90	0.91	0.81	1.01	1.29	3.13	4.98	6.46	7.57
	6.00	2.17	1.92	1.83	1.71	2.28	2.90	7.49	11.66	15.01	17.41
	10.00	5.85	6.12	5.92	5.81	7.48	9.26	21.92	33.43	42.64	49.51

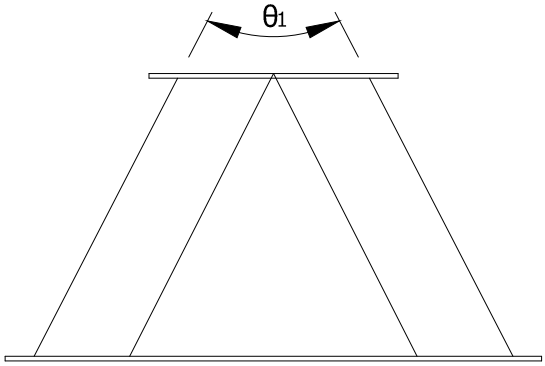
A_0 - cross-sectional area at the inlet in m^2 **A_1** - cross-sectional area at the outlet in m^2 **θ** - the larger of dihedral angles

SQUOVAL® TO CIRCULAR ADAPTER

REV. 3.2019







SURFACE ACC TO DIN 18379

SQUOVAL® TO CIRCULAR ADAPTER

$$H=\sqrt{L^2+e^2}$$

A+B ≥ DN $F=2\cdot(A+B)\cdot(H)$

A+B < DN $F=\pi\cdot DN\cdot H$

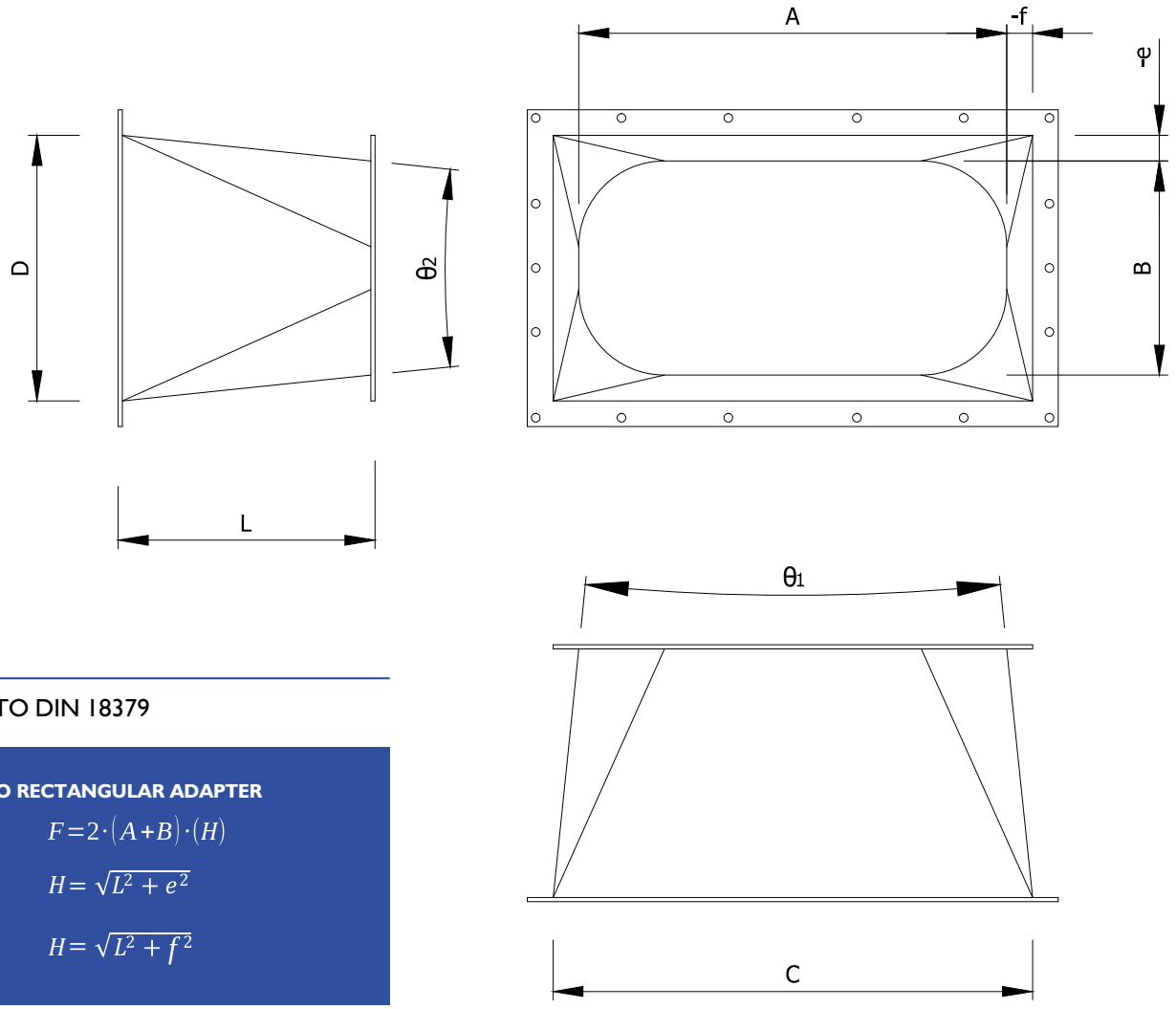
LOCAL FRICTION ζ COEFFICIENT SQUOVAL® TO CIRCULAR

ζ - COEFFICIENT		Θ									
		10	15	20	30	45	60	90	120	150	180
A_0/A_1	0.06	0.30	0.54	0.53	0.65	0.77	0.88	0.95	0.98	0.98	0.93
	0.10	0.30	0.50	0.53	0.64	0.75	0.84	0.89	0.91	0.91	0.88
	0.25	0.25	0.36	0.45	0.52	0.58	0.62	0.64	0.64	0.64	0.64
	0.50	0.15	0.21	0.25	0.30	0.33	0.33	0.33	0.32	0.31	0.30
	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.00	0.24	0.28	0.26	0.20	0.22	0.24	0.49	0.73	0.97	1.04
	4.00	0.89	0.78	0.79	0.70	0.88	1.12	2.72	4.33	5.62	6.58
	6.00	1.89	1.67	1.59	1.49	1.98	2.52	6.51	10.14	13.05	15.14
	10.00	5.09	5.32	5.15	5.05	6.50	8.05	19.06	29.07	37.08	43.05

A_0 - cross-sectional area at the inlet in m^2 A_1 - cross-sectional area at the outlet in m^2 θ - the larger of dihedral angles

SQUOVAL TO RECTANGULAR ADAPTER

REV. 3.2019



SURFACE ACC TO DIN 18379

SQUOVAL® TO RECTANGULAR ADAPTER

A+B ≥ C+D	$F = 2 \cdot (A+B) \cdot (H)$
e ≥ f	$H = \sqrt{L^2 + e^2}$
e < f	$H = \sqrt{L^2 + f^2}$

LOCAL FRICTION ζ - COEFFICIENT SQUOVAL® TO RECTANGULAR

ζ - **COEFFICIENT**		Θ									
		10	**15**	**20**	**30**	**45**	**60**	**90**	**120**	**150**	**180**
A_0/A_1	**0.06**	0.30	0.54	0.53	0.65	0.77	0.88	0.95	0.98	0.98	0.93
	0.10	0.30	0.50	0.53	0.64	0.75	0.84	0.89	0.91	0.91	0.88
	0.25	0.25	0.36	0.45	0.52	0.58	0.62	0.64	0.64	0.64	0.64
	0.50	0.15	0.21	0.25	0.30	0.33	0.33	0.33	0.32	0.31	0.30
	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.00	0.24	0.28	0.26	0.20	0.22	0.24	0.49	0.73	0.97	1.04
	4.00	0.89	0.78	0.79	0.70	0.88	1.12	2.72	4.33	5.62	6.58
	6.00	1.89	1.67	1.59	1.49	1.98	2.52	6.51	10.14	13.05	15.14
	10.00	5.09	5.32	5.15	5.05	6.50	8.05	19.06	29.07	37.08	43.05

A_0 - cross-sectional area at the inlet in m^2 **A_1** - cross-sectional area at the outlet in m^2 **θ** - the larger of dihedral angles

NucAir Technologies Sp. z o.o. ul. Powstańców 8 B 86-050 Solec Kujawski, Poland nucair@nucair.eu www.nucair.eu