



Calculation tables for thermal expansion

Contents

Subject	Page
1 THERMALLY INDUCED CHANGES IN LENGTH	5
1.1 Thermal expansion “ Δl ”	6
1.1.1 NiroSan® -, NiroSan®-ECO system pipes and copper pipes	7
1.1.2 NiroSan®-F system pipes	8
1.1.3 NiroTherm® system pipes	9
1.1.4 SANHA-Therm® system pipes	10
1.1.5 MultiFit®-Flex system pipes	11
1.2 Required expansion bend “X” between fitting and pipe installation	12
1.2.1 NiroSan® - and NiroSan®-ECO system pipes	14
1.2.2 NiroSan®-F system pipes	15
1.2.3 NiroTherm® system pipes	16
1.2.4 SANHA®-Therm system pipes	17
1.2.5 Copper pipes	18
1.2.6 MultiFit®-Flex system pipes	19
1.3 Required leg length “U” of the expansion compensator	20
1.3.1 NiroSan® - and NiroSan®-ECO system pipes	21
1.3.2 NiroSan®-F system pipes	22
1.3.3 NiroTherm® system pipes	23
1.3.4 SANHA®-Therm system pipes	24
1.3.5 Copper pipes	25
1.3.6 MultiFit®-Flex system pipes	26
1.4 Calculation of the expansion compensation of the SANHA® axial-compensator	27
1.5 Installation diagrams of the SANHA® axial compensator	31
2 PIPE INSTALLATION SPACING	32
2.1 Maximum distances for the installation of metal pipes according to EN 806-4	34
2.2 Maximum distances for the installation of plastic composite pipes according to EN 806-4	34

	Subject	Page
2.3	Maximum distances for the installation of SANHA® system pipes made of unalloyed steel and stainless steel	35
3	PIPE WEIGHTS	36
3.1	NiroSan® system pipes	36
3.2	NiroSan®-F system pipes	36
3.3	NiroSan®-ECO system pipes	37
3.4	NiroTherm® system pipes	37
3.5	SANHA®-Therm system pipes	38
3.6	MultiFit®-Flex system pipes	38
3.7	Copper pipes	39
4	APPENDIX	40
4.1	Axial compensator enquiry form	40
4.2	Axial compensator layout form	42

1 Thermally induced changes in length

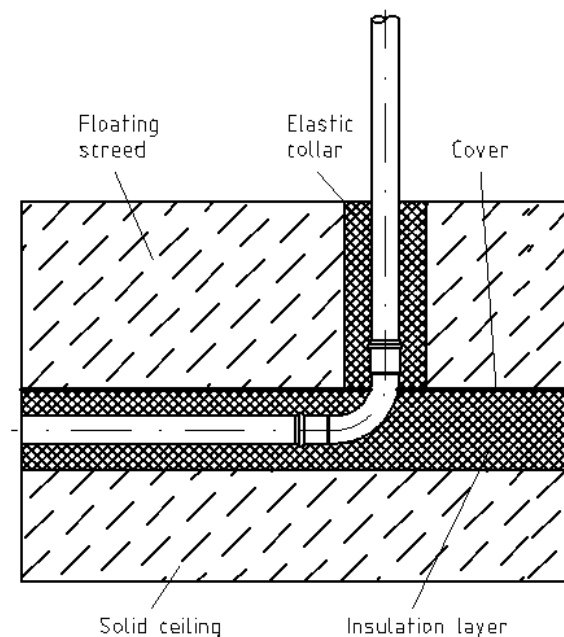
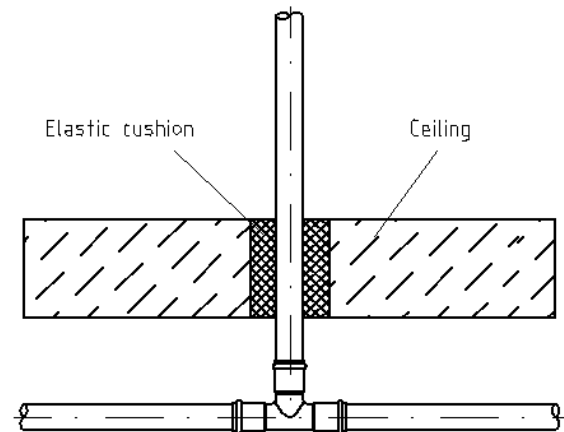
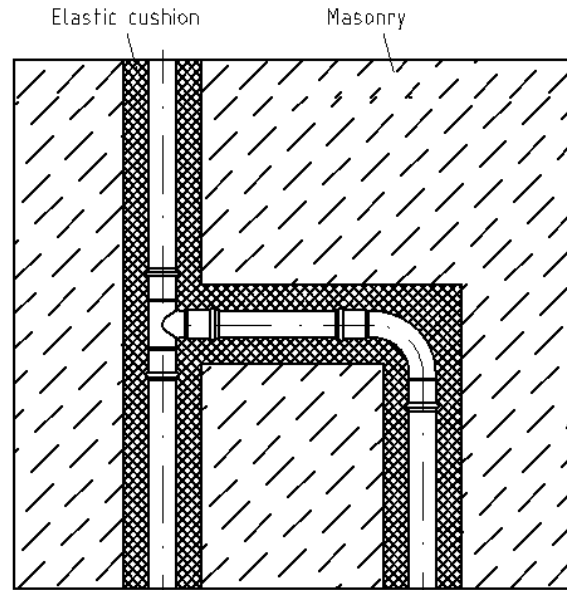
High-temperature pipes and lines which are exposed to high heat (e.g. sunshine etc.) expand to a different extent depending on the material. If the pipes are replaced hindered for restrained in this thermal linear expansion, damage may occur (mostly in terms of fatigue fractures). To avoid this risk, the pipeline must have sufficient space for expansion. Often it is possible to use the elasticity of the pipeline network for this purpose. By correct arrangement of the fastening clips, sufficient flexibility can be allowed for in the pipe layout.

The basic principle is that adequate expansion capacity must be given between two fixed points.

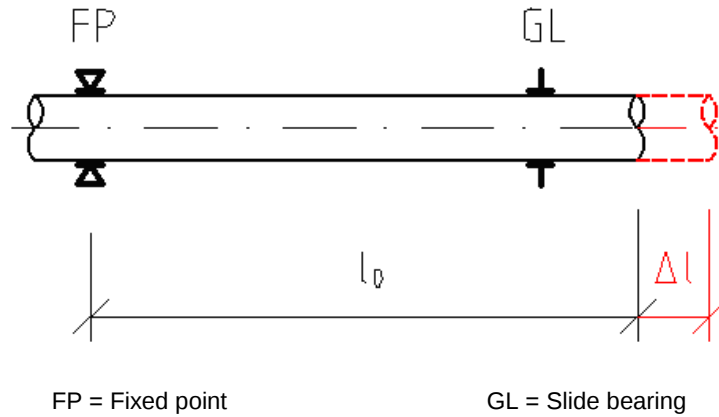
If the natural pipe routing does not allow for sufficient compensation of the thermal expansion, it must be achieved by the installation of special components such as axial compensators (**SANHA® catalog no. 9872L, 18872L, 91872L and 98872L**). If sufficient space is available, a U-pipe expansion joint can be used.

Please refer to the table on the following pages for the layout data of the required expansion bends or leg lengths of the U-pipe compensator for the various materials.

For concealed installations, the unimpeded thermal expansion must be ensured by providing the pipes with sufficiently thick jackets of elastic material. In particular, ceiling ducts must be padded carefully if a fixed point has not been deliberately installed (see illustrations).



1.1 Thermal expansion “ Δl ”



Picture 1: Thermally induced change in length of the pipe

Table 1:

Pipe material	Coefficient of thermal expansion α 10 ⁻⁶ K ⁻¹ bei 20 °C bis 100 °C
Stainless steel 1.4301	16.0
Stainless steel 1.4404	16.5
Stainless steel 1.4521	10.8
Unalloyed steel	12.0
copper	16.6
MultiFit®-Flex system pipe	23.0

Calculation formula of the thermally induced change in length:

$$\Delta l = l_0 \cdot \alpha \cdot \Delta T \quad (1)$$

- Δl = difference of the thermally induced change in length [mm]
- l_0 = length of pipe [mm]
- α = coefficient of thermal expansion from table 1 [K⁻¹]
- ΔT = temperature difference between installation temperature and max. operating temperature [K]

1.1.1 NiroSan[®]-, NiroSan[®]-ECO system pipes and copper pipes

Table 2:

Thermal expansion “ Δl ” [mm]									
ΔT [K] l_0 [m]	10	20	30	40	50	60	70	80	90
1	0.17	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.32
2	0.33	0.66	0.99	1.32	1.65	1.98	2.31	2.64	2.64
3	0.50	0.99	1.49	1.98	2.48	2.97	3.47	3.96	3.96
4	0.66	1.32	1.98	2.64	3.30	3.96	4.62	5.28	5.28
5	0.83	1.65	2.48	3.30	4.13	4.95	5.78	6.60	6.60
6	0.99	1.98	2.97	3.96	4.95	5.94	6.93	7.92	7.92
7	1.16	2.31	3.47	4.62	5.78	6.93	8.09	9.24	9.24
8	1.32	2.64	3.96	5.28	6.60	7.92	9.24	10.56	10.56
9	1.49	2.97	4.46	5.94	7.43	8.91	10.40	11.88	11.88
10	1.65	3.30	4.95	6.60	8.25	9.90	11.55	13.20	13.20
15	2.48	4.95	7.43	9.90	12.38	14.85	17.33	19.80	19.80
20	3.30	6.60	9.90	13.20	16.50	19.80	23.10	26.40	26.40
25	4.13	8.25	12.38	16.50	20.63	24.75	28.88	33.00	33.00
30	4.95	9.90	14.85	19.80	24.75	29.70	34.65	39.60	39.60
35	5.78	11.55	17.33	23.10	28.88	34.65	40.43	46.20	46.20
40	6.60	13.20	19.80	26.40	33.00	39.60	46.20	52.80	52.80
45	7.43	14.85	22.28	29.70	37.13	44.55	51.98	59.40	59.40
50	8.25	16.50	24.75	33.00	41.25	49.50	57.75	66.00	66.00
55	9.08	18.15	27.23	36.30	45.38	54.45	63.53	72.60	72.60
60	9.90	19.80	29.70	39.60	49.50	59.40	69.30	79.20	79.20
65	10.73	21.45	32.18	42.90	53.63	64.35	75.08	85.80	85.80
70	11.55	23.10	34.65	46.20	57.75	69.30	80.85	92.40	92.40
75	12.38	24.75	37.13	49.50	61.88	74.25	86.63	99.00	99.00
80	13.20	26.40	39.60	52.80	66.00	79.20	92.40	105.60	105.60
85	14.03	28.05	42.08	56.10	70.13	84.15	98.18	112.20	112.20
90	14.85	29.70	44.55	59.40	74.25	89.10	103.95	118.80	118.80
95	15.68	31.35	47.03	62.70	78.38	94.05	109.73	125.40	125.40
100	16.50	33.00	49.50	66.00	82.50	99.00	115.50	132.00	132.00

1.1.2 NiroSan®-F system pipes

Table 3:

Thermal expansion “ Δl ” [mm]									
ΔT [K] l_0 [m]	10	20	30	40	50	60	70	80	90
1	0.11	0.22	0.32	0.43	0.54	0.65	0.76	0.86	0.97
2	0.22	0.43	0.65	0.86	1.08	1.30	1.51	1.73	1.94
3	0.32	0.65	0.97	1.30	1.62	1.94	2.27	2.59	2.92
4	0.43	0.86	1.30	1.73	2.16	2.59	3.02	3.46	3.89
5	0.54	1.08	1.62	2.16	2.70	3.24	3.78	4.32	4.86
6	0.65	1.30	1.94	2.59	3.24	3.89	4.54	5.18	5.83
7	0.76	1.51	2.27	3.02	3.78	4.54	5.29	6.05	6.80
8	0.86	1.73	2.59	3.46	4.32	5.18	6.05	6.91	7.78
9	0.97	1.94	2.92	3.89	4.86	5.83	6.80	7.78	8.75
10	1.08	2.16	3.24	4.32	5.40	6.48	7.56	8.64	9.72
15	1.62	3.24	4.86	6.48	8.10	9.72	11.34	12.96	14.58
20	2.16	4.32	6.48	8.64	10.80	12.96	15.12	17.28	19.44
25	2.70	5.40	8.10	10.80	13.50	16.20	18.90	21.60	24.30
30	3.24	6.48	9.72	12.96	16.20	19.44	22.68	25.92	29.16
35	3.78	7.56	11.34	15.12	18.90	22.68	26.46	30.24	34.02
40	4.32	8.64	12.96	17.28	21.60	25.92	30.24	34.56	38.88
45	4.86	9.72	14.58	19.44	24.30	29.16	34.02	38.88	43.74
50	5.40	10.80	16.20	21.60	27.00	32.40	37.80	43.20	48.60
55	5.94	11.88	17.82	23.76	29.70	35.64	41.58	47.52	53.46
60	6.48	12.96	19.44	25.92	32.40	38.88	45.36	51.84	58.32
65	7.02	14.04	21.06	28.08	35.10	42.12	49.14	56.16	63.18
70	7.56	15.12	22.68	30.24	37.80	45.36	52.92	60.48	68.04
75	8.10	16.20	24.30	32.40	40.50	48.60	56.70	64.80	72.90
80	8.64	17.28	25.92	34.56	43.20	51.84	60.48	69.12	77.76
85	9.18	18.36	27.54	36.72	45.90	55.08	64.26	73.44	82.62
90	9.72	19.44	29.16	38.88	48.60	58.32	68.04	77.76	87.48
95	10.26	20.52	30.78	41.04	51.30	61.56	71.82	82.08	92.34
100	10.80	21.60	32.40	43.20	54.00	64.80	75.60	86.40	97.20

1.1.3 NiroTherm® system pipes

Table 4:

Thermal expansion “ Δl ” [mm]									
ΔT [K] l_0 [m]	10	20	30	40	50	60	70	80	90
1	0.16	0.32	0.48	0.64	0.80	0.96	1.12	1.28	1.44
2	0.32	0.64	0.96	1.28	1.60	1.92	2.24	2.56	2.88
3	0.48	0.96	1.44	1.92	2.40	2.88	3.36	3.84	4.32
4	0.64	1.28	1.92	2.56	3.20	3.84	4.48	5.12	5.76
5	0.80	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20
6	0.96	1.92	2.88	3.84	4.80	5.76	6.72	7.68	8.64
7	1.12	2.24	3.36	4.48	5.60	6.72	7.84	8.96	10.08
8	1.28	2.56	3.84	5.12	6.40	7.68	8.96	10.24	11.52
9	1.44	2.88	4.32	5.76	7.20	8.64	10.08	11.52	12.96
10	1.60	3.20	4.80	6.40	8.00	9.60	11.20	12.80	14.40
15	2.40	4.80	7.20	9.60	12.00	14.40	16.80	19.20	21.60
20	3.20	6.40	9.60	12.80	16.00	19.20	22.40	25.60	28.80
25	4.00	8.00	12.00	16.00	20.00	24.00	28.00	32.00	36.00
30	4.80	9.60	14.40	19.20	24.00	28.80	33.60	38.40	43.20
35	5.60	11.20	16.80	22.40	28.00	33.60	39.20	44.80	50.40
40	6.40	12.80	19.20	25.60	32.00	38.40	44.80	51.20	57.60
45	7.20	14.40	21.60	28.80	36.00	43.20	50.40	57.60	64.80
50	8.00	16.00	24.00	32.00	40.00	48.00	56.00	64.00	72.00
55	8.80	17.60	26.40	35.20	44.00	52.80	61.60	70.40	79.20
60	9.60	19.20	28.80	38.40	48.00	57.60	67.20	76.80	86.40
65	10.40	20.80	31.20	41.60	52.00	62.40	72.80	83.20	93.60
70	11.20	22.40	33.60	44.80	56.00	67.20	78.40	89.60	100.80
75	12.00	24.00	36.00	48.00	60.00	72.00	84.00	96.00	108.00
80	12.80	25.60	38.40	51.20	64.00	76.80	89.60	102.40	115.20
85	13.60	27.20	40.80	54.40	68.00	81.60	95.20	108.80	122.40
90	14.40	28.80	43.20	57.60	72.00	86.40	100.80	115.20	129.60
95	15.20	30.40	45.60	60.80	76.00	91.20	106.40	121.60	136.80
100	16.00	32.00	48.00	64.00	80.00	96.00	112.00	128.00	144.00

1.1.4 SANHA-Therm® system pipes

Table 5:

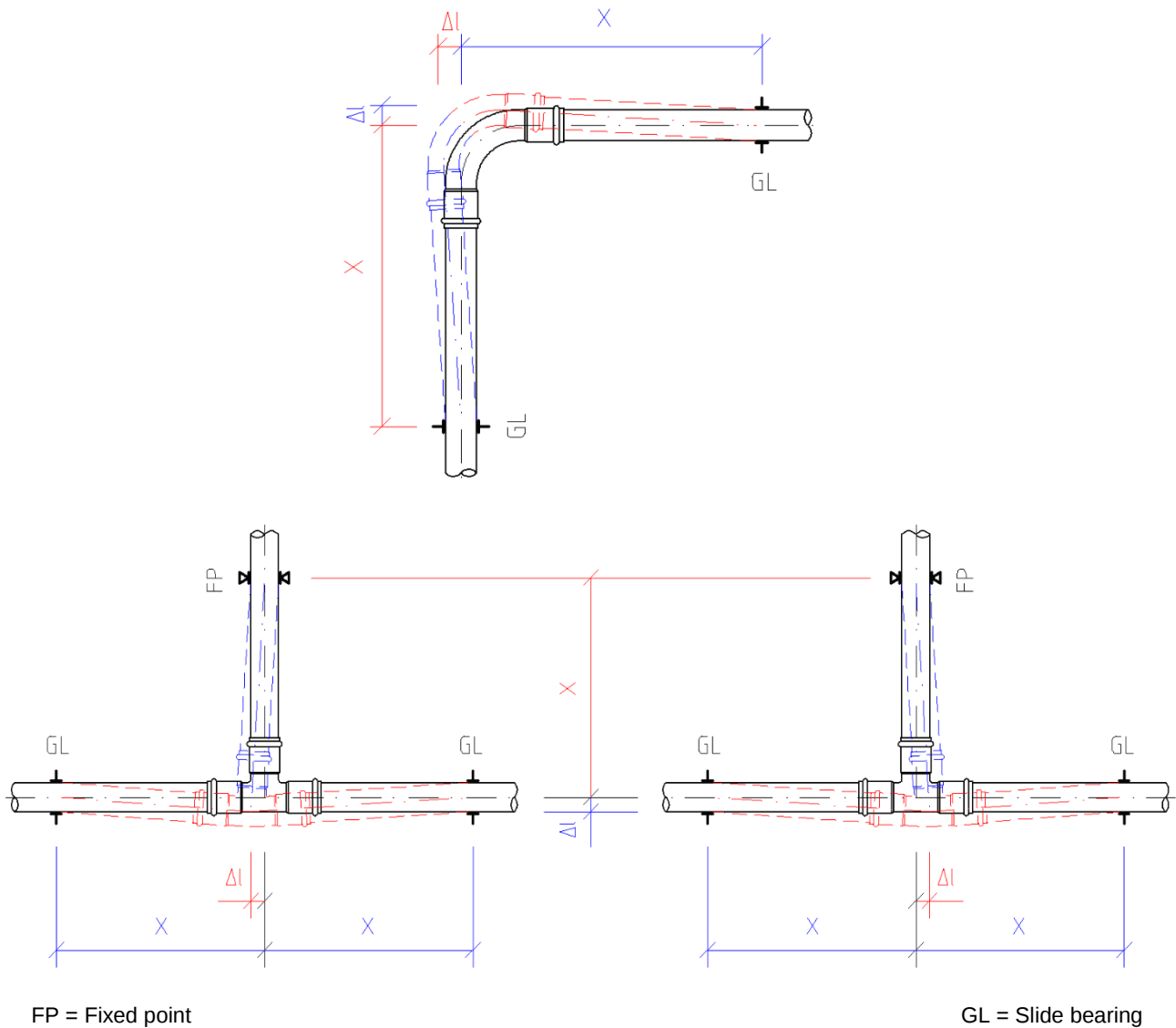
Thermal expansion “ Δl ” [mm]									
ΔT [K] l_0 [m]	10	20	30	40	50	60	70	80	90
1	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08
2	0.24	0.48	0.72	0.96	1.20	1.44	1.68	1.92	2.16
3	0.36	0.72	1.08	1.44	1.80	2.16	2.52	2.88	3.24
4	0.48	0.96	1.44	1.92	2.40	2.88	3.36	3.84	4.32
5	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40
6	0.72	1.44	2.16	2.88	3.60	4.32	5.04	5.76	6.48
7	0.84	1.68	2.52	3.36	4.20	5.04	5.88	6.72	7.56
8	0.96	1.92	2.88	3.84	4.80	5.76	6.72	7.68	8.64
9	1.08	2.16	3.24	4.32	5.40	6.48	7.56	8.64	9.72
10	1.20	2.40	3.60	4.80	6.00	7.20	8.40	9.60	10.80
15	1.80	3.60	5.40	7.20	9.00	10.80	12.60	14.40	16.20
20	2.40	4.80	7.20	9.60	12.00	14.40	16.80	19.20	21.60
25	3.00	6.00	9.00	12.00	15.00	18.00	21.00	24.00	27.00
30	3.60	7.20	10.80	14.40	18.00	21.60	25.20	28.80	32.40
35	4.20	8.40	12.60	16.80	21.00	25.20	29.40	33.60	37.80
40	4.80	9.60	14.40	19.20	24.00	28.80	33.60	38.40	43.20
45	5.40	10.80	16.20	21.60	27.00	32.40	37.80	43.20	48.60
50	6.00	12.00	18.00	24.00	30.00	36.00	42.00	48.00	54.00
55	6.60	13.20	19.80	26.40	33.00	39.60	46.20	52.80	59.40
60	7.20	14.40	21.60	28.80	36.00	43.20	50.40	57.60	64.80
65	7.80	15.60	23.40	31.20	39.00	46.80	54.60	62.40	70.20
70	8.40	16.80	25.20	33.60	42.00	50.40	58.80	67.20	75.60
75	9.00	18.00	27.00	36.00	45.00	54.00	63.00	72.00	81.00
80	9.60	19.20	28.80	38.40	48.00	57.60	67.20	76.80	86.40
85	10.20	20.40	30.60	40.80	51.00	61.20	71.40	81.60	91.80
90	10.80	21.60	32.40	43.20	54.00	64.80	75.60	86.40	97.20
95	11.40	22.80	34.20	45.60	57.00	68.40	79.80	91.20	102.60
100	12.00	24.00	36.00	48.00	60.00	72.00	84.00	96.00	108.00

1.1.5 MultiFit®-Flex system pipes

Table 6:

Thermal expansion “ Δl ” [mm]									
ΔT [K] l_0 [m]	10	20	30	40	50	60	70	80	90
1	0.23	0.46	0.69	0.92	1.15	1.38	1.61	1.84	2.07
2	0.46	0.92	1.38	1.84	2.30	2.76	3.22	3.68	4.14
3	0.69	1.38	2.07	2.76	3.45	4.14	4.83	5.52	6.21
4	0.92	1.84	2.76	3.68	4.60	5.52	6.44	7.36	8.28
5	1.15	2.30	3.45	4.60	5.75	6.90	8.05	9.20	10.35
6	1.38	2.76	4.14	5.52	6.90	8.28	9.66	11.04	12.42
7	1.61	3.22	4.83	6.44	8.05	9.66	11.27	12.88	14.49
8	1.84	3.68	5.52	7.36	9.20	11.04	12.88	14.72	16.56
9	2.07	4.14	6.21	8.28	10.35	12.42	14.49	16.56	18.63
10	2.30	4.60	6.90	9.20	11.50	13.80	16.10	18.40	20.70
15	3.45	6.90	10.35	13.80	17.25	20.70	24.15	27.60	31.05
20	4.60	9.20	13.80	18.40	23.00	27.60	32.20	36.80	41.40
25	5.75	11.50	17.25	23.00	28.75	34.50	40.25	46.00	51.75
30	6.90	13.80	20.70	27.60	34.50	41.40	48.30	55.20	62.10
35	8.05	16.10	24.15	32.20	40.25	48.30	56.35	64.40	72.45
40	9.20	18.40	27.60	36.80	46.00	55.20	64.40	73.60	82.80
45	10.35	20.70	31.05	41.40	51.75	62.10	72.45	82.80	93.15
50	11.50	23.00	34.50	46.00	57.50	69.00	80.50	92.00	103.50
55	12.65	25.30	37.95	50.60	63.25	75.90	88.55	101.20	113.85
60	13.80	27.60	41.40	55.20	69.00	82.80	96.60	110.40	124.20
65	14.95	29.90	44.85	59.80	74.75	89.70	104.65	119.60	134.55
70	16.10	32.20	48.30	64.40	80.50	96.60	112.70	128.80	144.90
75	17.25	34.50	51.75	69.00	86.25	103.50	120.75	138.00	155.25
80	18.40	36.80	55.20	73.60	92.00	110.40	128.80	147.20	165.60
85	19.55	39.10	58.65	78.20	97.75	117.30	136.85	156.40	175.95
90	20.70	41.40	62.10	82.80	103.50	124.20	144.90	165.60	186.30
95	21.85	43.70	65.55	87.40	109.25	131.10	152.95	174.80	196.65
100	23.00	46.00	69.00	92.00	115.00	138.00	161.00	184.00	207.00

1.2 Required expansion bend “X” between fitting and pipe installation



Picture 2: Minimum distance “X” of the clamps to the fittings with high-temperature pipes

Calculation formula of the minimum distance “X” of the clamps to the fittings

$$X = C_X \cdot \frac{\sqrt{d \cdot \Delta l}}{1000} \quad (2)$$

- X = minimum distance “X” of the clamps to the fittings [m]
- C_X = material constant from table 7
- d = outside diameter [mm]
- Δl = difference of the thermally induced change in length from formula 1 [mm]

Table 7:

Pipe material	Material constant C_x
Stainless steel 1.4301	39.2
Stainless steel 1.4404	35.4
Stainless steel 1.4521	34.6
Unalloyed steel	43.0
copper	33.2
MultiFit®-Flex system pipe	50.6

1.2.1 NiroSan® - and NiroSan®-ECO system pipes

Table 8:

Required leg length "X" [m]										
Δl [mm] d [mm]	5	10	15	20	25	30	35	40	45	50
15	0.31	0.43	0.53	0.61	0.68	0.75	0.81	0.87	0.92	0.97
18	0.34	0.47	0.58	0.67	0.75	0.82	0.89	0.95	1.01	1.06
22	0.37	0.52	0.64	0.74	0.83	0.91	0.98	1.05	1.11	1.17
28	0.42	0.59	0.72	0.84	0.94	1.02	1.11	1.18	1.25	1.32
35	0.47	0.66	0.81	0.94	1.05	1.15	1.24	1.32	1.40	1.48
42	0.51	0.72	0.89	1.02	1.15	1.25	1.36	1.45	1.54	1.62
54	0.58	0.82	1.01	1.16	1.30	1.42	1.54	1.64	1.74	1.84
64	0.63	0.89	1.10	1.26	1.41	1.55	1.67	1.79	1.90	2.00
76.1	0.69	0.98	1.19	1.38	1.54	1.69	1.82	1.95	2.07	2.18
88.9	0.75	1.05	1.29	1.49	1.67	1.83	1.97	2.11	2.24	2.36
108	0.82	1.16	1.42	1.64	1.84	2.01	2.17	2.32	2.46	2.60

Required leg length "X" [m]										
Δl [mm] d [mm]	55	60	65	70	75	80	85	90	95	100
15	1.02	1.06	1.10	1.15	1.19	1.22	1.26	1.30	1.33	1.37
18	1.11	1.16	1.21	1.25	1.30	1.34	1.38	1.42	1.46	1.50
22	1.23	1.28	1.34	1.39	1.44	1.48	1.53	1.57	1.62	1.66
28	1.39	1.45	1.51	1.57	1.62	1.67	1.72	1.77	1.82	1.87
35	1.55	1.62	1.69	1.75	1.81	1.87	1.93	1.98	2.04	2.09
42	1.70	1.77	1.85	1.92	1.98	2.05	2.11	2.17	2.23	2.29
54	1.93	2.01	2.09	2.17	2.25	2.32	2.40	2.46	2.53	2.60
64	2.10	2.19	2.28	2.37	2.45	2.53	2.61	2.68	2.76	2.83
76.1	2.29	2.39	2.49	2.58	2.67	2.76	2.84	2.93	3.01	3.08
88.9	2.47	2.58	2.69	2.79	2.89	2.98	3.07	3.16	3.25	3.33
108	2.72	2.85	2.96	3.07	3.18	3.29	3.39	3.49	3.58	3.67

1.2.2 NiroSan® -F system pipes

Table 9:

Required leg length "X" [m]										
Δl [mm] d [mm]	5	10	15	20	25	30	35	40	45	50
15	0.30	0.42	0.52	0.60	0.67	0.73	0.79	0.85	0.90	0.95
18	0.33	0.46	0.57	0.66	0.73	0.80	0.87	0.93	0.98	1.04
22	0.36	0.51	0.63	0.73	0.81	0.89	0.96	1.03	1.09	1.15
28	0.41	0.58	0.71	0.82	0.91	1.00	1.08	1.16	1.23	1.29
35	0.46	0.65	0.79	0.91	1.02	1.12	1.21	1.29	1.37	1.45
42	0.50	0.71	0.87	1.00	1.12	1.23	1.33	1.42	1.50	1.58
54	0.57	0.80	0.98	1.14	1.27	1.39	1.50	1.61	1.70	1.80
76.1	0.67	0.95	1.17	1.35	1.51	1.65	1.78	1.91	2.02	2.13
88.9	0.73	1.03	1.26	1.46	1.63	1.78	1.93	2.06	2.19	2.30
108	0.80	1.14	1.39	1.61	1.80	1.97	2.13	2.27	2.41	2.54

Required leg length "X" [m]										
Δl [mm] d [mm]	55	60	65	70	75	80	85	90	95	100
15	0.99	1.04	1.08	1.12	1.16	1.20	1.23	1.27	1.30	1.34
18	1.09	1.14	1.18	1.23	1.27	1.31	1.35	1.39	1.43	1.47
22	1.20	1.26	1.31	1.36	1.40	1.45	1.49	1.54	1.58	1.62
28	1.36	1.42	1.47	1.53	1.58	1.64	1.69	1.74	1.78	1.83
35	1.52	1.58	1.65	1.71	1.77	1.83	1.89	1.94	1.99	2.04
42	1.66	1.74	1.81	1.87	1.94	2.00	2.07	2.13	2.18	2.24
54	1.88	1.97	2.05	2.13	2.20	2.27	2.34	2.41	2.48	2.54
76.1	2.24	2.34	2.43	2.52	2.61	2.70	2.78	2.86	2.94	3.02
88.9	2.42	2.52	2.63	2.73	2.82	2.91	3.00	3.09	3.18	3.26
108	2.66	2.78	2.90	3.01	3.11	3.21	3.31	3.41	3.50	3.59

1.2.3 NiroTherm® system pipes

Table 10:

Required leg length "X" [m]										
Δl [mm] d [mm]	5	10	15	20	25	30	35	40	45	50
15	0.34	0.48	0.59	0.68	0.76	0.83	0.90	0.96	1.02	1.07
18	0.37	0.53	0.64	0.74	0.83	0.91	0.98	1.05	1.12	1.18
22	0.41	0.58	0.71	0.82	0.92	1.01	1.09	1.16	1.23	1.30
28	0.46	0.66	0.80	0.93	1.04	1.14	1.23	1.31	1.39	1.47
35	0.52	0.73	0.90	1.04	1.16	1.27	1.37	1.47	1.56	1.64
42	0.57	0.80	0.98	1.14	1.27	1.39	1.50	1.61	1.71	1.80
54	0.64	0.91	1.12	1.29	1.44	1.58	1.71	1.82	1.93	2.04
76.1	0.77	1.08	1.33	1.53	1.71	1.87	2.02	2.16	2.30	2.42
88.9	0.83	1.17	1.43	1.65	1.85	2.03	2.19	2.34	2.48	2.62
108	0.91	1.29	1.58	1.82	2.04	2.23	2.41	2.58	2.73	2.88

Required leg length "X" [m]										
Δl [mm] d [mm]	55	60	65	70	75	80	85	90	95	100
15	1.13	1.18	1.22	1.27	1.32	1.36	1.40	1.44	1.48	1.52
18	1.23	1.29	1.34	1.39	1.44	1.49	1.53	1.58	1.62	1.66
22	1.36	1.43	1.48	1.54	1.59	1.65	1.70	1.75	1.79	1.84
28	1.54	1.61	1.67	1.74	1.80	1.86	1.91	1.97	2.02	2.08
35	1.72	1.80	1.87	1.94	2.01	2.08	2.14	2.20	2.26	2.32
42	1.89	1.97	2.05	2.13	2.20	2.27	2.34	2.41	2.48	2.54
54	2.14	2.23	2.32	2.41	2.50	2.58	2.66	2.73	2.81	2.88
76.1	2.54	2.65	2.76	2.86	2.96	3.06	3.15	3.25	3.34	3.42
88.9	2.74	2.86	2.98	3.09	3.20	3.31	3.41	3.51	3.60	3.70
108	3.02	3.16	3.29	3.41	3.53	3.65	3.76	3.87	3.97	4.08

1.2.4 SANHA®-Therm system pipes

Table 11:

Required leg length "X" [m]										
Δl [mm] d [mm]	5	10	15	20	25	30	35	40	45	50
12	0.33	0.47	0.58	0.67	0.75	0.82	0.88	0.94	1.00	1.05
15	0.37	0.53	0.65	0.75	0.83	0.91	0.99	1.05	1.12	1.18
18	0.41	0.58	0.71	0.82	0.91	1.00	1.08	1.16	1.23	1.29
22	0.45	0.64	0.78	0.90	1.01	1.11	1.19	1.28	1.35	1.43
28	0.51	0.72	0.88	1.02	1.14	1.25	1.35	1.44	1.53	1.61
35	0.57	0.81	0.99	1.14	1.27	1.39	1.51	1.61	1.71	1.80
42	0.62	0.88	1.08	1.25	1.39	1.53	1.65	1.76	1.87	1.97
54	0.71	1.00	1.23	1.41	1.58	1.73	1.87	2.00	2.12	2.24
66.7	0.79	1.11	1.36	1.57	1.76	1.93	2.08	2.22	2.36	2.49
76.1	0.84	1.19	1.45	1.68	1.88	2.06	2.22	2.37	2.52	2.66
88.9	0.91	1.28	1.57	1.82	2.03	2.22	2.40	2.57	2.72	2.87
108	1.00	1.41	1.73	2.00	2.24	2.45	2.65	2.83	3.00	3.16

Required leg length "X" [m]										
Δl [mm] d [mm]	55	60	65	70	75	80	85	90	95	100
12	1.11	1.16	1.20	1.25	1.29	1.33	1.37	1.41	1.45	1.49
15	1.24	1.29	1.34	1.39	1.44	1.49	1.54	1.58	1.62	1.67
18	1.35	1.41	1.47	1.53	1.58	1.63	1.68	1.73	1.78	1.83
22	1.50	1.56	1.63	1.69	1.75	1.81	1.86	1.92	1.97	2.02
28	1.69	1.76	1.84	1.91	1.97	2.04	2.10	2.16	2.22	2.28
35	1.89	1.97	2.05	2.13	2.21	2.28	2.35	2.42	2.48	2.55
42	2.07	2.16	2.25	2.33	2.42	2.50	2.57	2.65	2.72	2.79
54	2.35	2.45	2.55	2.65	2.74	2.83	2.92	3.00	3.08	3.16
66.7	2.61	2.72	2.83	2.94	3.04	3.14	3.24	3.34	3.43	3.52
76.1	2.78	2.91	3.03	3.14	3.25	3.36	3.46	3.56	3.66	3.76
88.9	3.01	3.14	3.27	3.40	3.51	3.63	3.74	3.85	3.96	4.06
108	3.32	3.47	3.61	3.74	3.87	4.00	4.12	4.24	4.36	4.47

1.2.5 Copper pipes

Table 12:

Required leg length "X" [m]										
Δl [mm] d [mm]	5	10	15	20	25	30	35	40	45	50
12	0.26	0.36	0.44	0.51	0.57	0.63	0.68	0.73	0.77	0.81
15	0.29	0.41	0.50	0.57	0.64	0.70	0.76	0.81	0.86	0.91
18	0.31	0.44	0.54	0.63	0.70	0.77	0.83	0.89	0.94	0.99
22	0.35	0.49	0.60	0.70	0.78	0.85	0.92	0.98	1.04	1.10
28	0.39	0.55	0.68	0.78	0.88	0.96	1.04	1.11	1.18	1.24
35	0.44	0.62	0.76	0.88	0.98	1.07	1.16	1.24	1.32	1.39
42	0.48	0.68	0.83	0.96	1.07	1.18	1.27	1.36	1.44	1.52
54	0.54	0.77	0.94	1.09	1.22	1.33	1.44	1.54	1.63	1.72
64 / 66.7	0.61	0.86	1.05	1.21	1.35	1.48	1.60	1.71	1.82	1.92
76.1	0.65	0.91	1.12	1.29	1.45	1.58	1.71	1.83	1.94	2.05
88.9	0.70	0.99	1.21	1.40	1.56	1.71	1.85	1.98	2.10	2.21
108	0.77	1.09	1.33	1.54	1.72	1.89	2.04	2.18	2.31	2.44

Required leg length "X" [m]										
Δl [mm] d [mm]	55	60	65	70	75	80	85	90	95	100
12	0.85	0.89	0.93	0.96	0.99	1.03	1.06	1.09	1.12	1.15
15	0.95	0.99	1.04	1.07	1.11	1.15	1.18	1.22	1.25	1.28
18	1.04	1.09	1.13	1.18	1.22	1.26	1.30	1.33	1.37	1.41
22	1.15	1.20	1.25	1.30	1.35	1.39	1.43	1.48	1.52	1.56
28	1.30	1.36	1.41	1.47	1.52	1.57	1.62	1.66	1.71	1.75
35	1.46	1.52	1.58	1.64	1.70	1.75	1.81	1.86	1.91	1.96
42	1.59	1.66	1.73	1.80	1.86	1.92	1.98	2.04	2.09	2.15
54	1.81	1.89	1.96	2.04	2.11	2.18	2.25	2.31	2.38	2.44
64 / 66.7	2.01	2.10	2.18	2.27	2.35	2.42	2.50	2.57	2.64	2.71
76.1	2.15	2.24	2.33	2.42	2.51	2.59	2.67	2.74	2.82	2.89
88.9	2.32	2.42	2.52	2.62	2.71	2.80	2.88	2.97	3.05	3.13
108	2.56	2.67	2.78	2.88	2.98	3.08	3.18	3.27	3.36	3.45

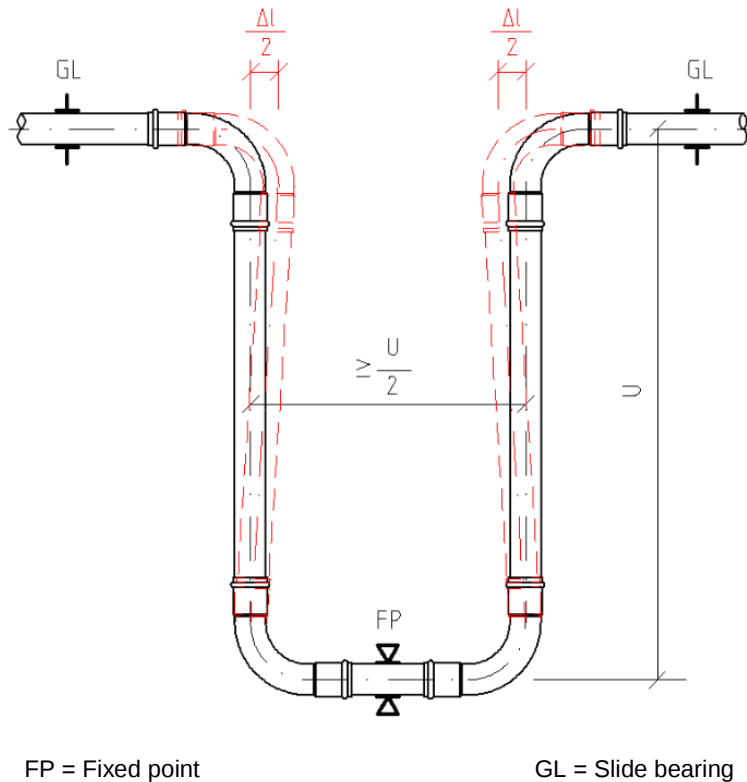
1.2.6 MultiFit®-Flex system pipes

Table 13:

Required leg length "X" [m]										
Δl [mm] d [mm]	5	10	15	20	25	30	35	40	45	50
16	0.45	0.64	0.78	0.90	1.01	1.11	1.20	1.28	1.36	1.43
20	0.51	0.72	0.88	1.01	1.13	1.24	1.34	1.43	1.52	1.60
26	0.58	0.82	1.00	1.15	1.29	1.41	1.53	1.63	1.73	1.82
32	0.64	0.90	1.11	1.28	1.43	1.57	1.69	1.81	1.92	2.02
40	0.72	1.01	1.24	1.43	1.60	1.75	1.89	2.02	2.15	2.26
50	0.80	1.13	1.39	1.60	1.79	1.96	2.12	2.26	2.40	2.53
63	0.90	1.27	1.56	1.80	2.01	2.20	2.38	2.54	2.69	2.84

Required leg length "X" [m]										
Δl [mm] d [mm]	55	60	65	70	75	80	85	90	95	100
16	1.50	1.57	1.63	1.69	1.75	1.81	1.87	1.92	1.97	2.02
20	1.68	1.75	1.82	1.89	1.96	2.02	2.09	2.15	2.20	2.26
26	1.91	2.00	2.08	2.16	2.23	2.31	2.38	2.45	2.51	2.58
32	2.12	2.22	2.31	2.39	2.48	2.56	2.64	2.71	2.79	2.86
40	2.37	2.48	2.58	2.68	2.77	2.86	2.95	3.04	3.12	3.20
50	2.65	2.77	2.88	2.99	3.10	3.20	3.30	3.39	3.49	3.58
63	2.98	3.11	3.24	3.36	3.48	3.59	3.70	3.81	3.91	4.02

1.3 Required leg length “U” of the expansion compensator



Picture 3: Required leg length “U” of the U-bend as expansion compensator to absorb thermal expansion

Calculation formula of the required leg length of the “U” of the U-bend:

$$U = C_{LU} \cdot \frac{\sqrt{d \cdot \Delta l}}{1000} \quad (3)$$

- U = required leg length “U” of the U-bend [m]
- C_{LU} = material constant from table 14
- d = outside diameter [mm]
- Δl = difference of the thermally induced change in length from formula 1 [mm]

Table 14:

Pipe material	Material constant C_{LU}
Stainless steel 1.4301	22.6
Stainless steel 1.4404	20.4
Stainless steel 1.4521	20.0
Unalloyed steel	24.9
copper	19.1
MultiFit®-Flex system pipe	29.2

1.3.1 NiroSan® - and NiroSan®-ECO system pipes

Table 15:

Required leg length "U" [m]										
Δl [mm] d [mm]	5	10	15	20	25	30	35	40	45	50
15	0.18	0.25	0.31	0.35	0.40	0.43	0.47	0.50	0.53	0.56
18	0.19	0.27	0.34	0.39	0.43	0.47	0.51	0.55	0.58	0.61
22	0.21	0.30	0.37	0.43	0.48	0.52	0.57	0.61	0.64	0.68
28	0.24	0.34	0.42	0.48	0.54	0.59	0.64	0.68	0.72	0.76
35	0.27	0.38	0.47	0.54	0.60	0.66	0.71	0.76	0.81	0.85
42	0.30	0.42	0.51	0.59	0.66	0.72	0.78	0.84	0.89	0.94
54	0.34	0.47	0.58	0.67	0.75	0.82	0.89	0.95	1.01	1.06
64	0.37	0.52	0.63	0.73	0.82	0.89	0.97	1.03	1.10	1.15
76.1	0.40	0.56	0.69	0.80	0.89	0.98	1.05	1.13	1.19	1.26
88.9	0.43	0.61	0.75	0.86	0.96	1.05	1.14	1.22	1.29	1.36
108	0.47	0.67	0.82	0.95	1.06	1.16	1.25	1.34	1.42	1.50

Required leg length "U" [m]										
Δl [mm] d [mm]	55	60	65	70	75	80	85	90	95	100
15	0.59	0.61	0.64	0.66	0.68	0.71	0.73	0.75	0.77	0.79
18	0.64	0.67	0.70	0.72	0.75	0.77	0.80	0.82	0.84	0.87
22	0.71	0.74	0.77	0.80	0.83	0.86	0.88	0.91	0.93	0.96
28	0.80	0.84	0.87	0.90	0.94	0.97	1.00	1.02	1.05	1.08
35	0.90	0.94	0.97	1.01	1.05	1.08	1.11	1.15	1.18	1.21
42	0.98	1.02	1.07	1.11	1.15	1.18	1.22	1.25	1.29	1.32
54	1.11	1.16	1.21	1.25	1.30	1.34	1.38	1.42	1.46	1.50
64	1.21	1.26	1.32	1.37	1.41	1.46	1.51	1.55	1.59	1.63
76.1	1.32	1.38	1.44	1.49	1.54	1.59	1.64	1.69	1.74	1.78
88.9	1.43	1.49	1.55	1.61	1.67	1.72	1.77	1.83	1.88	1.92
108	1.57	1.64	1.71	1.77	1.84	1.90	1.96	2.01	2.07	2.12

1.3.2 NiroSan® -F system pipes

Table 16:

Required leg length “U” [m]										
Δl [mm] d [mm]	5	10	15	20	25	30	35	40	45	50
15	0.17	0.24	0.30	0.35	0.39	0.42	0.46	0.49	0.52	0.55
18	0.19	0.27	0.33	0.38	0.42	0.46	0.50	0.54	0.57	0.60
22	0.21	0.30	0.36	0.42	0.47	0.51	0.55	0.59	0.63	0.66
28	0.24	0.33	0.41	0.47	0.53	0.58	0.62	0.67	0.71	0.75
35	0.26	0.37	0.46	0.53	0.59	0.65	0.70	0.75	0.79	0.83
42	0.29	0.41	0.50	0.58	0.65	0.71	0.77	0.82	0.87	0.91
54	0.33	0.46	0.57	0.66	0.73	0.80	0.87	0.93	0.98	1.04
76.1	0.39	0.55	0.67	0.78	0.87	0.95	1.03	1.10	1.17	1.23
88.9	0.42	0.59	0.73	0.84	0.94	1.03	1.11	1.19	1.26	1.33
108	0.46	0.66	0.80	0.93	1.04	1.14	1.23	1.31	1.39	1.47

Required leg length “U” [m]										
Δl [mm] d [mm]	55	60	65	70	75	80	85	90	95	100
15	0.57	0.60	0.62	0.65	0.67	0.69	0.71	0.73	0.75	0.77
18	0.63	0.66	0.68	0.71	0.73	0.76	0.78	0.80	0.83	0.85
22	0.69	0.73	0.75	0.78	0.81	0.84	0.86	0.89	0.91	0.94
28	0.78	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.06
35	0.88	0.91	0.95	0.99	1.02	1.06	1.09	1.12	1.15	1.18
42	0.96	1.00	1.04	1.08	1.12	1.16	1.19	1.23	1.26	1.29
54	1.09	1.14	1.18	1.23	1.27	1.31	1.35	1.39	1.43	1.47
76.1	1.29	1.35	1.40	1.46	1.51	1.56	1.60	1.65	1.70	1.74
88.9	1.40	1.46	1.52	1.57	1.63	1.68	1.73	1.78	1.83	1.88
108	1.54	1.61	1.67	1.74	1.80	1.85	1.91	1.97	2.02	2.07

1.3.3 NiroTherm® system pipes

Table 17:

Required leg length “U” [m]										
Δl [mm] d [mm]	5	10	15	20	25	30	35	40	45	50
15	0.20	0.28	0.34	0.39	0.44	0.48	0.52	0.55	0.59	0.62
18	0.21	0.30	0.37	0.43	0.48	0.53	0.57	0.61	0.64	0.68
22	0.24	0.34	0.41	0.48	0.53	0.58	0.63	0.67	0.71	0.75
28	0.27	0.38	0.46	0.54	0.60	0.66	0.71	0.76	0.80	0.85
35	0.30	0.42	0.52	0.60	0.67	0.73	0.79	0.85	0.90	0.95
42	0.33	0.46	0.57	0.66	0.73	0.80	0.87	0.93	0.98	1.04
54	0.37	0.53	0.64	0.74	0.83	0.91	0.98	1.05	1.12	1.18
76.1	0.44	0.62	0.77	0.88	0.99	1.08	1.17	1.25	1.33	1.40
88.9	0.48	0.68	0.83	0.95	1.07	1.17	1.26	1.35	1.43	1.51
108	0.53	0.74	0.91	1.05	1.18	1.29	1.39	1.49	1.58	1.66

Required leg length “U” [m]										
Δl [mm] d [mm]	55	60	65	70	75	80	85	90	95	100
15	0.65	0.68	0.71	0.73	0.76	0.78	0.81	0.83	0.85	0.88
18	0.71	0.74	0.77	0.80	0.83	0.86	0.89	0.91	0.94	0.96
22	0.79	0.82	0.86	0.89	0.92	0.95	0.98	1.01	1.04	1.06
28	0.89	0.93	0.97	1.00	1.04	1.07	1.10	1.14	1.17	1.20
35	0.99	1.04	1.08	1.12	1.16	1.20	1.24	1.27	1.31	1.34
42	1.09	1.14	1.18	1.23	1.27	1.31	1.35	1.39	1.43	1.47
54	1.23	1.29	1.34	1.39	1.44	1.49	1.53	1.58	1.62	1.66
76.1	1.47	1.53	1.59	1.65	1.71	1.77	1.82	1.87	1.93	1.98
88.9	1.58	1.65	1.72	1.79	1.85	1.91	1.97	2.03	2.08	2.14
108	1.75	1.82	1.90	1.97	2.04	2.10	2.17	2.23	2.29	2.35

1.3.4 SANHA®-Therm system pipes

Table 18:

Required leg length "U" [m]										
Δl [mm] d [mm]	5	10	15	20	25	30	35	40	45	50
12	0.19	0.27	0.33	0.39	0.43	0.47	0.51	0.54	0.58	0.61
15	0.22	0.30	0.37	0.43	0.48	0.53	0.57	0.61	0.65	0.68
18	0.24	0.33	0.41	0.47	0.53	0.58	0.62	0.67	0.71	0.75
22	0.26	0.37	0.45	0.52	0.58	0.64	0.69	0.74	0.78	0.82
28	0.29	0.42	0.51	0.59	0.66	0.72	0.78	0.83	0.88	0.93
35	0.33	0.46	0.57	0.66	0.74	0.81	0.87	0.93	0.99	1.04
42	0.36	0.51	0.62	0.72	0.81	0.88	0.95	1.02	1.08	1.14
54	0.41	0.58	0.71	0.82	0.91	1.00	1.08	1.16	1.23	1.29
66.7	0.45	0.64	0.79	0.91	1.01	1.11	1.20	1.28	1.36	1.44
76.1	0.48	0.69	0.84	0.97	1.08	1.19	1.28	1.37	1.45	1.53
88.9	0.52	0.74	0.91	1.05	1.17	1.28	1.39	1.48	1.57	1.66
108	0.58	0.82	1.00	1.16	1.29	1.41	1.53	1.63	1.73	1.83

Required leg length "U" [m]										
Δl [mm] d [mm]	55	60	65	70	75	80	85	90	95	100
12	0.64	0.67	0.69	0.72	0.75	0.77	0.79	0.82	0.84	0.86
15	0.71	0.75	0.78	0.81	0.83	0.86	0.89	0.91	0.94	0.96
18	0.78	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.05
22	0.86	0.90	0.94	0.98	1.01	1.04	1.07	1.11	1.14	1.17
28	0.98	1.02	1.06	1.10	1.14	1.18	1.21	1.25	1.28	1.32
35	1.09	1.14	1.19	1.23	1.27	1.32	1.36	1.39	1.43	1.47
42	1.19	1.25	1.30	1.35	1.39	1.44	1.48	1.53	1.57	1.61
54	1.35	1.41	1.47	1.53	1.58	1.63	1.68	1.73	1.78	1.83
66.7	1.51	1.57	1.64	1.70	1.76	1.82	1.87	1.93	1.98	2.03
76.1	1.61	1.68	1.75	1.81	1.88	1.94	2.00	2.06	2.11	2.17
88.9	1.74	1.82	1.89	1.96	2.03	2.10	2.16	2.22	2.28	2.34
108	1.92	2.00	2.08	2.16	2.24	2.31	2.38	2.45	2.52	2.58

1.3.5 Copper pipes

Table 19:

Required leg length "U" [m]										
Δl [mm] d [mm]	5	10	15	20	25	30	35	40	45	50
12	0.15	0.21	0.26	0.30	0.33	0.36	0.39	0.42	0.44	0.47
15	0.17	0.23	0.29	0.33	0.37	0.41	0.44	0.47	0.50	0.52
18	0.18	0.26	0.31	0.36	0.41	0.44	0.48	0.51	0.54	0.57
22	0.20	0.28	0.35	0.40	0.45	0.49	0.53	0.57	0.60	0.64
28	0.23	0.32	0.39	0.45	0.51	0.55	0.60	0.64	0.68	0.72
35	0.25	0.36	0.44	0.51	0.57	0.62	0.67	0.72	0.76	0.80
42	0.28	0.39	0.48	0.55	0.62	0.68	0.73	0.78	0.83	0.88
54	0.31	0.44	0.54	0.63	0.70	0.77	0.83	0.89	0.94	0.99
64 / 66.7	0.35	0.49	0.61	0.70	0.78	0.86	0.93	0.99	1.05	1.11
76.1	0.37	0.53	0.65	0.75	0.84	0.91	0.99	1.06	1.12	1.18
88.9	0.40	0.57	0.70	0.81	0.90	0.99	1.07	1.14	1.21	1.28
108	0.44	0.63	0.77	0.89	0.99	1.09	1.18	1.26	1.33	1.41

Required leg length "U" [m]										
Δl [mm] d [mm]	55	60	65	70	75	80	85	90	95	100
12	0.49	0.51	0.53	0.55	0.57	0.59	0.61	0.63	0.65	0.66
15	0.55	0.57	0.60	0.62	0.64	0.66	0.68	0.70	0.72	0.74
18	0.60	0.63	0.65	0.68	0.70	0.73	0.75	0.77	0.79	0.81
22	0.67	0.70	0.72	0.75	0.78	0.80	0.83	0.85	0.88	0.90
28	0.75	0.78	0.82	0.85	0.88	0.91	0.93	0.96	0.99	1.01
35	0.84	0.88	0.91	0.95	0.98	1.01	1.04	1.07	1.10	1.13
42	0.92	0.96	1.00	1.04	1.07	1.11	1.14	1.18	1.21	1.24
54	1.04	1.09	1.13	1.18	1.22	1.26	1.30	1.33	1.37	1.41
64 / 66.7	1.16	1.21	1.26	1.31	1.35	1.40	1.44	1.48	1.52	1.56
76.1	1.24	1.29	1.35	1.40	1.45	1.49	1.54	1.58	1.63	1.67
88.9	1.34	1.40	1.46	1.51	1.56	1.61	1.66	1.71	1.76	1.81
108	1.48	1.54	1.60	1.66	1.72	1.78	1.83	1.89	1.94	1.99

1.3.6 MultiFit®-Flex system pipes

Table 20:

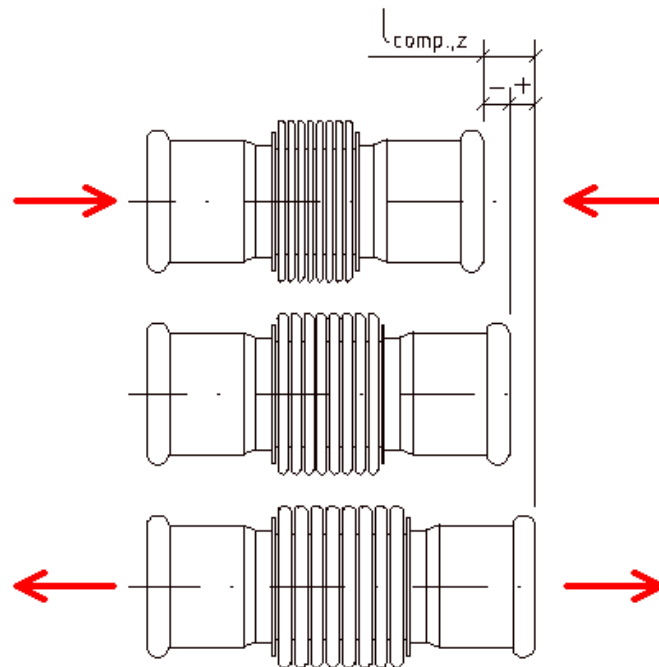
Required leg length "U" [m]										
Δl [mm] d [mm]	5	10	15	20	25	30	35	40	45	50
16	0.26	0.37	0.45	0.52	0.58	0.64	0.69	0.74	0.78	0.83
20	0.29	0.41	0.51	0.58	0.65	0.72	0.77	0.83	0.88	0.92
26	0.33	0.47	0.58	0.67	0.74	0.82	0.88	0.94	1.00	1.05
32	0.37	0.52	0.64	0.74	0.83	0.90	0.98	1.04	1.11	1.17
40	0.41	0.58	0.72	0.83	0.92	1.01	1.09	1.17	1.24	1.31
50	0.46	0.65	0.80	0.92	1.03	1.13	1.22	1.31	1.39	1.46
63	0.52	0.73	0.90	1.04	1.16	1.27	1.37	1.47	1.56	1.64

Required leg length "U" [m]										
Δl [mm] d [mm]	55	60	65	70	75	80	85	90	95	100
16	0.87	0.90	0.94	0.98	1.01	1.04	1.08	1.11	1.14	1.17
20	0.97	1.01	1.05	1.09	1.13	1.17	1.20	1.24	1.27	1.31
26	1.10	1.15	1.20	1.25	1.29	1.33	1.37	1.41	1.45	1.49
32	1.23	1.28	1.33	1.38	1.43	1.48	1.52	1.57	1.61	1.65
40	1.37	1.43	1.49	1.55	1.60	1.65	1.70	1.75	1.80	1.85
50	1.53	1.60	1.66	1.73	1.79	1.85	1.90	1.96	2.01	2.07
63	1.72	1.80	1.87	1.94	2.01	2.07	2.14	2.20	2.26	2.32

1.4 Calculation of the expansion compensation of the SANHA® axial-compensator

The **SANHA**® axial-compensators (catalogue-no. 9872L, 18872L, 91872L and 98872L) are designed to absorb axial movements. The basic data of these compensators are:

- Nominal pressure (operating pressure) of PN 16 (max. 16 bar)
- Reference temperature (operating temperature) of 20 °C
- Maximum axial movement absorption " $l_{comp.,z}$ " (see table 21)
- 1000 load changes with maximum axial movement absorption.



Picture 4: Axial movement „ $l_{komp.,z}$ “ of the **SANHA**® axial-compensators

Table 21: Technical specifications for **SANHA**® axial-compensator

Dimension d [mm]	Axial movement ^{*)} $l_{comp.,z}$ [mm]	Axial movement ^{**)} $l_{comp.,z}$ [mm]	Spring rate (± 30%) C [N/mm]	Effective cross section area AB [cm ²]
15	± 7	- 7	42	4
18	± 7	- 7	42	4
22	± 11	- 11	38	5
28	± 12	- 12	36	8
35	± 12	- 12	42	12
42	± 12	- 12	72	19
54	± 14	- 14	65	28
64	± 23	- 23	111	46
76.1	± 23	- 23	111	46
88.9	± 23	- 23	81	66
108	± 23	- 23	80	100
^{*)} applies for 1,000 load changes			^{**)} applies for 10,000 load changes	

Every axial compensator must be adjusted to the requirements of the individual system. The influencing factors are:

- the expansion coefficient of the pipe material (α),
- the operating pressure of the system (p_B),
- the operating temperature (ϑ_B),
- the pipe length (l_0),
- number of daily load changes and the resulting service life of the axial compensator.

These parameters are taken into account in the calculation formulas 1 (see section 1.1.), 4 to 7 by means of various correction factors. The service life can be increased, deviating from the basic value of the axial compensator, when taking into account the correction factors. An extension of the service life of the axial compensator effects the number and their possible expansion compensations. If an operating pressure higher than 16 bar, or a different type of axial compensator (e.g. with higher expansion compensation) is required, the enquiry or layout forms attached may be used to make an enquiry to SANHA UK Ltd.

Calculation formula for the correction of the nominal pressure of the axial compensator:

$$PN = p_B / A_p \quad (4)$$

PN = nominal pressure of the axial compensator [bar]
 p_B = max. operating pressure of the system [bar]
 A_p = operating pressure correction factor from table 22

Calculation formula for the correction of the axial movement absorption by operating temperature:

$$\Delta l_B = \Delta l / A_f \quad (5)$$

Δl_B = corrected axial movement absorption by operating temperature [mm]
 Δl = difference of the thermally induced change in length [mm]
 A_f = expansion compensation correction factor from table 22

Calculation formula for the correction of the axial movement absorption by the load changes (1000 load changes at max. axial expansion compensation):

$$\Delta l_{\text{comp.}} = \Delta l_B / A_L \quad (6)$$

$\Delta l_{\text{comp.}}$ = corrected axial movement absorption by load change [mm]
 Δl_B = corrected axial movement absorption [mm]
 A_L = load cycles factor from diagram 1

Calculation formula for the number of axial compensators:

$$N_o = \Delta l_{\text{comp.}} / l_{\text{comp.,z}} \quad (7)$$

N_o = number of axial compensators of the selected pipe length [units]
 $\Delta l_{\text{comp.}}$ = corrected load change [mm]
 $\Delta l_{\text{comp.,z}}$ = axial movement absorption of the axial compensator from table 21 [mm]

Example:

given:

Basic values of the axial compensator

PN 16

1000 load changes at $\vartheta = 20^\circ\text{C}$

$d = 54\text{ mm}$ (selected)

4 cycles per day (selected) $\rightarrow$ 250 days

$\Delta l_{\text{comp.,z}} = 14\text{ mm}$ (table 21)

Selected values for axial compensator calculation

$p_o = 13\text{ bar}$

$\vartheta_B = 70^\circ\text{C}$

$\Delta T = 50\text{ K}$ (Installation temperature 20°C , selected)

$d = 54\text{ mm}$

8 cycles per day (selected) $\rightarrow$ 2,920 cycles per year

$l_o = 20\text{ m}$

Material: stainless steel 1.4404 $\rightarrow \alpha = 16.5 \cdot 10^{-6}\text{ K}^{-1}$ (table 1)

needed:

N_o

Service life_{comp.}

Solution:

$\Delta l = 16.5\text{ mm}$ (from formula 1)

PN = 15.48 bar ≈ 16 ($A_p = 0.84$ from table 22 and formula 4)

$\Delta l_B = 17.01\text{ mm}$ ($A_f = 0.97$ from table 22 and from formula 5)

$\Delta l_{\text{comp.}} = 21.8\text{ mm}$ ($A_L = 0.78$ from diagram 1 with load change 2,920 at pressure load 100 % and from formula 6)

$N_o = 2$ (from formula 7)

$\Delta l_{\text{comp.,z,eff}} = 10.9\text{ mm}$ per axial compensator (effective load change)

$\Delta l_{\text{comp.,z,eff}} < \Delta l_{\text{comp.,z}} \rightarrow \text{load change}_{\text{eff.}} < \text{load change}_{\text{comp.,z}}$ of the basic value (from table 21)

Check:

$A_L = 0.39$ (ratio equation between $\Delta l_{\text{comp.}}$ and $\Delta l_{\text{comp.,z,eff}}$)

load change_{eff} = 50.000 (diagram 1 with $A_L = 0,39$ by pressure load 100 %)

load change_{eff} > load change_{gewählt}

Service life_{comp.} = 17 years (with load change_{eff} = 50.000 by 8 cycles per day)

Conclusion:

The selected compensators are only compressed due to the temperature change between room temperature (20 °C) and operating temperature (70 °C) , if they are installed according to the state of the art and tensile free. Therefore, tension loading does not occur. The maximum axial movement absorption can subsequently be reduced to ~ 39 % and the load cycle rate increased to 50,000 given that all other parameter stay the same. The arithmetical service life is ~ 17 years.

Diagram 1: Service life diagram for **SANHA**® axial compensator

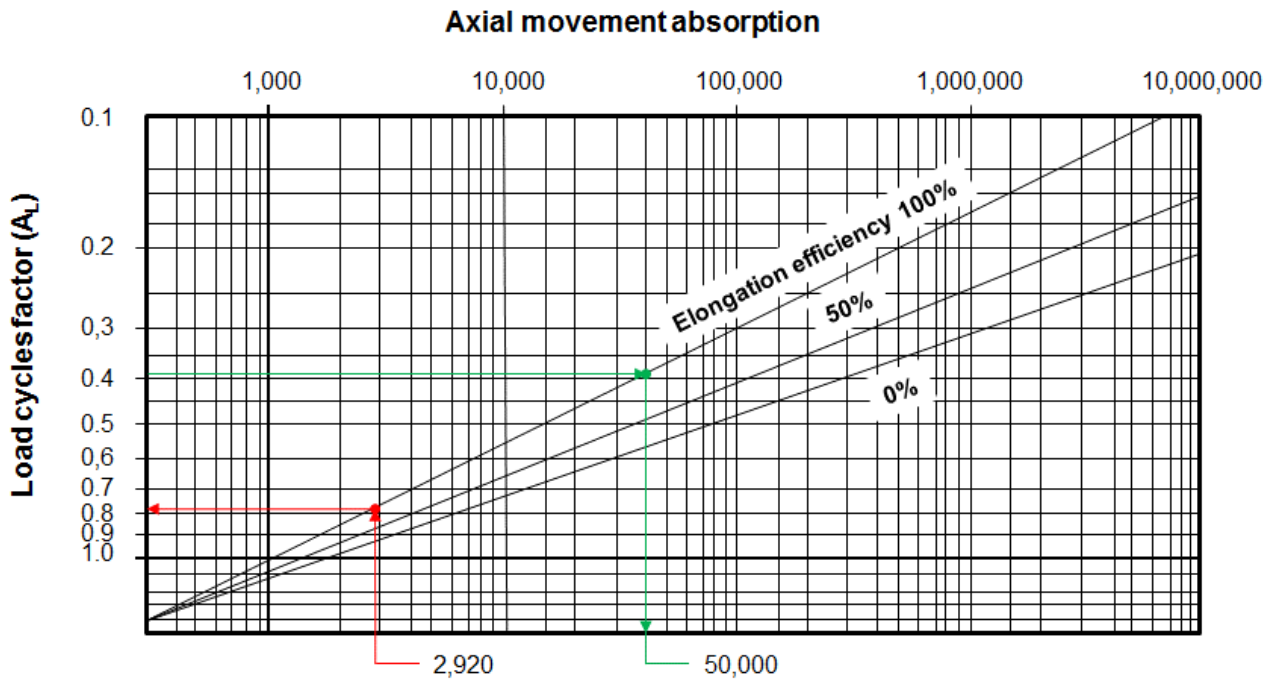
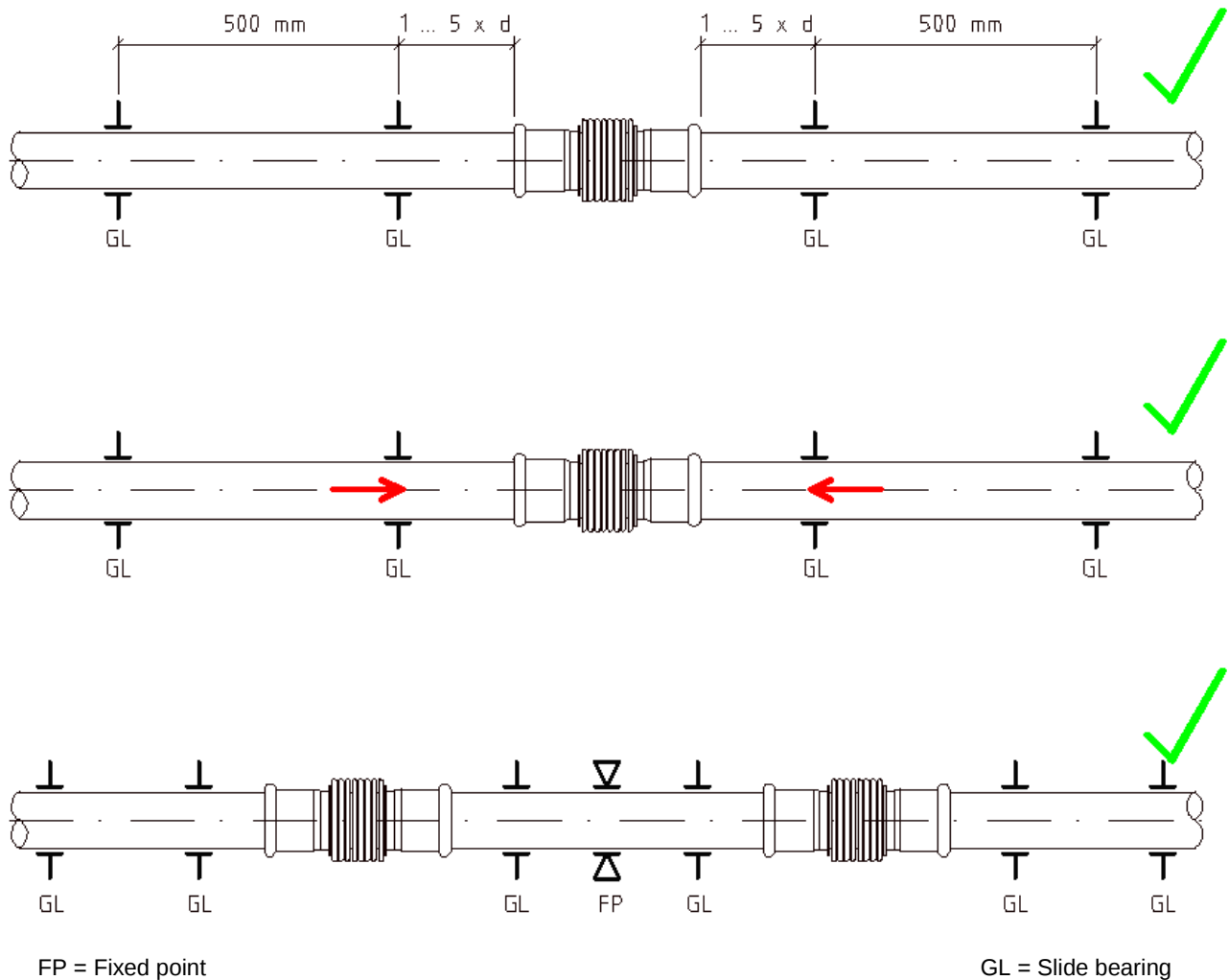


Table 22:

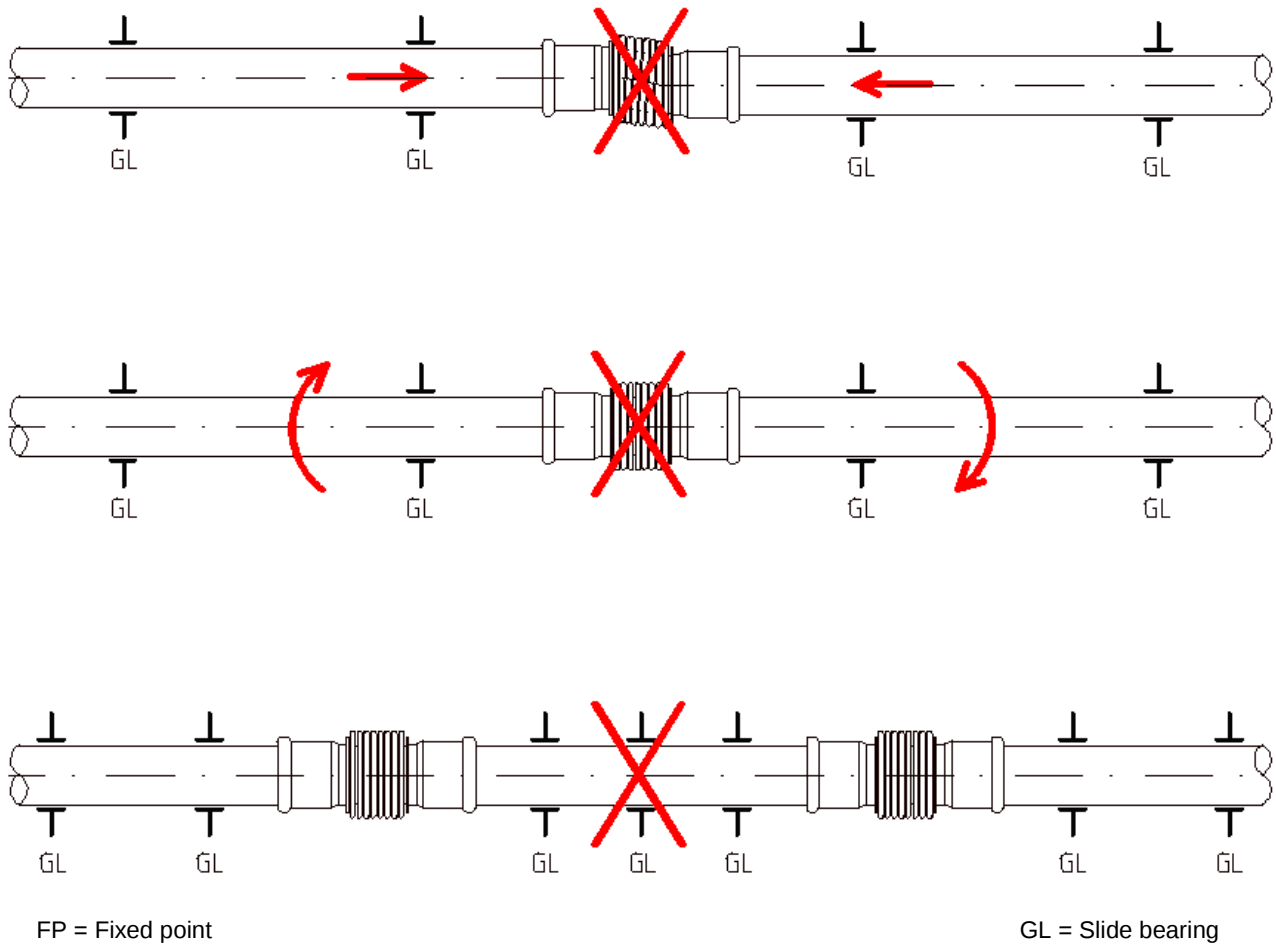
Operating temperature ϑ_B °C	Operating pressure correction factor A_p	Expansion compensation correction factor A_f
20	1.00	1.00
100	0.84	0.97
150	0.78	0.95
200	0.74	0.93
250	0.70	0.91
300	0.67	0.89
350	0.64	0.87
400	0.63	0.85
450	0.62	0.84
500	0.60	0.82

1.5 Installation diagrams of the SANHA® axial compensator

The **SANHA**® axial compensators are installed in a tempered condition, in particular without pretension. They cannot absorb torsional, vibrational and shifted tension forces. The bellows of the axial compensators are subject to a limited service life due to the movement caused by the thermally induced change in length of the pipeline. The compensators must thus always be installed in freely accessible, uncovered areas and undergo periodical checks.



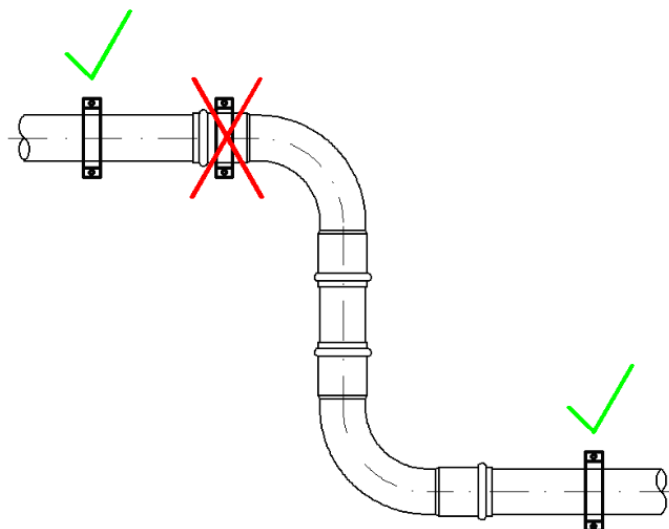
Picture 5: Correct installation of the **SANHA**® axial compensator



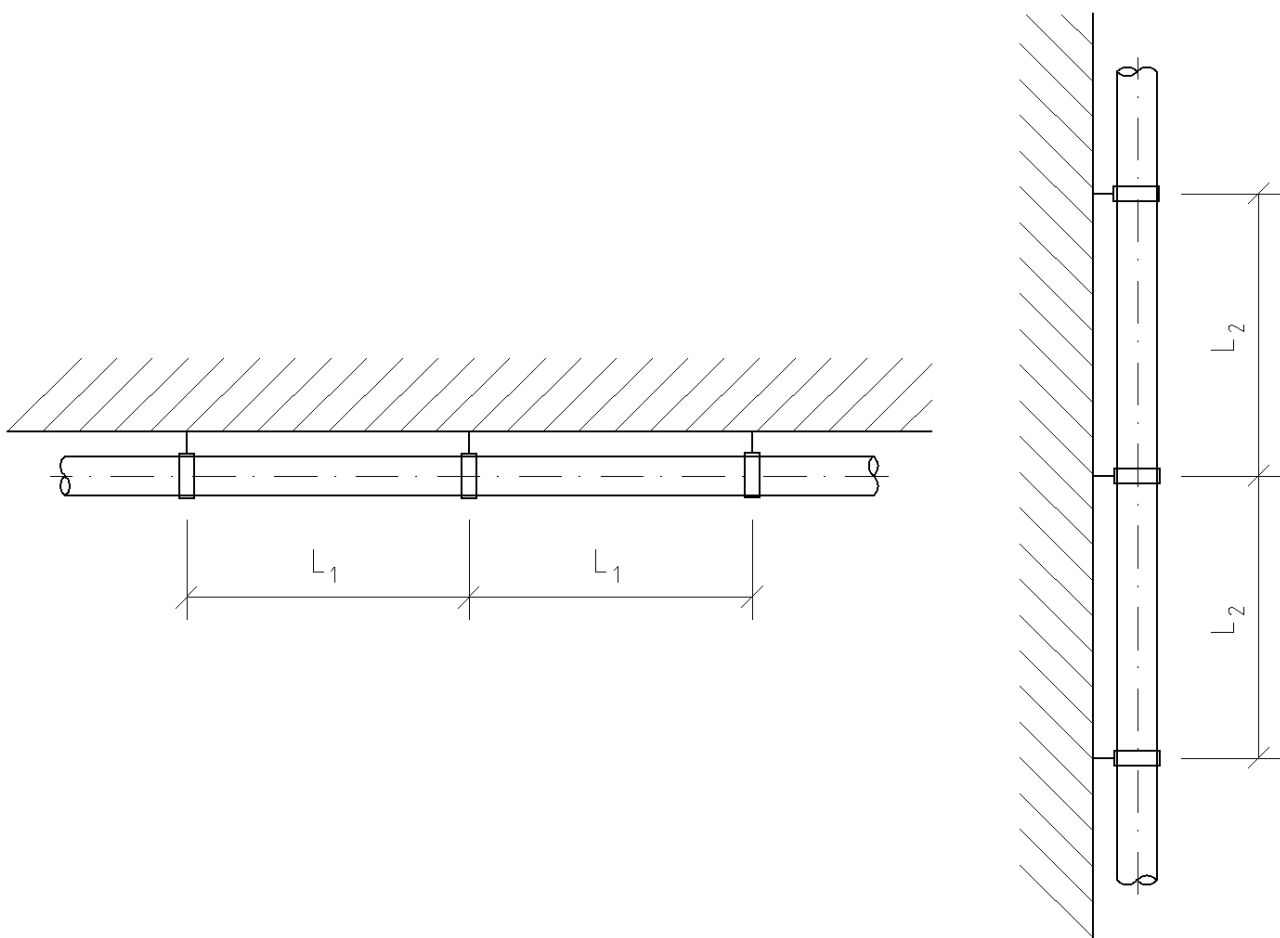
Picture 6: Incorrect installation of the **SANHA®** axial compensator

2 Pipe installation spacing

Pipes must be connected directly to the building using standard commercial clamps and must not be mounted on other pipes. In order to fulfil the noise protection requirements, clamps with rubber lining must be used. Clamps must always be attached to the pipe, not to the fitting (see picture 7). In order to avoid unintended fixed points, keep a distance from points where the pipeline changes direction. As waste fittings and traps and device connections act as fixed points, it is important to maintain a distance from these too.



Picture 7: Installation of the pipe clamps



Picture 8: Schematic diagram of the pipe installation spacing

The tables of points 2.1 to 2.5 refer to the schematic diagram shown here.

2.1 Maximum distances for the installation of metal pipes according to EN 806-4

Table 23:

Copper pipe according to EN 1057	d [mm]	Fastening distance for the horizontal pipe string* L ₁ [m]	Fastening distance for the vertical pipe string * L ₂ [m]
	Stainless steel pipes accord. to EN 10312		
12	-	1.00	1.50
15	15	1.20	1.80
18	18	1.20	1.80
22	22	1.80	2.40
28	28	1.80	2.40
35	35	2.40	3.00
42	42	2.40	3.00
54	54	2.70	3.60
64	64	3.00	3.60
66.7	-	3.00	3.60
76.1	76.1	3.00	3.60
88.9	88.9	3.00	3.60
108	108	3.00	3.60
* Due to different wall thickness and degrees of hardness, the distances between the fastenings for copper pipes may vary depending on locally applied dimensions.			

2.2 Maximum distances for the installation of plastic composite pipes according to EN 806-4

Table 24:

d [mm]	Fastening distance L ₁ or L ₂ [m]	
	Cold water	Hot water
≤ 16	0.60	0.25
> 16 up to ≤ 20	0.70	0.30
> 20 up to ≤ 25	0.80	0.35
> 25 up to ≤ 32	0.90	0.40
> 32 up to ≤ 40	1.10	0.50
> 40 up to ≤ 50	1.25	0.60
> 50 up to ≤ 63	1.40	0.75

2.3 Maximum distances for the installation of SANHA[®] system pipes made of unalloyed steel and stainless steel

Table 25:

d [mm]	Fastening distance L₁ or L₂ [m]
12	1.25
15	1.25
18	1.50
22	2.00
28	2.25
35	2.75
42	3.00
54	3.50
64	4.00
66.7	4.00
76.1	4.25
88.9	4.75
108	5.00

The values listed in the table can be used if the regulations of the selected field of application do not specify any rules on the fastening distances.

3 Pipe weights

3.1 NiroSan® system pipes

Table 26:

d x s [mm]	Weight of empty pipe [kg/m]	Weight of water-filled pipe [kg/m]	Water volume [l/m]
15 x 1,0	0.35	0.48	0.13
18 x 1,0	0.43	0.63	0.20
22 x 1,2	0.63	0.93	0.30
28 x 1,2	0.81	1.32	0.51
35 x 1,5	1.26	2.06	0.80
42 x 1,5	1.52	2.72	1.19
54 x 1,5	1.97	4.02	2.04
64 x 2,0	3.11	5.94	2.83
76.1 x 2,0	3.72	7.80	4.08
88.9 x 2,0	4.36	10.02	5.66
108 x 2,0	5.31	13.81	8.49

3.2 NiroSan®-F system pipes

Table 27:

d x s [mm]	Weight of empty pipe [kg/m]	Weight of water-filled pipe [kg/m]	Water volume [l/m]
15 x 1,0	0.34	0.47	0.13
18 x 1,0	0.41	0.61	0.20
22 x 1,2	0.60	0.91	0.30
28 x 1,2	0.78	1.29	0.51
35 x 1,5	1.22	2.02	0.80
42 x 1,5	1.47	2.66	1.19
54 x 1,5	1.90	3.95	2.04
76.1 x 2,0	3.58	7.67	4.08
88.9 x 2,0	4.20	9.87	5.66
108 x 2,0	5.13	13.62	8.49

3.3 NiroSan®-ECO system pipes

Table 28:

d x s [mm]	Weight of empty pipe [kg/m]	Weight of water-filled pipe [kg/m]	Water volume [l/m]
15 x 0,6	0.22	0.37	0.15
18 x 0,7	0.30	0.52	0.22
22 x 0,7	0.37	0.71	0.33
28 x 0,8	0.55	1.09	0.55
35 x 1,0	0.85	1.71	0.86
42 x 1,1	1.13	2.37	1.24
54 x 1,2	1.59	3.68	2.09
76.1 x 1,5	2.81	7.00	4.20
88.9 x 1,5	3.29	9.08	5.80
108 x 1,5	4.00	12.66	8.66

3.4 NiroTherm® system pipes

Table 29:

d x s [mm]	Weight of empty pipe [kg/m]	Weight of water-filled pipe [kg/m]	Water volume [l/m]
15 x 0,6	0.21	0.36	0.15
18 x 0,7	0.30	0.52	0.22
22 x 0,7	0.37	0.70	0.33
28 x 0,8	0.54	1.09	0.55
35 x 1,0	0.84	1.70	0.86
42 x 1,1	1.12	2.36	1.24
54 x 1,2	1.57	3.66	2.09
76.1 x 1,5	2.78	6.97	4.20
88.9 x 1,5	3.25	9.05	5.80
108 x 1,5	3.96	12.62	8.66

3.5 SANHA®-Therm system pipes

Table 30:

d x s [mm]	Weight of empty pipe [kg/m]	Weight of water-filled pipe [kg/m]	Water volume [l/m]
12 x 1,2	0.32	0.40	0.07
15 x 1,2	0.42	0.54	0.12
18 x 1,2	0.51	0.70	0.19
22 x 1,5	0.77	1.05	0.28
28 x 1,5	1.00	1.49	0.49
35 x 1,5	1.26	2.06	0.80
42 x 1,5	1.52	2.72	1.19
54 x 1,5	1.97	4.02	2.04
66.7 x 1,5	2.45	5.64	3.19
76.1 x 2,0	3.72	7.80	4.08
88.9 x 2,0	4.36	10.02	5.66
108 x 2,0	5.31	13.81	8.49

3.6 MultiFit®-Flex system pipes

Table 31:

d x s [mm]	Weight of empty pipe [kg/m]	Weight of water-filled pipe [kg/m]	Water volume [l/m]
16 x 2,0	0,10	0,21	0,11
20 x 2,0	0,14	0,34	0,20
26 x 3,0	0,26	0,57	0,31
32 x 3,0	0,35	0,88	0,53
40 x 3,5	0,49	1,35	0,86
50 x 4,0	0,72	2,10	1,39
63 x 4,5	1,06	3,35	2,29

3.7 Copper pipes

Table 32

d x s [mm]	Weight of empty pipe [kg/m]	Weight of water-filled pipe [kg/m]	Water volume [l/m]
12 x 0,8	0,25	0,34	0,08
12 x 1,0	0,31	0,39	0,08
15 x 1,0	0,39	0,52	0,13
18 x 1,0	0,48	0,68	0,20
22 x 1,0	0,59	0,90	0,31
28 x 1,0	0,75	1,29	0,53
28 x 1,5	1,11	1,60	0,49
35 x 1,2	1,13	1,97	0,83
35 x 1,5	1,40	2,21	0,80
42 x 1,2	1,37	2,60	1,23
42 x 1,5	1,70	2,89	1,19
54 x 1,5	2,20	4,24	2,04
54 x 2,0	2,91	4,87	1,96
64 x 2,0	3,47	6,29	2,83
76,1 x 2,0	4,14	8,23	4,08
88,9 x 2,0	4,86	10,52	5,66
108 x 2,5	7,37	15,71	8,33

4 Appendix

4.1 Axial compensator enquiry form

Form for the axial compensator enquiry for aqueous media			
Name of field sales employee:			
Process no.:		Date of receipt:	
Customer's address:			
Project address:			
Application:			
Name of medium:			
Operation pressure:			
Required nominal pressure level:			
Operating temperature of medium mixture:			
Special requirements / external influences:			
Requested pipe material:		Stainless steel, material no. 1.4404:	☐
		Copper, material no. CW 024A:	☐
Connection type of the compensator:		Press connection:	☐
		Flange connection:	☐
		Whitworth pipe coupling:	☐
		Screw connection:	☐

Form for the axial compensator enquiry for aqueous media (continued)

Selected service life (load change):			1000 (standard): ☐		
			Other quantity:		
Units:		Dimension:		Selected expansion compensation:	
Other requirements (influencing factors):					

4.2 Axial compensator layout form

Form for the axial compensator layout for aqueous media			
Name of field sales employee:			
Process no.:		Date of receipt:	
Customer's address:			
Project address:			
Required drawings:		Ground plan, sectional drawing, ducting scheme	
Application:			
Name of medium:			
Operation pressure:			
Required nominal pressure level:			
Operating temperature of medium mixture:			
Special requirements / external influences:			
Requested pipe material:		Stainless steel, material no. 1.4404:	☐
		Copper, material no. CW 024A:	☐
Connection type of the compensator:		Press connection:	☐
		Flange connection:	☐
		Whitworth pipe coupling:	☐
		Screw connection:	☐

Form for the axial compensator layout for aqueous media (continued)

Selected service life (load change):	1000 (standard): ☐	
	Other quantity:	
Calculated flow rate	Distributor line:	
	Riser:	
	Storey line:	
	Individual supply line:	
Flow rate at operating conditions:	Distributor line:	
	Riser:	
	Storey line:	
	Individual supply line:	
Other requirements (influencing factors):		

With safety on your side

SANHA offers genuine advantages

As a family enterprise for over 50 years we have been observing a simple principle: every pipe and every fitting must give the customer added value in terms of safety and practical use at a fair price. This is our mission and, at the same time, the best recommendation from our satisfied customers.

As a specialist for pipeline systems we offer a unique breadth and depth of products for all of the usual connection techniques and applications from a one stop shop. Tried and tested installation techniques are as much a part of our program as practice-oriented innovations.

And that's why: SANHA. Always a perfect fit.

Your advantages:

1 Full tool compatibility

Throughout the industry, SANHA system fittings are the only ones that can be pressed with all the usual original press profiles – with a full guarantee. You gain security by ruling out errors, thus saving time and money.

2 Large product range

SANHA offers a wide material, product and dimension range, multiple connection methods, with significant expertise and experience – all from a one stop shop. SANHA, the pipeline specialist.

3 Guaranteed safety

SANHA has all the important approvals, certifications and warranties, backed up by WRAS and BSI, ensuring you are always on the safe side.

4 Nationwide technical service

SANHA is pleased to offer a wide range of services from installation training, technical seminars, design advice, specifications and on site support as and when required.

