

Manaqurite® 9000



MANOIR
A PARALLOY GROUP COMPANY

CHEMICAL COMPOSITION

Element	Minimum	Maximum
C	0.10	0.18
Mn	-	1.50
Si	0.50	1.25
Ni	30.0	35.0
Cr	19.0	23.0
Nb	0.80	1.20

(Typical composition, slight modifications can be carried out depending on the application).

PHYSICAL PROPERTIES

Specific gravity: 8.02 kg/dm³ 0.290 lb/inch³

Melting point: 1 380° C 2 520°F

Thermal conductivity:

At 100°C: 13 W/m.°C (210°F: 7.5 BTU/h.ft.°F)

At 820°C: 25 W/m.°C (1 500°F: 14.5 BTU/h.ft.°F)

Electrical resistivity at: 20°C (77°F): 1 x 10⁻⁶ Ω.m

Modulus of elasticity			
°C	Kg/mm ²	°F	ksi
20	16 200	68	23 300
100	15 800	212	23 000
200	15 100	390	22 000
300	14 500	570	21 000
400	13 400	750	19 500
500	12 400	930	18 000
600	11 900	1 110	17 300
700	11 100	1 290	15 100
800	10 500	1 470	15 250
850	10 200	1 560	14 800
900	10 100	1 650	14 700

Coefficient of expansion from 20 °C (68°F) to temperature			
°F	in/in°F (x10 ⁻⁶)	°C	mm/mm°C (x 10 ⁻⁶)
212	9.6	100	17.5
390	9.3	200	16.9
570	9.5	300	17.3
750	9.7	400	17.6
930	9.95	500	17.9
1 110	10.05	600	18.3
1 290	10.2	700	18.5
1 470	10.3	800	18.7
1 650	10.4	900	18.9
1 830	10.6	1 000	19.3
2 010	10.95	1 100	19.9
2 100	11.1	1 150	20.1

MECHANICAL PROPERTIES

1. At room temperature – as cast tubes (minimum values)

Ultimate tensile strength:	448 MPa	65 000 psi
Yield strength:	186 MPa	27 000 psi
Elongation (on 4d):	30% for tubes / 25% for fittings	

2. At room temperature after ageing

Mechanical properties at room temperature 20°C (68°F) after ageing

	Y.S.		UTS		E
	ksi	MPa	ksi	MPa	%
As cast	33.6	232	74.0	510	41.4
1 h at 750°C (1 382°F)	31.9	220	70.8	489	32.3
10 h at 750°C (1 382°F)	38.5	266	78.1	539	24.7
100 h at 750°C (1 382°F)	41.8	288	79.8	550	29.4
1 000 h at 750°C (1 382°F)	41.8	288	78.1	539	23.4
2 000 h at 750°C (1 382°F)	41.0	283	76.5	528	22.0
5 000 h at 750°C (1 382°F)	38.7	267	73.4	506	15.9
10 000 h at 750°C (1 382°F)	37.0	255	71.1	491	17.2
1 h at 830°C (1 526°F)	35.7	246	78.1	539	28.2
10 h at 830°C (1 526°F)	39.3	271	79.2	546	28.2
100 h at 830°C (1 526°F)	32.7	226	74.7	515	40.2
500 h at 830°C (1 526°F)	41.3	284	79.3	546	27.4
1 000 h at 830°C (1 526°F)	41.0	283	75.1	518	19.4
2 000 h at 830°C (1 526°F)	35.8	247	75.1	518	25.9
5 000 h at 830°C (1 526°F)	35.3	243	74.0	510	27.5
1 h at 900°C (1 652°F)	37.8	261	78.5	542	23.1
10 h at 900°C (1 652°F)	36.4	251	78.5	542	21.7
100 h at 900°C (1 652°F)	35.8	247	75.7	522	27.0
500 h at 900°C (1 652°F)	33.6	232	74.3	512	30.2
1 000 h at 900°C (1 652°F)	32.9	227	75.4	520	29.7
2 000 h at 900°C (1 652°F)	34.7	239	76.0	524	27.7

3. At high temperature – short time tests – as cast material

	750°C (1 385°F)					830°C (1 530°F)					900°C (1 650°F)				
	U.T.S.		Y.S.		E%	U.T.S.		Y.S.		E%	U.T.S.		Y.S.		E%
	psi	MPa	psi	MPa	4d	psi	MPa	psi	MPa	4d	psi	MPa	psi	MPa	4d
Tube	40000	276	16000	110	32	27500	190	16000	110	35	17000	117	13700	94.5	41
Casting	35000	241	15000	103	31	25000	172	15000	107	32	16000	110	13500	93	48

4. At high temperature – short time tests on aged material

	750°C (1 382°F)					830°C (1 462°F)				
	Y.S.		T.S.		E	Y.S.		T.S.		E
	ksi	MPa	ksi	MPa	%	ksi	MPa	ksi	MPa	%
As cast	17.8	123	45.9	317	25.3	18.9	130	31.2	215	29.1
1 h at 750°C (1 382°F)	17.6	122	41.3	284	35.0	17.4	120	29.6	204	34.6
10 h at 750°C (1 382°F)	22.6	156	41.3	284	35.6	21.2	146	28.6	197	30.1
100 h at 750°C (1 382°F)	25.7	178	36.3	250	32.0	22.6	156	26.9	185	34.2
1 000 h at 750°C (1 382°F)	27.3	188	36.1	249	31.6	21.6	149	25.7	178	30.2
2 000 h at 750°C (1 382°F)	25.6	177	35.8	247	32.3	20.3	140	25.6	177	42.4
5 000 h at 750°C (1 382°F)	23.6	163	33.9	233	36.8	19.9	137	25.3	175	44.2
10 000 h at 750°C (1 382°F)	22.8	157	35.6	245	35.9	18.5	128	25.6	177	38.5
1 h at 830°C (1 526°F)	19.9	137	41.7	287	30.1	19.6	135	29.9	200	32.2
10 h at 830°C (1 526°F)	23.6	163	36.7	253	49.0	21.6	149	27.3	188	33.8
100 h at 830°C (1 526°F)	20.3	140	42.2	291	21.7	23.5	162	27.9	192	28.5
500 h at 830°C (1 526°F)	26.7	184	35.6	245	30.1	21.6	149	25.9	179	34.4
1 000 h at 830°C (1 526°F)	25.2	174	36.0	248	34.3	21.2	146	25.7	178	43.8
2 000 h at 830°C (1 526°F)	21.8	150	34.3	236	32.5	18.9	130	24.0	166	40.6
5 000 h at 830°C (1 526°F)	21.9	151	34.4	237	36.1	18.6	129	24.0	166	40.1
1 h at 900°C (1 652°F)	23.2	160	36.8	254	29.8	20.5	141	27.3	188	34.5
10 h at 900°C (1 652°F)	21.5	148	36.6	252	26.9	20.1	138	26.0	180	35.7
100 h at 900°C (1 652°F)	21.2	146	34.6	239	41.8	19.3	133	23.9	165	42.1
500 h at 900°C (1 652°F)	20.1	138	34.7	239	33.8	18.2	126	23.9	165	45.1
1 000 h at 900°C (1 652°F)	19.8	136	34.0	234	29.9	19.9	130	24.8	171	41.8
2 000 h at 900°C (1652°F)	19.6	135	33.3	230	44.0	18.2	126	25.3	175	43.0

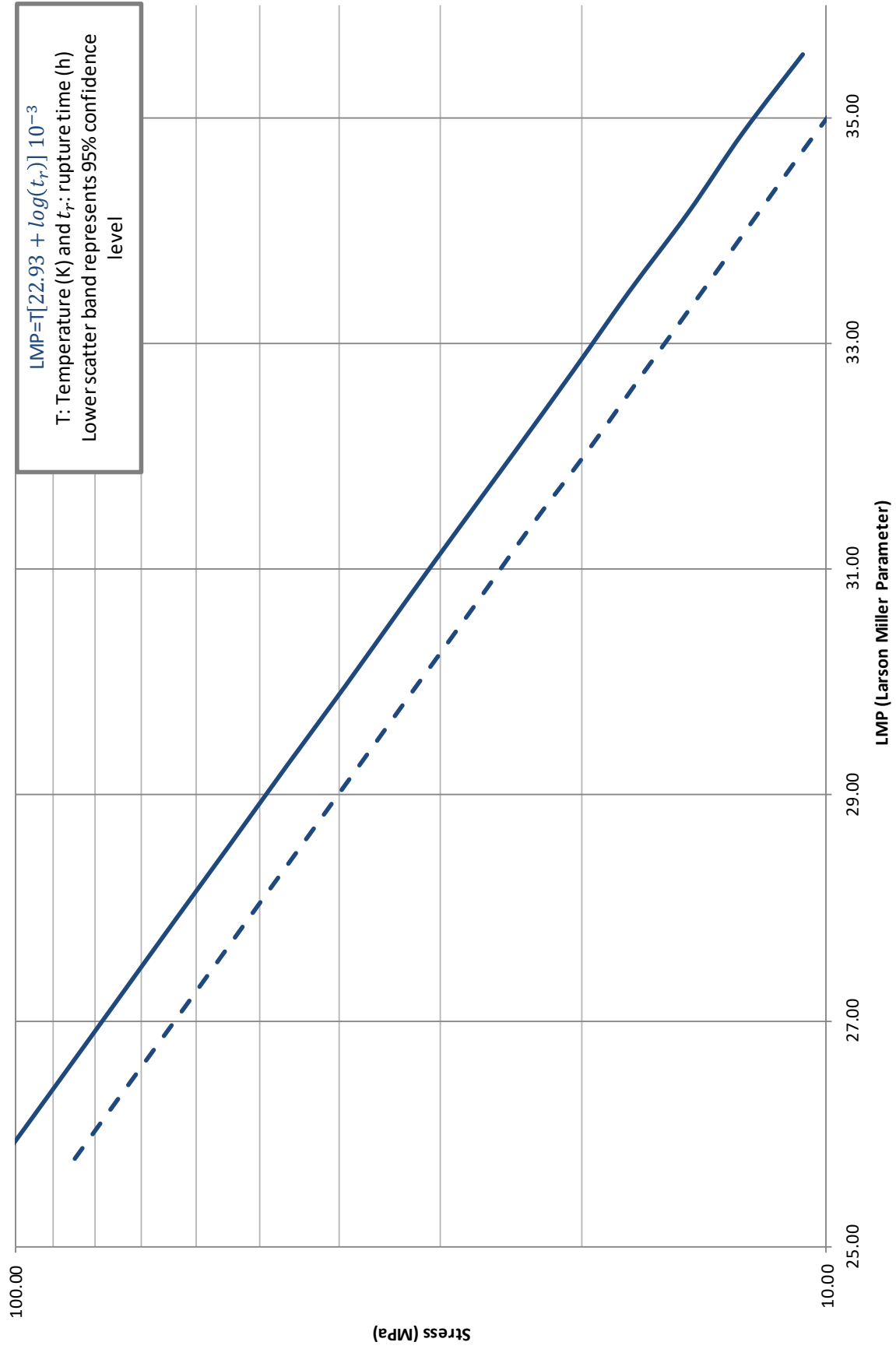
	900°C (1 652°F)					930°C (1 706°F)				
	Y.S.		T.S.		E	Y.S.		T.S.		E
	ksi	MPa	ksi	MPa	%	ksi	MPa	ksi	MPa	%
As cast	17.9	124	20.5	141	41	14.2	98	17.1	118	41.7
1 h at 750°C (1 382°F)	12.8	88	19.5	134	52	13.7	94	18.2	126	51
10 h at 750°C (1 382°F)	16.5	114	20.8	143	38.4	16.2	112	18.5	128	33.7
100 h at 750°C (1 382°F)	16.6	115	19.5	134	37.1	15.1	104	17.2	119	45
1 000 h at 750°C (1 382°F)	16.6	115	19.2	132	34.2	14.5	100	16.9	117	36.9
2 000 h at 750°C (1 382°F)	16.5	114	19.3	133	43.6	14.5	100	16.8	116	42
5 000 h at 750°C (1 382°F)	15.6	108	18.8	129	39.6	13.2	91	15.8	109	35.5
10 000 h at 750°C (1 382°F)										
1 h at 830°C (1 526°F)	16.6	115	20.3	140	35	14.5	100	17.5	121	55.7
10 h at 830°C (1 526°F)	15.2	105	19.5	134	43.7	13.9	96	16.6	115	46.3
100 h at 830°C (1 526°F)	15.9	110	18.2	126	44.6	14.4	99	16.4	113	46.2
500 h at 830°C (1 526°F)	16.1	111	18.9	130	35.1	14.1	97	16.4	113	46.1
1 000 h at 830°C (1 526°F)	16.2	112	19.9	137	37	14.5	100	16.8	116	38.9
2 000 h at 830°C (1 526°F)	14.5	100	17.9	124	33.4	13.1	90	15.9	110	44.5
5 000 h at 830°C (1 526°F)	13.9	96	18.2	126	49.2	12.8	88	15.6	108	42.3
1 h at 900°C (1 652°F)	15.6	108	19.3	133	38.5	13.9	96	16.8	116	42.2
10 h at 900°C (1 652°F)	14.7	101	18.3	127	37.5	13.9	96	16.8	116	45.4
100 h at 900°C (1 652°F)	15.2	105	18.5	128	36.2	13.2	91	15.8	109	39.5
500 h at 900°C (1 652°F)	13.7	94	17.6	122	51.1	12.4	85	15.6	108	39.8
1 000 h at 900°C (1 652°F)	13.7	94	17.1	118	44.7	12.2	84	15.1	104	35.8
2 000 h at 900°C (1 652°F)	14.3	99	17.5	121	38.5	12.4	85	15.2	105	43.2

5. At high temperatures – long time tests

Creep rupture

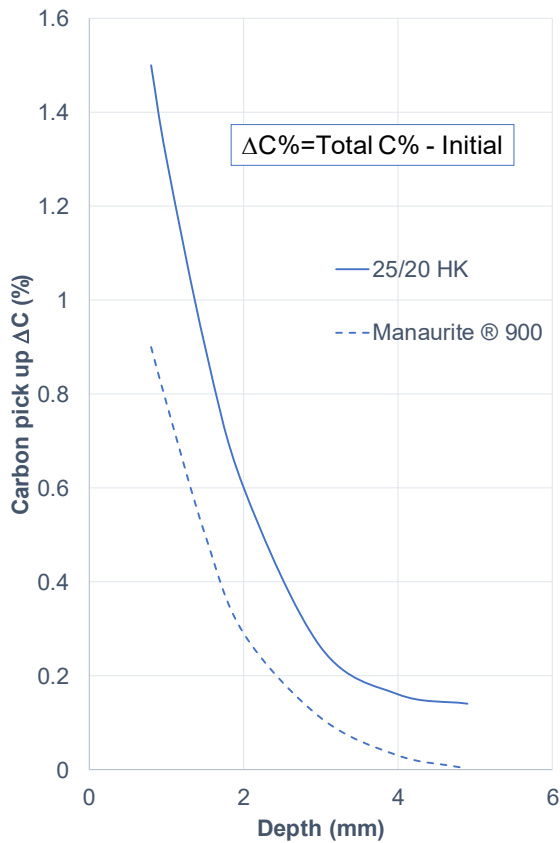
Temperature		Minimum		Stress average		Maximum	
°C	°F	MPa	ksi	MPa	ksi	MPa	ksi
10 000 hours							
650	1 202	104.8	15.19	128.6	18.65	158.0	22.92
675	1 247	89.6	12.99	110.1	15.96	135.2	19.60
700	1 292	76.6	11.11	94.1	13.64	115.6	16.76
725	1 337	65.5	9.50	80.5	11.68	98.9	14.34
750	1 382	56.1	8.14	68.9	9.99	84.6	12.26
775	1 427	48.0	6.96	58.9	8.53	72.3	10.48
800	1 472	41.0	5.95	50.4	7.31	61.9	8.98
825	1 517	35.1	5.09	43.1	6.24	52.9	7.67
850	1 562	30.0	4.35	36.9	5.35	45.2	6.56
875	1 607	25.7	3.73	31.5	4.57	38.7	5.62
900	1 652	22.0	3.19	27.0	3.91	33.2	4.81
925	1 697	18.7	2.72	23.1	3.34	28.4	4.11
950	1 742	16.1	2.33	19.7	2.86	24.2	3.51
975	1 787	13.7	1.99	16.9	2.45	20.7	3.00
1 000	1 832	11.8	1.71	14.4	2.09	17.8	2.57
100 000 hours							
650	1 202	84.6	12.26	103.9	15.06	127.5	18.49
675	1 247	71.9	10.43	88.3	12.80	108.5	15.73
700	1 292	61.1	8.86	75.1	10.90	92.2	13.37
725	1 337	52.0	7.54	63.9	9.26	78.4	11.37
750	1 382	44.2	6.42	54.3	7.88	66.7	9.67
775	1 427	37.6	5.45	46.2	6.70	56.7	8.22
800	1 472	32.0	4.64	39.2	5.69	48.3	7.00
825	1 517	27.2	3.94	33.4	4.84	41.0	5.95
850	1 562	23.2	3.36	28.4	4.13	34.9	5.06
875	1 607	19.6	2.84	24.1	3.5	29.6	4.30
900	1 652	16.7	2.42	20.5	2.97	25.2	3.66
925	1 697	14.2	2.06	17.5	2.53	21.5	3.12
950	1 742	12.1	1.75	14.8	2.15	18.2	2.65
975	1 787	10.3	1.49	12.7	1.83	15.5	2.25
1 000	1 832	8.7	1.27	10.7	1.55	13.1	1.91

CREEP RUPTURE DATA – MANAURITE® 900

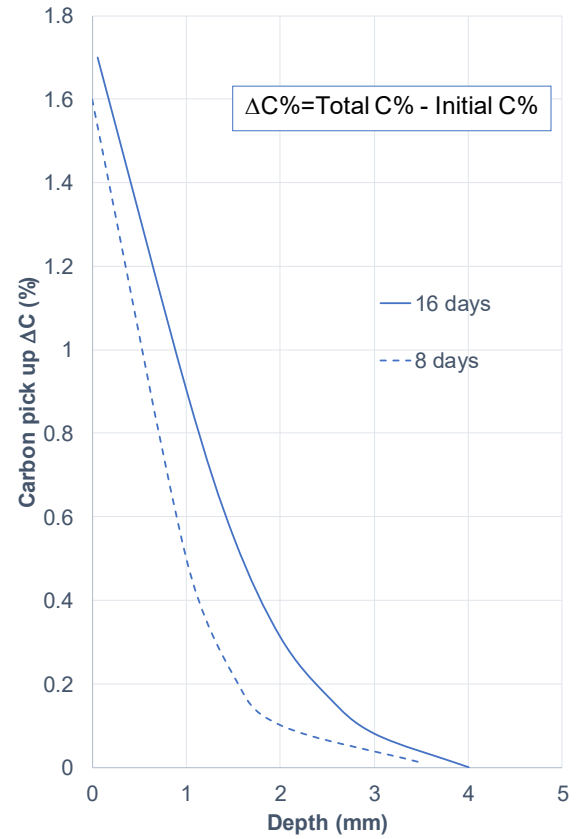


CARBURIZATION TESTS DATA

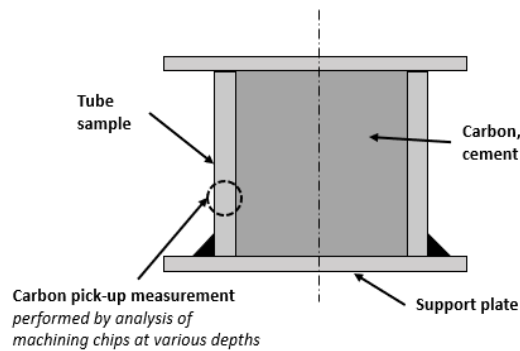
Carburization tests at 1 050°C (1 922°F)
8 days / 16 days



Carburization tests at 1 100°C (2 012°F)
4 days



CARBURIZATION TEST



MANOIR FRANCE

Future is our raw material.

As a metal processing specialist, Manoir Industries develops alloys and operates processes for the manufacture of high-performance components. Known and recognised for several decades, its know-how is complemented by its expertise in casting, forging, boilermaking, welding and assembly. Manoir's solid technical expertise continues to drive its sustainable leading position, offering innovative services to its customers worldwide as a true partner.