

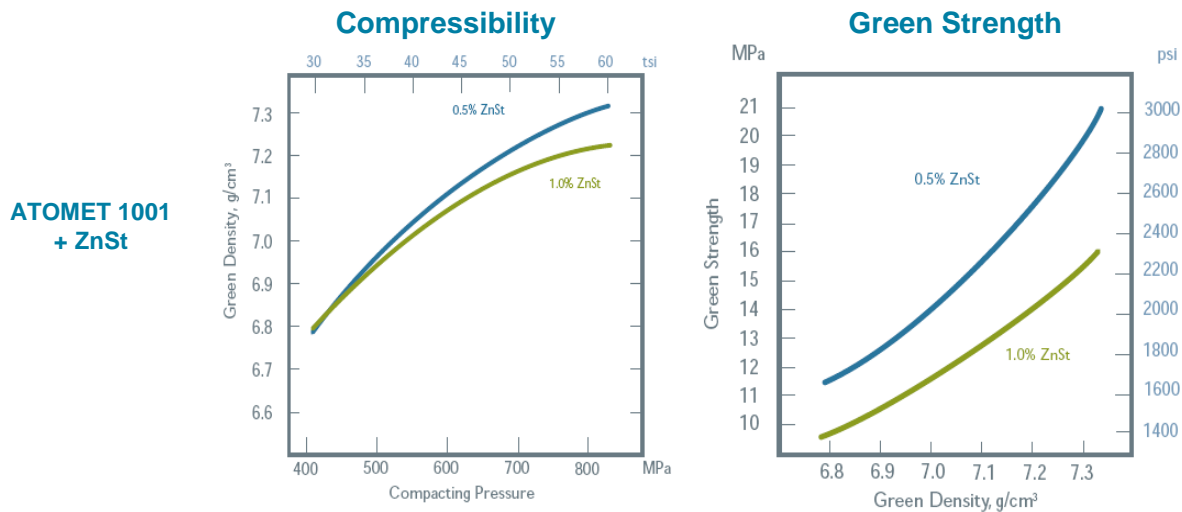
**ATOMET 1001** is a highly compressible, water-atomised steel powder specifically designed for high density, high strength powder metallurgy and powder forging applications.

- **High compressibility** - due to its superior compressibility, **ATOMET 1001** can be single pressed to 7.2 g/cm<sup>3</sup> or repressed to densities up to 7.4 g/cm<sup>3</sup>.
  - Extends the performance levels of P/M parts
  - Provides enhanced compaction capability
  - Provides higher strength, higher density P/M parts
- **Hardenability** - the manganese level of **ATOMET 1001** is precisely controlled to provide optimal heat-treated properties without sacrificing compressibility.
  - Improved hardness and tensile properties
- **Dimensional change** - **ATOMET 1001** can be used with existing tooling designed for conventional water-atomised powders.
  - No need to retool
- **Consistency** - a stable ore base and ultra-modern processing capability, including SPC, assure lot-to-lot consistency.
  - Improved P/M part consistency
- **Purity and cleanliness** - state-of-the-art clean steel practices and a proprietary powder manufacturing process produce a powder with exceptionally low levels of residuals and inclusions.
  - Improved mechanical and dynamic properties of powder forged parts
  - Improved machinability of P/M and P/F parts.

## PHYSICAL AND CHEMICAL PROPERTIES

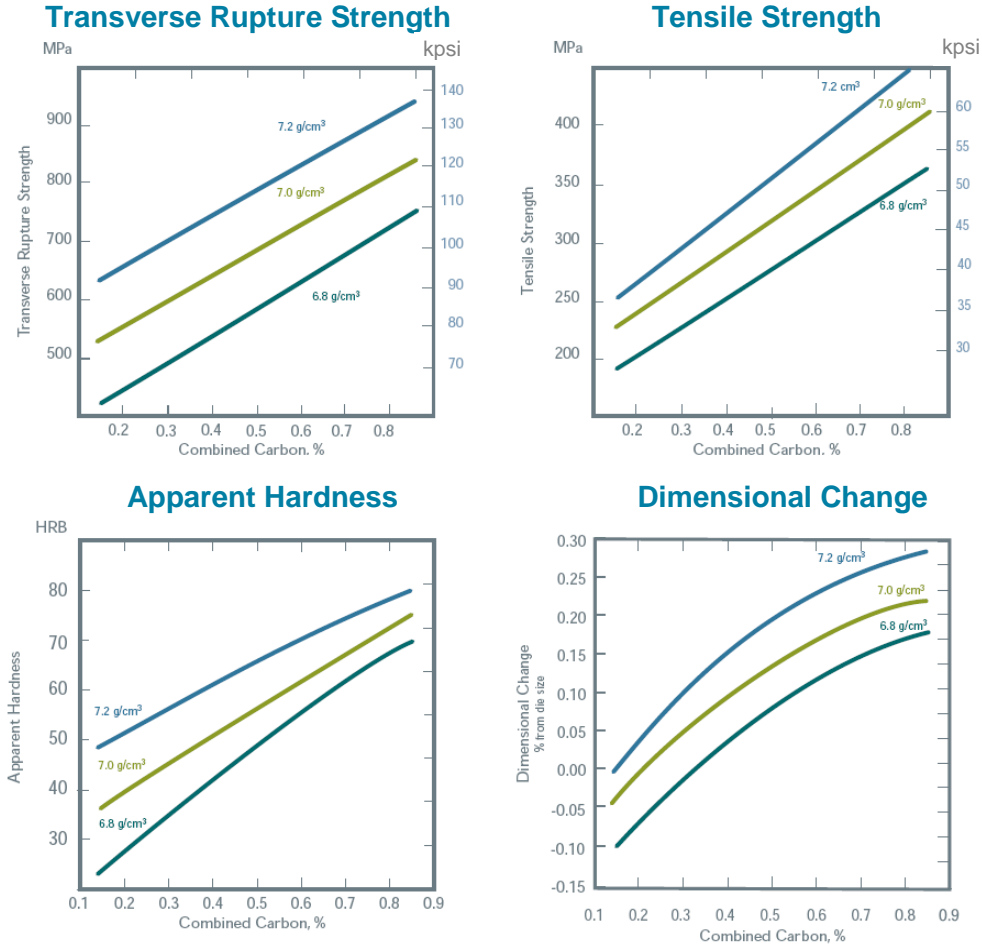
Chemistry, wt%					U.S. mesh µm	Particle Size Analysis, wt%				A.D. g/cm <sup>3</sup>	Flow s/50g	Density* g/cm <sup>3</sup>
C	O	S	Mn	Fe		+60	+100	+325	-325			
0.004	0.09	0.01	0.18	99.4+		+250	+150	+45	-45	2.95	26	7.10
						Trace	10	67	23			*@43.5 tsi @600 MPa

## COMPACTING PROPERTIES



## AS-SINTERED PROPERTIES - Carbon Steels

Composition: **ATOMET 1001** + graphite + 0.5% ZnSt.  
 Sintered in a rich endothermic atmosphere at 1120°C (2050°F) for 30 minutes.

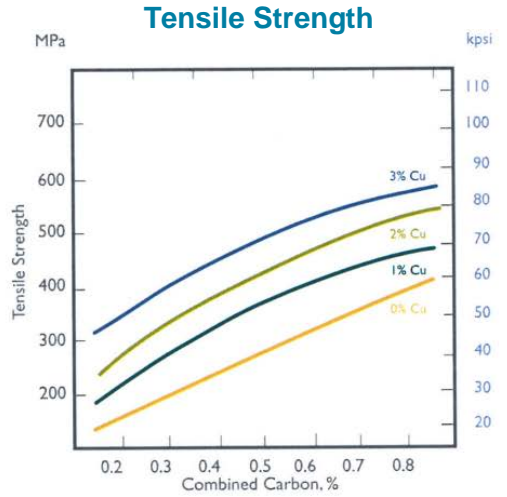
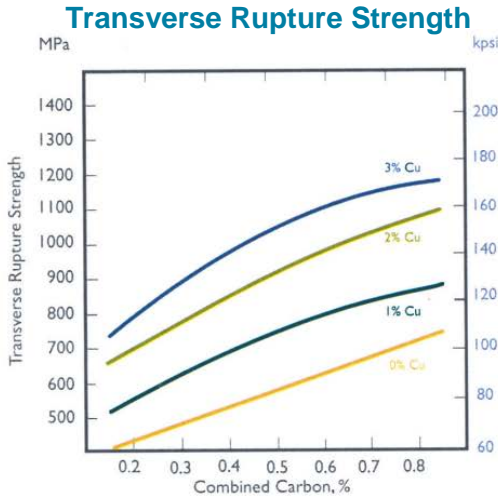


Material Designation Code	Sintered Density	Added Graphite	Combined Carbon	Transverse Rupture Strength		Apparent Hardness	Dimensional Change	Tensile Strength		Yield Strength		Elongation
				MPa	kpsi			MPa	kpsi	MPa	kpsi	
MPIF Std 35	6.80	0.00	0.19	445	65	27	-0.07	205	30	141	20	10.0
	7.00	0.00	0.15	535	78	37	-0.04	230	33	152	22	13.0
	7.20	0.00	0.11	619	90	47	-0.03	245	36	163	24	16.0
F-0000	6.80	0.30	0.35	493	72	38	0.01	243	35	170	25	7.0
	7.00	0.30	0.33	610	88	46	0.06	276	40	186	27	9.0
	7.20	0.30	0.29	699	101	57	0.1	297	43	201	29	11.0
F-0005	6.80	0.60	0.60	635	92	55	0.12	305	44	221	32	4.0
	7.00	0.60	0.58	722	105	61	0.16	342	50	237	34	5.0
	7.20	0.60	0.55	810	117	68	0.21	374	54	252	37	6.0
F-0008	6.80	0.90	0.82	737	107	68	0.17	359	52	264	38	3.0
	7.00	0.90	0.82	826	120	74	0.21	405	59	285	41	3.0
	7.20	0.90	0.82	927	134	79	0.28	452	66	307	45	4.0

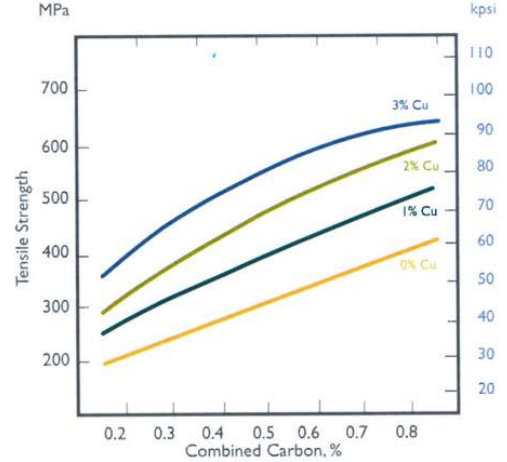
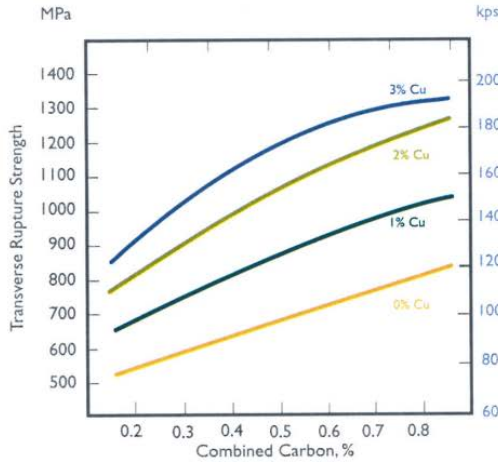
AS-SINTERED PROPERTIES - Copper Steels

Composition: ATOMET 1001 + copper + graphite + 0.5% ZnSt.  
 Sintered in a rich endothermic atmosphere at 1120°C (2050°F) for 30 minutes.

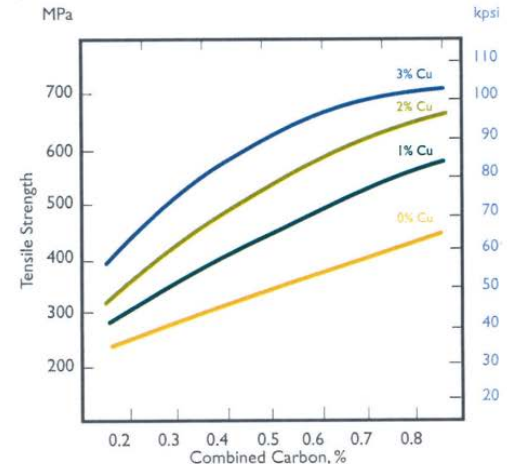
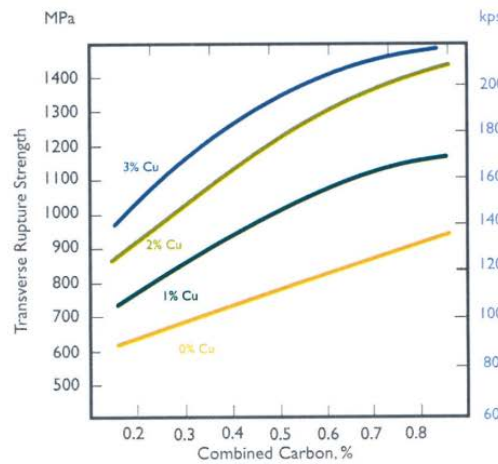
Sintered Density  
 6.8 g/cm<sup>3</sup>



Sintered Density  
 7.0 g/cm<sup>3</sup>



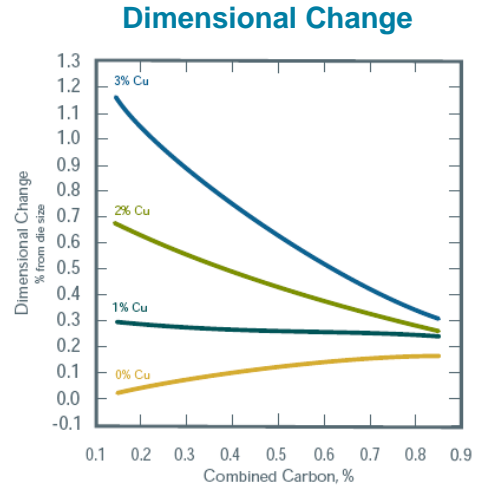
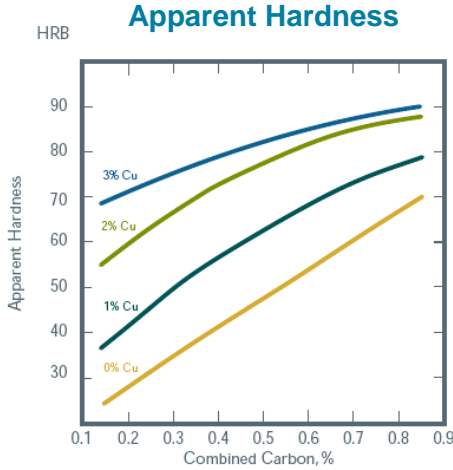
Sintered Density  
 7.2 g/cm<sup>3</sup>



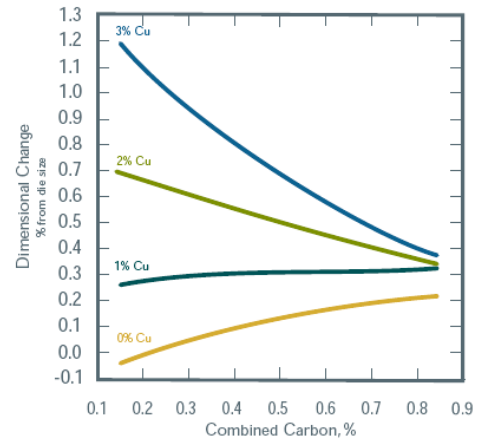
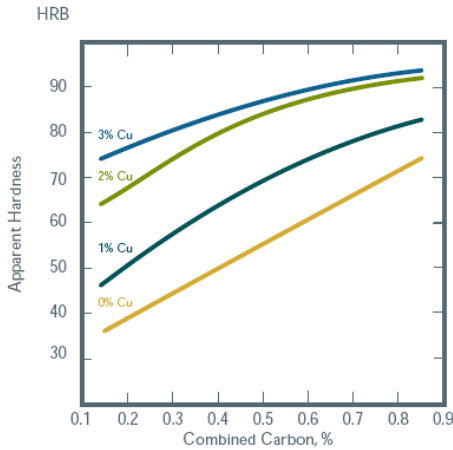
AS-SINTERED PROPERTIES (continued) - Copper Steels

Composition: ATOMET 1001 + copper + graphite + 0.5% ZnSt.  
 Sintered in a rich endothermic atmosphere at 1120°C (2050°F) for 30 minutes.

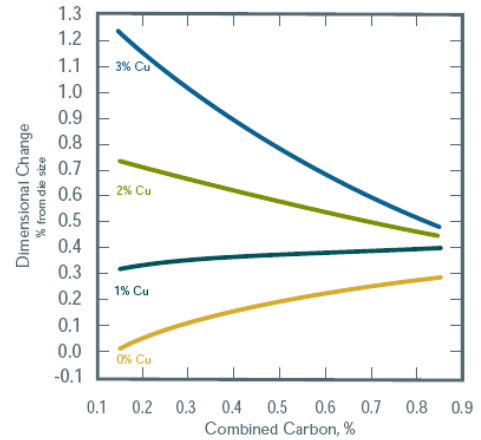
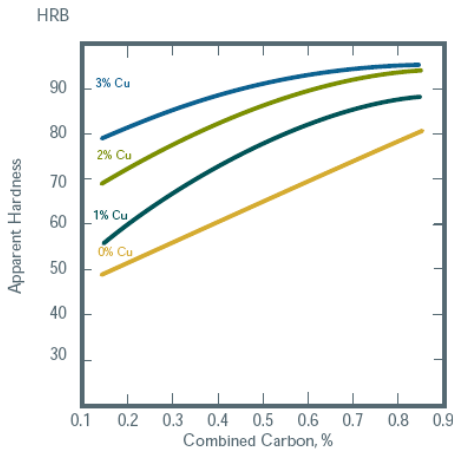
Sintered Density  
 6.8 g/cm<sup>3</sup>



Sintered Density  
 7.0 g/cm<sup>3</sup>



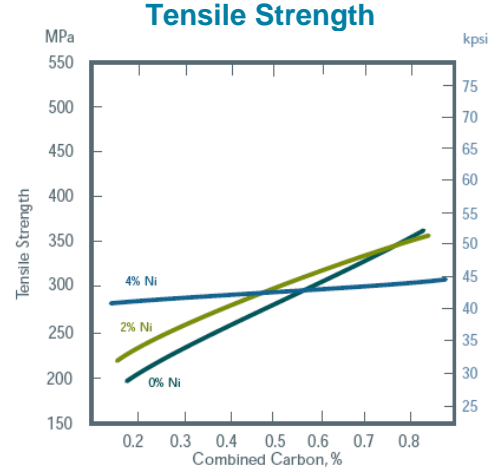
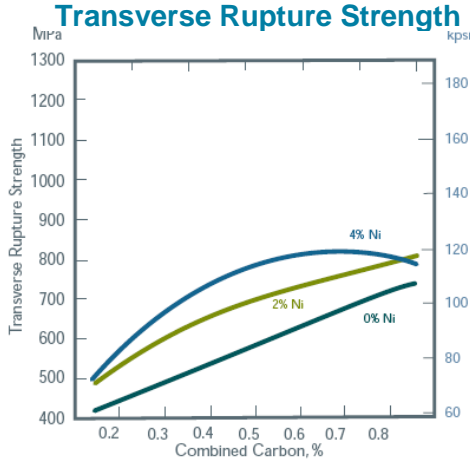
Sintered Density  
 7.2 g/cm<sup>3</sup>



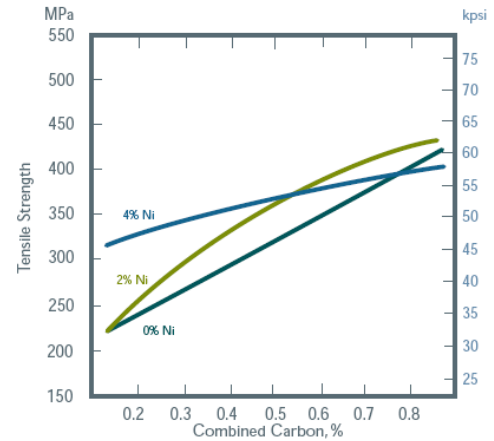
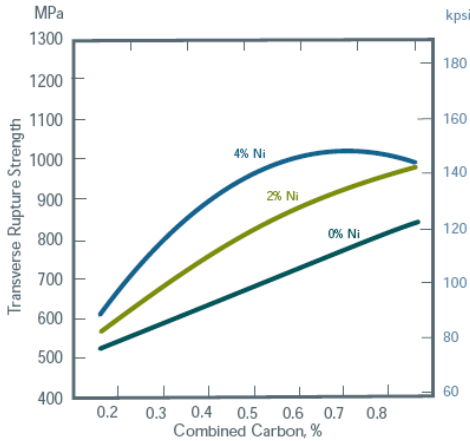
AS-SINTERED PROPERTIES - Nickel Steels

Composition: ATOMET 1001 + nickel + graphite + 0.5% ZnSt.  
 Sintered in a rich endothermic atmosphere at 1120°C (2050°F) for 30 minutes.

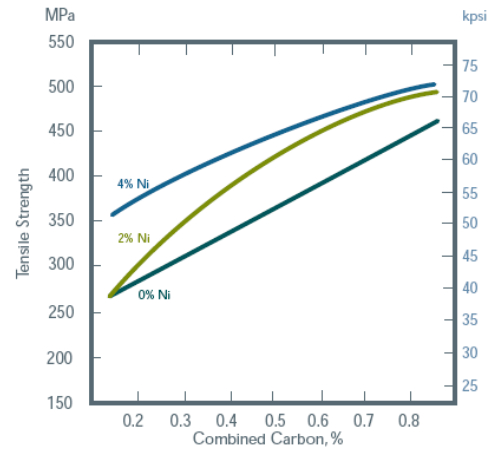
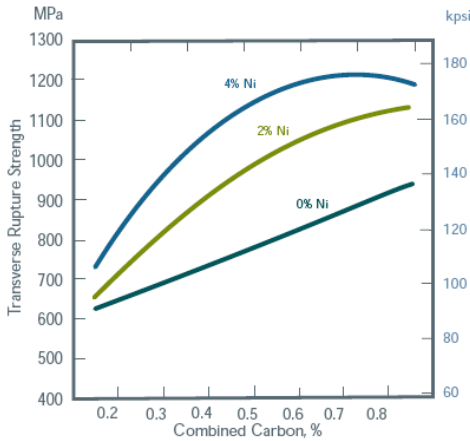
Sintered Density  
 6.8 g/cm<sup>3</sup>



Sintered Density  
 7.0 g/cm<sup>3</sup>



Sintered Density  
 7.2 g/cm<sup>3</sup>

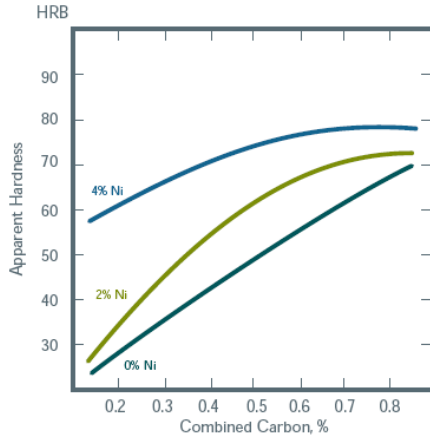


AS-SINTERED PROPERTIES (continued) - Nickel Steels

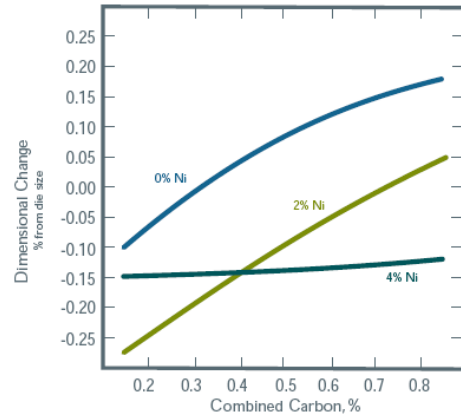
Composition: ATOMET 1001 + nickel + graphite + 0.5% ZnSt  
 Sintered in a rich endothermic atmosphere at 1120°C (2050°F) for 30 minutes.

Sintered Density  
 6.8 g/cm<sup>3</sup>

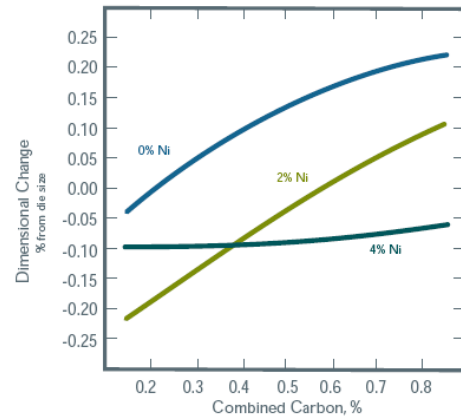
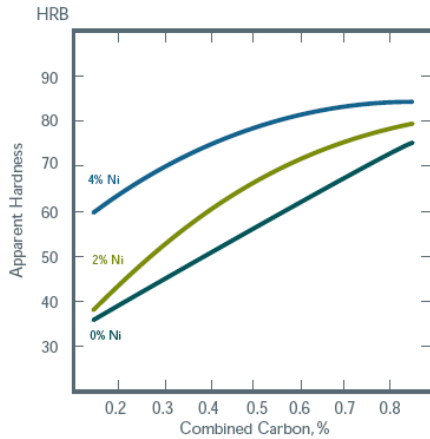
Apparent Hardness



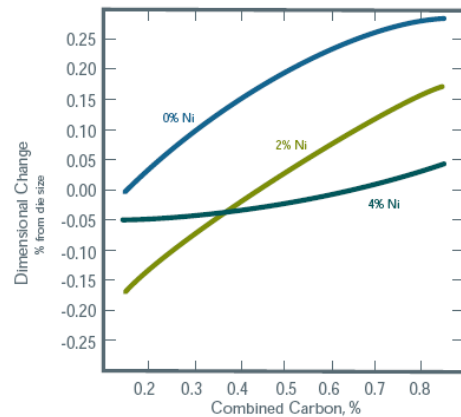
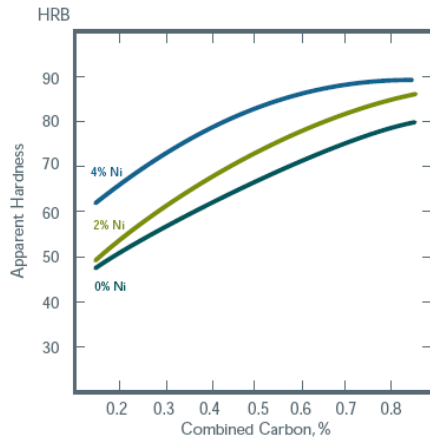
Dimensional Change



Sintered Density  
 7.0 g/cm<sup>3</sup>

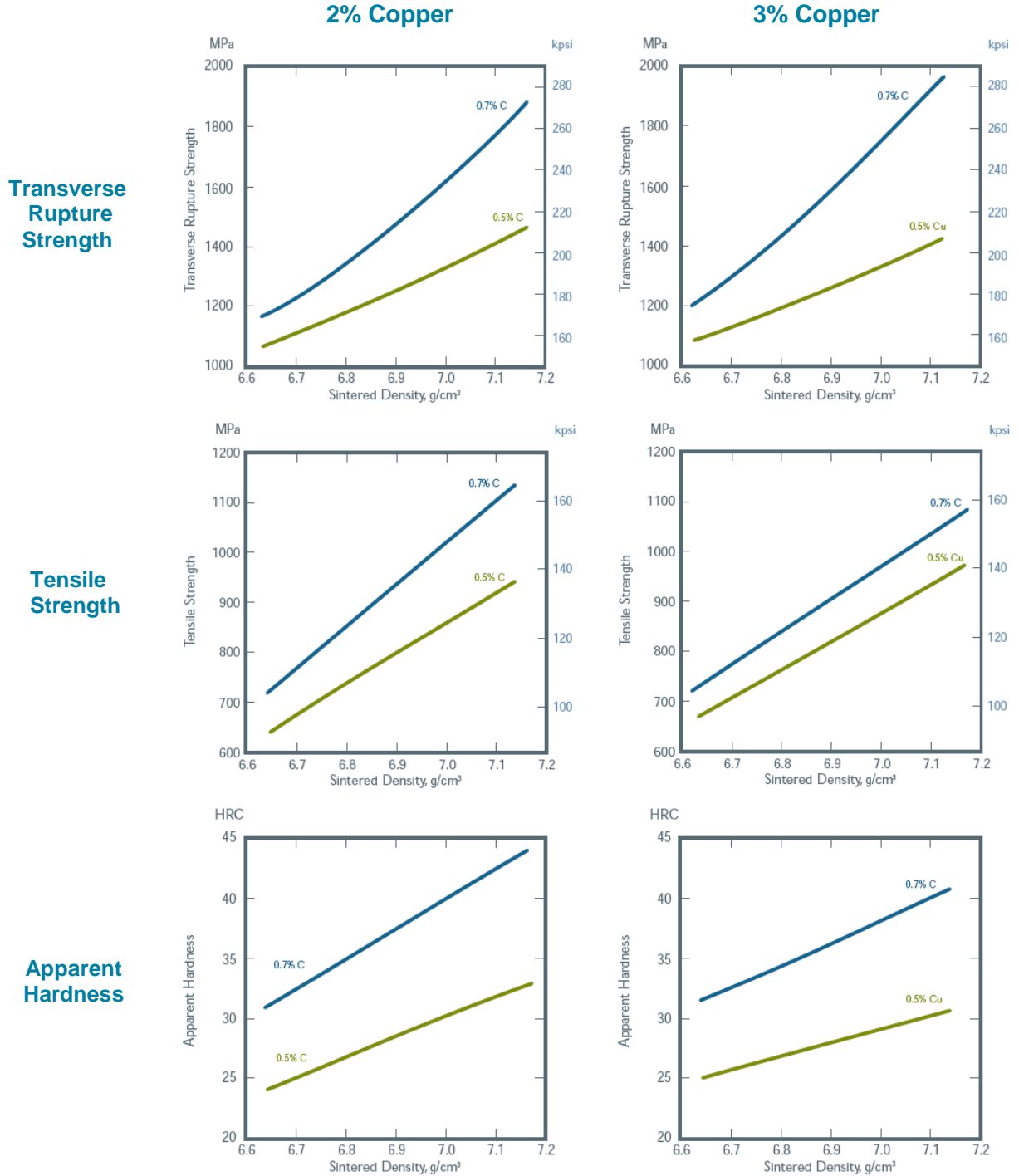


Sintered Density  
 7.2 g/cm<sup>3</sup>



**HEAT-TREATED PROPERTIES - Copper Steels**

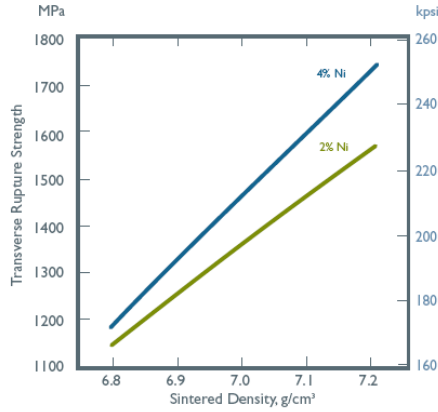
Composition: **ATOMET 1001** + copper + graphite + 0.5% ZnSt  
 Sintered in a rich endothermic atmosphere at 1120°C (2050°F) for 30 minutes.  
 Heat Treatment: austenitized at 845°C (1550°F) for 15 minutes.  
 Oil quenched. Tempered at 175°C (350°F) for 60 minutes.



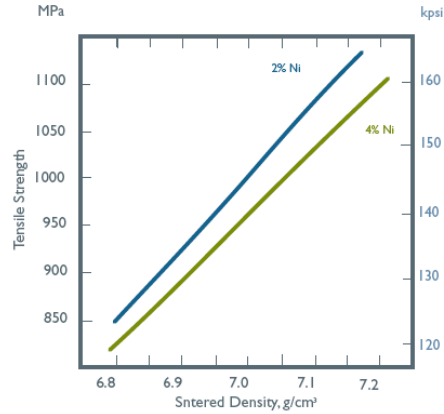
**HEAT-TREATED PROPERTIES - Nickel Steels**

Composition: **ATOMET 1001** + nickel + 0.6% graphite + 0.5% ZnSt  
 Sintered in a rich endothermic atmosphere at 1120°C (2050°F) for 30 minutes.  
 Heat Treatment: austenitized at 845°C (1550°F) for 15 minutes.  
 Oil quenched. Tempered at 260°C (500°F) for 60 minutes.

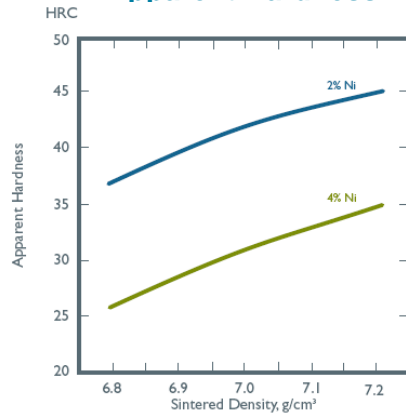
**Transverse Rupture Strength**



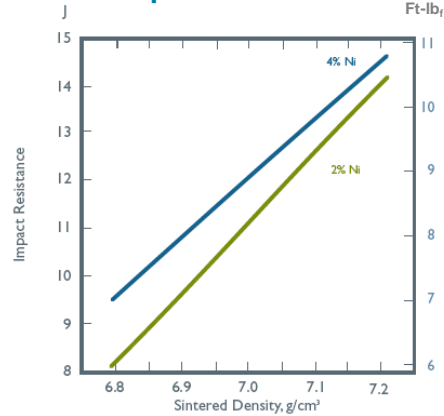
**Tensile Strength**



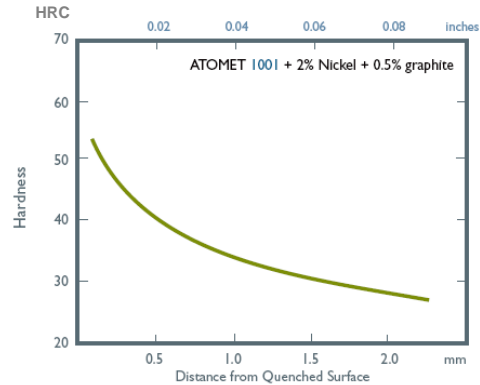
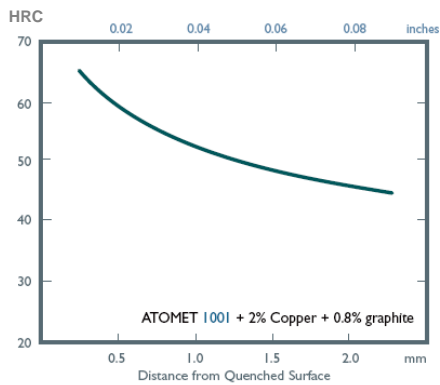
**Apparent Hardness**



**Impact Resistance**



**Hardenability of Sintered Steel (1)**



(1) Diameter of discs: 2.54 cm (1 inch). Thickness of discs: 7.0 g/cm³. Sintered in dissociated ammonia at 1120°C (2050°F) for 30 minutes. Austenitized at 845°C (1550°F) for 30 minutes in a neutral atmosphere. Oil quenched. Tempered at 175°C (350°F) for 60 minutes.



## AS-SINTERED PROPERTIES - Copper Steels <sup>(2)</sup>

Material Designation Code	Sintered Density	Added Copper	Added Graphite	Combined Carbon	Transverse Rupture Strength		Apparent Hardness	Dimensional Change	Tensile Strength		Yield Strength		Elongation
					MPa	kpsi			MPa	kpsi	MPa	kpsi	
MPIF Std 35	g/cm <sup>3</sup>	%	%	%	MPa	kpsi	HRC (HRB)	%	MPa	kpsi	MPa	kpsi	%
FC-0200	6.80	2.00	0.00	0.15	661	96	(56)	0.68	248	36	145	21	3.0
	7.00	2.00	0.00	0.12	745	108	(63)	0.71	276	40	165	24	5.0
	7.20	2.00	0.00	0.08	807	117	(65)	0.77	283	41	179	26	8.0
FC-0205	6.80	2.00	0.60	0.55	944	137	(80)	0.41	455	66	358	52	2.0
	7.00	2.00	0.60	0.55	1096	159	(86)	0.47	503	73	386	56	3.0
	7.20	2.00	0.60	0.54	1243	181	(88)	0.58	552	80	414	60	4.0
FC-0208	6.80	2.00	0.90	0.83	1082	157	(88)	0.28	538	78	448	65	2.0
	7.00	2.00	0.90	0.83	1255	182	(92)	0.35	600	87	489	71	2.0
	7.20	2.00	0.90	0.82	1413	205	(94)	0.46	655	95	517	75	2.0

## AS-SINTERED PROPERTIES - Nickel Steels <sup>(2)</sup>

Material Designation Code	Sintered Density	Added Nickel	Added Graphite	Combined Carbon	Transverse Rupture Strength		Apparent Hardness	Dimensional Change	Tensile Strength		Yield Strength		Elongation
					Mpa	kpsi			HRC (HRB)	%	MPa	kpsi	
MPIF Std 35	g/cm <sup>3</sup>	%	%	%	Mpa	kpsi	HRC (HRB)	%	MPa	kpsi	MPa	kpsi	%
FN-0200	6.80	2.00	0.30	0.35	634	92	(49)	-0.17	269	39	159	23	2.0
	7.00	2.00	0.30	0.33	717	104	(55)	-0.12	303	44	165	24	5.0
	7.20	2.00	0.30	0.31	834	121	(62)	-0.07	352	51	179	26	7.0
FN-0205	6.80	2.00	0.60	0.54	717	104	(64)	-0.08	303	44	214	31	2.0
	7.00	2.00	0.60	0.53	841	122	(67)	-0.03	372	54	234	34	3.0
	7.20	2.00	0.60	0.53	1000	145	(74)	0.04	427	62	255	37	4.0
FN-0208	6.80	2.00	0.90	0.82	807	117	(73)	0.03	352	51	290	42	1.0
	7.00	2.00	0.90	0.81	965	140	(79)	0.09	421	61	317	46	1.0
	7.20	2.00	0.90	0.81	1124	163	(85)	0.15	483	70	352	51	2.0
FN-0405	6.80	4.00	0.60	0.62	820	119	(77)	-0.14	296	43	255	37	<1
	7.00	4.00	0.60	0.60	1007	146	(81)	-0.08	379	55	290	42	1.0
	7.20	4.00	0.60	0.59	1186	172	(86)	-0.01	462	67	324	47	2.0
FN-0408	6.80	4.00	0.90	0.84	800	116	(78)	-0.12	303	44	283	41	<1
	7.00	4.00	0.90	0.83	1000	145	(84)	-0.06	400	58	331	48	<1
	7.20	4.00	0.90	0.82	1200	174	(89)	0.03	496	72	386	56	1.0

## HEAT-TREATED PROPERTIES - Copper Steels <sup>(2)(3)</sup>

Material Designation Code	Sintered Density	Added Copper	Added Graphite	Combined Carbon	Transverse Rupture Strength		Apparent Hardness	Tensile Strength	
					MPa	kpsi		MPa	kpsi
MPIF Std 35	g/cm <sup>3</sup>	%	%	%	MPa	kpsi	HRC	MPa	kpsi
F-0205 HT	6.80	2.00	0.60	0.51	1172	170	27	789	114
	7.00	2.00	0.60	0.50	1344	195	30	869	126
	6.80	2.00	0.60	0.52	1234	179	27	765	111
	7.00	2.00	0.60	0.53	1372	199	29	882	128
F-0208 HT	6.80	2.00	0.90	0.72	1358	197	35	862	125
	7.00	2.00	0.90	0.71	1593	231	40	1027	149
	6.80	2.00	0.90	0.73	1434	208	34	848	123
	7.20	2.00	0.90	0.72	1744	253	38	979	142

## HEAT-TREATED PROPERTIES - Nickel Steels <sup>(2)(3)</sup>

Material Designation Code	Sintered Density	Added Copper	Added Graphite	Combined Carbon	Transverse Rupture Strength		Apparent Hardness	Tensile Strength		Impact Resistance	
					MPa	kpsi		HRC	MPa	kpsi	J
MPIF Std 35	g/cm <sup>3</sup>	%	%	%	MPa	kpsi	HRC	MPa	kpsi	J	ft-lbs
F-0205 HT	6.80	2.00	0.60	0.73	1158	168	37	855	124	8	6
	7.00	2.00	0.60	0.68	1358	197	42	1013	147	11	8
	7.20	2.00	0.60	0.63	1565	227	45	1158	168	14	10
F-0405 HT	6.80	4.00	0.60	0.64	1200	174	26	834	121	9	7
	7.00	4.00	0.60	0.62	1462	212	31	965	140	12	9
	7.20	4.00	0.60	0.59	1724	250	35	1096	159	15	11

(2) All mixes contain 0.5% ZnSt. Sintered 30 minutes at 1120°C (2050°F) in a rich endo atmosphere.

(3) Heat treatment: Austenitized at 845°C (1150°F) for 15 minutes. Oil quenched.  
 Copper steels: Tempered at 175°C (350°F) for 60 minutes.  
 Nickel steels: Tempered at 260°C (500°F) for 60 minutes.

## RE-PRESSED/ RE-SINTERED PROPERTIES

The high compressibility of **ATOMET 1001** allows for added flexibility to conventional press and sinter manufacturing. **ATOMET 1001** may be re-pressed/re-sintered to achieve final densities exceeding 7.3 g/cm<sup>3</sup>. These higher densities provide improved mechanical and dynamic properties for demanding applications.

Material Designation Code	Final Density	Transverse Rupture Strength		Apparent Hardness	Dimensional Change	Tensile Strength		Yield Strength		Elongation	Impact Resistance	
		MPa	kpsi			HRC (HRB)	%	MPa	kpsi		MPa	kpsi
MPIF Std 35	g/cm <sup>3</sup>											
FC-0208	7.30	1722	250	(92)	0.46	675	98	455	66	3.0	16	12
FC-0208 HT	7.30	1895	275	50	0.38	896	130	834	121	<1	9.5	7
FC-0205	7.30	1206	175	(75)	0.19	482	70	255	37	6.0	24	18
FC-0205 HT	7.30	2136	310	43	0.26	1268	184	1165	169	<1	11	8

Pressed at 550 MPa (40 tsi) and pre-sintered 30 minutes at 845°C (1550°F) in dissociated ammonia. Re-pressed at 690 MPa (50 tsi) and sintered 20 minutes at 1120°C (2050°F) in a nitrogen-based atmosphere. Heat treatments: austenitized at 870°C (1660°F) for 30 minutes and 845°C (1550°F) for 30 minutes in a carbon potential of 0.8%. Copper steels: Oil quenched. Tempered at 175°C (350°F) for 60 minutes. Nickel steels: Oil quenched. Tempered at 260°C (500°F) for 60 minutes.

## HIGH TEMPERATURE SINTERED PROPERTIES

**ATOMET 1001** may also be single pressed / high temperature sintered for improved performance properties. Additionally, this process greatly improves impact resistance for the most challenging P/M applications.

Material Designation Code	Compacting Pressure		Green Density	Final Density	Added Graphite	Apparent Hardness	Transverse Rupture Strength		Dimensional Change	Tensile Strength		Elongation	Yield Strength		Impact Resistance	
	MPa	tsi					g/cm <sup>3</sup>	g/cm <sup>3</sup>		%	HRC (HRB)		MPa	kpsi	%	MPa
FN-0205	410	30	6.80	6.90	0.60	(74)	981	142	-0.27	485	70	2.0	374	54	16	12
	690	50	7.20	7.30	0.60	(83)	1238	180	0.01	618	90	4.0	465	68	34	25
FN-0205 HT	410	30	6.80	6.90	0.60	30	1747	180	-0.27	1137	174	2.0	913	132	16	12
	690	50	7.20	7.30	0.60	40	2117	307	0.01	1300	189	3.0	924	134	20	15

Sintered 60 minutes at 1230°C (2250°F) in nitrogen backfilled vacuum furnace. Heat-treatments: Austenitized at 845°C (1550°F) for 30 minutes. Oil quenched. Tempered at 175°C (350°F) for 60 minutes.

## POWDER FORGED PROPERTIES

**ATOMET 1001PF**, due to its high cleanliness level, allows for improved mechanical and dynamic properties of powder forged parts. In addition, the exceptionally low levels of residuals and inclusions improve the machinability of powder forged parts.

### Cleanliness

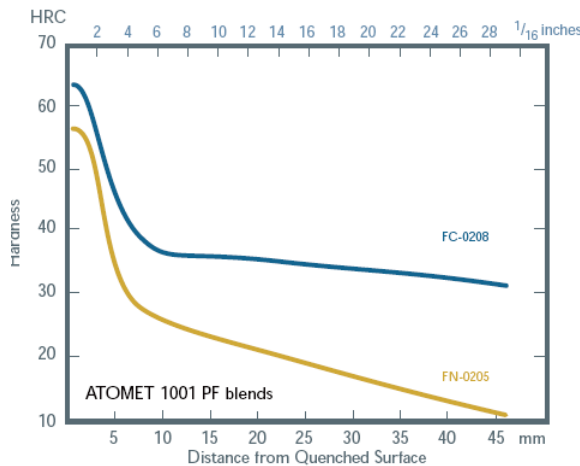
A) Non-metallic inclusion count:

Length μm	Number/ 100mm <sup>2</sup>	Material	Final	Tensile		Yield		Reduction	Elongation	Endurance	
		Designation Code	Density	Strength	Strength	Strength	Strength	of area	%	Fatigue Limit at 50% probability	
		MPIF Std 35	g/cm <sup>3</sup>	MPa	kpsi	MPa	kpsi	%	%	MPa	kpsi
30/50	2.0	FC-0205	7.85*	843	122.5	575	83.5	32	20	293	42.5
50/100	0.5										
>150	0.0										

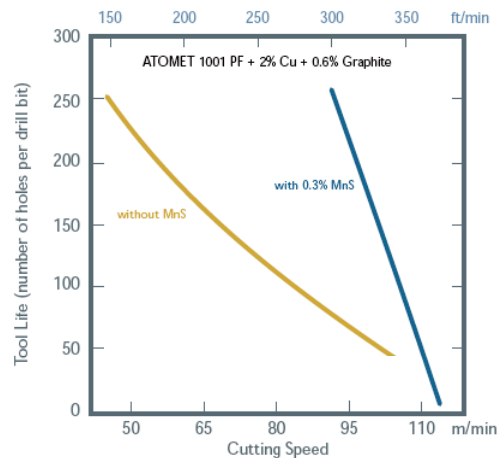
\* Density measured in water.

B) Fraction of surface area occupied by inclusions: **0.004%**

**Jominy Curves**



**Machinability**



Test Conditions:

Drill 8mm HSS / Feed rate: 0.125 mm (0.005 in.) per revolution

Depth of drilled holes: 19.0 mm (0.75 in.)

Cutting fluid: Trim Sol (1:20)

### Rio Tinto Metal Powders

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