

NAVISTAR, INC.		
Material, Parts, and Process Specifications (MPAPS)		NUMBER: MPAPS- A-9
		Former Designation: CEMS A-9
TITLE: Steel Spring Wire		CURRENT REV No.: 1506
		DATE: June 2015
WRITTEN/EDITED BY: W. Cook	APPROVED BY: R. Goluch	SUPERSEDES: December 2002
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<i>This specification may involve hazardous materials, equipment, and procedures. This specification does not purport to address all of the safety issues associated with its use. The user is responsible to consult appropriate safety and health practices and to determine the applicability of regulatory limits prior to use.</i>		
Change Notice: Reformated to MPAPS		

1.0 APPLICATION

Springs are used in a great variety of applications as return springs, balancing springs, compression springs, valve springs, etc. They are generally loaded in torsion; Strength, fatigue life, and surface quality are controlling design features.

2.0 SCOPE

This specification covers the Company's requirements for steel wire used for the manufacturing of springs. General requirements for springs are shown in Engineering Standard 146.

2.1 Restricted Chemical Substances

Effective January 1, 2007, all product supplied to the requirements of this specification must comply with the requirements of the MPAPS B-50 specification.

3.0 REFERENCE DOCUMENTS

Unless otherwise specified, the latest issue of all referenced standards shall apply. The following standards, specifications and regulations are referenced in this specification.

Quality System Standard ISO 9001 or TS-16949	ASTM A 227	ASTM A 232
CFR Title 29, Part 1910	ASTM A 228	ASTM A 313
NAVISTAR Manufacturing Std. MS-D-13	ASTM A 229	ASTM A 370
NAVISTAR Engineering Design Std A-16	ASTM A 230	ASTM A 877
NAVISTAR MPAPS B-50	ASTM A 231	
INTERNATIONAL Engineering Standard 146		

4.0 GENERAL REQUIREMENTS

4.1 Classification

Steel spring wire is classified by material composition and strength properties.

4.2 Chemical Composition

Spring wire purchased to this specification will conform to the ladle chemical composition shown in Table I for the type specified.

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TABLE I – CHEMICAL COMPOSITION

International Type	Approx ASTM	Description	Chemical Composition, percent (max except where shown as range)						
			Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Others
1	A 227 Class II	High Tensile Cold Drawn Carbon Steel	0.45-0.85*	0.60-1.30*	0.04	0.05	0.10-0.30	--	--
1H	--	Extra High Tensile Cold Drawn Carbon Steel	0.70-1.00**	0.20-1.30**	0.04	0.04	0.10-0.30	--	--
2	A 227 Class I	Cold Drawn Carbon Steel	0.45-0.85*	0.60-1.30*	0.04	0.05	0.10-0.30	--	--
3	A 229 Class I	Oil Tempered Carbon Steel	0.55-0.85	0.60-1.20	0.04	0.05	0.10-0.30	--	--
3H	A 229 Class II	High Tensile Oil Tempered Carbon Steel	0.55-0.85	0.60-1.20	0.04	0.05	0.10-0.30	--	--
3S	--	Square Wire, Oil Tempered	0.55-0.75	0.60-1.20	0.04	0.05	0.12-0.30	--	--
4	A 230	Carbon Steel, Oil Tempered, Valve Spring Quality	0.65-0.75	.065-0.90	0.03	0.03	0.12-0.35	--	--
5	--	Cold Drawn Carbon Steel, Valve Spring Quality	0.65-0.75	0.60-0.90	0.03	0.03	0.12-0.30	--	--
6	A 228	Music Wire	.070-1.00	0.20-0.60	0.03	0.03	0.12-0.30	--	--
7	A 231	Chromium Vanadium, Oil Tempered, Regular Quality	0.45-0.55	0.60-0.90	0.03	0.03	0.20-0.35	0.80-1.10	Vanadium 0.15-0.25
8 8Aψ	A 232 --	Chromium Vanadium, Oil Tempered, Valve Spring Quality	0.45-0.55	0.60-0.90	0.03	0.03	0.20-0.35	0.80-1.10 0.40-0.60	Vanadium 0.15-0.25
9	A 877	Chromium Silicon, Valve Spring Quality	0.51-0.59	0.50-0.80	0.025	0.025	1.20-1.60	0.60-0.80	--
12	A 313	Stainless, UNS S30200	0.15	2.00	0.04	0.03	1.00	17.00-19.00	Nickel 8.00-10.00
13	A 313	Stainless, UNS S30400, Regular Quality	0.08	2.00	0.04	0.03	1.00	18.00-20.00	Nickel 8.00-12.00
14	--	Stainless, UNS S30400 Valve Spring Quality	0.08	2.00	0.04	0.03	1.00	18.00-20.00	Nickel 8.00-12.00
15	--	17-7 PH, Precipitation Hardening Stainless	0.09	1.00	0.04	0.03	1.00	16.00-18.00	Nickel 6.50-7.75 Aluminum 0.75-1.50

* Carbon and manganese in any one lot will not vary more than 0.13 and 0.30%, respectively

** Carbon and manganese in any one lot will not vary more than 0.20 and 0.30%, respectively.

ψ Type 8A is a modification of Type 8.

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4.3 Mechanical Properties

Wire purchased to this specification will conform to the mechanical property requirements shown herein for the type specified. See "Methods of Test," page 19.

4.3.1 Tensile Strength

Requirements for the tensile properties are shown in Tables II thru IX. Metric equivalents are shown in Tables IIA and IXA. Approximate values shown for theoretical torsion elastic limits are for design information only, and are not part of the specification requirements.

TABLE II
TENSILE PROPERTIES – COLD DRAWN CARBON STEEL SPRING WIRE

Wire Size		Type 1			Type IH			Type 2*		
		high tensile cold drawn carbon steel			extra high tensile cold drawn carbon steel			cold drawn carbon steel		
Steel Wire Gauge	Dia- meter, Inch	Tensile Strength Thousands, psi		Torsional** Elastic Limit, Thousands, psi (Not a Requirement)	Tensile Strength Thousands, psi		Torsional** Elastic Limit, Thousands, psi (Not a Requirement)	Tensile Strength Thousands, psi		Torsional** Elastic Limit, Thousands, psi (Not a Requirement)
		min	max		min	max		min	max	
25	0.0204	324	364	178	350	387	192	283	323	142
24	0.0230	320	360	176	346	381	190	279	319	140
23	0.0258	316	356	174	337	373	185	275	315	138
22	0.0286	312	352	172	332	367	193	271	311	136
21	0.0317	307	347	169	327	361	180	266	306	133
20	0.0348	302	342	166	325	359	179	261	301	130
19	0.0410	294	332	162	314	348	173	255	293	128
18	0.0475	287	325	158	306	339	168	248	286	124
17	0.0540	280	316	154	301	332	166	243	279	122
16	0.0625	273	308	150	295	325	162	237	272	118
15	0.0720	267	301	147	287	317	158	232	266	116
14	0.0800	262	296	144	282	312	155	227	261	114
13	0.0915	254	287	137	276	305	149	220	253	110
12	0.1055	249	281	134	269	297	145	216	248	108
11	0.1205	242	273	131	263	291	142	210	241	105
10	0.1350	238	269	129	258	285	139	206	237	103
9	0.1483	235	266	127	253	280	137	203	234	102
8	0.1620	231	261	125	249	275	134	200	230	100
7	0.1770	226	256	120	245	270	130	195	225	98
6	0.1920	222	251	118	241	267	128	192	221	96
5	0.2070	219	247	116	238	264	126	190	218	95
4	0.2253	215	243	114	235	260	125	186	214	93
3	0.2437	213	241	113	232	257	123	183	211	92
1/4	0.2500	211	239	112	230	255	122	182	210	91
2	0.2625	211	238	112	227	252	120	180	208	90
1	0.2830	209	236	111	224	249	119	178	204	89
1/0	0.3065	206	233	109	220	245	117	175	201	88
5/16	0.3125	201	227	107	217	242	115	174	200	87
11/32	0.3438	197	223	104	213	238	113	170	196	85
3/8	0.3750	194	220	103	210	235	111	167	193	84
13/32	0.4063	192	217	102	208	233	110	166	191	83
7/16	0.4375	191	216	101	206	231	109	165	190	82
1/2	0.5000	181	205	96	195	220	103	156	180	78
17/32	0.5312	178	202	94	190	210	101	154	178	77

* Type 2- Sizes below 0.0204 inch; tensile properties are subject to agreement.

** Average values.

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4.3.1 Tensile Strength (Continued)

TABLE III
TENSILE PROPERTIES – OIL TEMPERED CARBON STEEL SPRING WIRE

Wire Size		Type 3*			Type 3H		
		Oil Tempered Carbon Steel			High Tensile Oil Tempered Carbon Steel		
		Tensile Strength Thousands, psi		Torsional** Elastic Limit, Thousands, psi (Not a Requirement)	Tensile Strength Thousands, psi		Torsional** Elastic Limit, Thousands, psi (Not a Requirement)
Steel Wire Gage	Dia- meter, Inch	min	max		min	max	
25	0.0204	293	323	178	324	354	198
24	0.0230	289	319	176	320	350	195
23	0.0258	286	316	174	317	347	193
22	0.0286	283	313	173	314	344	192
21	0.0317	280	310	171	311	341	190
20	0.0348	274	304	167	305	335	186
19	0.0410	266	296	165	297	327	184
18	0.0475	259	289	161	290	320	180
17	0.0540	253	283	157	284	314	176
16	0.0625	247	277	153	278	308	172
15	0.0720	241	271	149	272	302	169
14	0.0800	235	265	146	266	296	165
13	0.0915	230	260	143	261	291	162
12	0.1055	225	255	140	256	286	159
11	0.1205	220	250	136	251	281	156
10	0.1350	215	240	133	241	266	149
9	0.1483	210	235	130	236	261	146
8	0.1620	205	230	127	231	256	143
7	0.1770	200	225	124	226	251	140
6	0.1920	195	220	123	221	246	139
5	0.2070	190	215	120	216	241	136
4	0.2253	188	213	118	214	239	135
3	0.2437	187	212	118	213	238	134
1/4	0.2500	185	210	117	211	236	133
2	0.2625	185	210	117	211	236	133
1	0.2830	184	209	116	210	235	132
1/0	0.3065	183	208	112	209	234	128
5/16	0.3125	183	208	110	209	234	125
11/32	0.3438	181	206	109	207	232	124
3/8	0.3750	180	205	108	206	231	122
13/32	0.4063	177	202	106	203	228	122
7/16	0.4375	175	200	105	201	226	121
1/2	0.5000	170	195	102	196	221	118
17/32	0.5312	167	192	100	193	218	116

* Type 3 – Sizes below 0.0204 inch; tensile properties are subject to agreement.

** Average values.

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4.3.1 Tensile Strength (Continued)

TABLE IV
TENSILE PROPERTIES – OIL TEMPERED CARBON STEEL SQUARE SPRING WIRE

Type 3S								
Wire Size	Square Wire, Oil Tempered				Wire Size	Square Wire, Oil Tempered		
	Tensile Strength Thousands, psi		Torsional Elastic Limit, * Thousands, psi (Not a Requirement)			Tensile Strength Thousands, psi		Torsional Elastic Limit, * Thousands, psi (Not a Requirement)
0.050	253	283	162		0.162	200	225	
0.054	247	277	158		0.177	195	220	
0.062	241	271	154		0.192	190	215	
0.072	235	265	150		0.207	188	213	
0.080	230	260	147		0.225	185	210	
0.091	225	255	144		0.250	183	208	
0.105	220	250	141		0.312	180	205	
0.120	215	240	138		0.375	175	200	
0.135	210	235	134		0.437	170	195	
0.148	205	230	131		0.500	165	190	

* Average values

TABLE V
TENSILE PROPERTIES – CARBON STEEL SPRING WIRE, VALVE SPRING QUALITY

Wire Size		Type 4*			Type 5*		
		Carbon Steel, Oil Tempered, Valve Spring Quality			Cold Drawn Carbon Steel, Valve Spring Quality		
		Tensile Strength Thousands, psi		Torsional** Elastic Limit, Thousands, psi (Not a Requirement)	Tensile Strength Thousands, psi		Torsional** Elastic Limit, Thousands, psi (Not a Requirement)
Steel Wire Gage	Dia- meter, Inch	min	max		min	max	
13	0.0915				235	260	132
12	0.1055	235	255	152	235	260	132
11	0.1205				235	260	132
10	0.1350				225	250	126
9	0.1483	230	250	148	225	250	126
8	0.1620				225	250	126
7	0.1770				215	240	122
6	0.1920	225	245	145	215	240	122
5	0.2070						
4	0.2253	220	240	142	--	--	--
3	0.2437						
2	0.2625	215	235	138	--	--	--

* Minimum reduction of area will be 40%

** Average values

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4.3.1 Tensile Strength (Continued)

TABLE VI
TENSILE PROPERTIES – MUSIC SPRING WIRE

Type 6									
Wire Size		Tensile Strength Thousands, psi		Torsional* Elastic Limit, Thousands, psi (Not a Requirement)	Wire Size		Tensile Strength Thousands, psi		Torsional* Elastic Limit, Thousands, psi (Not a Requirement)
Steel Wire Gage	Dia- meter, Inch	min	max		Steel Wire Gage	Dia- meter, Inch	min	max	
6/0	0.004	439	485	191	23	0.051	303	335	173
5/0	0.005	426	471	191	24	0.055	300	331	171
4/0	0.006	415	559	191	25	0.059	296	327	169
3/0	0.007	407	449	191	26	0.063	293	324	167
2/0	0.008	399	441	190	27	0.067	290	321	165
1/0	0.009	393	434	190	28	0.071	288	318	164
1	0.010	387	428	190	--	0.072	287	317	163
2	0.011	382	422	190	--	0.076	284	314	161
3	0.012	377	417	189	30	0.080	282	312	160
4	0.013	373	412	189	31	0.085	279	308	158
5	0.014	369	408	189	32	0.090	276	305	156
--	--	--	--	--	33	0.095	274	303	155
-	0.015	365	404	189	34	0.100	271	300	153
6	0.016	362	400	188	--	0.102	270	299	153
7	0.018	356	393	188	--	0.107	268	296	151
8	0.020	350	387	188	--	0.110	267	295	151
9	0.022	345	382	187	36	0.112	266	294	150
10	0.024	341	377	186	--	--	--	--	--
11	0.026	337	373	185	--	0.121	263	290	148
--	0.028	333	368	184	--	0.125	261	288	147
--	0.030	330	365	183	39	0.130	259	286	146
--	0.032	327	361	182	--	0.135	258	285	145
--	0.034	324	358	182	--	--	--	--	--
--	0.036	321	355	181	--	0.140	256	283	144
--	0.038	318	352	179	--	0.145	254	281	143
--	0.040	315	349	179	--	0.150	253	279	142
--	0.042	313	346	178	--	0.156	251	277	140
20	0.045	309	342	176	--	--	--	--	--
--	0.048	306	339	174	--	0.162	249	275	--
--	--	--	--	--	--	0.177	245	270	--
--	--	--	--	--	--	0.192	241	267	--
--	--	--	--	--	--	0.207	238	264	--

* Average Values

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4.3.1 Tensile Strength (Continued)

**TABLE VII
TENSILE PROPERTIES – ALLOY STEEL SPRING WIRE**

Wire Size		Type 7*	Type 8*	Type 8A**			Type 9*		
		Regular Quality	Valve Spring Quality	Modified Chromium Vanadium, Oil Tempered, Valve Spring Quality			Chromium Silicon, Valve Spring Quality		
		Chromium Vanadium, Oil Tempered							
Steel Wire Gage	Dia-meter, inch	Tensile Strength Thousands, psi		Torsional ψ Elastic Limit, Thousands, psi (Not a Requirement)	Tensile Strength Thousands, psi		Torsional ψ Elastic Limit, Thousands, psi (Not a Requirement)	Tensile Strength Thousands, psi	
		min	max		min	max		min	max
22	0.0286	290	315	174	--	--	--	303	328
21	0.0317	286	311	171	--	--	--	302	327
20	0.0348	283	308	170	--	--	--	301	326
19	0.0410	278	303	166	--	--	--	300	325
18	0.0475	275	300	164	--	--	--	298	323
17	0.0540	270	295	162	--	--	--	296	321
16	0.0625	265	289	160	--	--	--	294	319
15	0.0720	260	284	158	--	--	--	292	317
14	0.0800	256	279	156	--	--	--	290	315
13	0.0915	251	274	154	245	265	160	287	312
12	0.1055	245	267	151	245	265	160	284	309
11	0.1205	240	261	149	245	265	160	280	305
10	0.1350	235	255	147	240	260	156	276	301
9	0.1483	231	251	144	240	260	156	273	298
8	0.1620	227	247	143	235	255	152	270	295
7	0.1770	223	243	141	235	255	152	268	293
6	0.1920	220	240	140	230	250	148	265	290
5	0.2070	216	236	139	230	250	148	263	288
4	0.2253	213	233	137	225	245	145	258	283
3	0.2437	210	230	136	225	245	145	256	281
2	0.2625	207	227	135	225	245	145	253	278
1	0.2830	205	225	135	--	--	--	251	276
1/0	0.3065	--	--	--	--	--	--	250	275
5/16	0.3125	203	223	133	--	--	--	250	275
11/32	0.3438	199	219	132	--	--	--	248	273
3/8	0.3750	197	217	131	--	--	--	247	272

* Minimum reduction of area will be 45% for sizes 0.156 inch and finer, 40% for sizes larger than 0.156 inch. Reduction of area does not apply to sizes under 0.0915 inch in diameter.

** Minimum reduction of area will be 40%

ψ Average values.

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4.3.1 Tensile Strength (Continued)

**TABLE VIII
TENSILE PROPERTIES
STAINLESS STEEL SPRING WIRE**

Wire Size	Type 12 UNS S30200 Type 13 UNS S30400 Type 14 UNS S30400		
	Tensile Strength, Thousands, psi		Torsional* Elastic Limit, Thousands, psi (Not a Requirement)
	min	max	
0.009 and Smaller	325	355	155
0.010	320	350	154
0.011	318	348	153
0.012	316	346	152
0.013	314	344	151
0.014	312	342	150
0.015	310	340	149
0.016	308	338	148
0.017	306	336	147
0.018	304	334	146
0.020	300	330	144
0.022	296	326	142
0.024	292	322	140
0.026	289	319	138
0.032	277	307	133
0.036	273	303	131
0.041	269	299	129
0.047	262	292	126
0.054	260	290	125
0.062	255	285	121
0.072	250	280	119
0.080	245	275	116
0.092	240	270	114
0.105	232	262	110
0.120	225	255	107
0.148	210	240	100
0.162	205	235	97
0.177	195	225	92
0.207	185	215	88
0.225	180	210	85
0.250	175	205	83
0.312	160	190	76
0.375	140	170	67

* Average Values

**TABLE IX
TENSILE PROPERTIES
STAINLESS STEEL SPRING WIRE**

Wire Size	Type 15 Precipitation Hardening Stainless Steel 17-7 PH		
	Tensile Strength, Thousands, psi		Torsional** Elastic Limit, Thousands, psi (CH Condition) (Not a Requirement)
	*Condition C	*Condition CH	
0.021-0.025	275-305	330-360	179
0.026-0.029	270-300	325-355	176
0.030-0.041	260-290	320-350	174
0.042-0.051	255-285	310-340	169
0.052-0.061	250-280	305-335	166
0.062-0.071	242-272	297-327	162
0.072-0.086	240-270	292-322	159
0.087-0.090	230-260	282-312	155
0.091-0.100	227-257	279-309	153
0.101-0.106	223-253	274-304	151
0.107-0.130	221-251	272-302	147
0.131-0.138	215-245	260-290	144
0.139-0.146	213-243	258-288	143
0.147-0.162	211-241	256-286	141
0.163-0.180	209-239	254-284	140
0.181-0.207	207-237	252-282	138
0.208-0.225	203-233	248-278	137

* Condition C – As received in coils.
Condition CH – After heating at 900°
for 1 hour and air cooling.

** Average Values

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