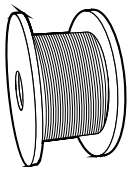
ZAPP PRECISION WIRE
WIRELINE SPECIFICATIONS

QUALITY SYSTEM CERTIFIED TO ISO 9001:2015



For down hole oil, gas, and geothermal drilling, where severe corrosive environments are involved.

RECOMMENDED GRADES

_ Type 316, 2205, XM19, 2507, 25-6MO, 27-7MO, MP35N®, C276

SIZES

_ .082", .092", .108", .125", .140", .150", .160" (other sizes as requested)

LENGTHS

_ 10,000/35,000 feet measured lengths (+500, -0 feet tolerance)

DIAMETER TOLERANCES

± 0.001"

TEMPERS

_ 200,000/ 270,000 psi, depending upon alloy

GOOD WIRELINE HANDLING PRACTICES

_ Do not drop or damage spools
_ Maintain adequate back tension during respooling and winding operations
_ Maintain natural curvature of the wire during winding and respooling operations
_ Do not rub on ground or non-rolling sheaves and bearing surfaces
_ Do not allow loops, bends, or kinks to occur – this can damage or break the line
_ Do clean the wireline after use
_ Keep reels in upright position

ALLOY PRODUCT LINE

Carbon Steel

For sweet wells. Not recommended for well environments containing H_2S or CO_2. Produced to API 9A

316 SS

Good resistance for general corrosion. Not recommended for wells with H_2S. Produced to ASTM A580.
PREN = 25

Duplex 2205

Better resistance to chloride stress corrosion cracking than lower alloyed materials such as 316SS. Not recommended for wells with H_2S. Produced to ASTM A580.
PREN = 36

XM19

An improved version of 316 SS. Better corrosion resistance and break strength than 316 SS. Works well in chlorides and CO_2. Not recommended for wells with high H_2S.
Produced to ASTM A580.
PREN = 38

Super Duplex 2507

Better resistance to chloride stress corrosion cracking than lower alloyed materials such as 316SS. Not recommended for wells with high H_2S. Produced to ASTM A580.
PREN = 41

25-6MO

Intermediate alloy. Suitable for use in wells that have moderate concentrations of H_2S. Produced to ASTM A580, B649
PREN = 47

27-7MO

Optimum intermediate alloy. An improved version of 25-6MO. Better corrosion resistance and break strength than 25-6MO. Produced to ASTM A580.
PREN = 56

MP35N®

Top of the line. Used in the most severe well environments. Produced to ASTM F562.
PREN = 53*

C276

For use in severe well environments. Produced to ASTM 580.
PREN = 68

* It should be noted that the PREN value for MP35N® doesn't reflect the true comparative corrosion resistance compared to the other alloys. MP35N® contains about 35% cobalt. Cobalt is a critical factor in terms of corrosion resistance and break strength. However, cobalt percentages are not included in the PREN formula and thus tend to skew the relative corrosion resistance results in this instance.

ALLOY CHEMISTRY (KEY ELEMENTS)

Alloy	UNS	C	Mn	Cr	Ni	Mo	Cu	N	Co	Ti	Fe
316	S31600	.08	2.0	16.0 – 18.0	10.0 – 14.0	2.0 – 3.0	-	-	-	-	bal.
2205	S32205	.03	2.0	21.0 – 23.0	4.5 – 6.5	2.5 – 3.5	-	.18	-	-	bal.
XM19	S20910	.06	4.0 – 6.0	20.5 – 23.5	11.5 – 13.5	1.5 – 3.0	-	.20 - .40	-	-	bal.
2507	S32750	.03	1.2	25.0	7.0	4.0	-	.30	-	-	bal.
25-6MO*	NO8926	.02	2.0	19.0 – 21.0	24.0 – 26.0	6.0 – 7.0	0.5 – 1.5	.15 - .25	-	-	bal.
27-7MO	S31277	.02	3.0	20.5 – 23.0	26.0 – 28.0	6.6 – 8.0	0.5 – 1.5	.30 - .40	-	-	bal.
MP35N®	R30035	.02	0.1	19.0 – 21.0	33.0 – 37.0	9.0 – 10.5	-	-	bal.	1.0	1.0
C276	N10276	.01	1.0	14.5 – 16.5	bal.	15.0 – 17.0	-	-	2.5	-	4.0 - 7.0

* Note: 25-6MO, SUPA 75®, and GD31MO® have equivalent chemistries
Chemical values are maximum values unless a range is given or otherwise noted.

MINIMUM BREAK STRENGTH

Size	316	2205	XM19	2507	25-6MO	27-7MO	MP35N®	C276
.082"	1150#	1345#	1215#	1345#	1175#	1300#	1300#	1280#
.092"	1500#	1690#	1540#	1690#	1500#	1650#	1690#	1615#
.108"	2000#	2240#	2200#	2240#	2130#	2250#	2300#	2210#
.125"	2700#	2945#	3000#	2975#	2750#	3000#	3100#	2935#
.140"	3300#	3540#	3540#	3694#	3250#	3670#	3725#	3680#
.150"	3750#	3975#	4065#	4150#	3750#	4155#	4240#	4205#
.160"	4225#	4425#	4625#	4665#	4250#	4650#	4825#	4785#

RECOMMENDED SAFE WORKING LOAD (60% OF MIN. BREAK STRENGTH)

Size	316	2205	XM19	2507	25-6MO	27-7MO	MP35N®	C276
.082"	690#	807#	729#	777#	705#	780#	780#	768#
.092"	900#	1014#	924#	978#	900#	990#	1014#	969#
.108"	1200#	1344#	1320#	1344#	1278#	1350#	1380#	1326#
.125"	1620#	1767#	1800#	1785#	1650#	1800#	1860#	1761#
.140"	1980#	2124#	2124#	2216#	1950#	2202#	2235#	2208#
.150"	2250#	2385#	2439#	2490#	2250#	2493#	2544#	2523#
.160"	2535#	2655#	2775#	2799#	2550#	2790#	2895#	2871#

RECOMMENDED MINIMUM SHEAVE DIAMETER (INCHES):

Wire size	Sheave size
.082"	13"
.092"	13"
.108"	15"
.125"	17.5"
.140"	20"
.150"	20"
.160"	22"

DENSITY/CORROSION

Alloy	Density (lb/in³)	Corrosion (PREN)
316	.287	26
2205	.282	36
XM19	.285	38
2507	.281	41
25-6MO	.290	47
27-7MO	.289	56
MP35N®	.309	53
C276	.321	68

WEIGHT PER FOOT (LBS.) FOR WIRELINES

Alloy	.082"	.092"	.108"	.125"	.140"	.150"	.160"
316	0.018	0.023	0.031	0.042	0.053	0.060	0.069
2205	0.018	0.022	0.031	0.041	0.052	0.059	0.068
XM19	0.018	0.023	0.031	0.042	0.053	0.060	0.069
2507	0.018	0.022	0.031	0.041	0.052	0.059	0.068
25-6MO	0.018	0.023	0.032	0.043	0.054	0.062	0.070
27-7MO	0.018	0.023	0.032	0.043	0.054	0.062	0.070
MP35N®*	0.020	0.025	0.034	0.046	0.057	0.066	0.075
C276	0.018	0.022	0.031	0.041	0.052	0.059	0.068

* It should be noted that the PREN value for MP35N® doesn't reflect the true comparative corrosion resistance compared to the other alloys. MP35N® contains about 35% cobalt. Cobalt is a critical factor in terms of corrosion resistance and break strength. However, cobalt percentages are not included in the PREN formula and thus tend to skew the relative corrosion resistance results in this instance.

MINIMUM WIRELINE STRETCH

Alloy	.082"	.092"	.108"	.125"	.140"	.150"	.160"
316	6.76×10^{-6}	5.37×10^{-6}	3.90×10^{-6}	2.91×10^{-6}	2.32×10^{-6}	2.02×10^{-6}	1.77×10^{-6}
2205	6.53×10^{-6}	5.19×10^{-6}	3.90×10^{-6}	3.21×10^{-6}	2.56×10^{-6}	2.23×10^{-6}	1.96×10^{-6}
XM19	6.76×10^{-6}	5.37×10^{-6}	3.90×10^{-6}	2.91×10^{-6}	2.32×10^{-6}	2.02×10^{-6}	1.77×10^{-6}
2507	6.53×10^{-6}	5.19×10^{-6}	3.90×10^{-6}	3.21×10^{-6}	2.56×10^{-6}	2.23×10^{-6}	1.96×10^{-6}
25-6MO	6.94×10^{-6}	5.52×10^{-6}	4.00×10^{-6}	2.99×10^{-6}	2.38×10^{-6}	2.08×10^{-6}	1.82×10^{-6}
27-7MO	6.84×10^{-6}	5.43×10^{-6}	3.94×10^{-6}	2.94×10^{-6}	2.35×10^{-6}	2.04×10^{-6}	1.80×10^{-6}
MP35N®	5.61×10^{-6}	4.46×10^{-6}	3.23×10^{-6}	2.41×10^{-6}	1.92×10^{-6}	1.68×10^{-6}	1.47×10^{-6}
C276	6.35×10^{-6}	5.05×10^{-6}	3.66×10^{-6}	2.73×10^{-6}	2.18×10^{-6}	1.90×10^{-6}	1.67×10^{-6}

The formula seen below will provide elastic stretch (feet):

$S = F * L * (T + .5W)$

S = Elastic Stretch (feet)
F = Stretch Factor (/lb)
L = Length of line in well (feet)
T = Tool weight (lb)
W = Weight of line in well (lb)

Example
Stretch for a 25-6MO 125'' wireline at a length of 8,000 feet and a tool weight of 200 lbs

$S= (2.99 \times 10^{-6}) * (8000) * (200 + .5(344))$
$S= (2.99 \times 10^{-6}) * (8000) * (372)$
S= 8.898 feet

PITTING RESISTANCE

One way that alloy corrosion resistance may be determined is by its Pitting Resistance Equivalent Number (PREN) and Pitting Index (PI). An alloy´s corrosion resistance is determined by its chemical composition. PREN and PI are formulas that are commonly used to rate chemical resistance of an alloy.

ALLOY CHEMISTRY RANGES

Alloy	UNS	C	Mn	Cr	Ni	Mo	Cu	N	Co	Ti	Fe	PREN	PI
316	S31600	.08	2.0	16.0 – 18.0	10.0 – 14.0	2.0 – 3.0	-	-	-	-	bal.	26	25
2205	S32205	.03	2.0	21.0 – 23.0	4.5 – 6.5	2.5 – 3.5	-	.18	-	-	bal.	36	31
XM19	S20910	.06	4.0 – 6.0	20.5 – 23.5	11.5 – 13.5	1.5 – 3.0	-	.20 - .40	-	-	bal.	38	33
2507	S32750	.03	1.2	24.0 – 26.0	6.0 – 8.0	3.0 – 5.0	.5	.30	-	-	bal.	41	40
25-6MO	NO8926	.02	2.0	19.0 – 21.0	24.0 – 26.0	6.0 – 7.0	.5 – 1.5	.15 - .25	-	-	bal.	47	43
27-7MO	S31277	.02	3.0	20.5 – 23.0	26.0 – 28.0	6.6 – 8.0	.5 – 1.5	.30 - .40	-	-	bal.	56	49
MP35N®	R30035	.02	0.1	19.0 – 21.0	33.0 – 37.0	9.0 – 10.5	-	-	bal.	1.0	1.0	53	52
C276	N10276	.01	1.0	14.5 – 16.5	bal.	15.0 – 17.0	-	-	2.5	-	4.0 – 7.0	68	74

(Maximum values range specified)

CRITICAL PITTING TEMPERATURE

Another method occasionally used for alloy comparison purposes is outlined in ASTM G48. Within ASTM G48, a standard test method for measuring the Critical Pitting Temperature (CPT) of a material is outlined. To measure CPT, a material is submersed in a pH controlled aqueous environment of 6 % FeCI by mass and 1 % HCI at a predetermined testing temperature that remains constant within 1 °C.

Grade Name	UNS	PREN	PI	CPT (°C)	CPT (°F)
316	S31600	26	25	22	72
Duplex 2205	S32205	36	31	42	108
XM-19	S20910	38	33	41	106
Super Duplex 2507	S32750	41	40	61	143
25-6MO	N08926	47	43	65	149
27-7MO	S31277	56	49	80	176
MP35N®	R30035	53	52	84	183
C276	N01276	73	76	>150	>302

PREN = Cr + 3.3Mo + 16N *Depending on supplier

PREN = Cr + 3.3Mo + 30N *Depending on supplier
PI = Cr + 3.3Mo + 11N +1.5(W+Nb)

After 72 hours if the material has not been pitted at its testing temperature, then the testing temperature is raised by 10 °C and the 72 hour submersion test is repeated.
ASTM G48 states that the starting testing temperature can be estimated using the following equation:
CPT (°C) = 2.5 Cr + 7.6 Mo + 31.9 N - 41

STRESS CORROSION CRACKING RESISTANCE

The chemical balance (and especially the 25% nickel and the 0.20% nitrogen content) provides 25-6MO significantly better resistance to chloride-ion stress corrosion cracking than lower nickel alloys such as AISI 317 stainless steel. This is illustrated quite well by the Copson U-Curve in the Special Metals Corporation publication SMC-005.

ZAPP PRECISION WIRE STANDARDS

1. All wirelines must pass an eddy current test as part of our NDT quality assurance program.
2. All wirelines must pass an aged wrap test as part of our NDT quality assurance program.
3. All wirelines have full traceability.

ZAPP PRECISION WIRE
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