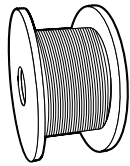


# WIRELINES | SLICKLINES

## ZAPP 316 (UNS S31600)



ZAPP QUALITY SYSTEM CERTIFIED TO ISO 9001:2015



### Alloy ZAPP 316 (UNS S31600) Wire for

- Armoring applications on electromechanical cables
- Wirelines/ Slicklines for down hole service applications

### Characteristics

ZAPP 316 (UNS S31600) is an austenitic stainless steel that provides good corrosion resistance in CO<sub>2</sub> well environments. The ZAPP 316L stainless steel alloy is our entry level CRA (corrosion resistant alloy) product for oil patch applications. It contains about 17% chromium, 12% nickel, and 2.5% molybdenum, which readily enables it to replace conventional carbon/plow steel in corrosive environments.

The alloy offers good resistance to pitting and crevice corrosion, but is not recommended for use in H<sub>2</sub>S environments. Performance in these areas is often measured using Critical Pitting Temperatures (CPT), Critical Crevice Temperatures (CCT), and Pitting Resistance Equivalent Numbers (PREN). ASTM Standard Test Methods G 48 is also referenced. It covers the procedures for the determination of the resistance of various alloys to pitting and crevice corrosion.

### Chemistry Standards

- UNS S31600
- Alloy-No. 1.4401
- ASTM A580

For comparison purposes, PREN and CPT numbers are presented for these alloys:

### PREN and CPT Numbers\*

Alloy	PREN	CPT (°F)	CPT (°C)
ZAPP 316	26	72	22
ZAPP 2205	36	108	42
ZAPP XM19	38	106	41
ZAPP 2507	41	143	61
ZAPP 28	40	129	54
ZAPP 25-6MO	47	149	65
ZAPP 27-7MO	56	176	80
ZAPP MP35N	53	183	84
ZAPP C276	68	>302	>150

\*PREN = Cr + 3.3 Mo + 30N

\*CPT (°C) = 2.5 Cr + 7.6 Mo + 31.9 N - 41

### Weight per Foot (lbs.) for Wirelines

Alloy	.082"	.092"	.108"	.125"	.140"	.150"	.160"
ZAPP 316	0.018	0.023	0.031	0.042	0.053	0.060	0.069
ZAPP 2205	0.018	0.022	0.031	0.041	0.052	0.059	0.068
ZAPP XM19	0.018	0.023	0.031	0.042	0.053	0.060	0.069
ZAPP 2507	0.018	0.022	0.031	0.041	0.052	0.059	0.068
ZAPP 25-6MO	0.018	0.023	0.032	0.043	0.054	0.062	0.071
ZAPP 27-7MO	0.018	0.023	0.032	0.043	0.054	0.062	0.071
ZAPP MP35N	0.020	0.025	0.034	0.046	0.057	0.066	0.075
ZAPP C276	0.018	0.022	0.031	0.041	0.052	0.059	0.068

**Limiting Chemical Composition of Alloy ZAPP 316**

Ni	Cr	Mo	N	C	Mn	Fe
10.00 – 14.00	16.00 – 18.00	2.00 – 3.00	0.10 max.	0.08 max.	2.00 max.	remainder

Tensile strengths in the order of 205/260,000 psi are achieved through cold drawing. At these strength levels, the wire is ductile and able to successfully pass the wrap test in the as drawn condition as well as the as drawn plus exposed to temperatures as high as 300°F conditions. This wrap or bend test shows no surface cracking or failure in either condition

**Physical Properties of Alloy ZAPP 316 at Room Temperature Are as Follows**

Density	0.287 [lb/in <sup>3</sup> ] / 7.94 [g/cm <sup>3</sup> ]
Melting Range	2,500 – 2,550 [°F] / 1,370 – 1,400 [°C]
Specific Heat	0.12 [Btu/lb·°F] / 500 [J/kg · °C]
Electrical Resistivity	445 [ohm-circ mil/ft] / 0.74 [μΩ · m]
Permeability at 200 Oersted (15.9 kA/m)	1.02 max. [annealed]
Young ´s Modulus at 70 °F (21 °C)	28.0 [10 <sup>3</sup> ksi] / 193.0 [GPa]
Thermal Expansion at 200 °F (100 °C)	8.90 [in/in/°F · 10 <sup>-6</sup> ] / 16.0 [cm/cm/°C · 10 <sup>-6</sup> ]

ZAPP 316 is also identified as UNS S31600. Wire products are covered by ASTM A580.

Material produced to the UNS S31600 chemistry ranges and manufactured into armor wire or wirelines by Zapp Precision Wire will provide an excellent quality product. Zapp Precision Wire technology, quality, and superior wire drawing capabilities will make the difference for these critical applications.

The Zapp Precision Wire quality system is registered to ISO-9001:2008. For additional information on this or any other Zapp Precision Wire product, please contact the Customer Service Department at 843-851-0700 or fax your inquiry to 843-851-0010, or e-mail the inquiry to [sales@zapp.com](mailto:sales@zapp.com).

**Zapp Technical Data**

**Alloy Chemistry**

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

(Maximum values unless range specified)

**Armor Wire Typical Tensile Strength Ranges (ksi)**

Size	ZAPP 316	ZAPP XM19	ZAPP 25-6MO	ZAPP 27-7MO	ZAPP MP35N
.020" - .029"	230/265	250/280	245/275	255/280	275/300
.030" - .066"	225/260	245/280	240/275	255/280	275/300

**Wireline Minimum Break Strength\*\***

Size	ZAPP 316	ZAPP 2205	ZAPP XM19	ZAPP 2507	ZAPP 25-6MO	ZAPP 27-7MO	ZAPP MP35N	ZAPP C276
.082"	1150#	1345#	1215#	1345#	1175#	1300#	1300#	1280#
.092"	1500#	1690#	1540#	1690#	1500#	1650#	1690#	1615#
.108"	2000#	2240#	2215#	2240#	2150#	2250#	2300#	2210#
.125"	2700#	2945#	3000#	2975#	2800#	3000#	3100#	2935#
.140"	3300#	3540#	3540#	3694#	3480#	3670#	3725#	3680#
.150"	3750#	3975#	4065#	4150#	3950#	4155#	4240#	4205#
.160"	4225#	4425#	4625#	4665#	4350#	4650#	4825#	4785#

(\*\* The recommended **safe working load** is 60% of minimum break strength)

**Density/Corrosion**

Alloy	Density (lb/in <sup>3</sup> )	Corrosion (PREN)*	CPT (°F)	CPT (°C)**
ZAPP 316	.287	26	72	22
ZAPP 2205	.278	36	108	42
ZAPP XM19	.285	38	106	41
ZAPP 2507	.281	41	144	62
ZAPP 25-6MO	.290	47	149	65
ZAPP 27-7MO	.289	56	176	80
ZAPP MP35N	.309	53	183	84
ZAPP C276	.321	68	>302	>150

\* PREN = Cr + 3.3 Mo + 30N

**Examples of Theoretical Acceptable Well Environments for ZAPP 316 Wire\***

Chlorides	Temp °F	H <sub>2</sub> S	CO <sub>2</sub>	Pressure (PSI)	Req. Minimum Pitting Index (PI)	ZAPP 316 (PI)	ZAPP 316 (PREN)
20,000 ppm	325	0 %	6 %	12,000	16.50	25.25	26
10,000 ppm	106	0 %	5 %	1,100	13.00	25.25	26
25,000 ppm	275	0 %	8 %	3,000	16.50	25.25	26
50,000 ppm	240	0 %	10 %	3,500	13.00	25.25	26
5,000 ppm	276	0 %	0.5 %	13,000	16.50	25.25	26

\* The theoretical acceptable well environments are based on the SOCRATES software. SOCRATES is a comprehensive material selection tool for oil and gas applications that selects corrosion resistant alloys (CRA) through material evaluation based on mechanical strength parameters, heat treatment/cold work and hardness limitations. The program also evaluates the characterization of the environment in terms of operating pressure, temperature, pH, H<sub>2</sub>S, chlorides, elemental sulfur, aeration, gas to oil ratio and water to gas ratio water cut. Stress corrosion cracking, hydrogen embrittlement cracking, sulfide stress cracking and resistance to pitting corrosion are also evaluated.

The examples above are based on the environment listed and do not take into consideration the actual values of elemental sulfur, aeration, gas to oil ratio and water to gas ratio water cut.

$$PI = Cr + 3.3Mo + 11N + 1.5(W+Nb)$$

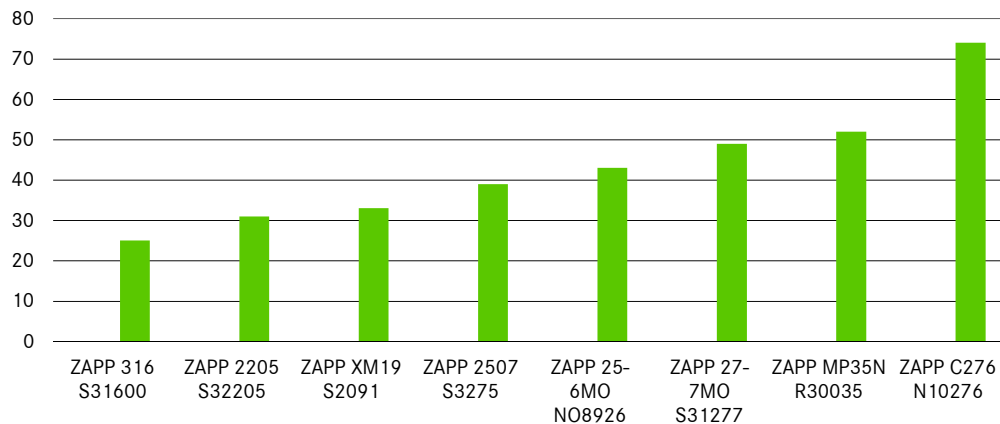
$$PREN = Cr + 3.3Mo + 30N$$

**Note:** The information in the Socrates summary report does not represent a commitment by Honeywell InterCorr International or Zapp Precision Wire, Inc. The information contained in this document and the Socrates software is purely advisory in nature. In no event shall Honeywell InterCorr, Zapp Precision Wire, Inc., or their employees or agents have liability for damages, including but not limited to, consequential damages arising out of or in connection with any person's use or inability to use the information in this document.

#### Nominal Chemical Composition Comparison

Chemical Element	ZAPP 316	ZAPP 2205	ZAPP XM19	ZAPP 2507	ZAPP 25-6MO	ZAPP 27-7MO	ZAPP MP35N	ZAPP C276
Fe	65.40	67.71	56.40	62.43	46.30	39.65	1.00	5.5
Mn	2.00	2.0	5.00	0.6	2.00	3.00	0.15	0.5
Ni	12.00	5.5	12.50	7.0	25.00	27.00	35.00	55.0 bal.
Co	*	*	*	*	*	*	32.90	2.0
Cr	17.00	22.0	22.00	25.0	20.00	21.75	20.00	15.5
Mo	2.50	2.5	2.25	4.0	6.50	7.25	9.75	16.0
W	*	*	*	*	*	*	*	*
Nb	*	*	0.20	*	*	*	*	*
N	*	.12	0.30	*	0.20	0.35	*	*
* Trace								
PI	25.25	31.57	33.03	39.85	43.65	49.53	52.18	74.43

Pitting Index



### **Zapp Precision Wire Standards**

1. All wirelines must pass an eddy current test as part of our NDT quality assurance program.
2. All wirelines and armor wires must pass an aged wrap test as part of our NDT quality assurance program.
3. All wirelines and armor wires have full traceability.
4. All ZAPP 316 wirelines are 100% weld free and supplied in continuous lengths.

### **Zapp Precision Wire Quality**

The Zapp Precision Wire technology, quality, and superior wire drawing capabilities will make the difference for critical armor wire and wireline applications.

The Zapp Precision Wire quality system is registered to ISO 9001:2015.

### **ZAPP PRECISION WIRE WIRE | BAR | PROFILE | FLAT WIRE**

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