X-Tract®
Electrical Submersible Pump Cable

Born in the lab to outlast in the field

JANUARY 2013

General Cable

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X-Tract®

Servicing Oil Field Electrical Submersible Pump Applications

The upstream global oil, gas and petrochemical market demands cables that efficiently and cost-effectively operate in the field under complex conditions. That is why General Cable developed the X-Tract® line of Electrical Submersible Pump (ESP) cables, designed and engineered specifically to provide maximum performance and longevity in even the most severe ESP applications.

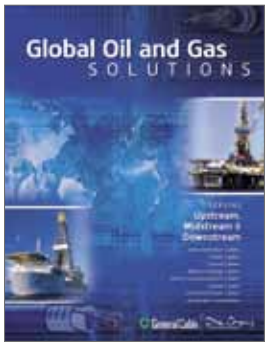
This catalog contains in-depth information on our line of Electrical Submersible Pump (ESP) cables. It features the latest information from applications and constructions to detailed technical and specification data in indexed sections — with an easy-to-use "spec-on-a-page" format.

And, of course, if you need any further data, General Cable's customer service staff and technical experts are specifically trained to help our customers achieve their desired end results.

General Cable

What's New?

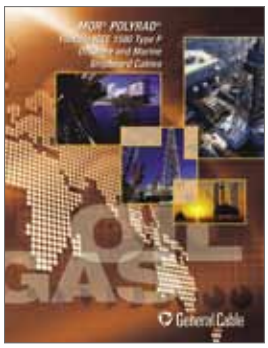
GLOBAL OIL AND GAS SOLUTIONS



Serving Upstream, Midstream and Downstream

From exploration and extraction to production and processing of natural resources, General Cable's products satisfy virtually every oil and gas industry cabling requirement around the globe.

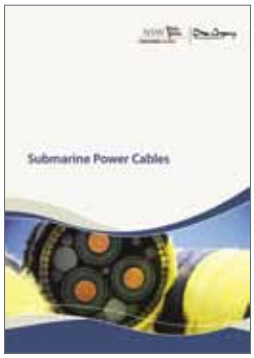
FLEXIBLE IEEE 1580 TYPE P



Serving the Offshore and Marine Shipboard Markets

From drilling rigs and semi-submersibles to FPSOs and FSOs, General Cable offers a full line of MOR® Polyrad® XT-125 Marine IEEE 1580 Type P listed cables.

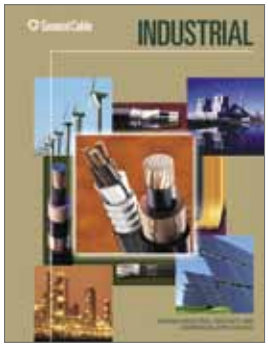
SUBMARINE POWER CABLES



Serving the Offshore Oil and Gas Industry

As recognized experts in submarine power cables for the offshore oil and gas industry, NSW, a General Cable company, offers complete project solutions by meeting the most stringent industrial requirements.

FULL LINE INDUSTRIAL CATALOG



Instrumentation, Power and Control Cables

This catalog contains in-depth information on the most comprehensive line of instrumentation, power and control cables available today.

X-Tract®

Electrical Submersible Pump (ESP) Cable

Participation in the global oil, gas and petrochemical (OGP) market sector is an important part of General Cable's long-term energy strategy.

General Cable has positioned itself globally as an "energy company" and is making major investments in wire and cable products for the energy infrastructure markets. With oil and gas as a primary driver of energy, General Cable has listened to customers and analyzed its product offering based on market input. Consequently, it is rounding out its portfolio of products on a global scale, adding X-Tract® (Electrical Submersible Pump Cable), CCW (Continuously Corrugated Welded Cable), umbilical, and subsea cables to a suite of products used by the oil, gas and petrochemical industries for power, control, instrumentation, and communications.

The introduction of the X-Tract® Electrical Submersible Pump (ESP) product line expands General Cable's current OGP product offering, providing existing and new customers with a single source for their wire and cable needs, while at the same time allowing General Cable to participate more broadly in the upstream segment of the OGP market, which includes onshore and offshore oil and gas exploration and production.

X-Tract® cables are specifically engineered for longevity, offering the highest degree of reliability in the sweetest to the most sour wells, even in high-temperature and severe-corrosion environments. They are offered in both round and flat constructions with varying designs adapted to different well environments, based on temperature, corrosion and pressure-resistance needs. All designs reference IEEE 1018, IEEE 1019 and all subordinate specifications.

General Cable is committed to maintaining an adequate level of inventory to assure maximum availability for customers.

Our Green Initiative symbol recognizes our role and responsibility in promoting sustainability. The symbol also reflects our commitment to achieving industry-leading standards and responding proactively to environmental global issues.

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General Cable

General Cable | One Company Connecting the World

General Cable is a leader in the development, design, manufacture, marketing and distribution of copper, aluminum and fiber optic wire and cable for the energy, industrial, specialty and communications markets.

Our products inspire progress worldwide … customers use our value-added products to create global infrastructure that improves the standard of living for people everywhere.

Each day we're building business momentum — developing ideas into innovative solutions and industry-leading products, expanding geographic access and furthering our investment in highly capable associates, Lean Manufacturing, material science and technology resources.

General Cable is influencing the world … with more than two-thirds of our sales generated outside North America, 14,000 associates worldwide and 57 manufacturing facilities throughout 26 countries. As one of the largest wire and cable manufacturers, we are the *One Company Connecting the World.*

Energy Cables

Our cables carry energy across the world — through the air, underground and under the sea. Increasing demand for energy is accelerating investment in exploration, extraction, power generation, transmission and distribution — whether based on coal, natural gas, oil, nuclear, wind, solar or water.

Industrial & Specialty Cables

Our cables channel the power and signals that make equipment hum and engines run. From oil rigs and broadcast studios to cars and trains, and in commercial buildings, public venues, factory floors and special applications such as military, nuclear, marine and mining — we serve an extensive range of markets.

Communications Cables

Our cables keep information flowing — facilitating a non-stop stream of words and images around the world. We meet the high-speed bandwidth needs of global communications networks, from fiber optic submarine communications cables, copper and fiber aerial and underground cables to copper and fiber optic enterprise cables and system solutions.

World Headquarters

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4 Tesseneer Drive
Highland Heights, KY
41076-9753 U.S.A.

Product Range and Well Application Chart

SPEC	TYPE	DESCRIPTION AND VOLTAGE	TEMPERATURE RATING	WELL TYPE	WELL CONDITIONS
120	2R205	Light-to-Medium-Duty, Round Power Supply (PS) Cable – 5 kV	-40°C to +96°C -40°F to +205°F	Low-to-Moderate Gas and Vapor Concentrations Low-to-Moderate Corrosion Low-to-Moderate Temperature	**LOW/SHALLOW/SWEET** **Temperature:** 205°F (96°C) **Well Depth:** 600 ft (183 m) **Bottom Hole Pressure (BHP):** down to 350 psi (24 bar) **H_2S to CO_2 Ratio:** < 1/500 **pH:** up to 8
121	2F205	Light-to-Medium-Duty, Flat Power Supply (PS) Cable – 5 kV	-40°C to +96°C -40°F to +205°F		
130	3R302	Medium-Duty, Round Power Supply (PS) Cable – 5 kV	-40°C to +150°C -40°F to +302°F	Moderate Gas and Vapor Concentrations Moderate Corrosion Moderately High Temperature	
131	3F302	Medium-Duty, Flat Power Supply (PS) Cable – 5 kV	-40°C to +150°C -40°F to +302°F		
140	4R400	Heavy-Duty, Round Power Supply (PS) Cable – 5 kV	-51°C to +205°C -60°F to +400°F	Significant Gas and Vapor Concentrations Significant Corrosion High Temperature	**pH:** down to 3 **H_2S to CO_2 Ratio:** > 1/500 **Bottom Hole Pressure (BHP):** up to 7,500 psi (517 bar) **Well Depth:** 11,000 ft (3,353 m) **Temperature:** 450°F (232°C) **HIGH/DEEP/SOUR**
151	5F450	Severe-Duty, Flat Power Supply (PS) Cable – 5 kV	-51°C to +232°C -60°F to +450°F	High Gas and Vapor Concentrations Severe Corrosion Very High Temperature	

Note: The presence of oxygen and/or salt water (and/or other minerals) will also influence corrosion levels.

Additional Cable Selection Criteria:

- Ambient Well Temperature
- Corrosion Conditions
- Annulus Clearance
- Amperage
- Voltage Drop

Nomenclature

Cable Nomenclature

Abbreviation	Description
Cable Type	
ESP	Electrical Submersible Pump
PS	Power Supply
Cable Geometry	
F	Flat Cable Configuration
R	Round Cable Configuration
Conductors	
SBC	Solid Bare Copper
STC	Solid Tinned Copper
StBC7	Stranded Bare Copper – 7 strands
Cu or CU	Copper
AWG	American Wire Gauge (size)

Abbreviation	Description
Compound	
EPDM	Ethylene Propylene Diene Monomer
Tapes	
FTP or FTp	Fluoropolymer Tape
BTP or BTp	Barrier Tape
Metals	
G	Galvanized Steel
SS	Stainless Steel
Pb or PB	Lead

Part Number Construction Nomenclature

Example: 151.4314505G

1	5	1	.	4	3	1	4	5	0	5	G
A	B	C		D	E	F	G	G	G	H	I

Letter	Description
A	Premium Series (1) or Economy Series (2)
B	Type (2-5)
C	Flat (1) or Round (0)
D	AWG
E	Number of Conductors
F	Solid Bare Copper (1) or Stranded Copper (2)
GGG	Temperature (F)
H	Voltage (kV)
I	Armor: Galvanized Steel (G), Stainless Steel (SS)

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X-Tract® Electrical Submersible Pump Cable for Oil Fields

SPECIFICATION NO.		PRODUCT DESCRIPTION	REVISION DATE	PAGE
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121	X-Tract® ESP	2F205 Light-to-Moderate-Duty, Flat Power Supply (PS) Cable 5 kV, Rated -40°C to +96°C/-40°F to +205°F	Jan. 2013	7-8
130	X-Tract® ESP	3R302 Moderate-Duty, Round Power Supply (PS) Cable 5 kV, Rated -40°C to +150°C/-40°F to +302°F	Jan. 2013	9-10
131	X-Tract® ESP	3F302 Moderate-Duty, Flat Power Supply (PS) Cable 5 kV, Rated -40°C to +150°C/-40°F to +302°F	Jan. 2013	11-12
140	X-Tract® ESP	4R400 Heavy-Duty, Round Power Supply (PS) Cable 5 kV, Rated -51°C to +205°C/-60°F to +400°F	Jan. 2013	13-14
151	X-Tract® ESP	5F450 Severe-Duty, Flat Power Supply (PS) Cable 5 kV, Rated -51°C to +232°C/-60°F to +450°F	Jan. 2013	15-16

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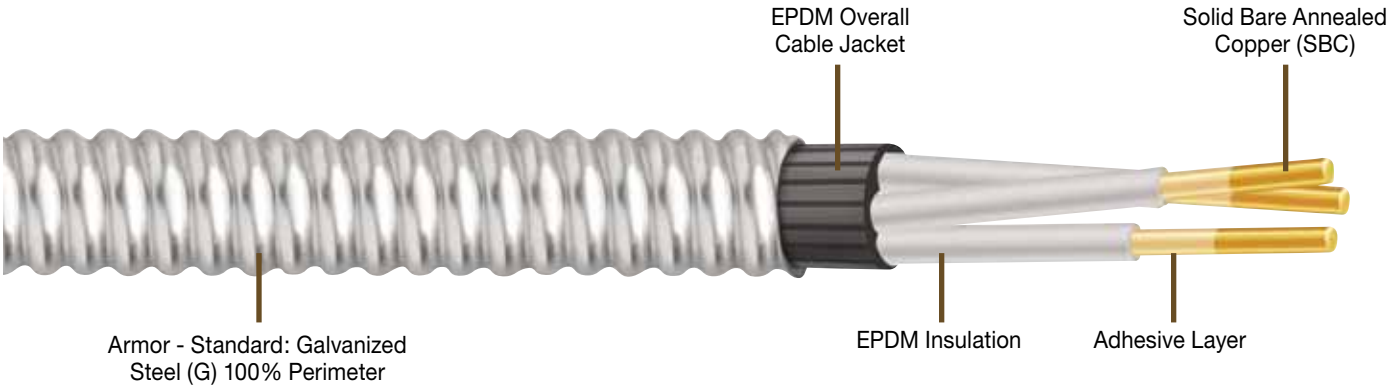
X-Tract® Electrical Submersible Pump Cable

2R205 Light-to-Moderate-Duty, Round Power Supply (PS) Cable
5 kV, Rated -40°C to +96°C/-40°F to +205°F



Round Type 2 cables are lower-temperature-rated for operating temperatures of -40 to +205 degrees F/ -40 to +96 degrees C. The Type 2 design provides excellent performance and life expectancy in less gassy wells and where decompression resistance is not required. Type 2 cables are designed for light-to-moderate-duty use in low-pressure, cooler and less gassy wells with less corrosive conditions.

Product Construction:

Conductor:
- Solid bare annealed copper per ASTM B3

Insulation:
- Adhesive layer
- EPDM insulation
  - — *Cross-linked, high dielectric strength, high oil resistance, low swell, chemically inert, mechanically stable*

Overall Cable Jacket:
- EPDM insulation jacket
  - — *Cross-linked, high dielectric strength, high oil resistance, low swell, chemically inert, mechanically stable*

Armor:
- Galvanized steel 100% perimeter
  - — *Heavy zinc alloy plating for extra corrosion resistance – interlocked profile for enhanced mechanical stability*

Armor (cont'd):
- Armor Options:
  - — *Stainless steel alloy for increased performance in highly corrosive well environments*

Marker Tape:

GENERAL CABLE® USA X-TRACT® TYPE 2 5 KV -40C to +96C/-40F to +205F 3/C XAWG ARMOR TYPE MONTH/YEAR OF MFG SEQUENTIAL FOOTAGE MARK

Applications:

- Power Supply (PS) light-to-moderate-duty service:
  - — *Low-to-moderate gas and vapor concentrations*
  - — *Low-to-moderate corrosion*
  - — *Low-to-moderate temperature*

Industry References:

- IEEE 1018
- API RP 11S5
- API RP 11S6
- ASTM A459
- ASTM B3
- ASTM D412

Standard Packaging:

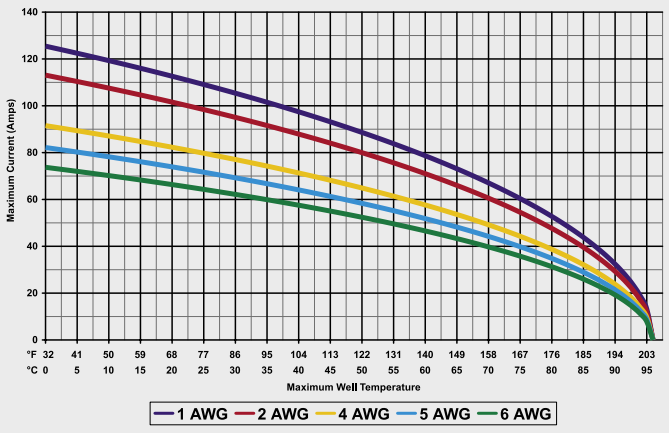
- DIN standard heavy-duty steel reels
  - — *Corrosion-resistant design with 100% protective over-coating*
- The cable ends will be sealed with weather-resistant caps or suitable tape
- Lagging: 2-by-4-inch treated wood with 3 encircling corrosion-resistant bands
- Option: multiple non-standard lengths per reel

X-Tract® Electrical Submersible Pump Cable

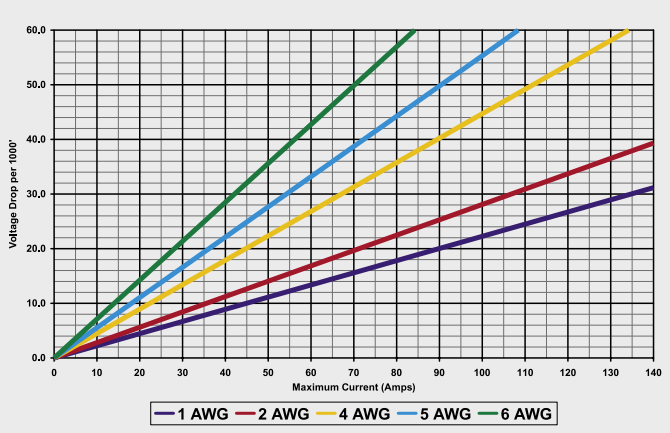
2R205 Light-to-Moderate-Duty, Round Power Supply (PS) Cable
5 kV, Rated -40°C to +96°C/-40°F to +205°F

PART NUMBER	kV	COND. SIZE (Solid)		NOMINAL CONDUCTOR DIAMETER		NOMINAL INSULATION DIAMETER		NOMINAL JACKET DIAMETER		ARMOR TYPE	NOMINAL CABLE O.D.		NOMINAL WEIGHT	
		AWG	mm²	INCHES	mm	INCHES	mm	INCHES	mm		INCHES	mm	LBS/1000 FT	kg/km
120.6312055G	**5**	6	13.30	0.162	4.11	0.342	8.69	0.857	21.77	Galvanized Steel (G)	1.10	27.86	959	1427
120.6312055SS	**5**	6	13.30	0.162	4.11	0.342	8.69	0.857	21.77	Stainless Steel (SS)	1.02	25.83	815	1213
120.5312055G	**5**	5	16.78	0.182	4.62	0.362	9.19	0.900	22.86	Galvanized Steel (G)	1.14	28.95	1078	1604
120.5312055SS	**5**	5	16.78	0.182	4.62	0.362	9.19	0.900	22.86	Stainless Steel (SS)	1.06	26.92	926	1378
120.4312055G	**5**	4	21.15	0.204	5.19	0.384	9.76	0.948	24.08	Galvanized Steel (G)	1.19	30.18	1204	1792
120.4312055SS	**5**	4	21.15	0.204	5.19	0.384	9.76	0.948	24.08	Stainless Steel (SS)	1.11	28.15	1045	1555
120.2312055G	**5**	2	33.63	0.258	6.54	0.438	11.12	1.063	27.00	Galvanized Steel (G)	1.30	33.10	1543	2295
120.2312055SS	**5**	2	33.63	0.258	6.54	0.438	11.12	1.063	27.00	Stainless Steel (SS)	1.22	31.06	1364	2029
120.1312055G	**5**	1	42.34	0.289	7.35	0.469	11.92	1.131	28.74	Galvanized Steel (G)	1.37	34.83	1769	2632
120.1312055SS	**5**	1	42.34	0.289	7.35	0.469	11.92	1.131	28.74	Stainless Steel (SS)	1.29	32.80	1578	2348

X-Tract® Type 2 Round: Ampacity



X-Tract® Type 2 Round: Voltage Drop per 1000'
Conductor Temperature 25°C (77°F)



Voltage drop based on 60Hz and 100% power factor

X-Tract® Electrical Submersible Pump Cable

2F205 Light-to-Moderate-Duty, Flat Power Supply (PS) Cable
5 kV, Rated -40°C to +96°C/-40°F to +205°F

Flat Type 2 cables are lower-temperature-rated for operating temperatures of -40 to +96 degrees C/ -40 to +205 degrees F. The Type 2 design provides excellent performance and life expectancy in less gassy wells and where decompression resistance is not required. Type 2 cables are designed for light-to-moderate-duty use in low-pressure, cooler and less gassy wells with less corrosive conditions.

Product Construction:

Conductor:
- Solid bare annealed copper per ASTM B3

Insulation:
- Adhesive layer
- EPDM insulation
  - *Cross-linked, high dielectric strength, high oil resistance, low swell, chemically inert, mechanically stable*
- EPDM insulation jacket
  - *Cross-linked, high dielectric strength, high oil resistance, low swell, chemically inert, mechanically stable*

Barrier:
- Barrier tape – woven fabric, rubber-impregnated, helically wrapped
  - *Stress-distributing, mechanically stable*

Armor:
- Galvanized steel 100% perimeter
  - *Heavy zinc alloy plating for extra corrosion resistance – interlocked profile for enhanced mechanical stability*
- Armor Options:
  - *Stainless steel alloy for increased performance in highly corrosive well environments*

Marker Tape:

GENERAL CABLE® USA X-TRACT® TYPE 2 5 KV -40C to +96C/-40F to +205F 3/C XAWG ARMOR TYPE MONTH/YEAR OF MFG SEQUENTIAL FOOTAGE MARK

Applications:

- Power Supply (PS) light-to-moderate-duty service:
  - *Low-to-moderate gas and vapor concentrations*
  - *Low-to-moderate corrosion*
  - *Low-to-moderate temperature*

Industry References:

- IEEE 1018
- API RP 11S5
- API RP 11S6
- ASTM A459
- ASTM B3
- ASTM D412

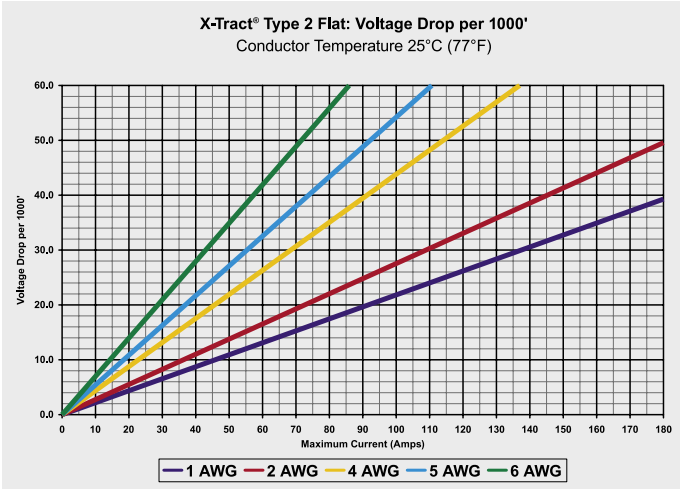
Standard Packaging:

- DIN standard heavy-duty steel reels
  - *Corrosion-resistant design with 100% protective over-coating*
- The cable ends will be sealed with weather-resistant caps or suitable tape
- Lagging: 2-by-4-inch treated wood with 3 encircling corrosion-resistant bands
- Option: multiple non-standard lengths per reel

X-Tract® Electrical Submersible Pump Cable

2F205 Light-to-Moderate-Duty, Flat Power Supply (PS) Cable
5 kV, Rated -40°C to +96°C/-40°F to +205°F

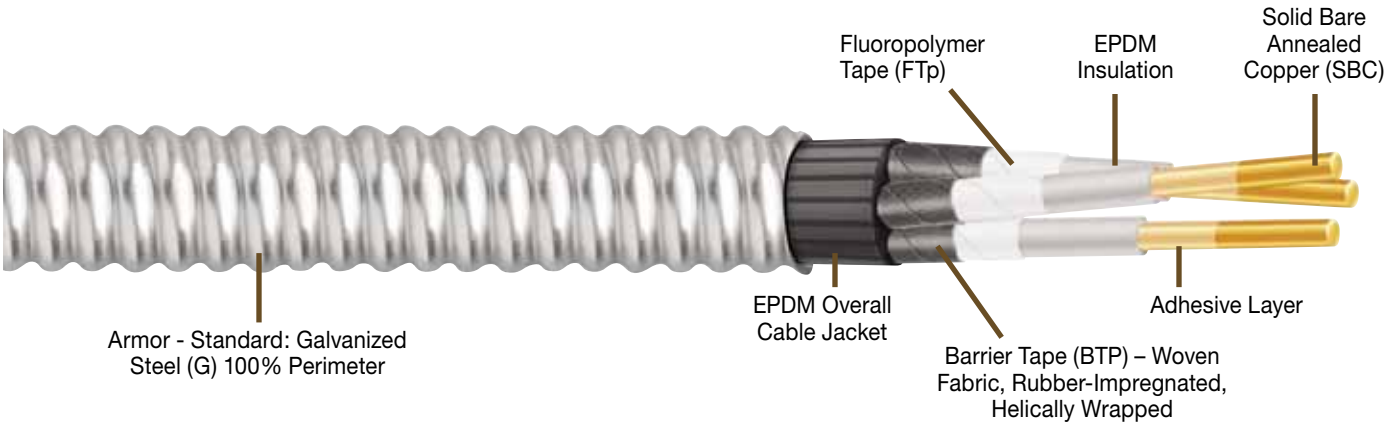
PART NUMBER	kV	COND. SIZE (Solid)		NOMINAL CONDUCTOR DIAMETER		NOMINAL INSULATION DIAMETER		ARMOR TYPE	FINISHED CABLE DIMENSIONS		NOMINAL WEIGHT	
		AWG	mm²	INCHES	mm	INCHES	mm		INCHES	mm	LBS/1000 FT	kg/km
121.6312055G	**5**	6	13.30	0.162	4.11	0.442	11.23	Galvanized Steel (G)	1.5 x 0.57	38.05 x 14.38	889	1323
121.6312055SS	**5**	6	13.30	0.162	4.11	0.442	11.23	Stainless Steel (SS)	1.47 x 0.54	37.41 x 13.74	789	1175
121.5312055G	**5**	5	16.78	0.182	4.62	0.462	11.73	Galvanized Steel (G)	1.56 x 0.59	39.57 x 14.88	982	1461
121.5312055SS	**5**	5	16.78	0.182	4.62	0.462	11.73	Stainless Steel (SS)	1.53 x 0.56	38.93 x 14.25	879	1308
121.4312055G	**5**	4	21.15	0.204	5.19	0.484	12.30	Galvanized Steel (G)	1.62 x 0.61	41.27 x 15.45	1095	1630
121.4312055SS	**5**	4	21.15	0.204	5.19	0.484	12.30	Stainless Steel (SS)	1.6 x 0.58	40.64 x 14.82	988	1470
121.2312055G	**5**	2	33.63	0.258	6.54	0.538	13.66	Galvanized Steel (G)	1.78 x 0.66	45.33 x 16.8	1402	2086
121.2312055SS	**5**	2	33.63	0.258	6.54	0.538	13.66	Stainless Steel (SS)	1.76 x 0.64	44.7 x 16.17	1284	1911
121.1312055G	**5**	1	42.34	0.289	7.35	0.569	14.46	Galvanized Steel (G)	1.88 x 0.69	47.75 x 17.61	1609	2394
121.1312055SS	**5**	1	42.34	0.289	7.35	0.569	14.46	Stainless Steel (SS)	1.85 x 0.67	47.11 x 16.97	1485	2210



Voltage drop based on 60Hz and 100% power factor

X-Tract® Electrical Submersible Pump Cable

3R302 Moderate-Duty, Round Power Supply (PS) Cable
5 kV, Rated -40°C to +150°C/-40°F to +302°F



Round Type 3 cables are moderate-temperature-rated for operating temperatures of -40 to +150 degrees C/ -40 to +302 degrees F in moderately gassy and corrosive well conditions. The Type 3 design provides excellent performance and life expectancy in moderately hot and gassy wells and where decompression resistance is required.

Product Construction:

Conductor:
- Solid bare annealed copper per ASTM B3

Insulation:
- Adhesive layer
- EPDM insulation
  - *Cross-linked, high dielectric strength, high oil resistance, low swell, chemically inert, mechanically stable*

Barrier:
- Fluoropolymer tape - helically applied
  - *High temperature resistance, chemically inert, mechanically stable*
- Barrier tape – woven fabric, rubber-impregnated, helically wrapped
  - *Stress-distributing, mechanically stable*

Overall Cable Jacket:
- EPDM overall cable jacket
  - *Cross-linked, high dielectric strength, high oil resistance, low swell, chemically inert, mechanically stable*

Armor:
- Galvanized steel 100% perimeter
  - *Heavy zinc alloy plating for extra corrosion resistance – interlocked profile for enhanced mechanical stability*
- Armor Options:
  - *Stainless steel alloy for increased performance in highly corrosive well environments*

Marker Tape:

GENERAL CABLE® USA X-TRACT® TYPE 3 5 KV -40C to +150C/-40F to +302F 3/C XAWG ARMOR TYPE MONTH/YEAR OF MFG SEQUENTIAL FOOTAGE MARK

Applications:

- Power Supply (PS) for moderate-duty service:
  - *Moderate gas and vapor concentrations*
  - *Moderate corrosion*
  - *Moderately high temperature*

Industry References:

- IEEE 1018
- API RP 11S5
- API RP 11S6
- ASTM A459
- ASTM B3
- ASTM D412

Standard Packaging:

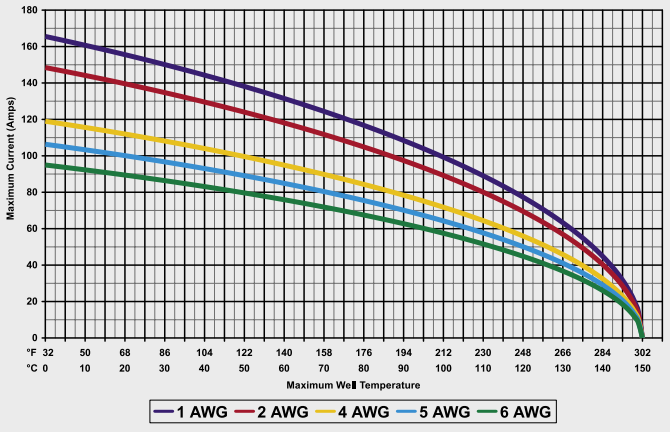
- DIN standard heavy-duty steel reels
  - *Corrosion-resistant design with 100% protective over-coating*
- The cable ends will be sealed with weather-resistant caps or suitable tape
- Lagging: 2-by-4-inch treated wood with 3 encircling corrosion-resistant bands
- Option: multiple non-standard lengths per reel

X-Tract® Electrical Submersible Pump Cable

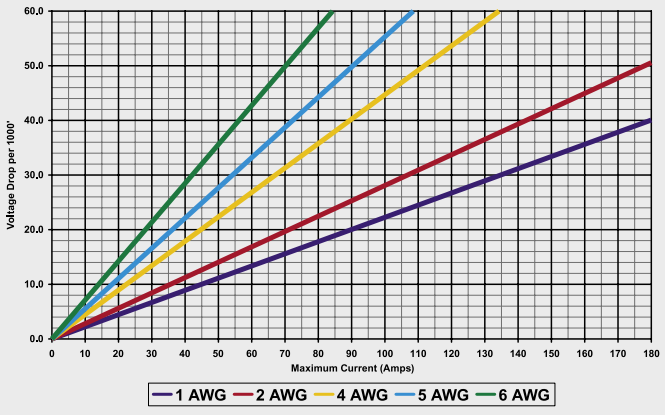
3R302 Moderate-Duty, Round Power Supply (PS) Cable
5 kV, Rated -40°C to +150°C/-40°F to +302°F

PART NUMBER	kV	COND. SIZE (Solid)		NOMINAL CONDUCTOR DIAMETER		NOMINAL INSULATION DIAMETER		NOMINAL JACKET DIAMETER		ARMOR TYPE	NOMINAL CABLE O.D.		NOMINAL WEIGHT	
		AWG	mm²	INCHES	mm	INCHES	mm	INCHES	mm		INCHES	mm	LBS/1000 FT	kg/km
130.6313025G	**5**	6	13.30	0.162	4.11	0.342	8.69	0.926	23.52	Galvanized Steel (G)	1.17	29.62	1161	1727
130.6313025SS	**5**	6	13.30	0.162	4.11	0.342	8.69	0.926	23.52	Stainless Steel (SS)	1.09	27.58	1005	1496
130.5313025G	**5**	5	16.78	0.182	4.62	0.362	9.19	0.969	24.61	Galvanized Steel (G)	1.21	30.70	1272	1893
130.5313025SS	**5**	5	16.78	0.182	4.62	0.362	9.19	0.969	24.61	Stainless Steel (SS)	1.13	28.67	1109	1651
130.4313025G	**5**	4	21.15	0.204	5.19	0.384	9.76	1.017	25.84	Galvanized Steel (G)	1.26	31.93	1406	2093
130.4313025SS	**5**	4	21.15	0.204	5.19	0.384	9.76	1.017	25.84	Stainless Steel (SS)	1.18	29.90	1235	1838
130.2313025G	**5**	2	33.63	0.258	6.54	0.438	11.12	1.132	28.75	Galvanized Steel (G)	1.37	34.85	1763	2623
130.2313025SS	**5**	2	33.63	0.258	6.54	0.438	11.12	1.132	28.75	Stainless Steel (SS)	1.29	32.82	1572	2340
130.1313025G	**5**	1	42.34	0.289	7.35	0.469	11.92	1.200	30.49	Galvanized Steel (G)	1.44	36.58	2000	2976
130.1313025SS	**5**	1	42.34	0.289	7.35	0.469	11.92	1.200	30.49	Stainless Steel (SS)	1.36	34.55	1798	2675

X-Tract® Type 3 Round: Ampacity



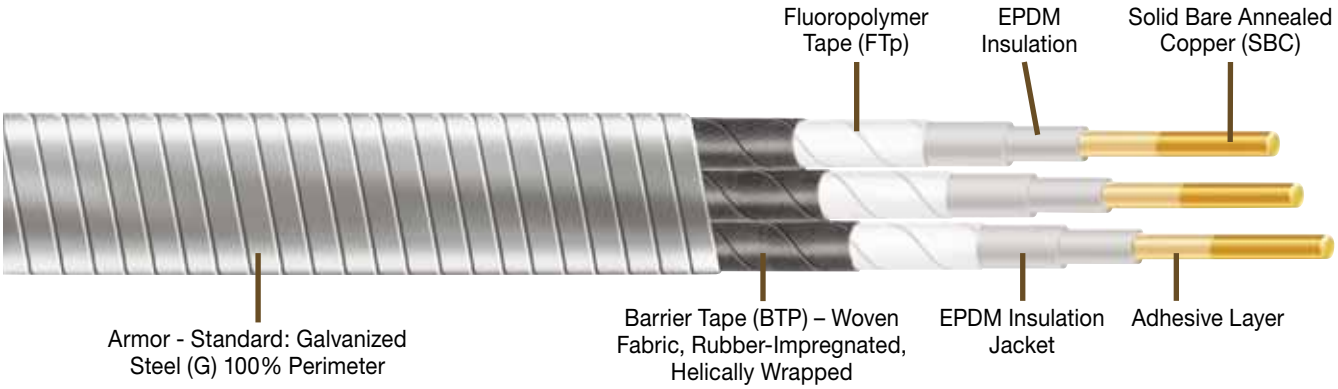
X-Tract® Type 3 Round: Voltage Drop per 1000'
Conductor Temperature 25°C (77°F)



Voltage drop based on 60Hz and 100% power factor

X-Tract® Electrical Submersible Pump Cable

3F302 Moderate-Duty, Flat Power Supply (PS) Cable
5 kV, Rated -40°C to +150°C/-40°F to +302°F



Flat Type 3 cables are moderate-temperature-rated for operating temperatures of -40 to +150 degrees C/ -40 to +302 degrees F in moderately gassy and corrosive well conditions. The Type 3 design provides excellent performance and life expectancy in moderately hot and gassy wells and where decompression resistance is required.

Product Construction:

Conductor:
- Solid bare annealed copper per ASTM B3

Insulation:
- Adhesive layer
- EPDM insulation
  - *Cross-linked, high dielectric strength, high oil resistance, low swell, chemically inert, mechanically stable*
- EPDM insulation jacket
  - *Cross-linked, high dielectric strength, high oil resistance, low swell, chemically inert, mechanically stable*

Barrier:
- Fluoropolymer tape - helically applied
  - *High temperature resistance, chemically inert, mechanically stable*
- Barrier tape – woven fabric, rubber-impregnated, helically wrapped
  - *Stress-distributing, semi-conductive, mechanically stable*

Armor:
- Galvanized steel 100% perimeter
  - *Heavy zinc alloy plating for extra corrosion resistance – interlocked profile for enhanced mechanical stability*
- Armor Options:
  - *Stainless steel alloy for increased performance in highly corrosive well environments*

Marker Tape:

GENERAL CABLE® USA X-TRACT® TYPE 3 5 KV -40C to +150C/-40F to +302F 3/C XAWG ARMOR TYPE MONTH/YEAR OF MFG SEQUENTIAL FOOTAGE MARK

Applications:

- Power Supply (PS) for moderate-duty service:
  - *Moderate gas and vapor concentrations*
  - *Moderate corrosion*
  - *Moderately high temperature*

Industry References:

- IEEE 1018
- API RP 11S5
- API RP 11S6
- ASTM A459
- ASTM B3
- ASTM D412

Standard Packaging:

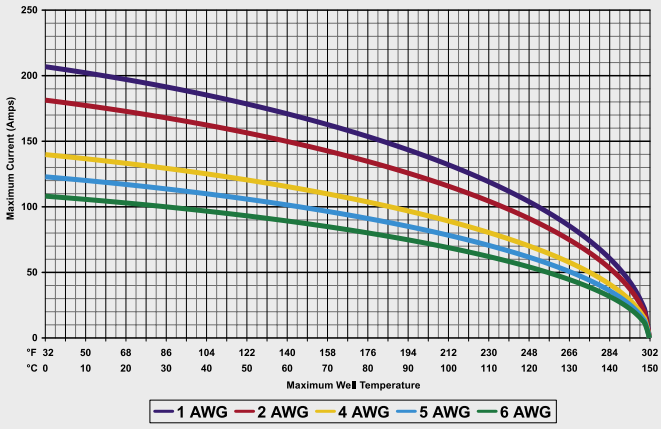
- DIN standard heavy-duty steel reels
  - *Corrosion-resistant design with 100% protective over-coating*
- The cable ends will be sealed with weather-resistant caps or suitable tape
- Lagging: 2-by-4-inch treated wood with 3 encircling corrosion-resistant bands
- Option: multiple non-standard lengths per reel

X-Tract® Electrical Submersible Pump Cable

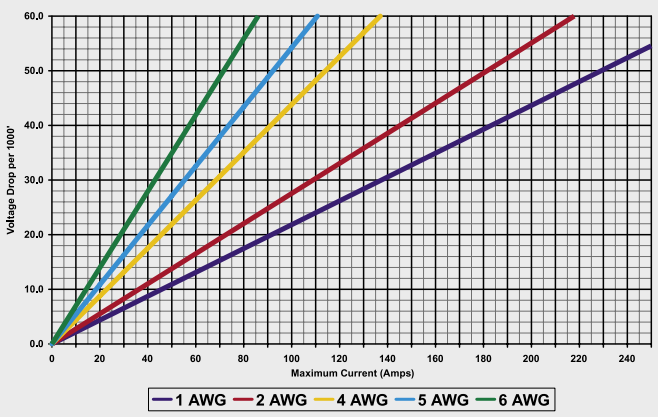
3F302 Moderate-Duty, Flat Power Supply (PS) Cable
5 kV, Rated -40°C to +150°C/-40°F to +302°F

PART NUMBER	kV	COND. SIZE (Solid)		NOMINAL CONDUCTOR DIAMETER		NOMINAL INSULATION DIAMETER		ARMOR TYPE	FINISHED CABLE DIMENSIONS		NOMINAL WEIGHT	
		AWG	mm²	INCHES	mm	INCHES	mm		INCHES	mm	LBS/1000 FT	kg/km
131.6313025G	**5**	6	13.30	0.162	4.11	0.442	11.23	Galvanized Steel (G)	1.52 x 0.57	38.66 x 14.58	936	1392
131.6313025SS	**5**	6	13.30	0.162	4.11	0.442	11.23	Stainless Steel (SS)	1.5 x 0.55	38.02 x 13.94	829	1233
131.5313025G	**5**	5	16.78	0.182	4.62	0.462	11.73	Galvanized Steel (G)	1.58 x 0.59	40.18 x 15.09	1030	1533
131.5313025SS	**5**	5	16.78	0.182	4.62	0.462	11.73	Stainless Steel (SS)	1.56 x 0.57	39.54 x 14.45	920	1368
131.4313025G	**5**	4	21.15	0.204	5.19	0.484	12.30	Galvanized Steel (G)	1.65 x 0.62	41.88 x 15.65	1119	1665
131.4313025SS	**5**	4	21.15	0.204	5.19	0.484	12.30	Stainless Steel (SS)	1.62 x 0.59	41.25 x 15.02	1010	1503
131.2313025G	**5**	2	33.63	0.258	6.54	0.538	13.66	Galvanized Steel (G)	1.81 x 0.67	45.94 x 17.01	1427	2123
131.2313025SS	**5**	2	33.63	0.258	6.54	0.538	13.66	Stainless Steel (SS)	1.78 x 0.64	45.31 x 16.37	1308	1947
131.1313025G	**5**	1	42.34	0.289	7.35	0.569	14.46	Galvanized Steel (G)	1.9 x 0.7	48.36 x 17.81	1635	2433
131.1313025SS	**5**	1	42.34	0.289	7.35	0.569	14.46	Stainless Steel (SS)	1.88 x 0.68	47.72 x 17.18	1510	2247

X-Tract® Type 3 Flat: Ampacity



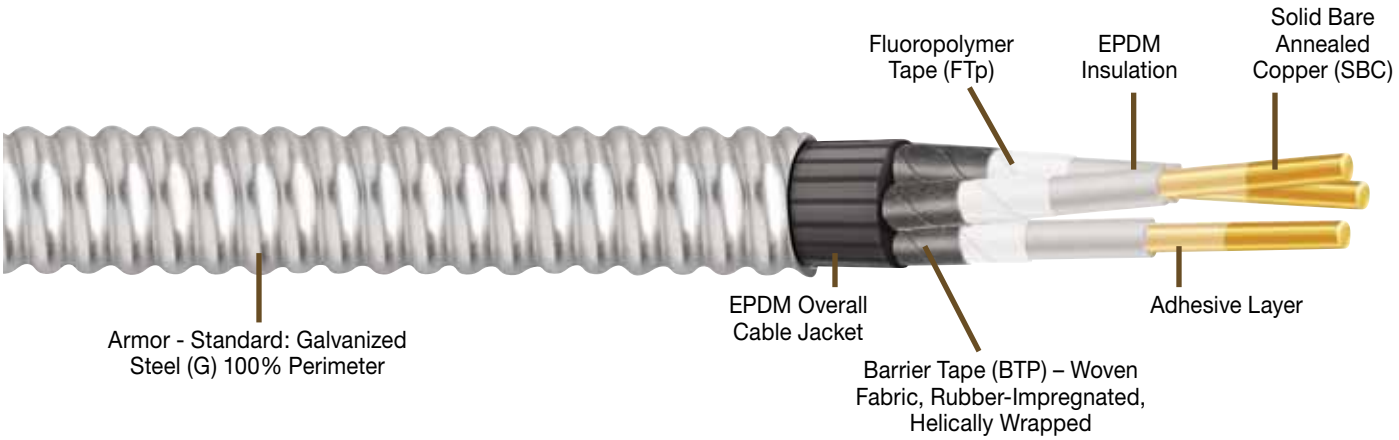
X-Tract® Type 3 Flat: Voltage Drop per 1000'
Conductor Temperature 25°C (77°F)



Voltage drop based on 60Hz and 100% power factor

X-Tract® Electrical Submersible Pump Cable

4R400 Heavy-Duty, Round Power Supply (PS) Cable
5 kV, Rated -51°C to +205°C/-60°F to +400°F



Round Type 4 cables are high-temperature-rated for operating temperatures of -51 to +205 degrees C/ -60 to +400 degrees F in significantly gassy and corrosive well conditions. The Type 4 design provides excellent performance and life expectancy in significantly hot and gassy wells and where decompression resistance is required.

Product Construction:

Conductor:
- Solid bare annealed copper per ASTM B3

Insulation:
- Adhesive layer
- EPDM insulation
  - — *Cross-linked, high dielectric strength, high oil resistance, low swell, chemically inert, mechanically stable*

Barrier:
- Fluoropolymer tape - helically applied
  - — *High temperature resistance, chemically inert, mechanically stable*
- Barrier tape – woven fabric, rubber-impregnated, helically wrapped
  - — *Stress-distributing, semi-conductive, mechanically stable*

Overall Cable Jacket:
- EPDM overall cable jacket
  - — *Cross-linked, high dielectric strength, high oil resistance, low swell, chemically inert, mechanically stable*

Armor:
- Galvanized steel 100% perimeter
  - — *Heavy zinc alloy plating for extra corrosion resistance – interlocked profile for enhanced mechanical stability*
- Armor Options:
  - — *Stainless steel alloy for increased performance in highly corrosive well environments*

Marker Tape:

GENERAL CABLE® USA X-TRACT® TYPE 4 5 KV -51C to +205C/-60F to +400F 3/C XAWG ARMOR TYPE MONTH/YEAR OF MFG SEQUENTIAL FOOTAGE MARK

Applications:

- Power Supply (PS) for heavy-duty service:
  - — *Significant gas and vapor concentrations*
  - — *Significant corrosion*
  - — *High temperature*

Industry References:

- IEEE 1018
- API RP 11S5
- API RP 11S6
- ASTM A459
- ASTM B3
- ASTM D412

Standard Packaging:

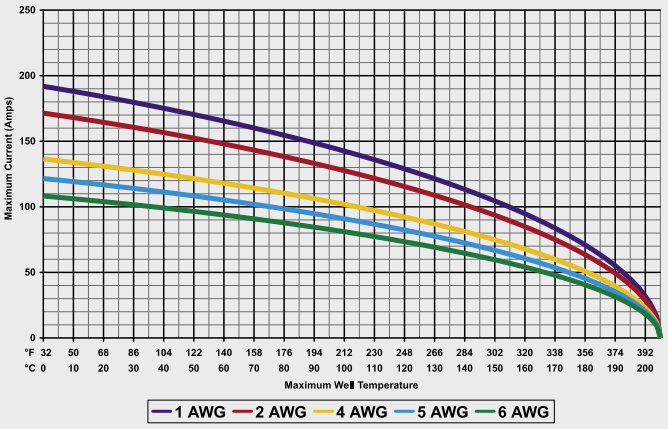
- DIN standard heavy-duty steel reels
  - — *Corrosion-resistant design with 100% protective over-coating*
- The cable ends will be sealed with weather-resistant caps or suitable tape
- Lagging: 2-by-4-inch treated wood with 3 encircling corrosion-resistant bands
- Option: multiple non-standard lengths per reel

X-Tract® Electrical Submersible Pump Cable

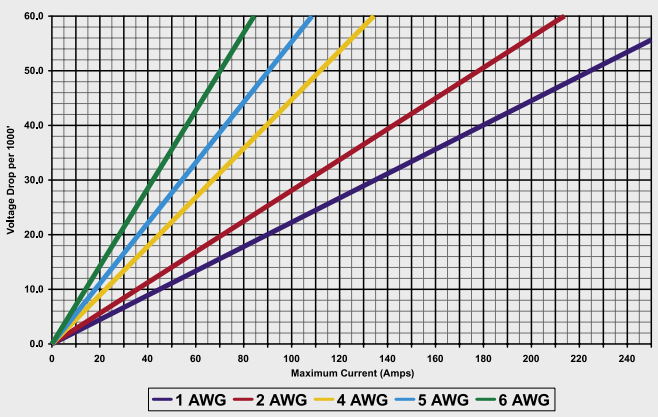
4R400 Heavy-Duty, Round Power Supply (PS) Cable
5 kV, Rated -51°C to +205°C/-60°F to +400°F

PART NUMBER	kV	COND. SIZE (Solid)		NOMINAL CONDUCTOR DIAMETER		NOMINAL INSULATION DIAMETER		NOMINAL JACKET DIAMETER		ARMOR TYPE	NOMINAL CABLE O.D.		NOMINAL WEIGHT	
		AWG	mm²	INCHES	mm	INCHES	mm	INCHES	mm		INCHES	mm	LBS/1000 FT	kg/km
140.6314005G	**5**	6	13.30	0.162	4.11	0.342	8.69	0.926	23.52	Galvanized Steel (G)	1.17	29.62	1161	1727
140.6314005SS	**5**	6	13.30	0.162	4.11	0.342	8.69	0.926	23.52	Stainless Steel (SS)	1.09	27.58	1005	1496
140.5314005G	**5**	5	16.78	0.182	4.62	0.362	9.19	0.969	24.61	Galvanized Steel (G)	1.21	30.70	1272	1893
140.5314005SS	**5**	5	16.78	0.182	4.62	0.362	9.19	0.969	24.61	Stainless Steel (SS)	1.13	28.67	1109	1651
140.4314005G	**5**	4	21.15	0.204	5.19	0.384	9.76	1.017	25.84	Galvanized Steel (G)	1.26	31.93	1406	2093
140.4314005SS	**5**	4	21.15	0.204	5.19	0.384	9.76	1.017	25.84	Stainless Steel (SS)	1.18	29.90	1235	1838
140.2314005G	**5**	2	33.63	0.258	6.54	0.438	11.12	1.132	28.75	Galvanized Steel (G)	1.37	34.85	1763	2623
140.2314005SS	**5**	2	33.63	0.258	6.54	0.438	11.12	1.132	28.75	Stainless Steel (SS)	1.29	32.82	1572	2340
140.1314005G	**5**	1	42.34	0.289	7.35	0.469	11.92	1.200	30.49	Galvanized Steel (G)	1.44	36.58	2000	2976
140.1314005SS	**5**	1	42.34	0.289	7.35	0.469	11.92	1.200	30.49	Stainless Steel (SS)	1.36	34.55	1798	2675

X-Tract® Type 4 Round: Ampacity



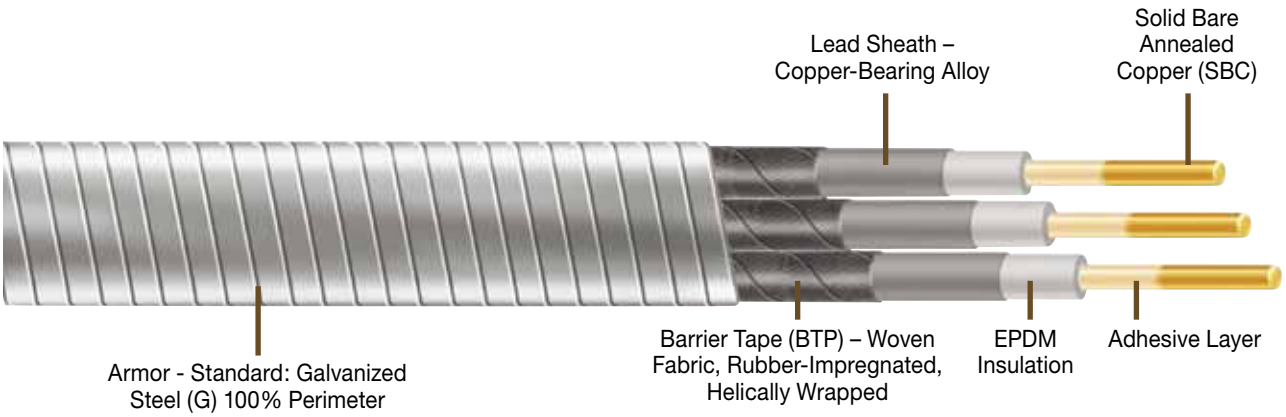
X-Tract® Type 4 Round: Voltage Drop per 1000'
Conductor Temperature 25°C (77°F)



Voltage drop based on 60Hz and 100% power factor

X-Tract® Electrical Submersible Pump Cable

5F450 Severe-Duty, Flat Power Supply (PS) Cable
5 kV, Rated -51°C to +232°C/-60°F to +450°F



Flat Type 5 cables are high-temperature-rated for operating temperatures of -51 to +232 degrees C/ -60 to +450 degrees F and severe well conditions.
The Type 5 design provides excellent performance and life expectancy in hot, gassy wells and where decompression resistance is required.

Product Construction:

Conductor:
- Solid bare annealed copper per ASTM B3

Insulation:
- Adhesive layer
- EPDM insulation
  - — *Cross-linked, high dielectric strength, high oil resistance, low swell, chemically inert, mechanically stable*

Sheath:
- Lead sheath – copper-bearing alloy
  - — *Impervious extruded, high temperature, chemically resistant, mechanically stable*

Barrier:
- Barrier tape – woven fabric, rubber-impregnated, helically wrapped
  - — *Stress-distributing, mechanically stable*

Armor:
- Galvanized steel 100% perimeter
  - — *Heavy zinc alloy plating for extra corrosion resistance – interlocked profile for enhanced mechanical stability*
- Armor Options:
  - — *Stainless steel alloy for increased performance in highly corrosive well environments*

Marker Tape:

GENERAL CABLE® USA X-TRACT® TYPE 5 5 KV -51C to +232C/-60F to +450F 3/C XAWG ARMOR TYPE MONTH/YEAR OF MFG SEQUENTIAL FOOTAGE MARK

Applications:

- Power Supply (PS) for severe-duty service:
  - — *High gas and vapor concentrations*
  - — *Severe corrosion*
  - — *Very high temperature*

Industry References:

- IEEE 1018
- API RP 11S5
- API RP 11S6
- ASTM A459
- ASTM B3
- ASTM D412

Standard Packaging:

- DIN standard heavy-duty steel reels
  - — *Corrosion-resistant design with 100% protective over-coating*
- The cable ends will be sealed with weather-resistant caps or suitable tape
- Lagging: 2-by-4-inch treated wood with 3 encircling corrosion-resistant bands
- Option: multiple non-standard lengths per reel

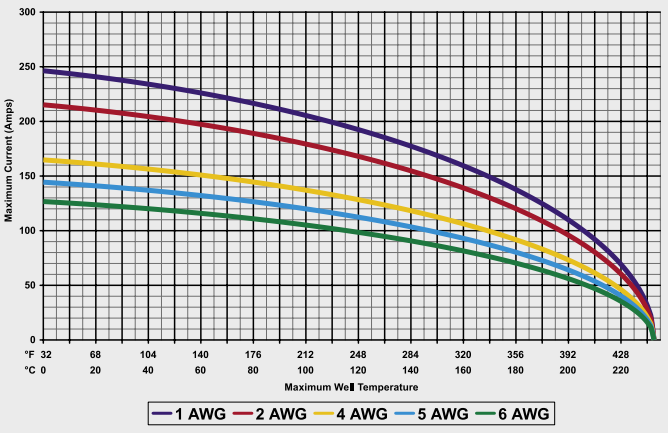
X-Tract® Electrical Submersible Pump Cable

5F450 Severe-Duty, Flat Power Supply (PS) Cable
5 kV, Rated -51°C to +232°C/-60°F to +450°F

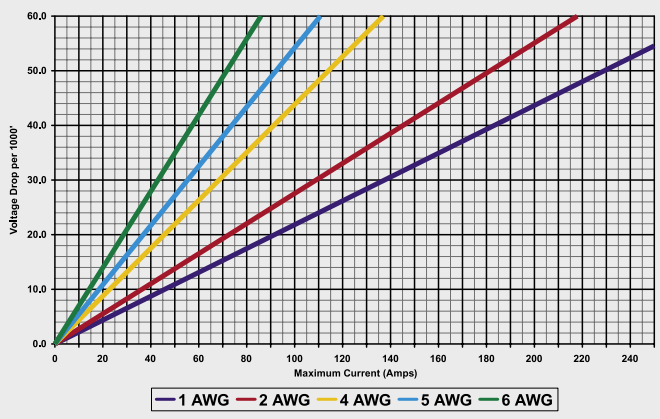
PART NUMBER	kV	COND. SIZE (Solid)		NOMINAL CONDUCTOR DIAMETER		NOMINAL INSULATION* DIAMETER		ARMOR TYPE	FINISHED CABLE DIMENSIONS		NOMINAL WEIGHT	
		AWG	mm²	INCHES	mm	INCHES	mm		INCHES	mm	LBS/1000 FT	kg/km
151.6314505G	**5**	6	13.30	0.162	4.11	0.312	7.92	Galvanized Steel (G)	1.32 x 0.51	33.48 x 12.85	1303	1938
151.6314505SS	**5**	6	13.30	0.162	4.11	0.312	7.92	Stainless Steel (SS)	1.29 x 0.48	32.84 x 12.22	1209	1800
151.5314505G	**5**	5	16.78	0.182	4.62	0.332	8.43	Galvanized Steel (G)	1.38 x 0.53	34.99 x 13.36	1400	2083
151.5314505SS	**5**	5	16.78	0.182	4.62	0.332	8.43	Stainless Steel (SS)	1.35 x 0.5	34.36 x 12.72	1308	1946
151.4314505G	**5**	4	21.15	0.204	5.19	0.354	9.00	Galvanized Steel (G)	1.44 x 0.55	36.7 x 13.93	1543	2295
151.4314505SS	**5**	4	21.15	0.204	5.19	0.354	9.00	Stainless Steel (SS)	1.42 x 0.52	36.07 x 13.29	1446	2152
151.2314505G	**5**	2	33.63	0.258	6.54	0.408	10.35	Galvanized Steel (G)	1.6 x 0.6	40.76 x 15.28	1918	2855
151.2314505SS	**5**	2	33.63	0.258	6.54	0.408	10.35	Stainless Steel (SS)	1.58 x 0.58	40.13 x 14.65	1812	2697
151.1314505G	**5**	1	42.34	0.289	7.35	0.439	11.16	Galvanized Steel (G)	1.7 x 0.63	43.18 x 16.09	2166	3224
151.1314505SS	**5**	1	42.34	0.289	7.35	0.439	11.16	Stainless Steel (SS)	1.67 x 0.61	42.54 x 15.45	2054	3057

*Pre-lead sheath

X-Tract® Type 5 Flat: Ampacity



X-Tract® Type 5 Flat: Voltage Drop per 1000'
Conductor Temperature 25°C (77°F)



Voltage drop based on 60Hz and 100% power factor

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Technical Information

Technical Information

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A150	Metric Conversion Factors	Sept. 2010	35
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Recommended Installation Practice: X-Tract® ESP Cables

This Recommended Installation Practice is written for guidance when handling Electrical Submersible Pump (ESP) cables at a well site. Recommended practice for transportation and storage references are made by General Cable; installation recommendations are made with reference to API RP 11S3 Recommended Practice for Electrical Submersible Pump Installations, IEEE 1018 Recommended Practice for Specifying Electric Submersible Pump Cable Ethylene-Propylene Rubber Insulation and IEEE 1019 Recommended Practice for Specifying Electric Submersible Pump Cable Polypropylene Insulation.

General Cable manufactures its X-Tract® ESP cables for downhole – oil and water well - applications with reference to IEEE 1018, IEEE 1019 and API RP 11S6 Recommended Practice for Testing of Electrical Submersible Pump Cable Systems. They are produced under strict supervision and enforced quality systems approved to ISO 9001-2008 (UL DQS).

This Recommended Installation Practice is based upon:

API Recommended Practice API RP 11S3:
Applicable clauses:

3.0	Transportation, Handling, and Storage of Equipment (Reel Diagram)
5.4	Cable Spoolers or Reels
5.5	Downhole Cable Protection
5.6	Cable Sheave
6.0	Running Equipment into the Well
6.2.1/6.2.2	Use of a Gauging Tool to Eliminate Burrs, etc.
6.4.4	Shipping Caps
6.4.5	Insulation Resistance Test during Lifting
6.5	Cable Splicing
6.6	Cable Banding
6.8	Running Practices
7.1.5	Phase-to-Ground IR Test
8.1.1	Historical data (Pulling Equipment out of Wells)
9.1.1	Downhole Pump Cables (Field Evaluation of Used Equipment)
9.1.6.3	Minimum HV IR Requirement
10.1	Downhole Pump Cables (Assessment of Used Equipment)

Recommended Installation Practice: X-Tract® ESP Cables

API Recommended Practice API RP 11S6:
Applicable clauses:

9.0 In Situ Testing

10.0 Diagnostic (Fault) Testing

11.0 Insulation Resistance (Megohmmeter) Tests

14.3 Time Domain Reflectometer Tests (Fault Location)

IEEE 1018:
Applicable clauses:

10.2.1 Installation (Reference API RP 11S3, Section 5.6)

10.2.2 Pull Rates (Minimizing Soluble Gas-Induced Damage)

10.2.3 Chemical Treatments (Particular Reference to Nitrile Jackets)

10.2.4 Balancing Flat Cable Phase Currents

IEEE 1019:
Applicable clauses:

9.2.1 Installation (reference API RP 11S3, Section 5.6)

9.2.2 Pull Rates (Minimizing Soluble Gas-Induced Damage)

9.2.3 Chemical Treatments (Particular Reference to Nitrile Jackets)

9.2.4 Balancing Flat Cable Phase Currents

General Cable Specification:

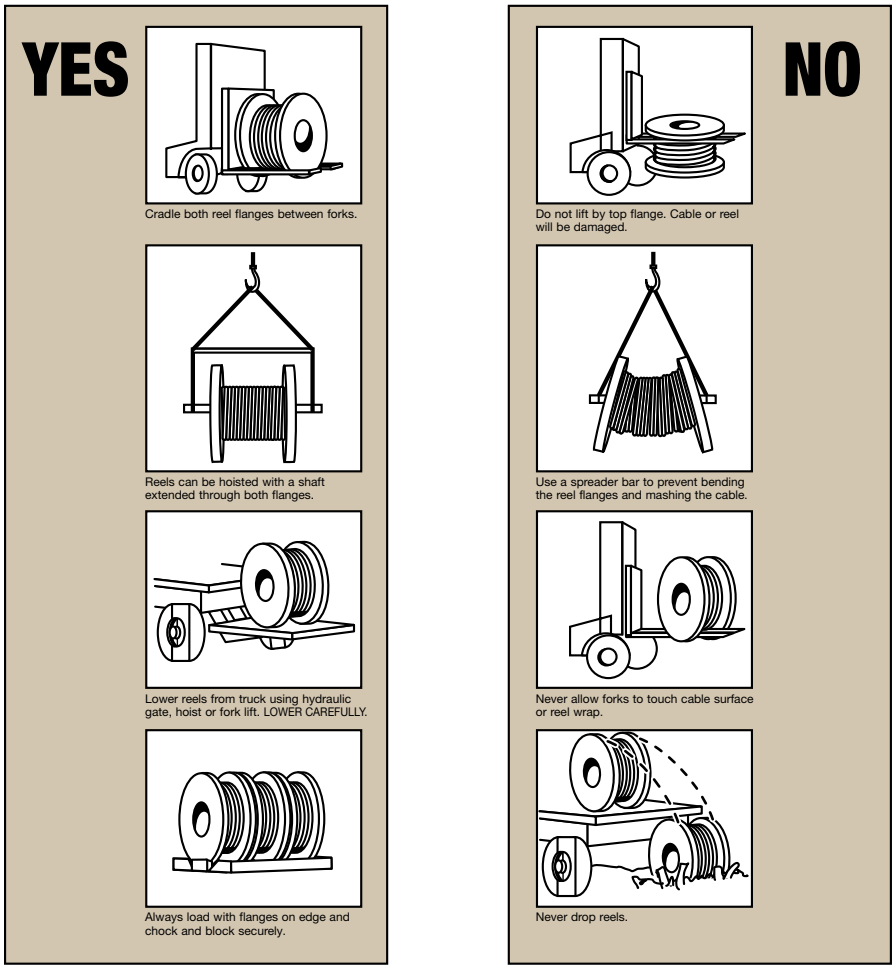
Recommended Installation Practice: X-Tract® ESP Cable

Recommended Installation Practice: X-Tract® ESP Cables

IMPORTANT NOTE:

Before unloading any cable delivered to the well site, check all delivery records to ensure that the correct cable has been shipped. All reels are to be inspected for damage prior to unloading or mounting for placement in a well. Damaged or incorrectly sized cables should not be used.

Figure 1: How to Handle Cable Reels



1.Transportation, Handling and Storage of Downhole ESP Cables

Cable packaging is in accordance with contractual requirement when shipped from the factory. Prior to shipment, all cables are subjected to 100% in-process testing and routine tests to ensure the finished cable is within specification. These tests are referenced in API RP 11S6, IEEE 1018 and IEEE 1019 as well as all relevant pages from the X-Tract® catalog.

To ensure a cable will arrive at a well site in the “as manufactured” condition, the reels must be transported and stored with the reel axle horizontal to the ground, and the reels must be chocked to ensure they are immobile. Loading and unloading cable reels must be done in compliance with best practice and safety, as illustrated **(Figure 1)** (API RP 11S3, Section 3.0).

Recommended Installation Practice: X-Tract® ESP Cables

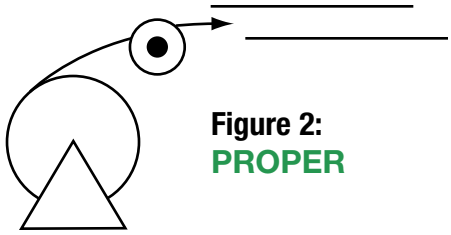


Figure 2:
PROPER

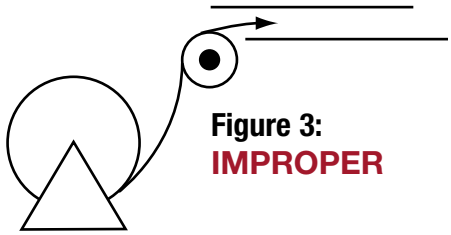


Figure 3:
IMPROPER

Remove the cable reel per instruction and place in a cable spooler with the cable paying off towards the well from the top of the cable reel. The feed-in setup should un-reel the cable with a natural curvature **(Figure 2)** as opposed to a reversed "S" curvature **(Figure 3)**.

Whether using a powered spooler or one that is manually assisted, it is essential to minimize the tension in the cable while feeding it into the well. General Cable recommends tension limits when handling all ESP cables as follows:

NUMBER OF INSULATED CONDUCTORS	AWG SIZE	MAXIMUM ALLOWABLE PULLING TENSION (LBS)
3	1	2009
3	2	1593
3	4	1002
3	5	794
3	6	630

The maximum allowable pulling tensions are for direct attachment to the conductor.
$T = 0.008 \times cmil \times n$, if $n \leq 3$
$T = 0.008 \times cmil \times n \times 0.8$, if $n > 3$

Cable reels should be placed 75-100 ft from the well head within the direct line-of-sight of the rig operator. The reels shall be located such that the cable does not pass over the operator's head, with the supports and spooler placed at right angles to the well head. All operators are to stay clear of the reel rims during running or pulling operations. When the ambient temperature requires heating the cable for running, a suitable shelter with heaters should be utilized. The lower handling temperature of the cable is defined by the stated operating temperature range.

2. Cable Testing Prior to Installation

To gain access to the cable conductors, remove the shipping cap from the end of the cable. The conductors at the other end of the reeled cable must be exposed, clean and dry. Using a Megohmmeter, connect the ground lead to the cable armor and then test each leg of the cable in rotation. Record all phase-to-phase and phase-to-ground readings.

New cable should read close to infinity for both phase-to-phase and phase-to-ground. In adverse conditions (high humidity/wet), lower readings may be obtained; experienced operators report that readings of only 1500 MΩ are obtainable and considered normal; this, however, is not a General Cable recommendation.

3. Downhole ESP Cable Protection

Where running over rugged, rocky ground, it may be necessary to place a protective covering (e.g., wooden planks) beneath the cable-run to the well head to ensure that the cable armor is not damaged while running to the sheave.

Recommended Installation Practice: X-Tract® ESP Cables

4. Cable Sheave

A cable sheave is to be used when running or pulling downhole ESP cable. The sheaves should have a minimum 54 inch (1.4 m) diameter and be of such construction to prevent cables from jumping off the sheave during operation. Single or "gooseneck" conveyor-type sheaves may be used if the minimum diameter requirement is satisfied.

For pulling around bends, use conveyor sheave assemblies of the appropriate radius series **(Figure 4)**.

The pulleys must be positioned to ensure that the effective curvature is smooth and changes directions or elevation evenly at each pulley. Never allow a polygon curvature to occur **(Figure 5)**. The fit of a pulley around the cable is also important when pulling heavy weights (i.e., pulleys at the top of a vertical drop).

During installation, the sheave should be supported above ground when preparing to feed the cable through it **(Figure 6)**. After the cable has been fed through and has been securely banded to the tubing, the sheave shall be raised to the "running position", approximately 25-45 ft (8-14 m) above the slips (the electrical connections made through a rotating assembly). The sheave should then be secured such that the cable is as close as possible inline with the movement of the travelling blocks which support the drill column and "travel" up and down as it hoists the pipe in and out of the hole. **The cable should not be used to reposition the sheave.** Note: When flat pump cable is being run, a flat rimmed sheave is to be used.

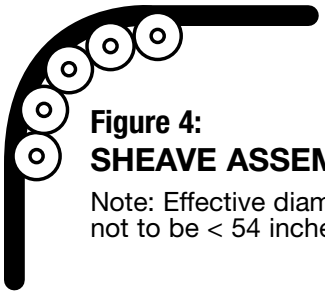


Figure 4:
SHEAVE ASSEMBLY
Note: Effective diameter not to be < 54 inches

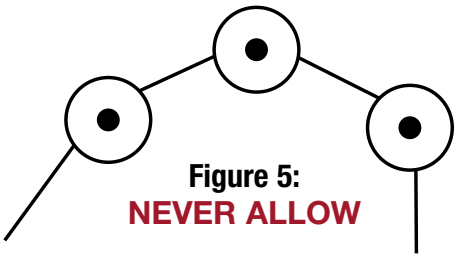


Figure 5:
NEVER ALLOW

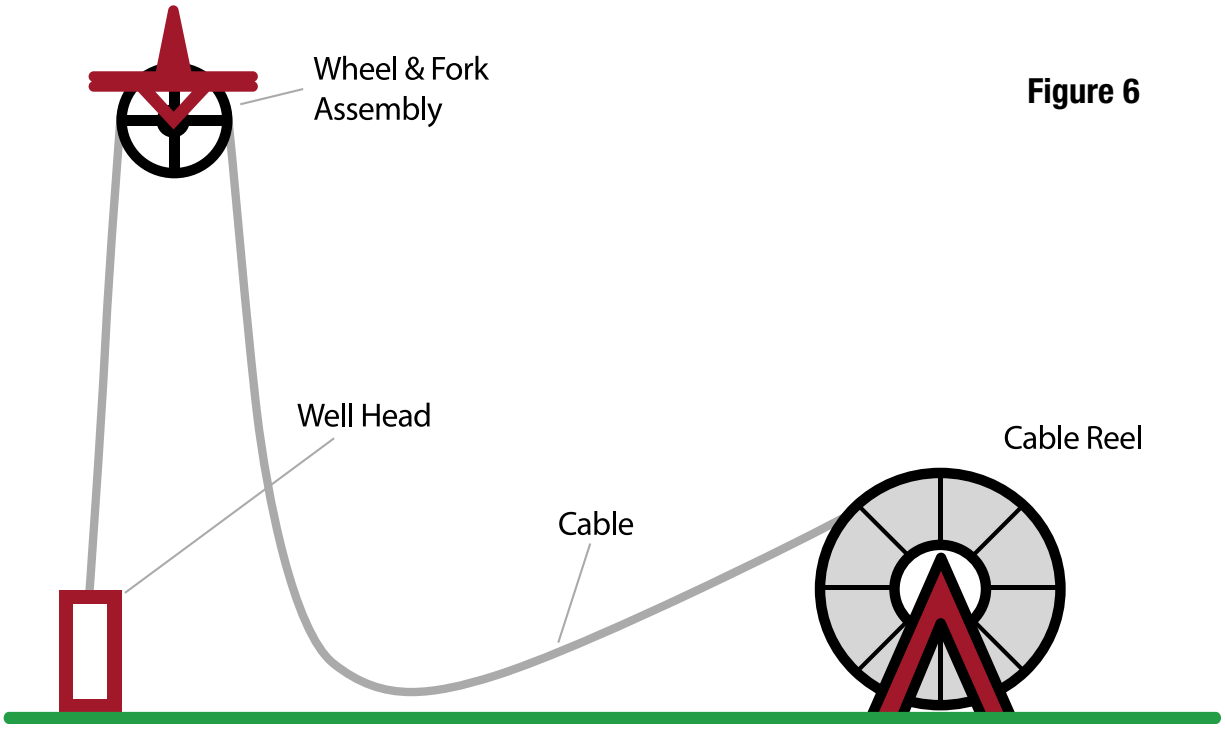


Figure 6

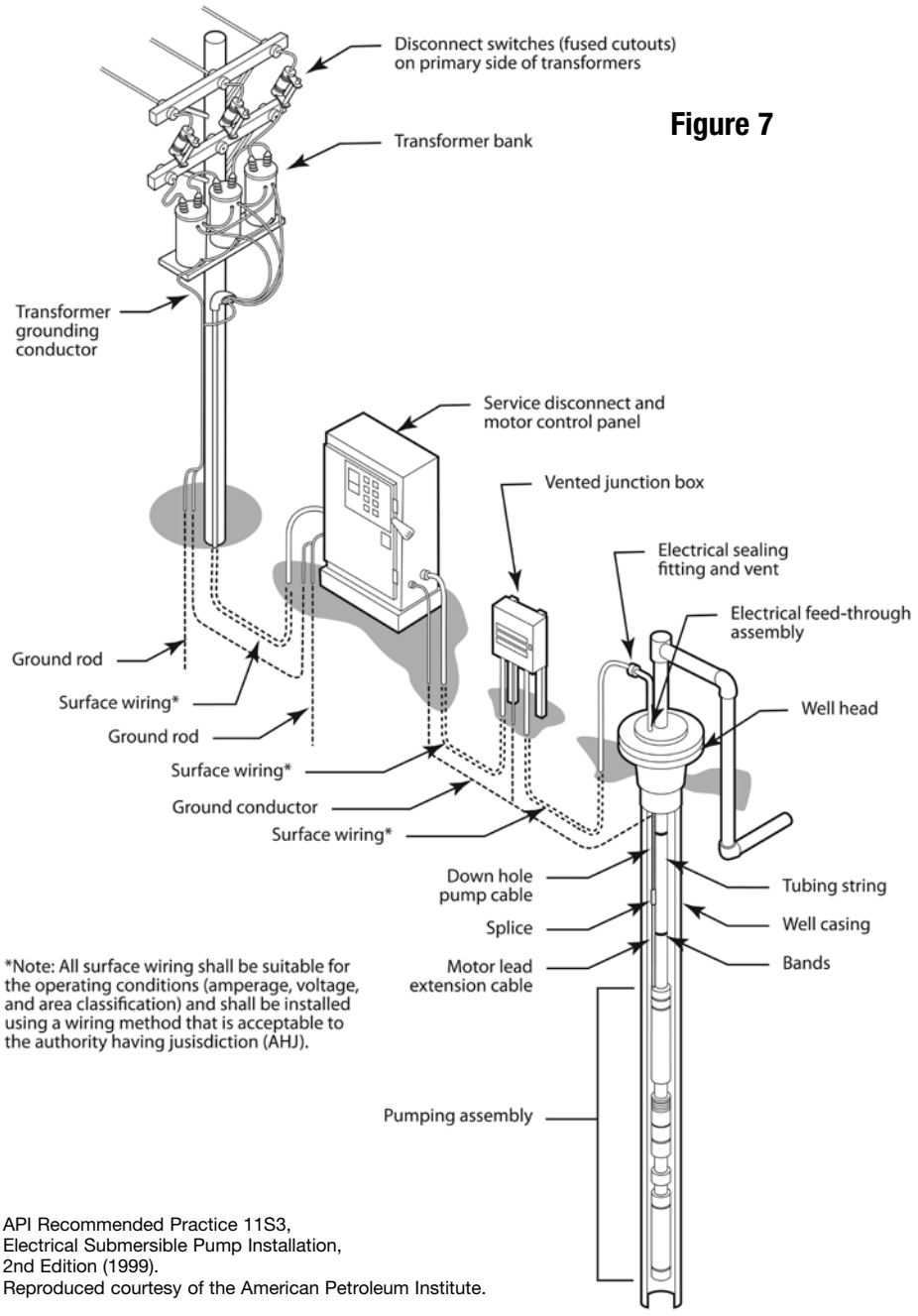
Recommended Installation Practice: X-Tract® ESP Cables

5. Casing Check

It is recommended that a full-gauge tool or a full-bore casing scraper be run through the casing prior to inserting the downhole ESP cable to remove burrs and ensure adequate clearance for the assembly.

6. Cable Connectorization & Installation (Figure 7)

Figure 7



API Recommended Practice 11S3,
Electrical Submersible Pump Installation,
2nd Edition (1999).
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Recommended Installation Practice: X-Tract® ESP Cables

General Cable acknowledges that there are several practical techniques available for splicing and that preferences exist based upon well-bore environment and cable materials (API RP 11S3). As such, General Cable does not specify or hold a preference for any one technique. Wherever possible, our recommendation is that splicing be completed away from the well site and in a clean environment. If a splice has to be made at the point of installation, then every effort must be made to ensure that no foreign matter enters into the splice.

6.1 Cable Splicing: Operator Instructions

The Motor Lead Extension (MLE) should be spliced to the Power Supply (PS) cable before being shipped to location.

High-temperature and Motor Lead Extension cables are manufactured with a durable inner insulation layer that must be completely removed prior to making a connection; all other General Cable ESP products have an adhesive layer between the insulation and conductor which must also be completely removed **(Figure 8)**.

When removing the inner layers and the primary conductor insulation, care must be taken to ensure that the conductors are not damaged. Fine, abrasive cloth can be lightly used as shown in **Figure 8** to create a smooth, clean surface. If the conductor is contaminated by oil or dirt, use a suitable solvent to clean the surface and leave the conductor dry. The length of exposed conductor and insulated phase protruding from the cable armor is to be as specified by the splicing technique used.

To minimize the potential for an in-service failure, the splice should not downrate the performance of the cable or reduce its service life potential. Attention should be given to ensure the correct phase-to-phase connections are made without loss of ampacity or causing an unusually elevated temperature under service conditions through the creation of a resistive contact. The tensile load-bearing capacity of the splice should not be less than that of the cable itself. The splice should not reduce the thermal rating of the cable system and must be rated to the environment in which it is to be used.

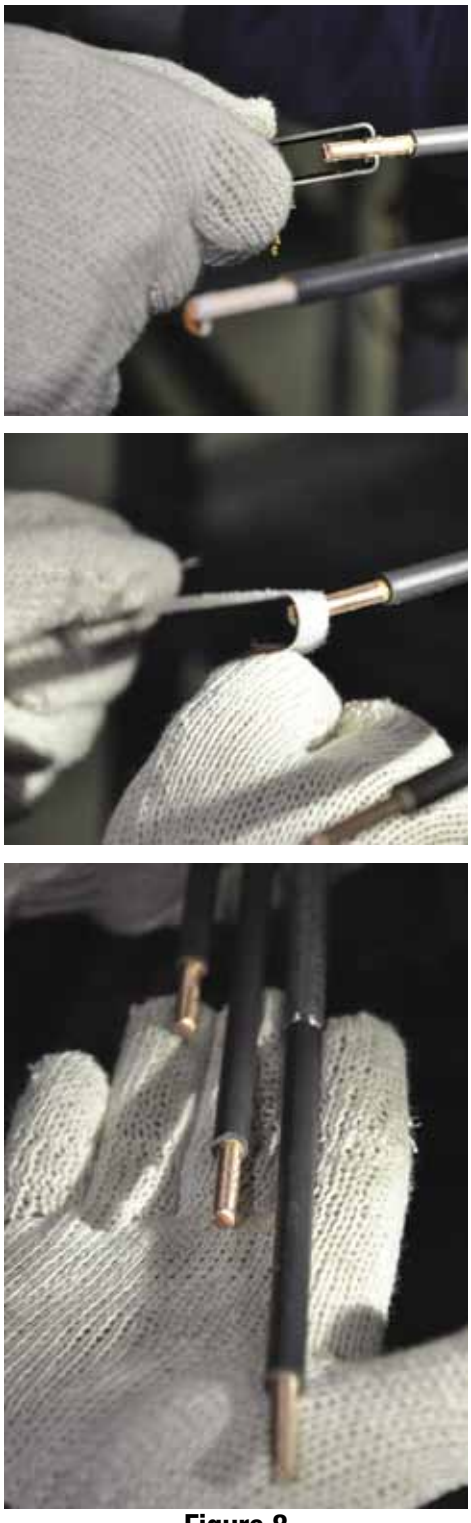

Figure 8

Recommended Installation Practice: X-Tract® ESP Cables

Figure 9:

Installation of the pothead prior to cable delivery to a well site is preferable

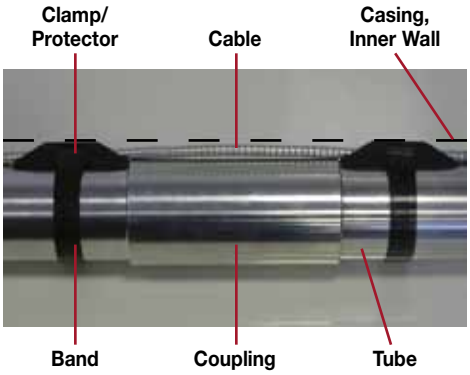

Figure 10:

Shows proper banding around a coupler

6.2 Cable Connections

Different types of connections are made during the set-up process, again offering many options that reflect both the severity of the environment and the personal preference of the operator/owner.

Types of Connections:

- Potheads **(Figure 9)**
- Well Head Penetrators
- Downhole Connectors
- Packer Feed-Through
- Breakout for multiple feed to motors in tandem

In all instances, where a cable is to be joined or connected, following the specific manufacturer's instructions ensures that the cable is not damaged and that the electrical connection is clean and well-made.

6.3 Cable Banding

Proper banding reduces the amount of strain a cable takes in its vertical installation — reduced vibration increases the life of the cable. The term "banding" is used generically and includes bands and cable clamps/protectors.

To achieve correct and consistent band tension, pneumatic tensioning is the preferred method for all banding of X-Tract® ESP cable. Tightening should be sufficient to ensure that the cable does not slip once attached to the tubing and that the cable itself is not damaged. A slight distortion of the cable armor is acceptable and indeed a good indication of appropriate tightness, but the armor should not be crushed. If a band is loose, it is recommended that it be cut off and replaced.

To attain a proper cable band (Figure 10):

- Banding tools should be in good condition and adjusted correctly. Personnel using these tools should be trained and supervised to ensure proper banding (API RP 11S3, Section 6.6 Cable Banding).
- Bands must be placed so that the buckle is located in the void between the cable and the tubing, out of the way of the banding tools and thus unable to be pushed into the cable and causing damage to it.
- Cable bands should not be installed over a cable splice but rather above and below it so as not to place any load on the splice.
- When placing bands on a Motor Lead Extension, make sure the cable fits up above the pump discharge head and not across a tubing collar.

Per API RP 11S3, no less than two bands are to be applied to secure the downhole ESP cable per tubing joint, with one being attached midway over the joint itself and the other 2-3 ft (60-90 cm) above the collar. However, more bands should be used on the first two joints (approx. 60 ft/18.29 m), as well as when running the tubing through a dogleg or other tight spots. This practice provides extra cable support in the area of "tubing cut-off" that might occur during a fishing operation.

Recommended Installation Practice: X-Tract® ESP Cables

7. Motor Lead Extension (MLE) Cable

ESP cables that have a Motor Lead Extension attached at a location away from the well site must be repackaged with the power cable reel prior to shipping to safeguard against in-transit damage.

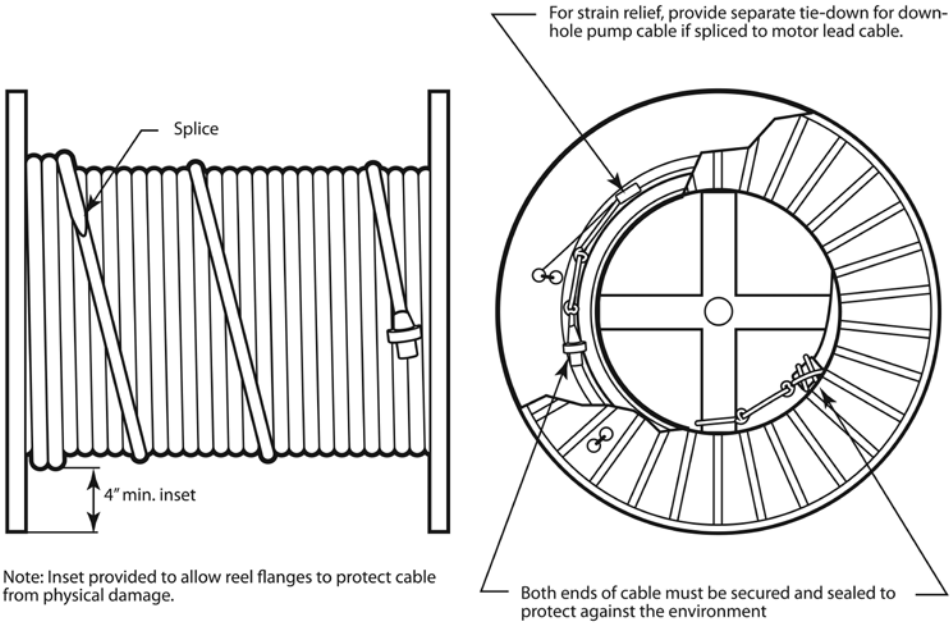

Figure 11:
Minimum requirement for ESP cable with an MLE spliced at a remote location prior to delivery at the well site (API RP 11S3, Section 3.0)

API Recommended Practice 11S3, Electrical Submersible Pump Installation, 2nd Edition (1999).
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MLE cable that is shipped separately (unattached to a ESP cable) should be boxed, crated, reeled or secured to a pallet/skid. To protect the MLE from weather damage and/or contamination, each end of the lead should be sealed.

8. Running Practices (API RP 11S3, Section 6.8)

The majority of cable damage occurs during handling and/or installation in a well casing. Running and pulling well tubing must be done slowly and smoothly. While running a new assembly into a well, rapid acceleration and deceleration may cause cable damage. It is not good practice to allow the cable to drag on the ground; cable slack should be maintained between the reel and the sheave. The cable should reel on or off the top of the reel.

Electrical continuity and insulation resistance should be measured periodically at:

- **(a)** a minimum of once every 2000 ft (610 m)
- **(b)** at pump depth setting
- **(c)** when terminations or splices are made

Run speed is to be defined by the operator taking account of experience and preference. Some operators set a limit of 1000 ft/hr (305 m/hr); this, however, is outside the scope of this Recommended Practice.

Note: IEEE 1018 and 1019 give run speeds in the range of 1000-4000 ft/hr (305-1219 m/hr) as being normal.

Recommended Installation Practice: X-Tract® ESP Cables

8.1 Pulling and Assessment of Used Cable

Pulling requires as much attention to detail and caution as running new equipment. Once all the preparations have been made, including opening the bleeder valve to remove the fluid, begin lifting the pump string out of the well.

A record of the number of bands that are missing should be kept, and the decision should be made whether to retrieve or push them to the bottom of the well. Remove the bands progressively by cutting and not by levering them away from the tube/cable, as that will damage the cable. If there is evidence of corrosion on the bands, it may be necessary to change them when re-establishing the well with bands of higher corrosion resistance.

Observe the condition of the cable as it emerges from the well. Look for evidence of overheating, melted lead, scorch marks on the armor and corroded or separated armor. Check for swollen insulation, exposed conductors and excessive corrosion of cable splices, as well as the number of splices. If there is a reported motor failure, ask the owner/operator whether to leave a portion of the MLE attached (1-2 ft [30-60 cm] above the pothead) or if it should be removed completely.

8.2 Guidelines for Established Re-Use of Cable

All observed issues with the cable should be marked on the cable while it is being recovered; this will save time in locating the defects for repair or deciding whether to scrap the cable length as a whole. The retrieved cable should be re-spooled on a reel of sufficient capacity for the length, size and type of cable being pulled. Do not run the cable across the ground and reel with the cable running onto the top of the reel. Lightly oil the cable and store it in a sheltered location if possible.

All cable lengths are to be tested according to API RP 11S6 prior to and after any repairs being made before they can be considered for an additional period in service. Failure of a test after repair should render the cable unfit for use. It is good practice to allow a cable to rest for several days prior to testing; this will reduce the content of soluble or entrapped gases.

Note: Motor Lead Extensions should not be re-used.

Testing

ITEM UNDER TEST	GENERAL DESCRIPTION OF TEST	TEST REFERENCE
Cable Component (Raw Materials)		
Conductor	Dimensional, visual, electrical and mechanical tests to determine fitness for use	GCC specification
Conductor Adhesive	Evaluation for contamination, premature aging, viscosity, volatiles content, pH and density	GCC specification
Insulation	Tested to international standards for mechanical, electrical and environmental consistency	GCC specification
Jacket	Tested to international standards for mechanical, electrical and environmental consistency	GCC specification
Barrier Tape	Dimensional, electrical and mechanical tests to determine fitness for use	GCC specification
Lead Jacket	Compositional assay to determine fitness for use	GCC specification
Thermal/Mechanical Barrier Tape	Dimensional, visual and mechanical tests to determine fitness for use	GCC specification
Metallic Armor	Dimensional, visual and mechanical tests to determine fitness for use	GCC specification
In Process		
Conductor Dimension	Testing completed during the manufacturing cycle to monitor and regulate product quality	GCC manufacturing dimensions & tolerance
Insulation Thickness	Testing completed during the manufacturing cycle to monitor and regulate product quality	GCC manufacturing dimensions & tolerance
Insulation Spark Testing	Testing completed during the manufacturing cycle to monitor and regulate product quality	GCC manufacturing dimensions & tolerance
Insulation - Jacket Wall Thickness	Testing completed during the manufacturing cycle to monitor and regulate product quality	GCC manufacturing dimensions & tolerance
Lead Jacket Wall Thickness	Testing completed during the manufacturing cycle to monitor and regulate product quality	GCC manufacturing dimensions & tolerance
Armor Overall Diameter and ID Clearance	Testing completed during the manufacturing cycle to monitor and regulate product quality	GCC manufacturing dimensions & tolerance
Mechanical Testing		
Gas Blockage	A pressurization test conducted on each conductor assembly to ensure no pathways exist for oil well gases within the cable	IEEE 1018 & IEEE 1019
Cable Bending	Cables are wrapped around mandrels (7x cable diameter) at 180° in alternating directions to evaluate armor integrity	IEEE 1018 & IEEE 1019
Environmental Testing		
Hot Air Aging	Mechanical tests conducted before and after aging as an evaluation of service life of the component (insulation and jacketing)	IEEE 1018 & IEEE 1019
Oil Resistance at High Temperature	Evaluation of cable jacket as an assesment of resistance to well environment	IEEE 1018 & IEEE 1019 requirements tested to ASTM D471
Oil Swell Testing	An in-house test to ensure consistency in materials and process (cable jacket and insulation)	GCC requirement tested to ASTM D471
Cold Bend	An evaluation of handling characteristics at low temperature	ICEA T-27-581
Operation Simulation	Testing of completed cables under 3000 psi (206.8 bar) in oil at the design operating temperature	GCC specification
Thermal Cycling	An evaluation of cable perfomance when subjected to thermally induced expansion and contraction cycles	GCC specification
Electrical Testing		
Conductivity	Conductor resistance is measured in the finished cable to ensure continuity and electrical function in the field	ICEA S-96-659 in reference to ASTM B3/B33/B189
High Voltage Withstand Tests Under AC And DC	Tests to ensure the insulation materials are defect-free and functioning to design performance	IEEE 1018 & IEEE 1019
Insulation Resistance	A quality test of the insulation to ensure electrical performance of a finished cable	IEEE 1018 & IEEE 1019 in reference to ICEA T-27-581
Insulation Conductance	The inverse of Insulation Resistance and a measure of power losses in a cable through the insulation	IEEE 1018 & IEEE 1019 in reference to API RP 11S6
Phase Unbalance	A measure of power loss unbalance in a flat ESP cable; field correction is possible for unbalance that remains within specification	IEEE 1017, IEE 1018, IEEE 1019 and API RP 11S6

Option: Detailed Certified Test Document (CTD) will ship with cable.

Testing

	SAMPLING REGIME		
Dimension & Weight	**In-Process Test**	**Routine Certification Test**	**Type Testing**
Conductor	x	x	x
Insulation Wall Thickness	x	x	x
Jacket Wall Thickness	x	x	x
Lead Sheath Wall Thickness	x	x	x
Armor Size	x	x	x
Armor Coating			x
Mechanical			
Insulation Physical Properties	x	x	x
Jacket Physical Properties	x	x	x
Flat Cable Bending		x	x
Round Cable Bending		x	x
Gas Blockage	x	x	x
Environmental			
Insulation, Air Aging			x
Jacket, Air Aging			x
Jacket, Oil Resistance			x
Volume Swell In Oil			x
Volume Swell In Water			x
Cold Bend			x
Operation Simulation			x
Thermal Cycling			x
Electrical			
Conductor (General)	x		
Conductivity	x		x
Conductor Resistance, Cable	x	x	x
DC Withstand, Cable		x	x
AC Withstand, Cable		x	x
Insulation Resistance, Insulated Conductors	x		
Insulation Resistance, Cable		x	x
Leakage Current (Same As Conductance Leakage)	x	x	x
Phase Unbalance	x	x	x
Spark Testing	x		
Continuity (Cable)	x	x	x

In-Process Test - testing during the manufacturing process
Routine Certification Test - certifying cable to a referenced standard
Type Test - in-house qualification testing to ensure a design is correct

Voltage Drop and Ampacity Calculation

Voltage Drop

The voltage drop per 1000 feet of cable at 25°C (77°F) can be found in the Voltage Drop charts located on the applicable specification, pages 5-26. For cables operating at higher conductor temperatures, the values in the Voltage Drop charts must be multiplied by the Correction Factor from Table 1.

The voltage drop formula used for a given length of cable is as follows:

$$V_d = \sqrt{3} \times I \times [(R_{AC} \times \cos \alpha) + (X_L \times \tfrac{f}{60} \times \sin \alpha)]$$

Where: V_d = volts at specified conductor temperature, frequency and power factor

I = current in amperes

R_{AC} = ac resistance at specific conductor temperature (ohms per 1000 feet)

= R_{DC} (@ 20°C) x ac/dc factor x temperature correction factor

= R_{DC} (@ 20°C) x 1 (for sizes #6, 5, 4, 2, 1 AWG) x $\frac{[234.5+T_2]}{[234.5+20]}$

where T_2 is the specified operating conductor temperature (°C)

R_{DC} of Annealed Solid Bare Copper at 25°C (ohms per 1000 feet):

AWG	R_{DC}*
6	0.403
5	0.313
4	0.253
2	0.159
1	0.126

*add 2% for round constructions

cos α and sin α are based on the power factor of system:

POWER FACTOR	cos α	sin α
80%	0.80	0.60
85%	0.85	0.53
90%	0.90	0.44
95%	0.95	0.31
100%	1.00	0.00

X_L = inductive reactance (ohms per 1000 feet @ 60Hz)

AWG	ROUND	FLAT
6	0.045	0.051
5	0.042	0.048
4	0.039	0.046
2	0.034	0.040
1	0.031	0.038

f = frequency of operation (Hertz)

Table 1
Voltage Drop Correction Factors

°C	°F	C.F.
30	86	1.04
40	104	1.08
50	122	1.12
60	140	1.16
70	158	1.20
80	176	1.24
90	194	1.28
100	212	1.31
110	230	1.35
120	248	1.39
130	266	1.43
140	284	1.47
150	302	1.51
160	320	1.55
170	338	1.59
180	356	1.63
190	374	1.67
200	392	1.71
210	410	1.75
220	428	1.79
230	446	1.83

Voltage Drop and Ampacity Calculation

Ampacity

The Ampacity charts shown on specification pages 5 – 16 are used to select conductor sizes based on the appropriate cable construction, maximum well temperature and ampacity requirements.

Figures 12 – 21 can be used to determine the cable temperature rating required based on the conductor temperature, well temperature and ampacity.

These Ampacity charts have been prepared using a Neher-McGrath method tailored for submersible pump cable (G. Baker and M. Durham, *Correlations of Submersible Cable Performance to Neher-McGrath Ampacity Calculations*, IEEE Paper No. PID 91-15). They are based on the performance of a cable in the worst-case situation where there is no well liquid surrounding the cable. In this case, the rate of heat transfer from the cable into the surrounding well ambient is greatly hindered.

Though the method presented in the referenced paper includes many complex formulas, the basic modified ampacity calculation used is as follows:

$$I = \sqrt{\left(\frac{(T_c - T_a)}{(R_{DC} \times TR)}\right)}$$

Where: I = current in amperes
T_c = maximum conductor temperature (°C)
T_a = ambient temperature (°C)
R_{DC} = conductor DC resistance at conductor temperature (Ω/ft)
TR = thermal resistance (thermal ohm feet)

The thermal resistance value is the summation of the individual thermal resistance values of the cable's insulating and reinforcing layers as well as the gas zone between the cable surface and surrounding casing and is dependent upon the individual material properties as well as cable geometry.

The ampacity values presented in the ampacity charts shown on specification pages 5 – 16 and Figures 12 – 21 include a safety factor that is 90% of the Neher-McGrath calculated value per IEEE 1018-2004.

Voltage Drop and Ampacity Calculation

Figure 12: X-Tract® 1 AWG Conductor Temperature
Flat Cable

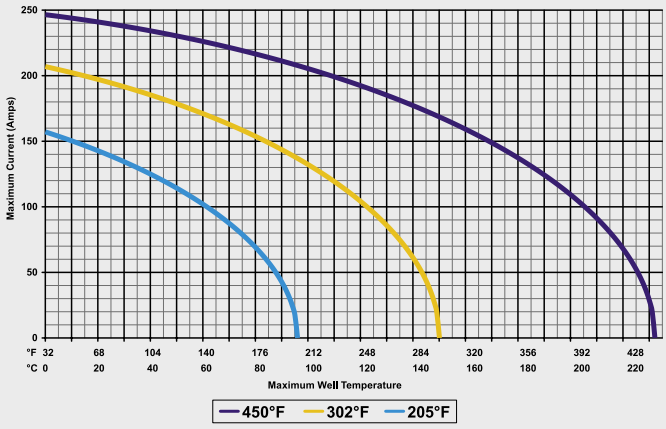


Figure 13: X-Tract® 1 AWG Conductor Temperature
Round Cable

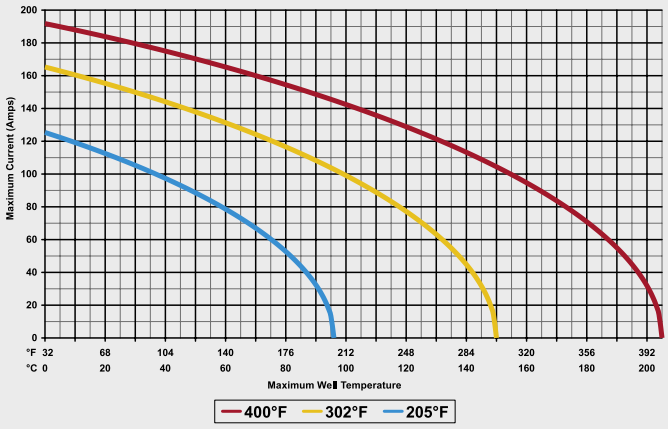


Figure 14: X-Tract® 2 AWG Conductor Temperature
Flat Cable

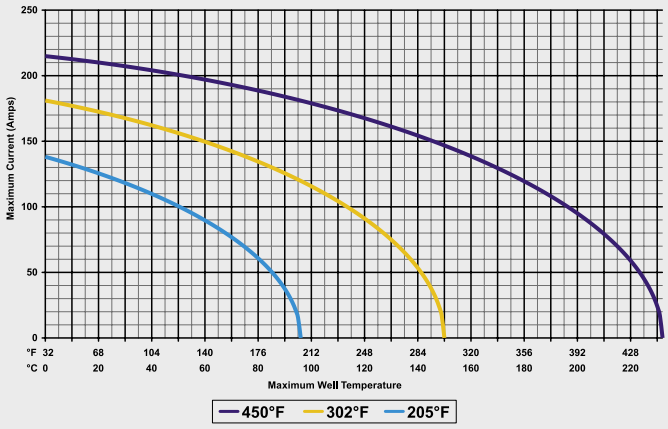


Figure 15: X-Tract® 2 AWG Conductor Temperature
Round Cable

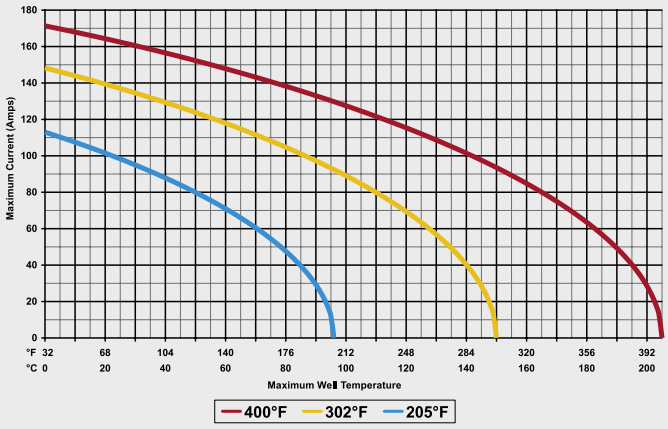


Figure 16: X-Tract® 4 AWG Conductor Temperature
Flat Cable

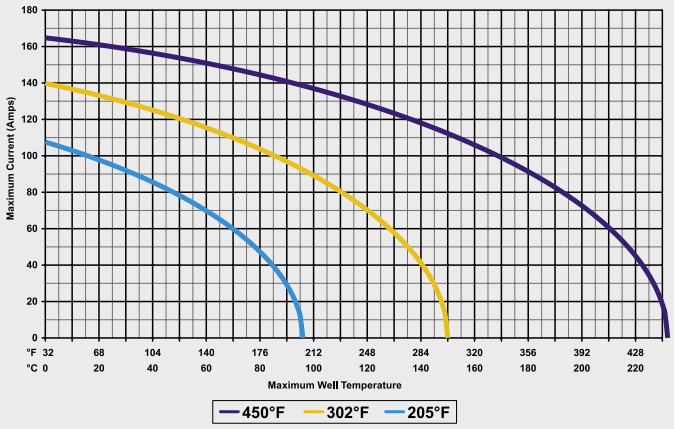
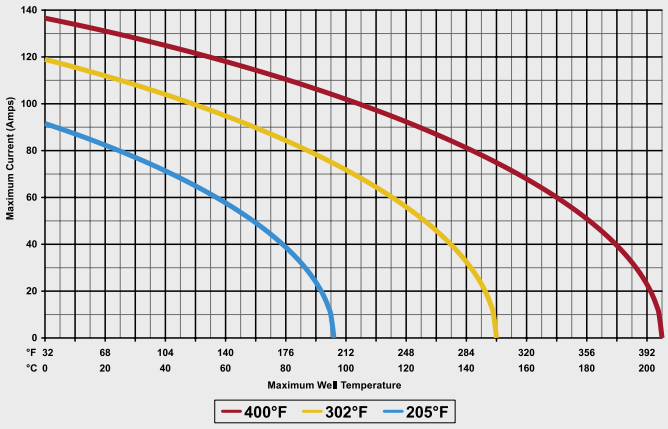


Figure 17: X-Tract® 4 AWG Conductor Temperature
Round Cable



Voltage Drop and Ampacity Calculation

Figure 18: X-Tract® 5 AWG Conductor Temperature
Flat Cable

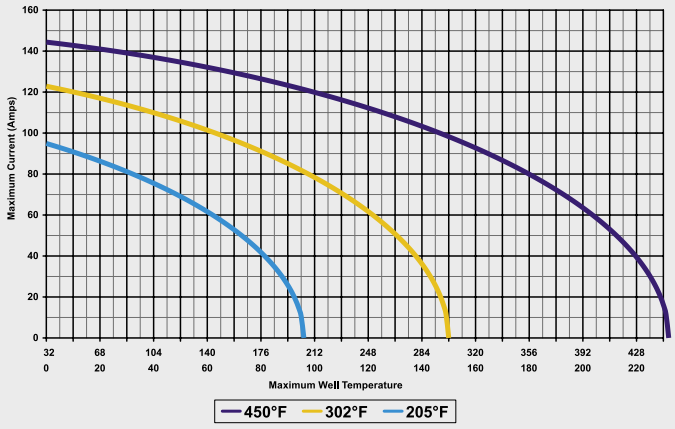


Figure 19: X-Tract® 5 AWG Conductor Temperature
Round Cable

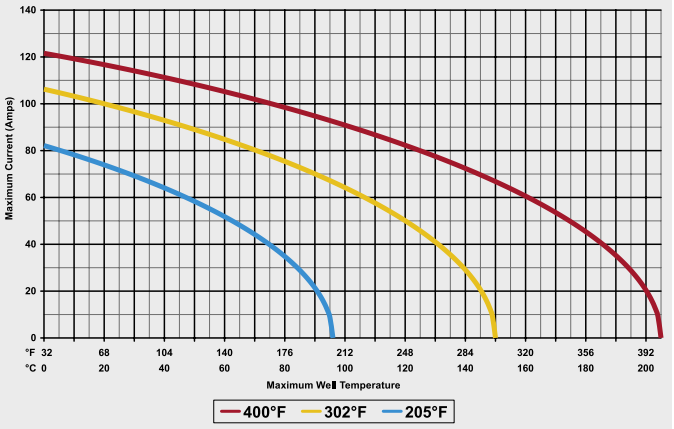


Figure 20: X-Tract® 6 AWG Conductor Temperature
Flat Cable

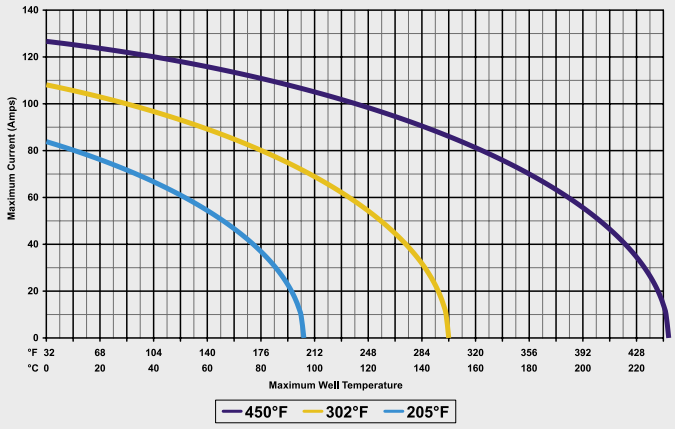
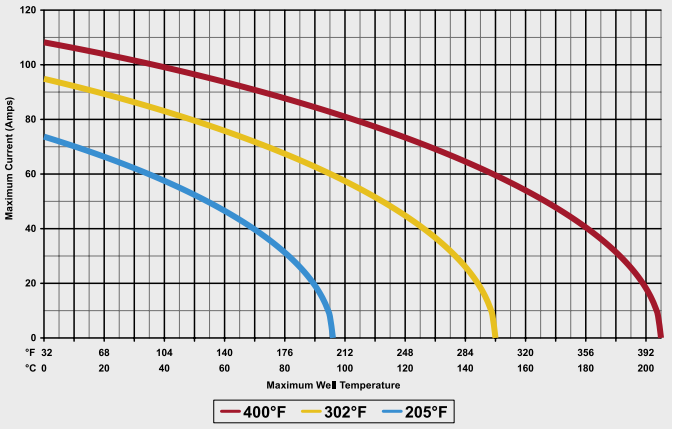


Figure 21: X-Tract® 6 AWG Conductor Temperature
Round Cable



ESP Cable Cross-Reference

Note: The product matches below are based on temperature rating ONLY and are not EXACT matches in terms of materials and/or dimensions.

ROUND								
			X-Tract®		BAKER HUGHES - CENTRILIFT*	SCHLUMBERGER (REDA)		PRYSMIAN
VOLTAGE	TEMP. RANGE	AWG	PRODUCT GROUP	PART NUMBER**	SP PERFOMANCE	PRODUCT GROUP	KERITE	PRODUCT GROUP
5 kV	-40°F to +205°F	1	2R205	120.1312055G	CPN			DEVILENE R 205/ DW 205 R
		2		120.2312055G				
		4		120.4312055G				
		5		120.5312055G				
		6		120.6312055G				
	-40°F to +302°F	1	3R302	130.1313025G	CEN	PPEO G5R		DW 300 R or DW 300 RE
		2		130.2313025G				
		4		130.4313025G				
		5		130.5313025G				
		6		130.6313025G				
	-40°F to +400°F	1	4R400	140.1314005G	CEE	ETBE G5R		DEVILENE R 400/ DW 400 R
		2		140.2314005G				
		4		140.4314005G				
		5		140.5314005G				
		6		140.6314005G				

FLAT								
			X-Tract®		BAKER HUGHES - CENTRILIFT*	SCHLUMBERGER (REDA)		PRYSMIAN
VOLTAGE	TEMP. RANGE	AWG	PRODUCT GROUP	PART NUMBER**	SP PERFOMANCE	PRODUCT GROUP	KERITE	PRODUCT GROUP
5 kV	-40°F to +205°F	1	2F205	121.1312055G	CPN		LTF3	DEVILENE F 205/ DW 205 F or DW 205 COLD F
		2		121.2312055G				
		4		121.4312055G				
		5		121.5312055G				
		6		121.6312055G				
	-40°F to +302°F	1	3F302	131.1313025G	CEN	POTB G5F	MTF3	
		2		131.2313025G				
		4		131.4313025G				
		5		131.5313025G				
		6		131.6313025G				
	-40°F to +450°F	1	5F450	151.1314505G	CEL	EL G5F	HTF3	DEVILEAD F 450/ DW 450 FL
		2		151.2314505G				
		4		151.4314505G				
		5		151.5314505G				
		6		151.6314505G				

*Voltage not provided - 5 kV is assumed. AWG size not provided - all AWG available assumed.
**G - Galvanized Steel Armor is standard. Replace G with SS for Stainless Steel.

Centrilift is a trademark of Baker Hughes.
REDA is a trademark of Schlumberger.
LTF, MTF, HTF, MFL are trademarks of Kerite.
Devilene is a trademark of Prysmian.

Metric Conversion Factors

	To Convert From	To	Multiply By
Length	Inches	Millimeters	25.4
	Millimeters	Inches	0.03937
	Inches	Centimeters	2.54
	Centimeters	Inches	0.3937
	Feet	Meters	0.3048
	Meters	Feet	3.2808
	Kilofeet (1000 feet)	Kilometers	0.3048
	Kilometers	Kilofeet (1000 feet)	3.2808
Area	Square Inches	Square Millimeters	645.16
	Square Millimeters	Square Inches	0.00155
	Square Inches	Square Centimeters	6.4516
	Square Centimeters	Square Inches	0.155
	Square Inches	Circular Mils	1,273,240
	Circular Mils	Square Inches	7.854×10^{-7}
	Circular Mils	Square Millimeters	5.066×10^{4}
	Square Millimeters	Circular Mils	1973.51
	Square Feet	Square Meters	0.0929
	Square Meters	Square Feet	10.764
Weight	Pounds	Kilograms	0.4536
	Kilograms	Pounds	2.2046
	Pound/Kilofeet	Kilograms/Kilometer	1.4882
	Kilograms/Kilometer	Pounds/Kilofeet	0.6720
Electrical	Ohms/Kilofeet	Ohms/Kilometer	3.2808
	Ohms/Kilometer	Ohms/Kilofeet	0.3048
	Microfarads/Kilofeet	Microfarads/Kilometer	3.2808
	Microfarads/Kilometer	Microfarads/Kilofeet	0.3048
	Insulation Resistance:		
	Megohms—Kilofeet	Megohms—Kilometer	0.3048
	Megohms—Kilometer	Megohms—Kilofeet	3.2808
Mechanical	Pounds/Square Inch	Kilo Pascal*	6.895
	Kilo Pascal*	Pounds/Square Inch	0.1432
	Pounds (force)	Newtons	4.448

* 1 Pascal = 1 Newton/square meters

AWG (American Wire Gauge) to mm² (Millimeters Squared) Conversion

AWG to mm² CONVERSION TABLE	
AWG/kcmil	[mm²]*
20	0.52
18	0.82
16	1.31
14	2.08
12	3.31
10	5.26
8	8.36
6	13.3
4	21.2
2	33.6
1	42.4
1/0	53.5
2/0	67.4
3/0	85.0
4/0	107
250	127
300	152
350	177
400	203
450	228
500	253
600	304
750	380
800	405
1000	507

* Equivalent mm² cross-sectional area

mm² to AWG CONVERSION TABLE		
mm²	[mm²]*	AWG/kcmil
0.5	0.52	20
0.75	0.82	18
1.5	1.31	16
2.5	2.08	14
2.5	3.31	12
4	3.31	12
6	5.26	10
10	8.36	8
16	13.3	6
25	21.2	4
35	33.6	2
35	42.4	1
50	53.5	1/0
70	67.4	2/0
95	85.0	3/0
95	107	4/0
120	107	4/0
120	127	250
150	152	300
185	177	350
185	203	400
240	228	450
240	253	500
300	304	600
400	380	750
400	405	800
500	507	1000

Multiple AWG choices — consult responsible engineer for required ampacity

Part Number Index

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120.1312055SS	SPEC 120	6
120.2312055G	SPEC 120	6
120.2312055SS	SPEC 120	6
120.4312055G	SPEC 120	6
120.4312055SS	SPEC 120	6
120.5312055G	SPEC 120	6
120.5312055SS	SPEC 120	6
120.6312055G	SPEC 120	6
120.6312055SS	SPEC 120	6
121.1312055G	SPEC 121	8
121.1312055SS	SPEC 121	8
121.2312055G	SPEC 121	8
121.2312055SS	SPEC 121	8
121.4312055G	SPEC 121	8
121.4312055SS	SPEC 121	8
121.5312055G	SPEC 121	8
121.5312055SS	SPEC 121	8
121.6312055G	SPEC 121	8
121.6312055SS	SPEC 121	8
130.1313025G	SPEC 130	10
130.1313025SS	SPEC 130	10
130.2313025G	SPEC 130	10
130.2313025SS	SPEC 130	10
130.4313025G	SPEC 130	10
130.4313025SS	SPEC 130	10
130.5313025G	SPEC 130	10
130.5313025SS	SPEC 130	10
130.6313025G	SPEC 130	10
130.6313025SS	SPEC 130	10
131.1313025G	SPEC 131	12
131.1313025SS	SPEC 131	12
131.2313025G	SPEC 131	12
131.2313025SS	SPEC 131	12
131.4313025G	SPEC 131	12
131.4313025SS	SPEC 131	12
131.5313025G	SPEC 131	12
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140.5314005SS	SPEC 140	14
140.6314005G	SPEC 140	14
140.6314005SS	SPEC 140	14
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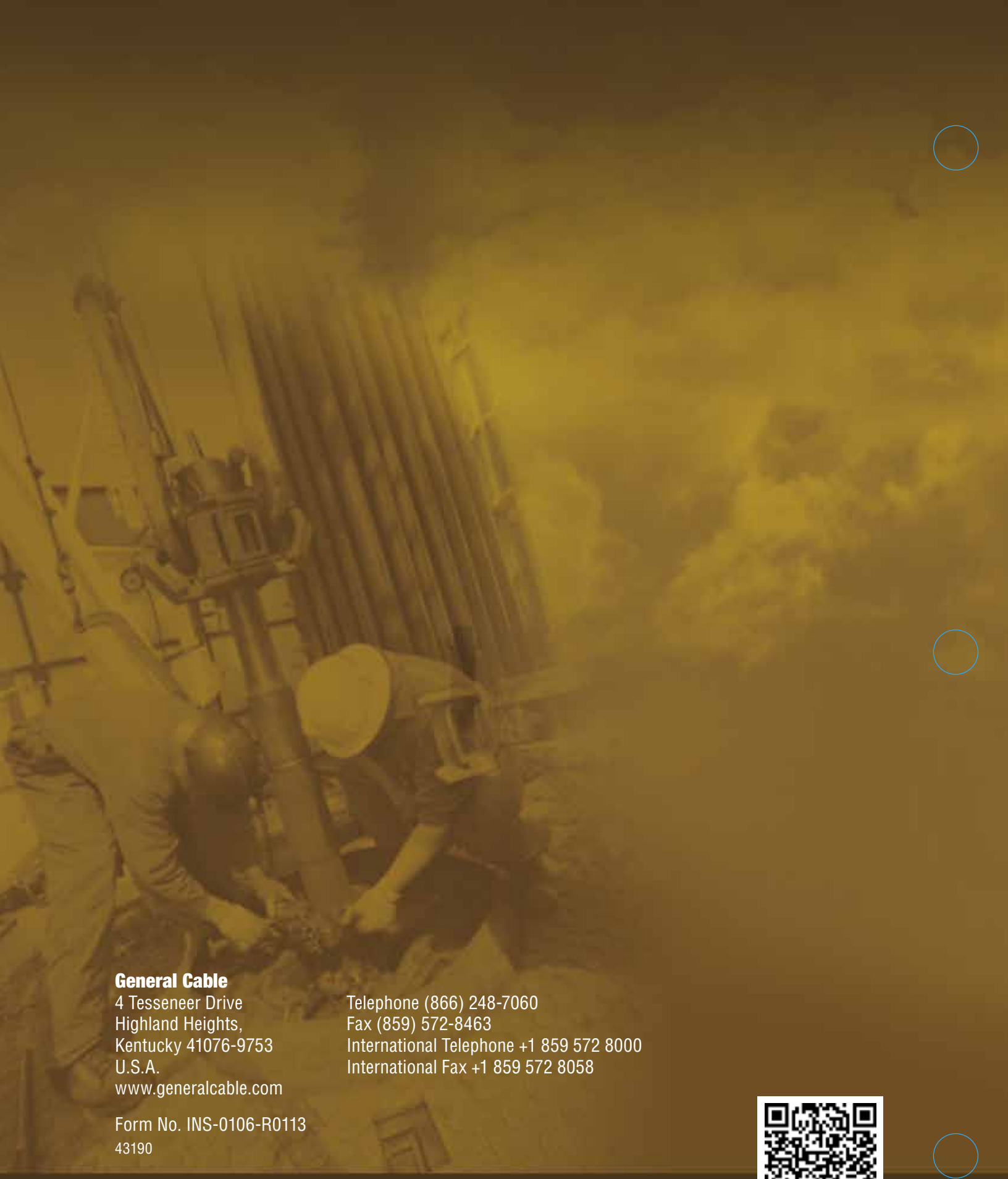
151.2314505SS	SPEC 151	16
151.4314505G	SPEC 151	16
151.4314505SS	SPEC 151	16
151.5314505G	SPEC 151	16
151.5314505SS	SPEC 151	16
151.6314505G	SPEC 151	16
151.6314505SS	SPEC 151	16



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