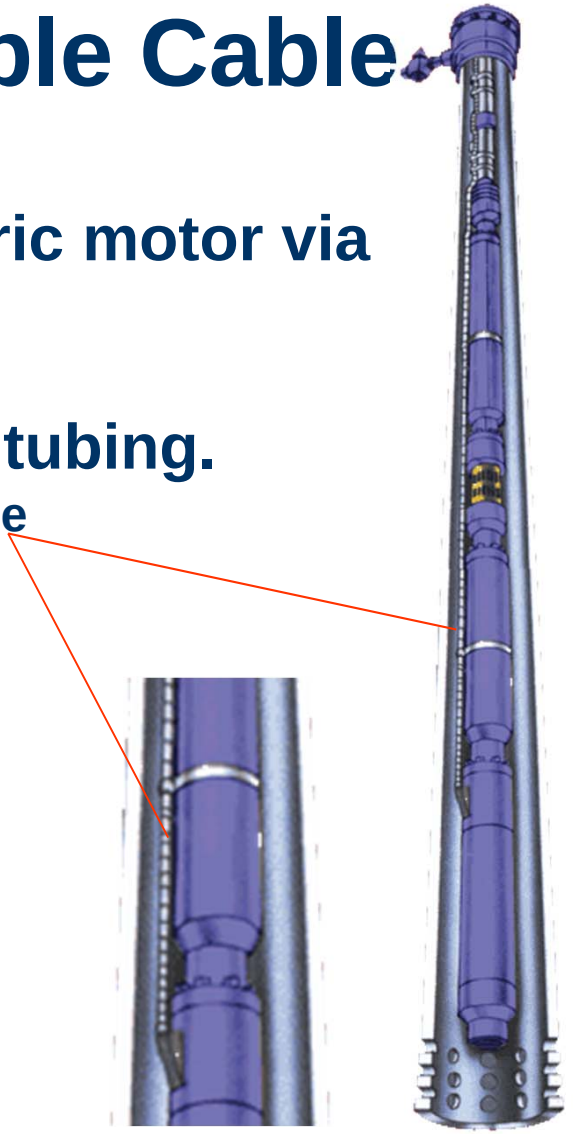
Submersible Power Cable

Cable Manufacture

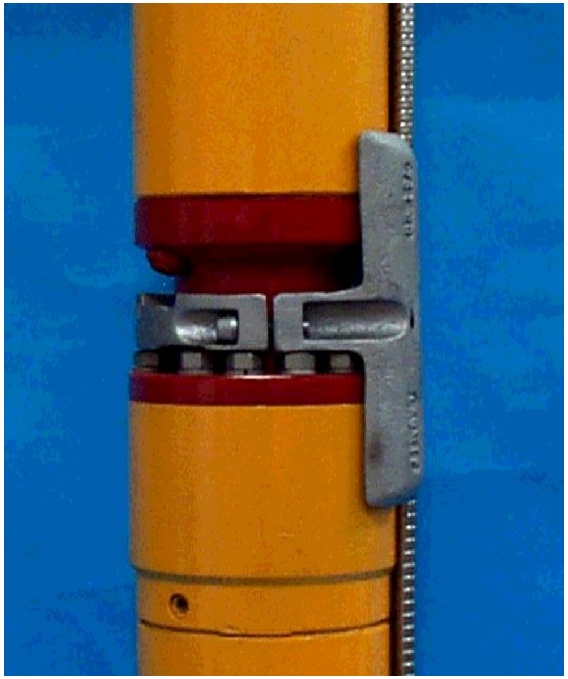
- ✓ Manufacturer of electric power cable and rubber molded components for ESP's
- ✓ Certified to ISO 9001
- ✓ Includes <u>All</u> aspects of Cable Manufacturing

Electrical Submersible Cable

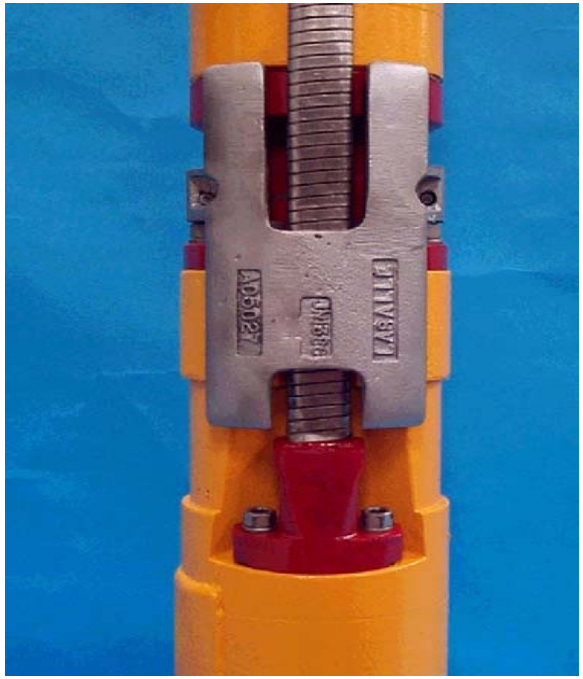
- ✓ Power is supplied to the electric motor via the electric cable.
- ✓ It is banded to the production tubing.



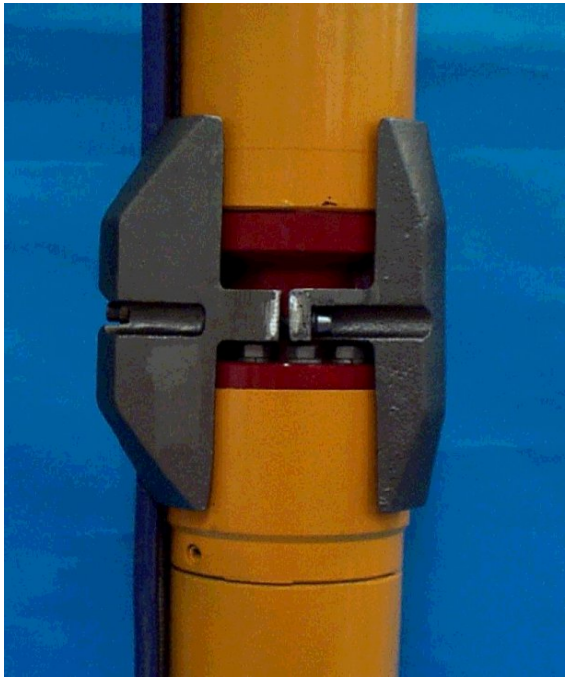
Cable Protection



Between
Equipment



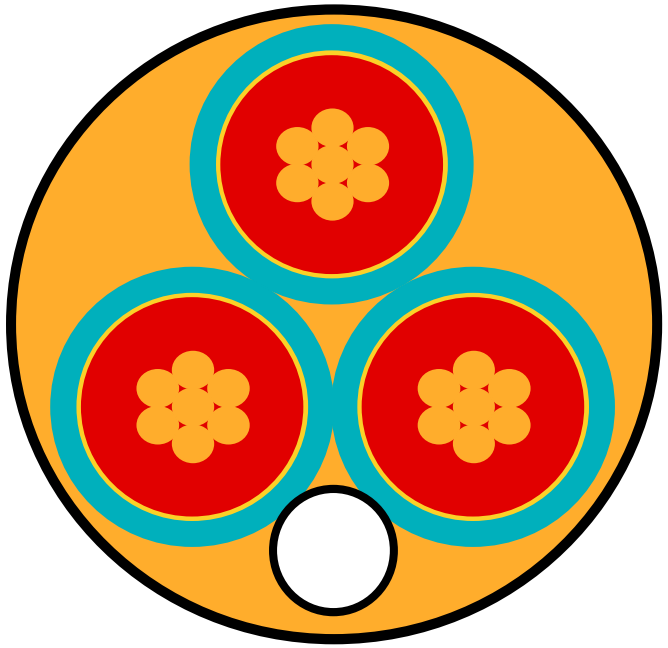
Pothead
Connection



4 Fin for
Centralization

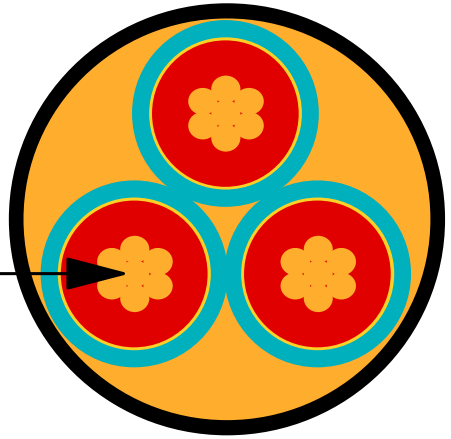
Cable Components

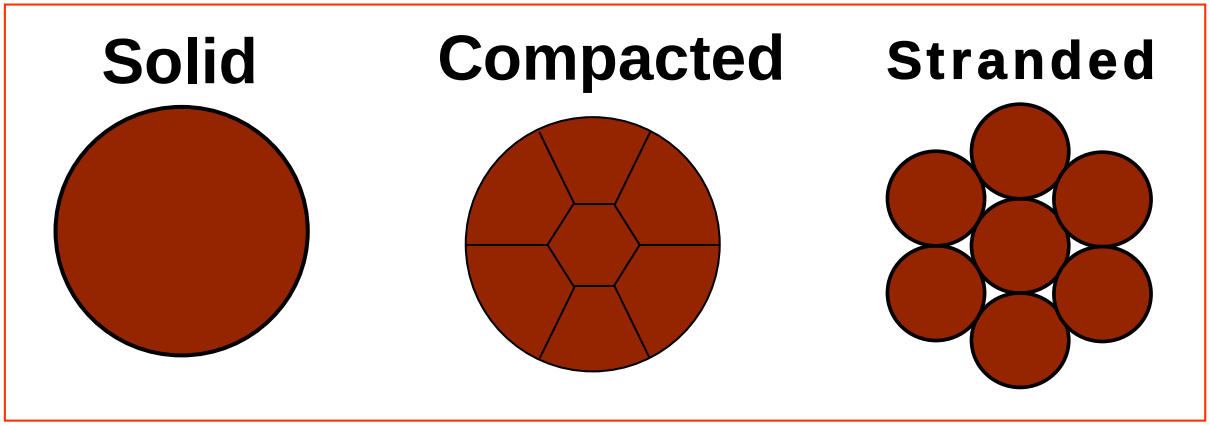
- ✓ CONDUCTOR
- ✓ INSULATION
- ✓ BARRIER
- ✓ INJECTION TUBE (optional)
- ✓ JACKET
- ✓ ARMOR



Conductor Selection

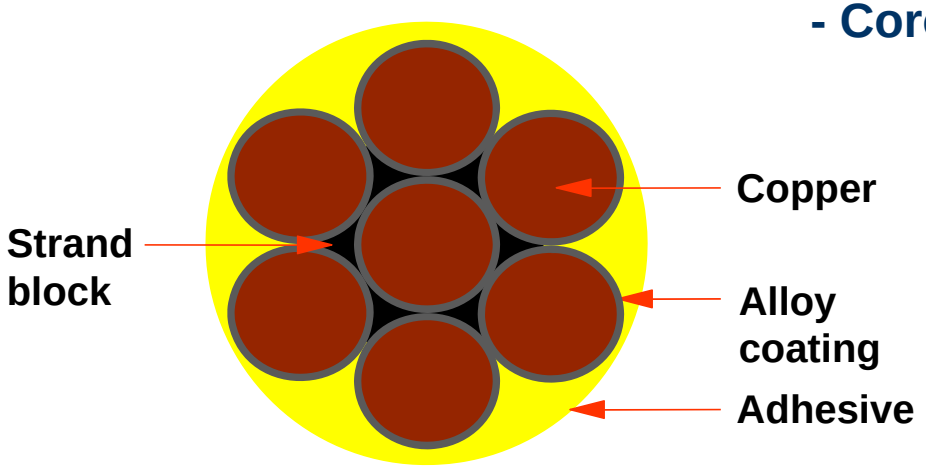
- ✓ SIZE (AWG#)
- ✓ DAMAGE RESISTANCE
- ✓ FLEXIBILITY
- ✓ COST





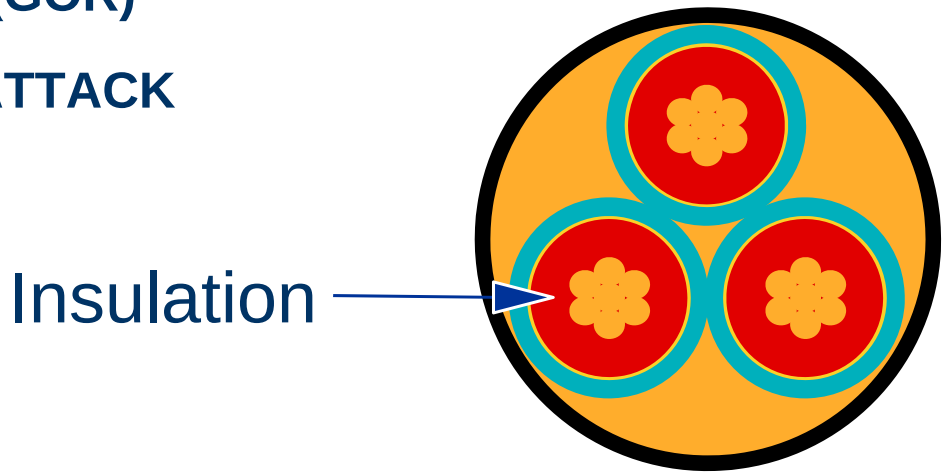
Coating / Adhesive

- ✓ **ALLOY COATING**
  - **- Chemical resistance**
- ✓ **ADHESION & STRAND BLOCKING**
  - **- Downhole Performance**
    - **- Gas transmission**
    - **- Gas entrapment/corrosion**
    - **- Corona discharge**



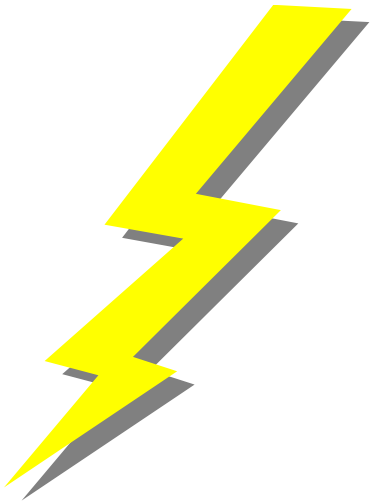
Insulation Selection

- ✓ **EPDM ethylene propylene dienemethylene**
- ✓ **TEMPERATURE**
- ✓ **PRESSURE CHANGES**
- ✓ **GAS TO OIL RATIO (GOR)**
- ✓ **CARBON DIOXIDE ATTACK**
- ✓ **OIL ATTACK**



Voltage Rating and Selection Criteria

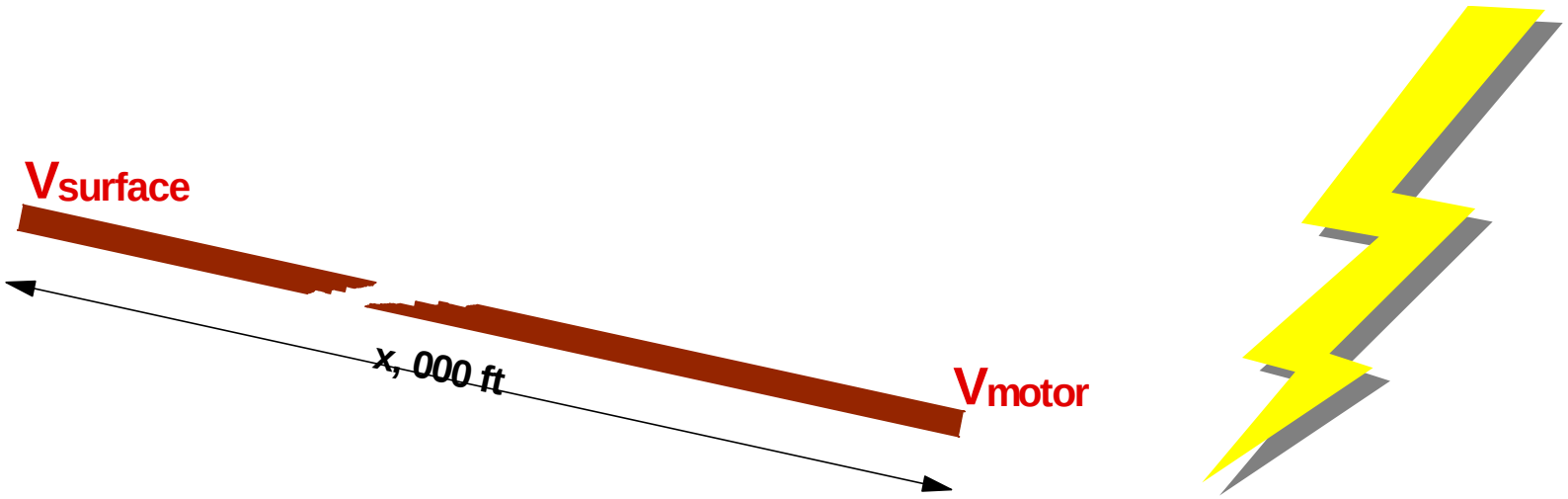
- ✓ 3 kV: tested at 20 kV DC, 7 kV AC
- ✓ 4 kV: tested at 30 kV DC, 10 kV AC
- ✓ 5 kV: tested at 35 kV DC, 13 kV AC



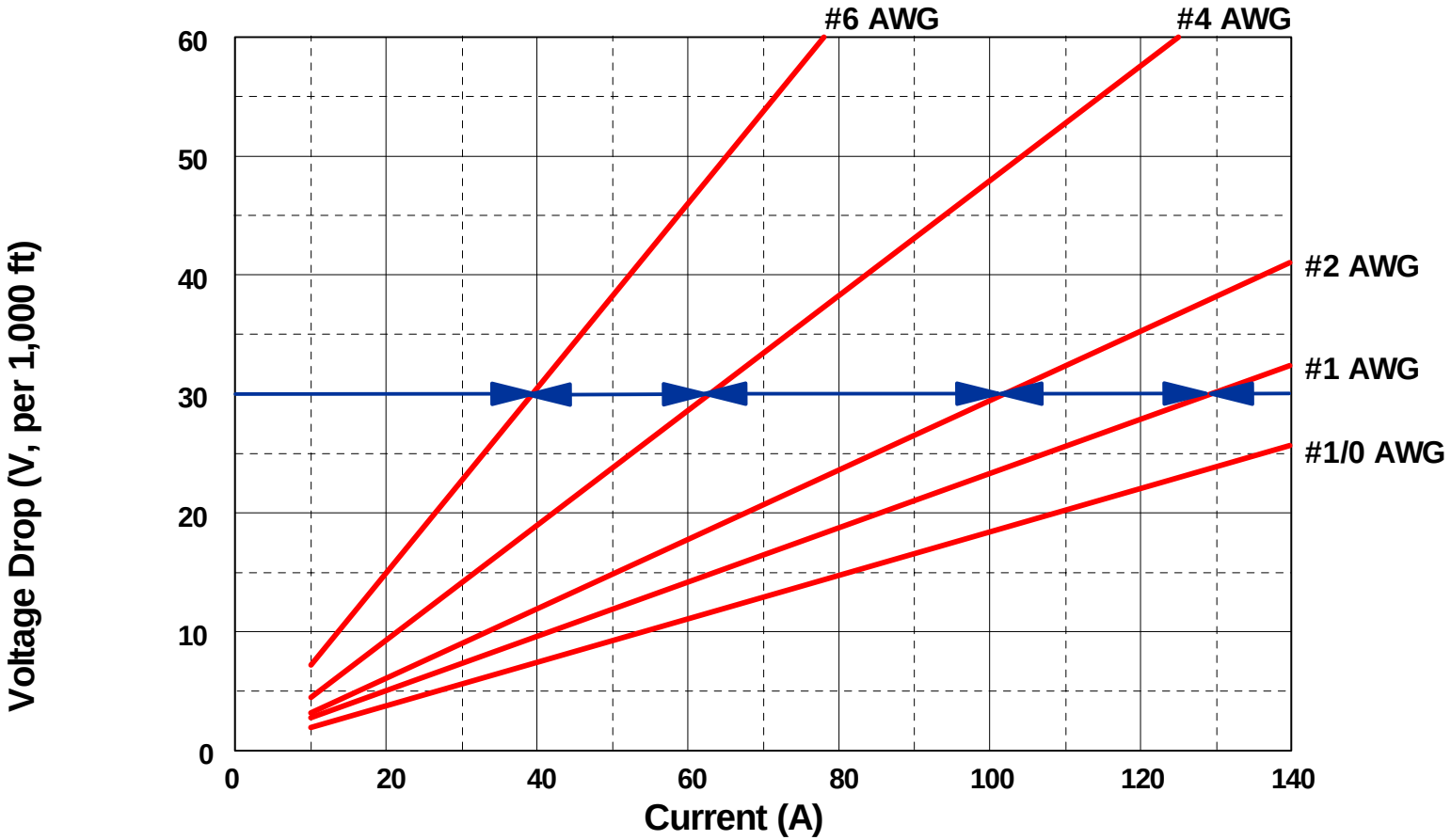
- ✓ OPERATING VOLTAGE
- ✓ VOLTAGE SPIKES/TRANSIENTS
- ✓ MECHANICAL DAMAGE

Voltage Drop

- ✓ Surface Voltage is higher than motor Voltage (Voltage drop)
- ✓ Energy is required to push current through a cable

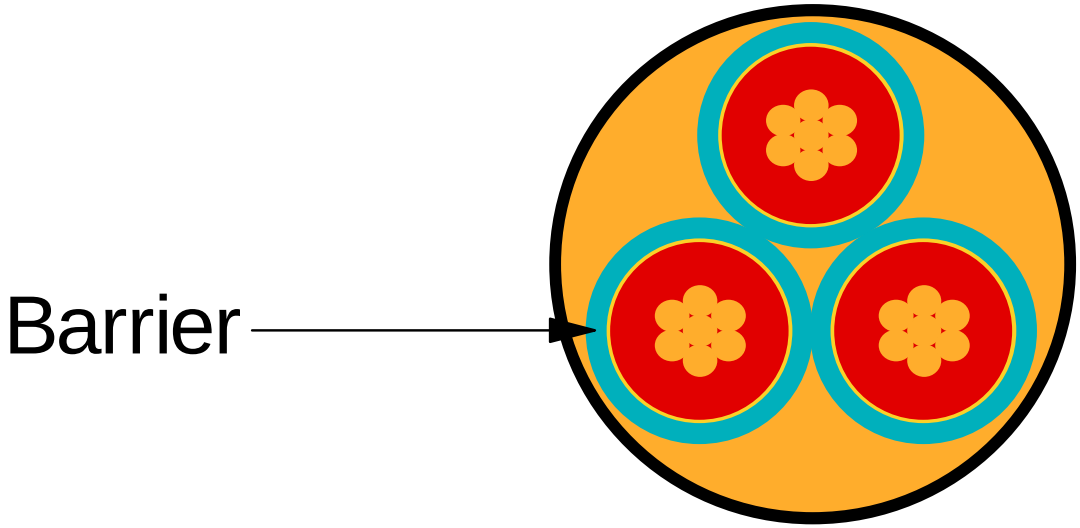


Voltage Drop Graph



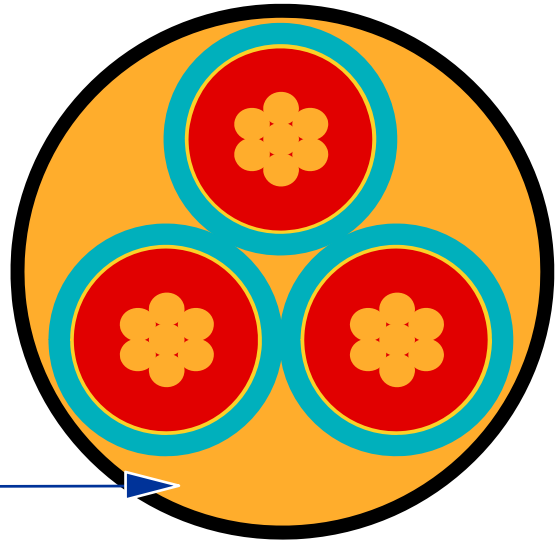
Barrier Selection

- ✓ TEMPERATURE
- ✓ CHEMICAL ENVIRONMENT
- ✓ GAS
- ✓ HANDLING



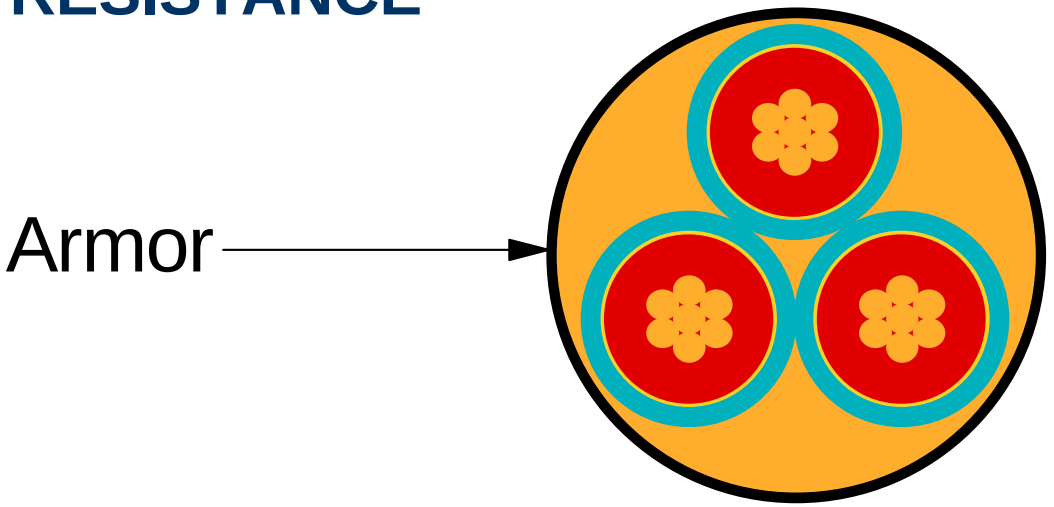
Jacket Selection

- ✓ **TEMPERATURE**
- ✓ **CHEMICAL ENVIRONMENT**
- ✓ **GAS**
- ✓ **HANDLING CONDITIONS**



Armor Selection

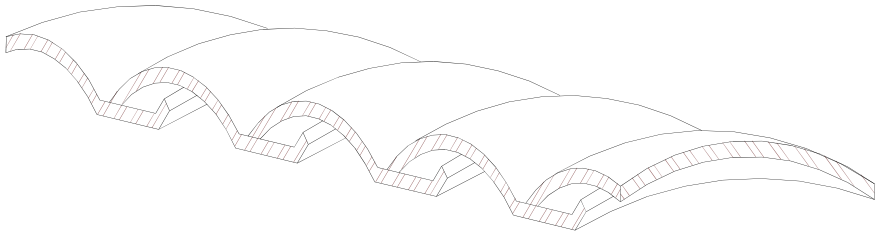
- ✓ DAMAGE RESISTANCE
- ✓ DECOMPRESSION CONTAINMENT
- ✓ CORROSION RESISTANCE



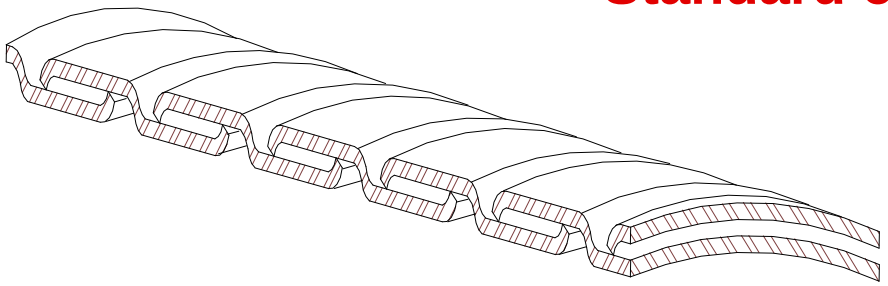
Armor Types

- ✓ **STANDARD GALVANIZED STEEL (CLASS I) (GSA, 0.020"/0.51mm & 0.025"/0.64mm thick)**
- ✓ **HEAVY GALVANIZED STEEL (0.034"/0.86mm thick)**
- ✓ **HEAVY COATING CLASS II GALVANIZED STEEL**
- ✓ **DOUBLE ARMOR (two layers)**
- ✓ **STAINLESS STEEL**
- ✓ **MONEL**
- ✓ **TWO DIFFERENT ARMOR PROFILES**

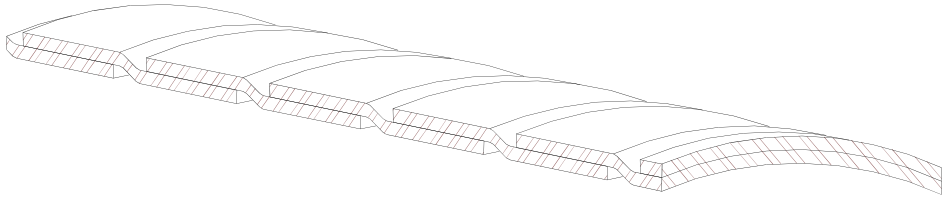
Armor Profile Types



Standard crown profile interlocked



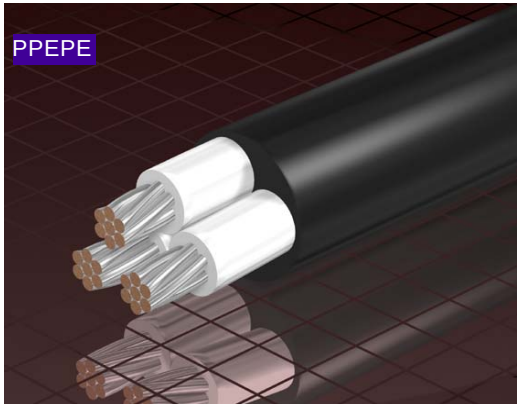
Flat profile interlocked



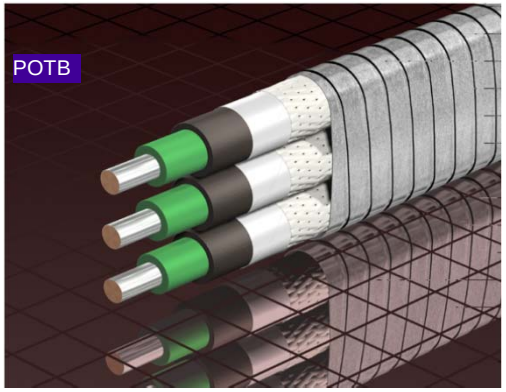
Flat profile

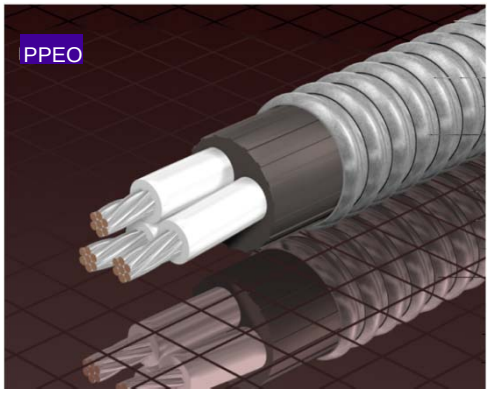
Production Systems
Cable Families

✓ **POLYETHYLENE: 185°F (85°C)**



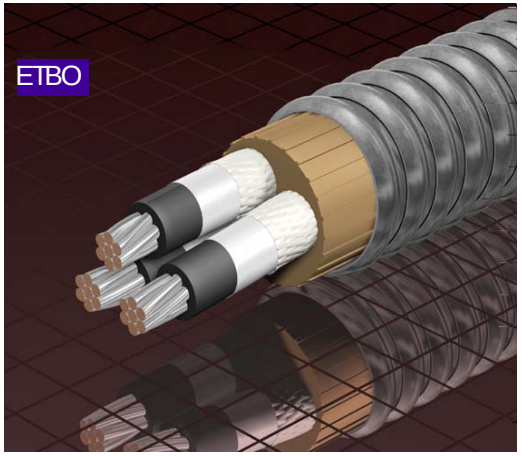
✓ **LOW TEMP: 205°F (96°C)**



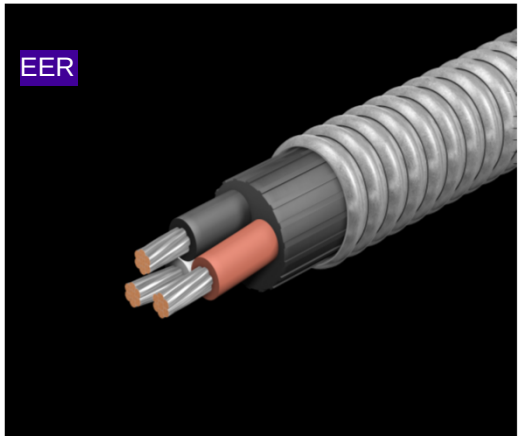


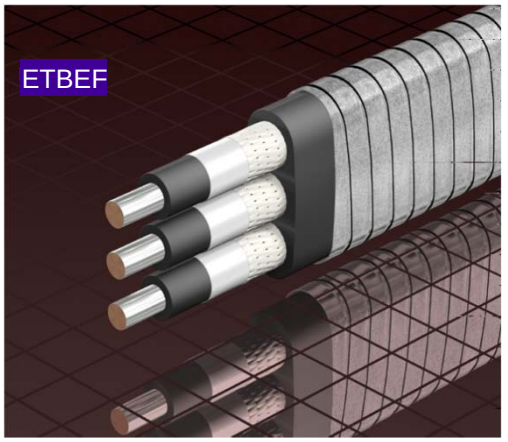
Production Systems
Cable Families

✓ **MEDIUM TEMP: 250-350°F (121-177°C)**



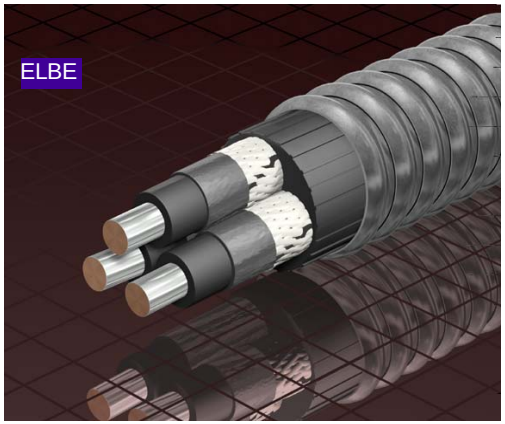
✓ **HOT: 300-400°F (149-204°C)**

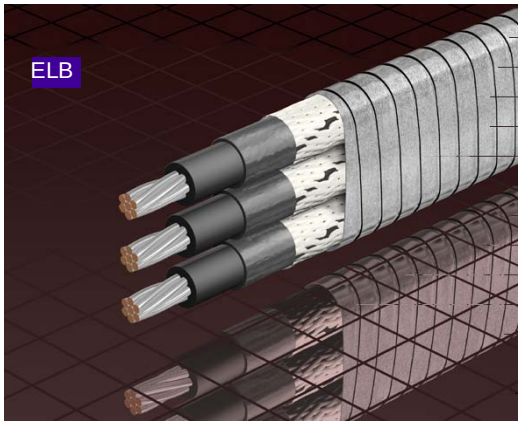


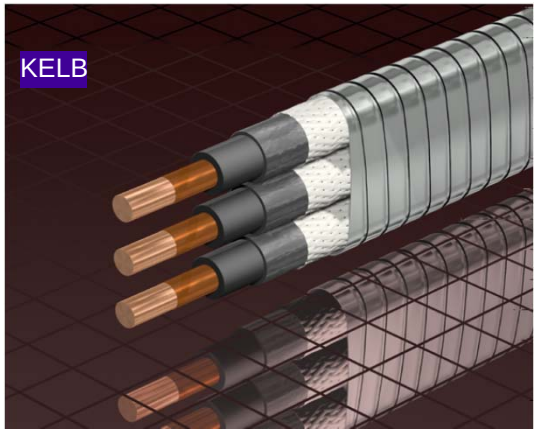


Production Systems
Cable Families

✓ **HOT with H2S and/or Gas: 400-450°F (203-232°C)**







✓ **MOTOR LEADS: 250-450°F (121-232°C)**

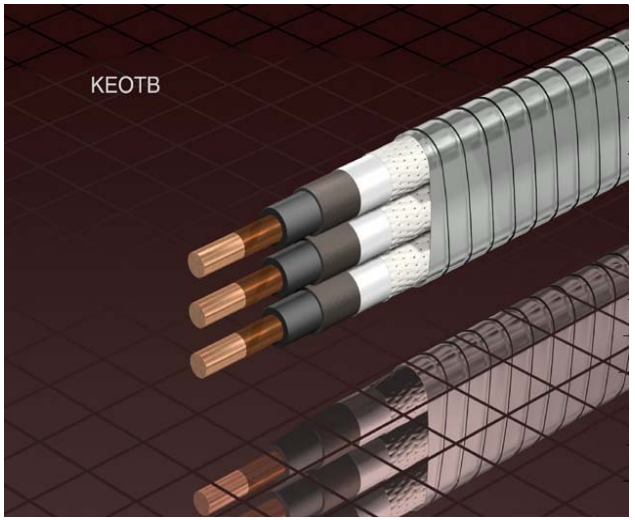
Motor Connection Options

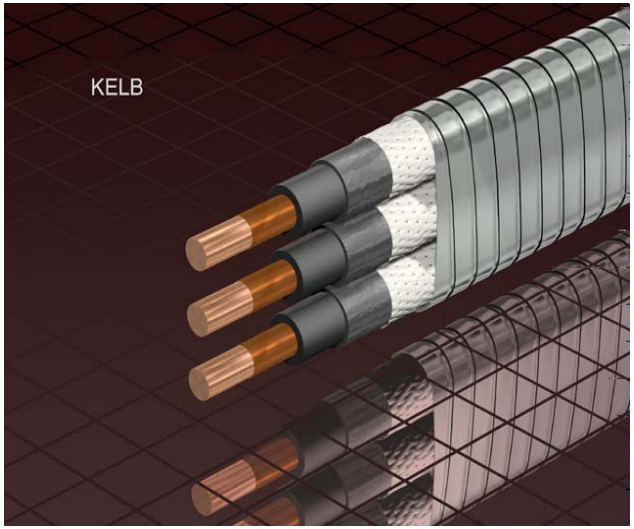
- ✓ **FLAT CABLE EXTENSIONS (FCE) (Motorlead & Pothead)**
- ✓ **MOTORLEAD - Typically smaller conductor than power cable, thus runs hotter.**

- KEOTB - 250°F (121°C)

- KELB - 450°F (232°C)

- KELTB - 450°F (232°C)





Motor Connection Options

- ✓ **POTHEADS**
  - **Tape-In Pothead - Tape wrapped around individual connector leads inside motor.**
  - **Plug-In Pothead - mating block mounted in motor.**
  - **Direct Connect Pothead - Power cable attached directly to the Pothead. (Plug-In Type)**

Cable Checks while Running In

Phase to Phase

0.7 to 3.5 Ohms

Must be Balanced

Phase to Ground

Surface: 2000 M Ohms

Hold 1000 V for 3 mins – V=IR I = $1000/2x10^9$ = 0.5 uA

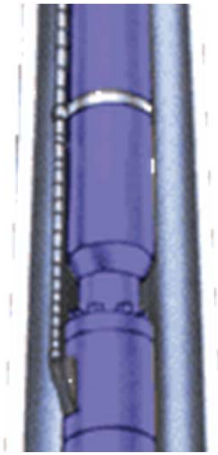
1000 ft 1800 M Ohms

3000 ft 1500 M Ohms

5000 ft 1000 M Ohms

Change due to Temperature

North Sea – 100 M Ohms



TDR – Time Domain Reflectometer