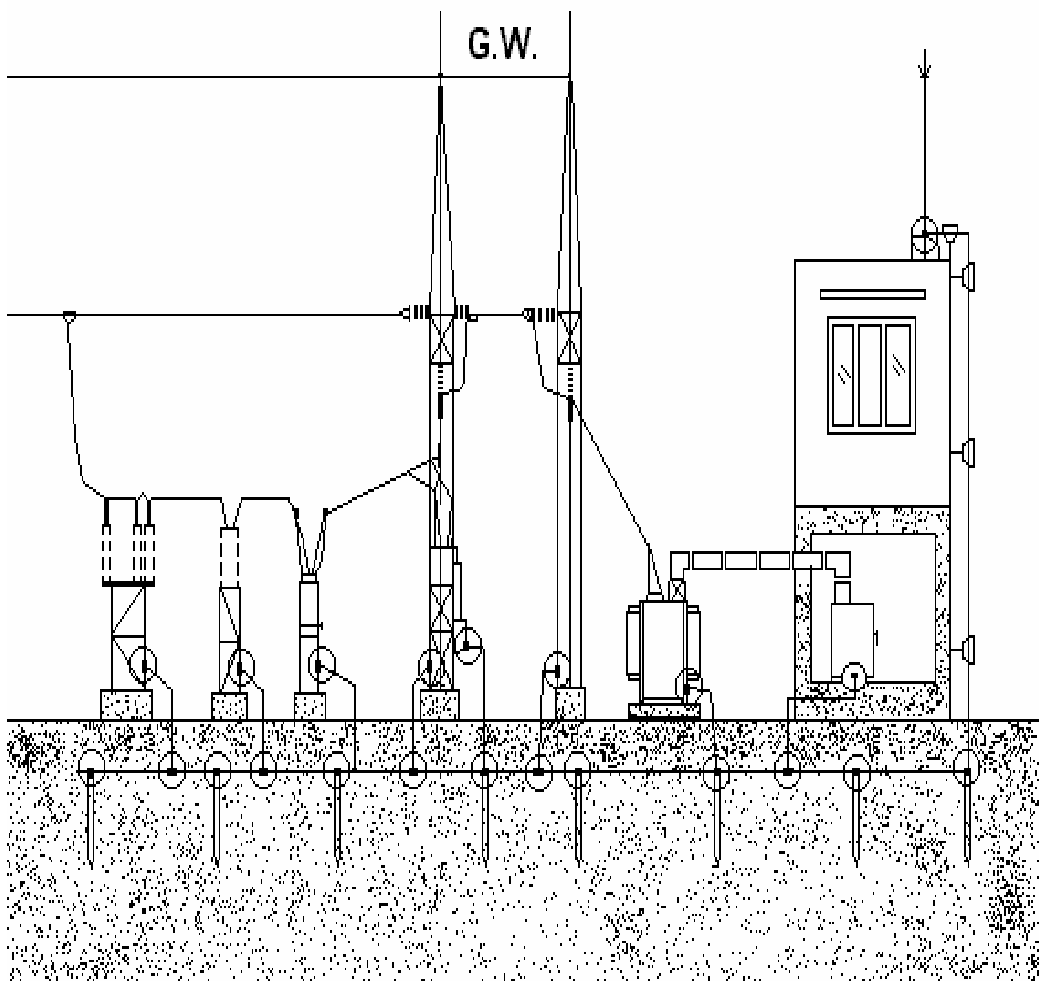
Technique: Electrical Connections

Connection's （joints）between conductors are often the cause of electrical failures. An ideal connection should possess the following qualities:

1. **Maintains contact integrity and electrical continuity;**
2. **When conducting current, connector temperature will remain lower than the conductor;**
3. **Will be able to withstand overload conditions without melting, burning or failing;**
4. **Long service life. Will not deteriorate, loosen or corrode when subject to weather over time.**

Of all the many different varieties of connectors available in the market, only exothermic welded connectors can meet the above listed criteria.

Therefore, **the exothermic welding is the best choice** of which safety, reliability, current carrying capacity and longevity.



Proper Connections Are Crucial For Effective Earthing

All electrically powered equipment and structures subjected to electrical current must be properly earthed. There are four major reasons for proper earthing:

1.To insure safety for operating personnel and casual bystanders;
2.To provide safe return paths during over current situations (shorts, surge, lightning).
3.To provide a stable reference potential to ensure safe and effective equipment operation.
4.To comply with codes and regulations.

Most regulatory authorities worldwide either require or encourage an earthing resistance of below 10Ω for safety. There is trend towards achieving a 5Ω or lower resistance for semi-conductor based equipment, due to their high sensitivity to fluctuations in voltage. In industrial and commercial power systems, it is very common for engineers to specify earthing resistance of below 1Ω due to the constant risk of extremely high current faults.

Earthing systems by design must be able to withstand a worst case scenario fault of the given site or equipment. The earthing system and its components must be able to withstand the highest current loading. From this clearly the proper selection of earthing system components (electrodes, conductors and connectors) is critical to the level of reliability and safety achieved. As with any type of system composed of several individual components, the connections of these components present themselves to be a potential weak link of the entire system.

Outlined in the IEEE Standard 80 are requirements that earthing system components must:

A) be able to withstand the maximum possible fault current and for the duration of this fault, the connections (joints) of this system must not melt or deteriorate;
B) possess a high degree of mechanical strength, specially in locations where conductors are easily subjected to exterior forces; and
C) has excellent electrical conductivity with little or no potential drop across the connection itself.

The Onderdonk Formula, *Figure 1*, illustrates this relationship mathematically. As stipulated in IEEE Std. 80, the ambient temperature is assumed to be 40 Celsius, melting point of copper is 1083℃ and the typical fault duration is 3 seconds (the typical rating of most switchgear).

Figure 1

For metric wire size

$$I = 343.5 A_m \sqrt{\frac{\text{Log} \frac{234+T_m}{234+T_a}}{S}}$$

$$I = \frac{A_m}{K\sqrt{S}}$$

For U.S. wire size

$$I = A_a \sqrt{\frac{\text{Log} \left(\frac{T_m - T_a}{234+T_a} + 1 \right)}{33\,S}}$$

$$I = \frac{A_a}{K\sqrt{S}}$$

I = Magnitude of fault current. Amps
A_m = Cross sectional area of conductor. mm^2
A_a = Cross sectional area of conductor. Circular mils
T_a = Ambient temperature. °C (usually 40 °C)
T_m = Maximum allowable temperature of conductor. °C (see fig. 2)
S = Duration of fault. Seconds
K = Constant. Refer to figure 2.

With these assumptions we can simplify the equation to just the cross sectional area, current magnitude, fault duration and a constant.

If we substitute maximum allowable temperature of different connector types for the conductor melting point we can derive a constant value of the connector as shown in *Figure 2*. Since Exoweld provides a molecular bond, the maximum allowable temperature would be the same as the melting point of the conductor.

Figure 2
Derived Constant for Metric Conductors

Connection Type	**Tm(℃)**	**Kx10^{-3}**
Exoweld	1083	3.52
Copper wire	1083	3.52
Brazed (Copper,Silver)	450	4.61
Compression Type	350	5.08
Clamp Type	250	5.85
Solder (50% tin/50% lead)	220	6.21
Wires Tied Together	100	9.91

Figure 3 shows the minimum cross sectional area required of different connectors under a range of fault current loads over 3 seconds. The table clearly illustrates the superiority of Exoweld connections. Exoweld offers a much higher current capacity, higher temperature tolerance and achieving this with a much more compact connection. These advantages are in addition to permanent reliability, extremely high corrosion resistance and ease of operation.

Figure 3. Minimum Cross Sectional Area of Connection

Connection Type	**Fault Current**						
	2KA	5KA	10KA	15KA	20KA	30KA	Difference%
Copper Wire	12.19	30.48	60.97	91.45	121.9	182.9	100
Exoweld	12.19	30.48	60.97	91.45	121.9	182.9	100
Brazed(Copper,Silver)	15.97	39.92	79.85	119.8	159.7	239.5	131
Compression Type	17.60	43.99	87.99	132.0	176.0	264.0	144
Clamp Type	20.26	50.66	101.3	152.0	202.6	304.0	166
Solder(50% tin,50% lead)	21.51	53.78	107.6	161.3	215.1	322.7	176
Wires Tied Together	34.61	86.52	173.0	259.6	346.1	519.1	284

Overall where applications require permanent connections with high fault tolerances, extreme reliability, long service life, corrosion free joints with no contact resistance and high mechanical strength; Exoweld connections ensure these conditions are met making it the most intelligent choice for your critical applications.