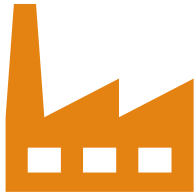


INTRO TO THE ELECTRIC DISTRIBUTION SYSTEM

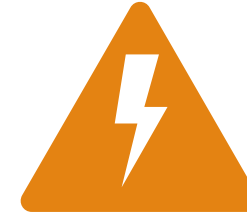




Overview of
Distribution System



Pathway of Power &
Fundamentals



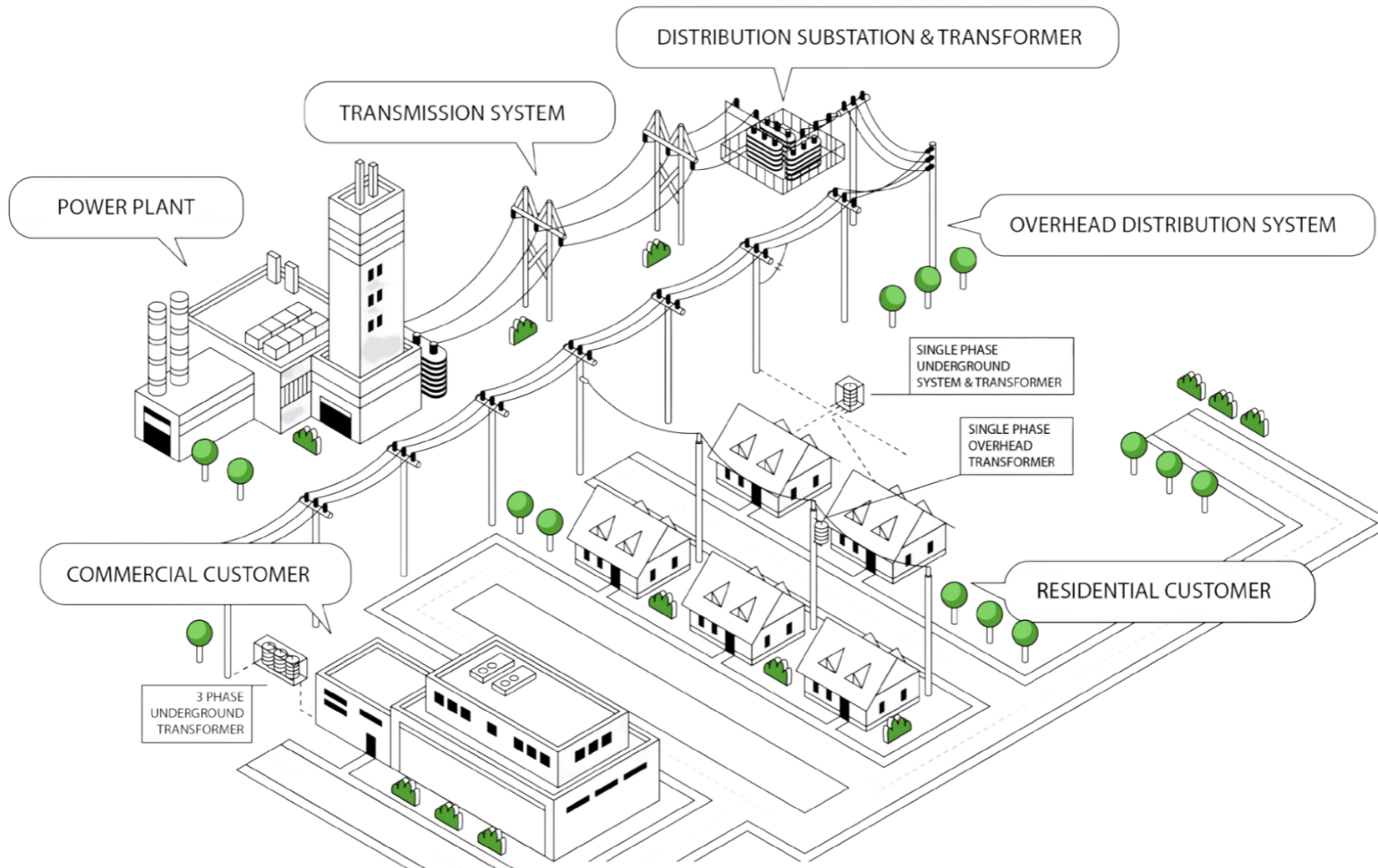
Distribution
Transformers & Voltages



WHAT IS AN ELECTRIC DISTRIBUTION SYSTEM?

Electric distribution systems are an essential part of the electrical power system. In order to transfer electric power from an alternating current (AC) source to the place where it will be used, some type of distribution network must be utilized.

In general, a *distribution* system is the electrical system between the [step-down substation] fed by the transmission system and the [consumers' electric meters].





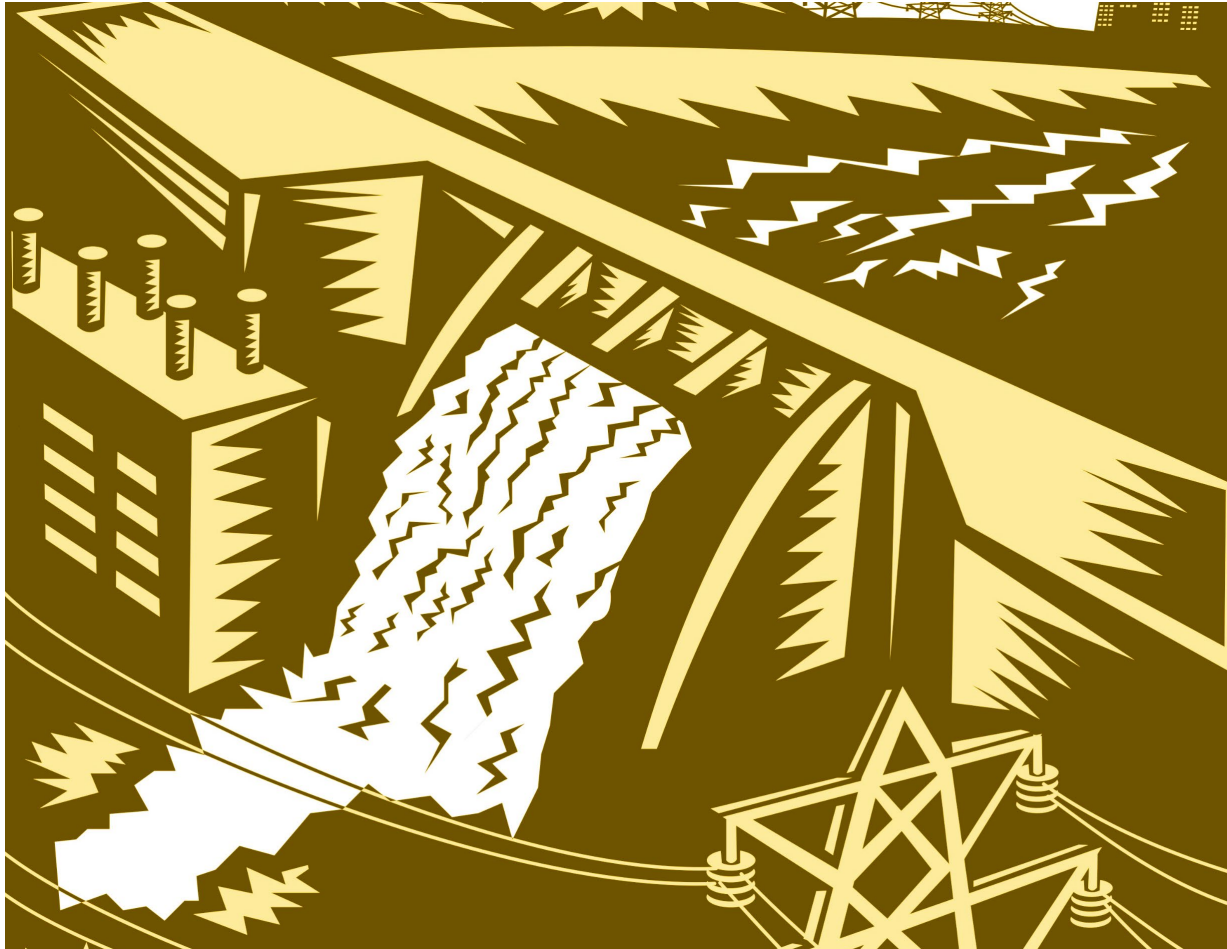
PATHWAY OF POWER

1. POWER PLANT

It all starts at a power generating plant. Bulk power is generated in the range of 11kV to 33kV and as three phase alternating current (AC). The voltage is then stepped up to a higher voltage through a step-up transformer. Power is transmitted at high voltages to increase efficiency.

Types of generation plants:

- | | |
|---------------|-------|
| Nuclear | Gas |
| Hydroelectric | Solar |
| Coal-fired | Wind |
| Diesel-fired | Tidal |
| Geothermal | |





PATHWAY OF POWER

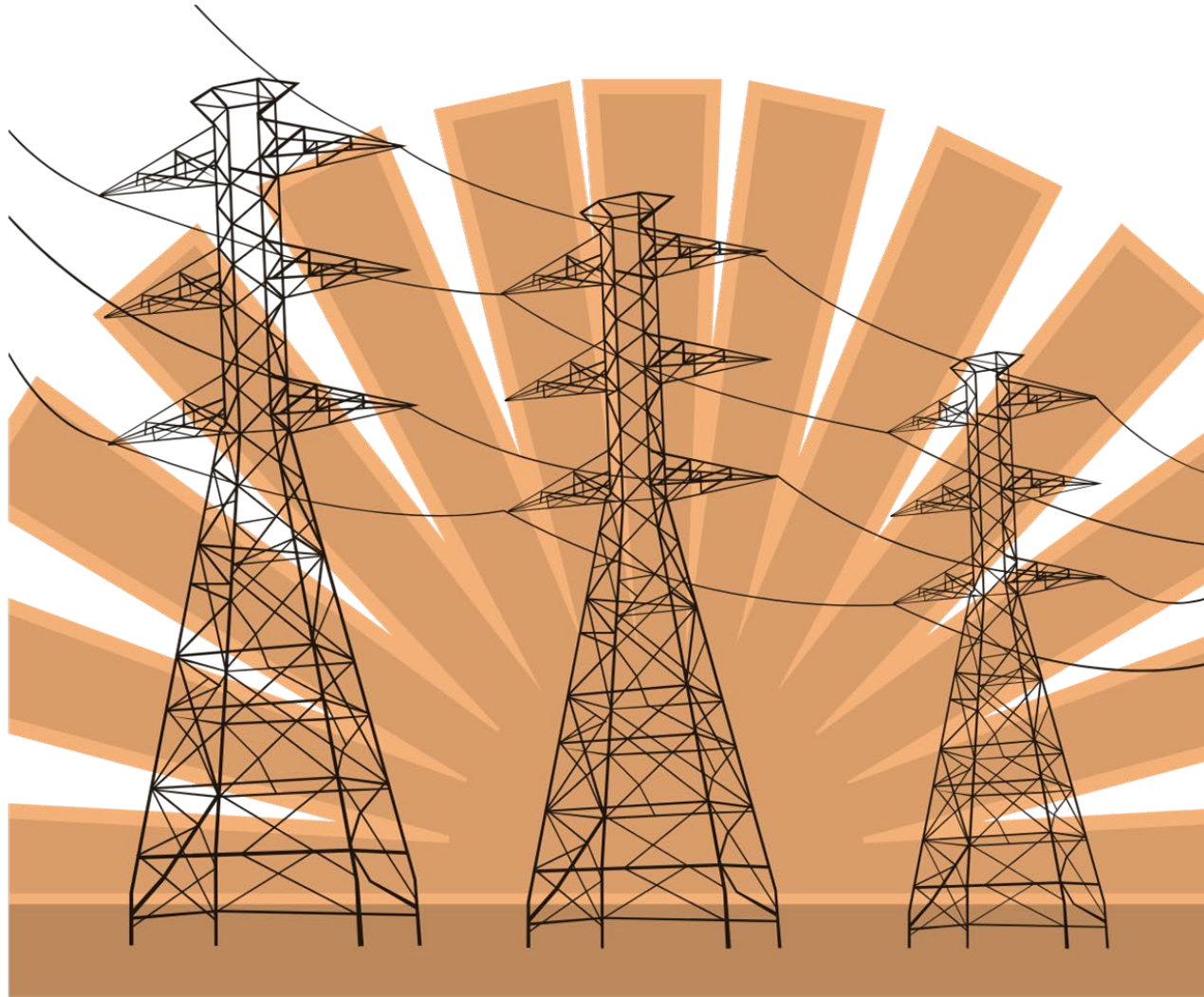
2. TRANSMISSION

When electricity is transmitted over long distances, there are energy losses along the way. The high voltage transmission system minimizes the amount of power lost as it travels from location to location.

Example transmission voltages in California:

69kV, 138kV, 230kV, 500kV

The transmission system connects power plants to distribution substations and substations to substations.



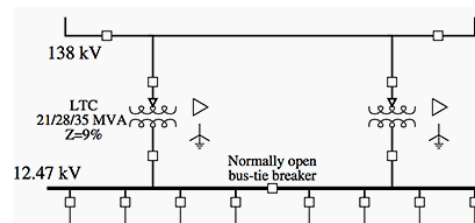


PATHWAY OF POWER

3. SUBSTATION STEP-DOWN TRANSFORMER



[San Juan Capistrano Sub - Photo by Kyusung Gong, Orange County Register/SCNG](#)



Example Substation single-line diagram showing 138kV to 12.47kV transformer & multiple distribution circuit breakers (4)

For power to be useful in a business or home, the transmission high voltage is lowered by using step-down transformers in the distribution power substation. The electricity can then be sent out on the distribution system as a medium voltage in multiple directions. Distribution voltages generally range between 4kV and 35kV in the U.S. and varies by the individual electric utility.

Example distribution voltages in California:

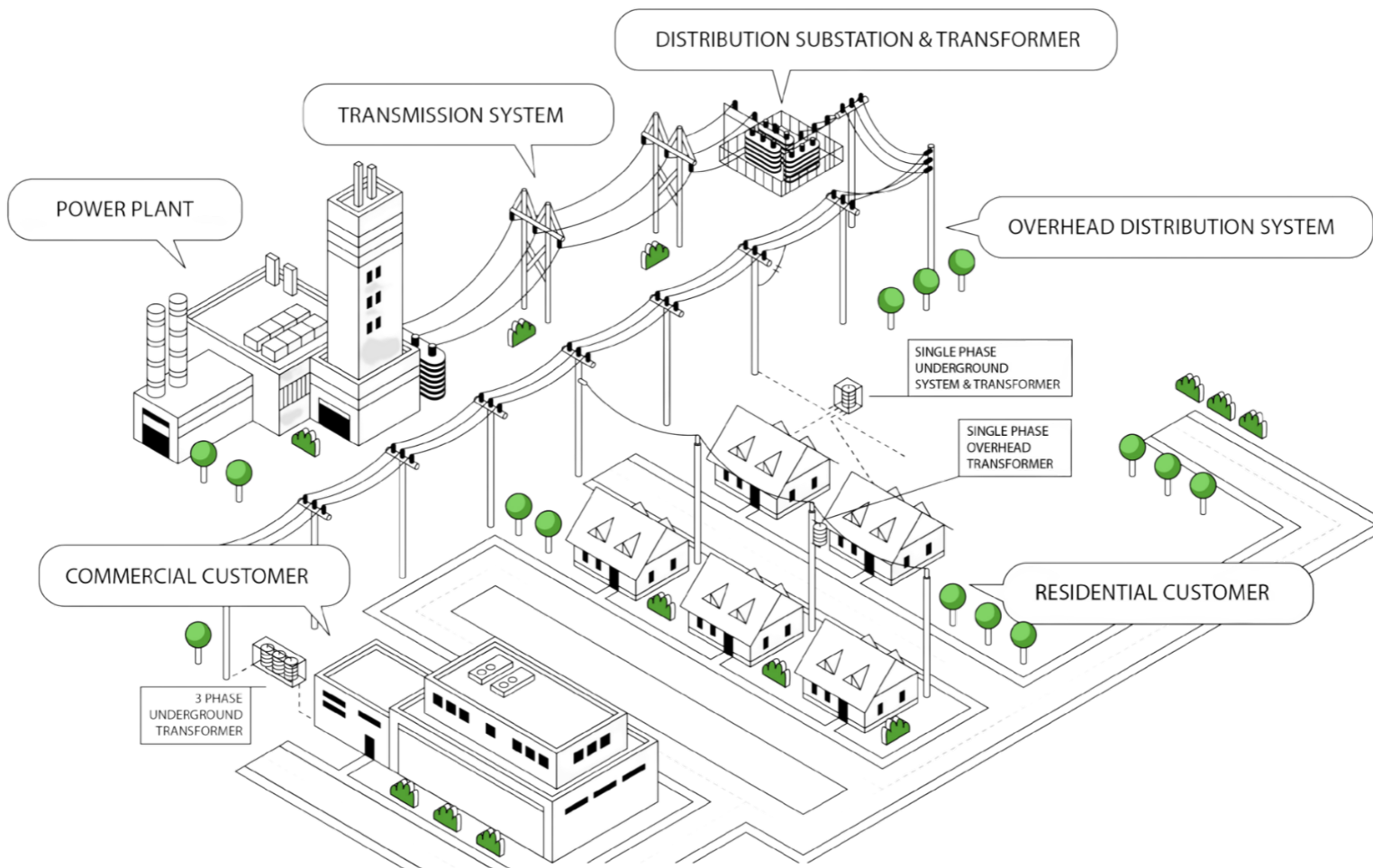
4kV, 12.47kV, 13.8kV

There are approximately 162 substations in SDG&E service territory



PATHWAY OF POWER

4. DISTRIBUTION



Distribution lines may be overhead (OH) or underground (UG) and carry primary distribution voltages and current through neighborhoods to feed residential and commercial customers.

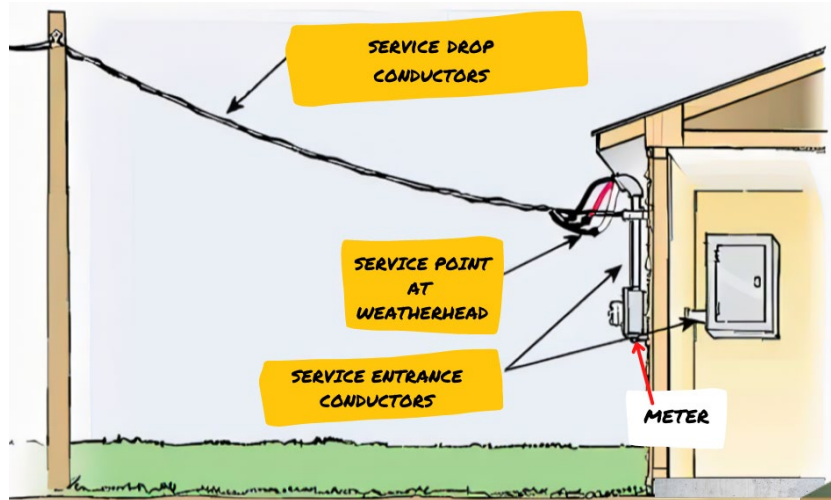
Distribution transformers are used to step down primary voltages once again to a secondary or service low voltage.

In the U.S.

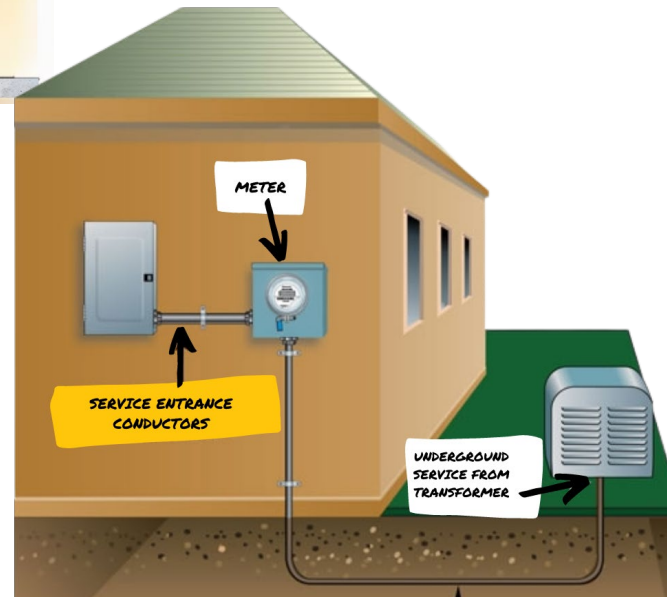
Residential service is usually 120/240V

Commercial service is usually 120/208V or 277/480V

OVERHEAD RESIDENTIAL SERVICE



UNDERGROUND RESIDENTIAL SERVICE



PATHWAY OF POWER

5. CUSTOMERS

Power comes to the customers via an overhead service drop and service point or an underground service into an electric meter.

Typical customer electric service types:

Residential dwelling

(home, apartment building, condo, etc.)

Single Phase 120/240V

or

Commercial building

(industrial warehouse, office building, shopping complex, etc.)

Three Phase 120/208V or 277/480V

SINGLE PHASE OH TRANSFORMERS



SINGLE PHASE UG TRANSFORMERS



TYPES OF TRANSFORMERS

A transformer is an electrical device consisting of two or more coils of wire used to transfer electrical energy by means of a changing magnetic field.

It's the most used piece of electrical equipment to provide service to a consumer. It's mainly used to step down the primary distribution voltage to a secondary voltage level.

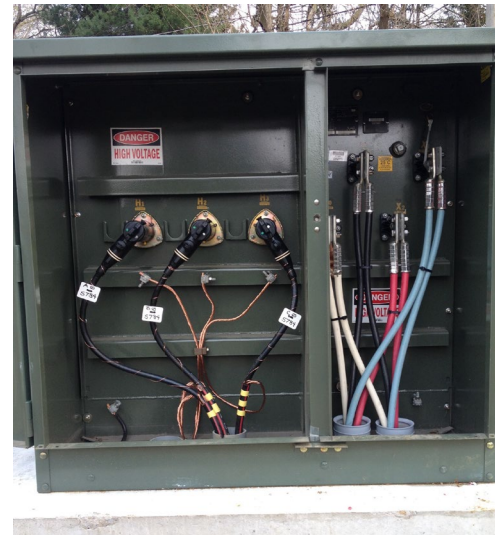
Common transformer secondary voltages:

Residential - 120/240V

Commercial – 120/208V or 277/480V



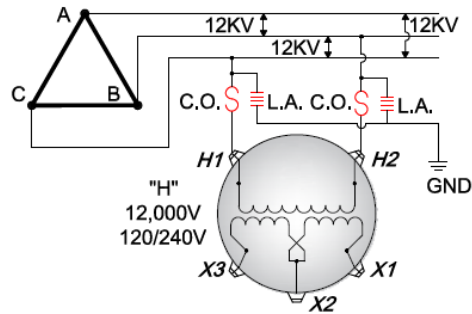
SINGLE PHASE OH TRANSFORMER



THREE PHASE UG TRANSFORMER



SINGLE PHASE OVERHEAD TRANSFORMERS

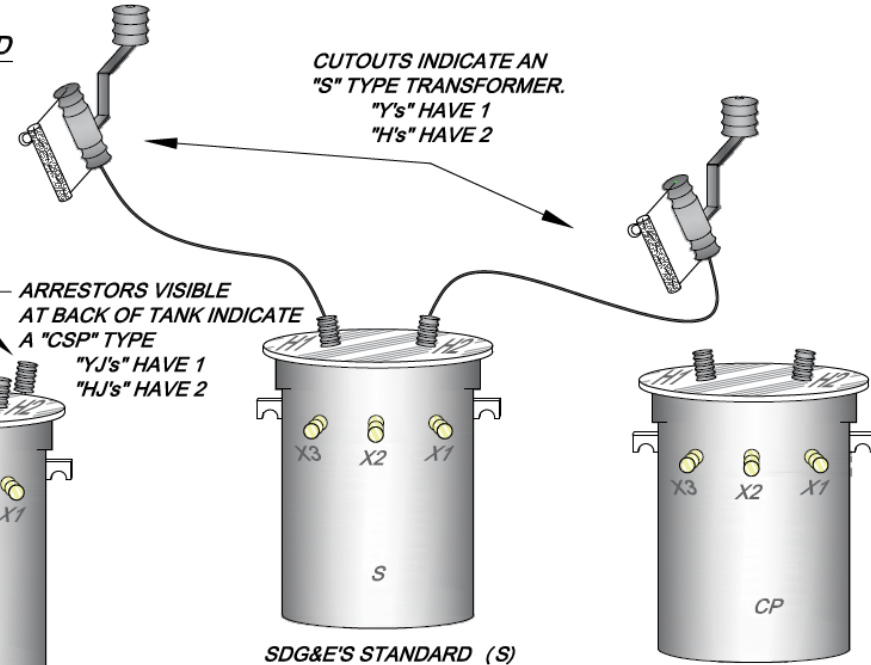
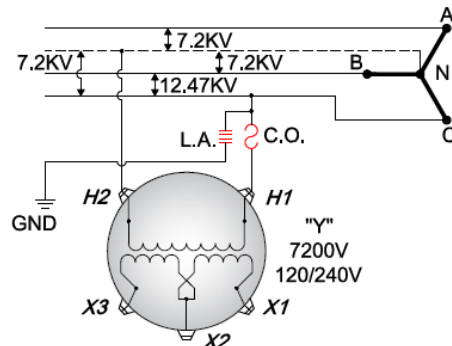


TYPICAL 120/240V SINGLE PHASE OVERHEAD TRANSFORMER TYPES

- S "STANDARD"
- SP "SURGE PROTECTED" (SDG&E DOES NOT USE)
- CP "CURRENT PROTECTED"
- CSP CURRENT & SURGE PROTECTED
AKA.. "COMPLETELY SELF PROTECTED"

"H" TRANSFORMERS ARE INSTALLED ON A 12KV "DELTA" CONNECTED PRIMARY CIRCUIT. PHASE-PHASE PRIMARY CONNECTION REQUIRES (2) FUSES VIA EXTERNAL CUTOUTS AND (2) ARRESTORS IN CERTAIN CONTAMINATION DISTRICTS

"Y" TRANSFORMERS ARE INSTALLED ON A 12.4/7.2KV "WYE" CONNECTED PRIMARY CIRCUIT. PHASE-NEUTRAL PRIMARY CONNECTION REQUIRES (1) FUSE VIA EXTERNAL CUTOUTS AND (1) ARRESTOR IN CERTAIN CONTAMINATION DISTRICTS



CUTOUTS INDICATE AN "S" TYPE TRANSFORMER.
"Y's" HAVE 1
"H's" HAVE 2

ARRESTORS VISIBLE AT BACK OF TANK INDICATE A "CSP" TYPE
"YJ's" HAVE 1
"HJ's" HAVE 2

- SDG&E'S CURRENT & SURGE PROTECTED (CSP) TRANSFORMERS "HJ" or "YJ" TYPE
- INTERNALLY FUSED (NOT VISIBLE)
 - ARRESTORS ATTACHED TO TANK

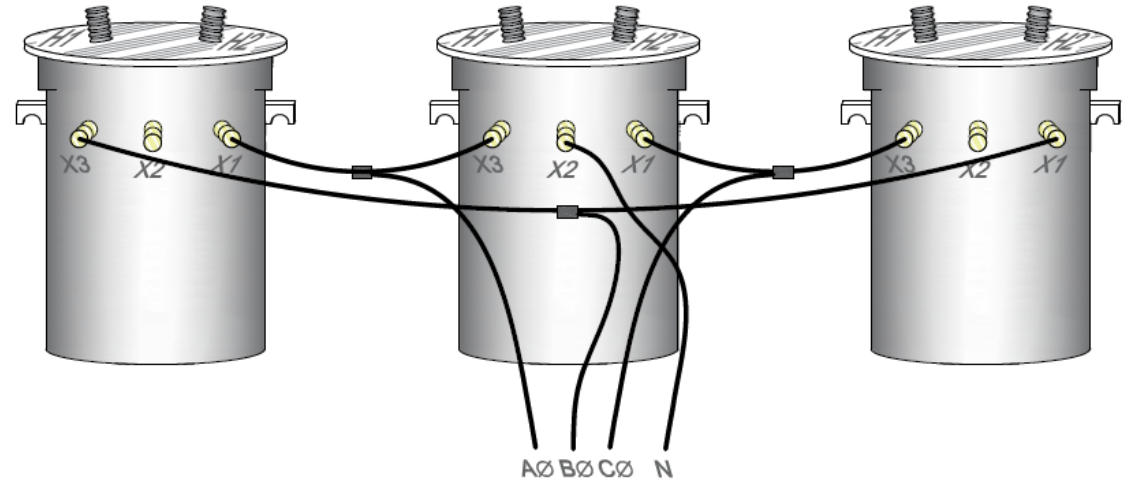
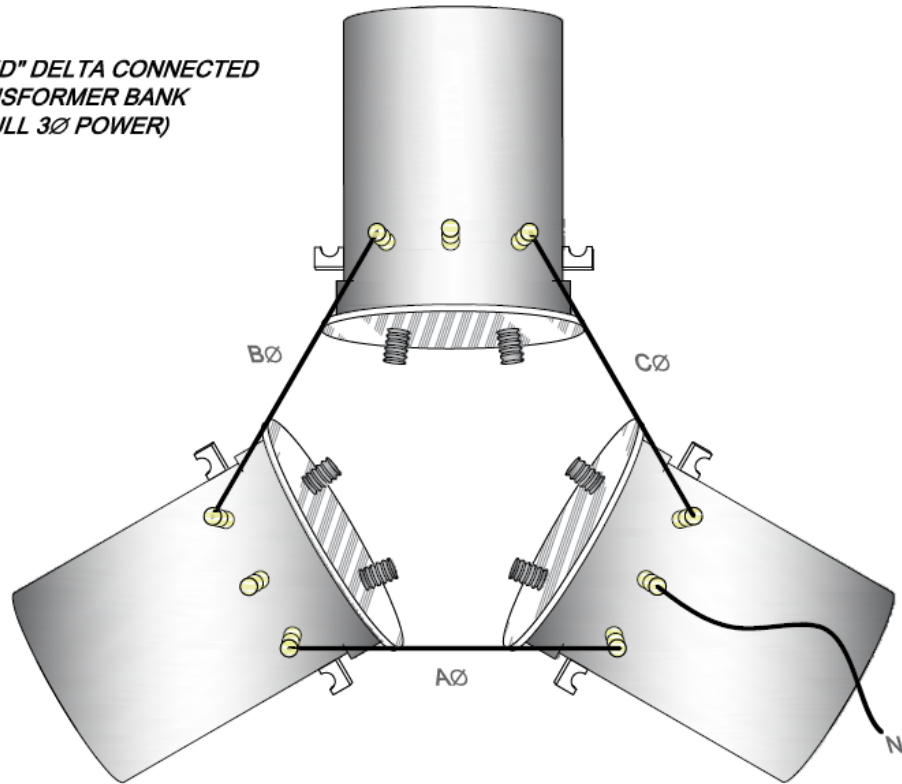
- SDG&E'S STANDARD (S) TRANSFORMERS
- "H" or "Y" TYPE
 - EXTERNALLY FUSED (VIA CUTOUTS)
 - EXTERNALLY ARRESTED

- SDG&E'S CURRENT PROTECTED (CP) TRANSFORMERS "HE" or "YE" TYPE
- INTERNALLY FUSED
 - NO ARRESTORS VISIBLE
 - NO CUTOUTS VISIBLE

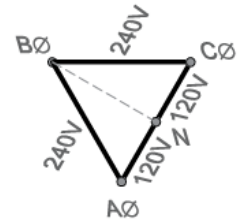


THREE PHASE "CLOSED" DELTA CONNECTED OVERHEAD TRANSFORMERS

3Ø "CLOSED" DELTA CONNECTED
TRANSFORMER BANK
(FULL 3Ø POWER)

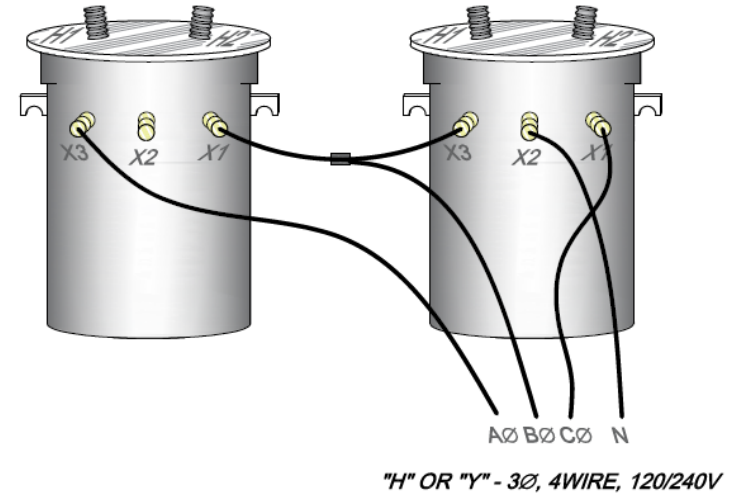
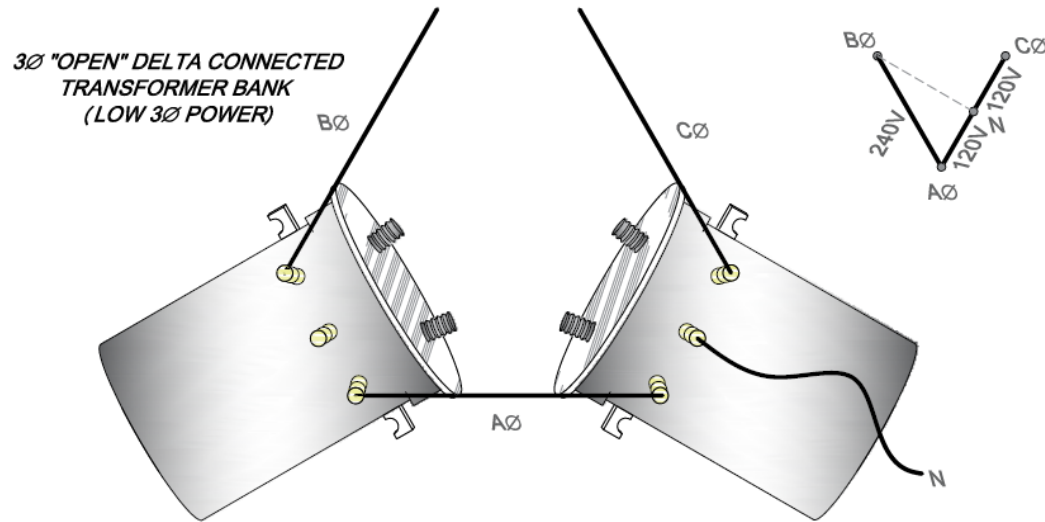


"H" OR "Y" - 3Ø, 4WIRE, 120/240V



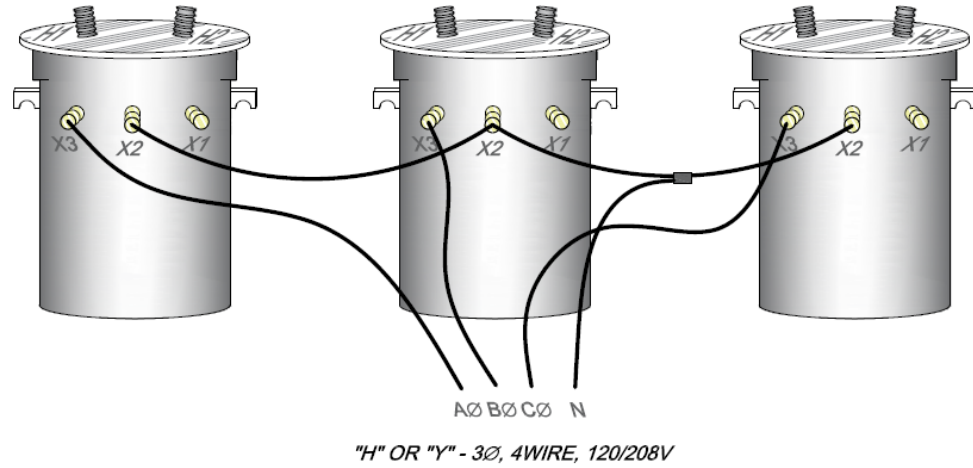
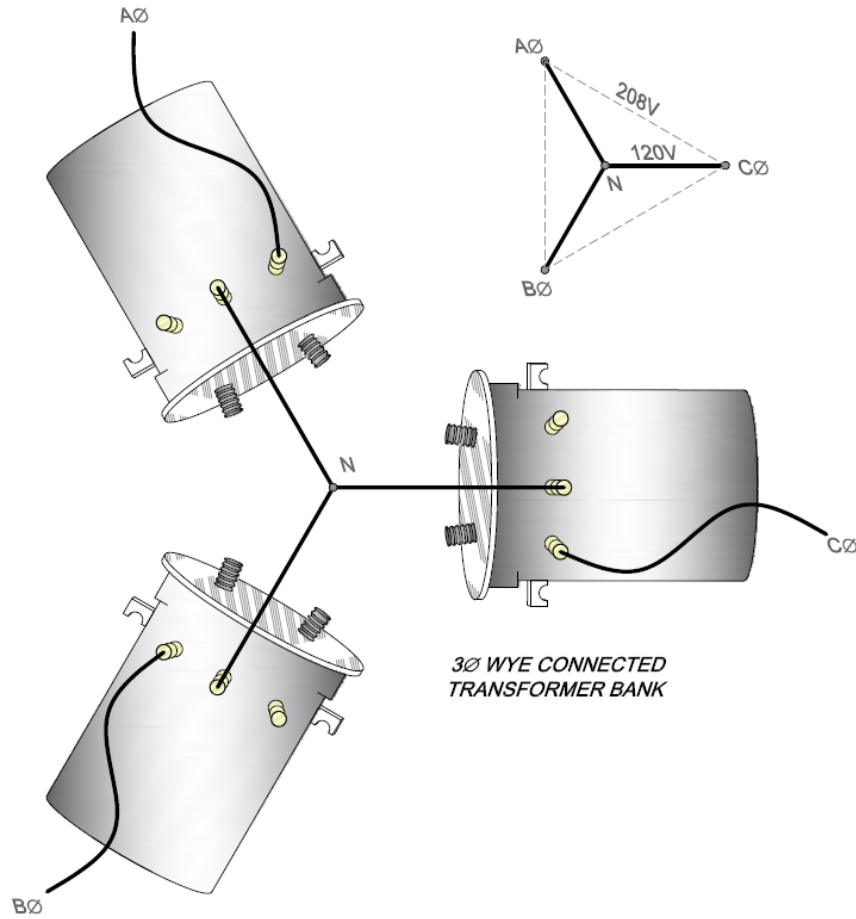


THREE PHASE "OPEN" DELTA CONNECTED OVERHEAD TRANSFORMERS





THREE PHASE "WYE" CONNECTED OVERHEAD TRANSFORMERS



VOLTAGE LEVELS

Transmission Line



Commonly used transmission voltages are 69kV and 138kV in San Diego. Transmission lines are usually >69kV and carry three-phase electricity over long distances at extremely high voltages and lower current (amperage). The wires are bare, to minimize resistance and voltage loss.

- 500,000 volts (500 kV)
- 230,000 volts (230 kV)
- 138,000 volts (138 kV)
- 69,000 volts (69 kV)



VOLTAGE LEVELS

Distribution Primary Line

Distribution primary voltages are typically between 4kV – 35kV and are also considered medium voltages. The most common medium distribution voltage is 12.47kV in San Diego. Primary distribution lines carry electricity from Distribution substations to communities.

In San Diego:

- 12,000 volts (12 kV)/6,900 volts (6.9 kV): Standard
- 4,160 volts (4kV)/2,400 volts (2.4 kV) (Being phased out)



VOLTAGE LEVELS

Distribution Secondary Line

Secondary and service lines carry electricity at low voltages that can be used in homes and businesses. Secondary lines carry power through communities, while service lines feed individual properties.

- 480/277 volts (3 \emptyset): Commercial only
- 208/120 volts (3 \emptyset): Commercial and large residential
- 240/120 volts (1 \emptyset): Residential

- Most modern homes are wired to receive 240 volts from the transformer, and through the use of split phase electrical power can have both 120V and 240V receptacles. 120V is typically for lighting and outlets. 240V is typically used for large appliances like ovens & clothes dryers, may also supply an electric car charger.