CONTENTS

Commercial electricians primarily focus on larger projects, such as installing all new electrical system for an entire building, or upgrading an entire floor of an office building as part of a remodeling process.

Commercial electricians work with many standard hand tools including sawzalls, screwdrivers, pliers and knives. Heavier equipment may be provided by the employer. Most electricians are familiar with using power tools, test meters, pipe threaders and conduit benders.

Most electricians want to move up through the ranks of the profession. Many of them dream of commercial electrical work were the jobs are long and well-paying.

Commercial electrical work is also more complex and deals with plans, diagrams, and schematics that may be unfamiliar to the residential electrician.

Alternating Current Fundamentals

Focuses on the behavior and flow of alternating current, including the operating principles of AC motors, generators and three-phase equipment.

•An understanding of impedance and reactance
•Recognizing power and continuous loading
•Problem solving of current and voltage factors
•Calculating ground-fault and short-circuit levels

Electrical Code

A strong overview of the National Electrical Code, including applications, intent, evolution, applicable tables, minimum requirements and protection devices.

•Understand the minimum of the NEC
•Know how to use applicable tables in figuring out electrical loads
•The proper use of protection devices

Advancing from residential to commercial work, each will have its own set of codes and specific tasks.

The residential electrician shall mean a person having the necessary qualifications, training, experience, and technical knowledge to wire for and install electrical equipment and apparatus for wiring, one, two, three and four-family dwellings.

A residential electrician generally is working with single phase installations.

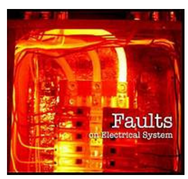
This book has ***eight chapters*** for a residential electrician to advance to commercial wiring installations.

Basic fundamentals such as theory, ohms law, voltage drop, ampacity are not fully covered because the electrician reading this book has already gained this knowledge on those topics as a Residential Journeyman Electrician and is ready to move into three phase wiring systems, etc.

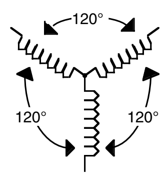
EIGHT CHAPTERS WITH EXAMS

Introduction

Commercial Wiring

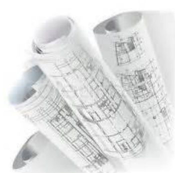


Fault Calculations



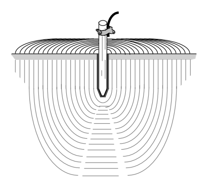
Three Phase

Calculations



Plan Reading

Conduit and Boxes



Grounding

Commercial Wiring

This book focuses on the three-phase electrical requirements and distribution for a typical commercial facility, including load requirements, and the calculations necessary to create a successful electrical system.

•Learn how to design electrical systems

•Understanding grounding and why you ground a system

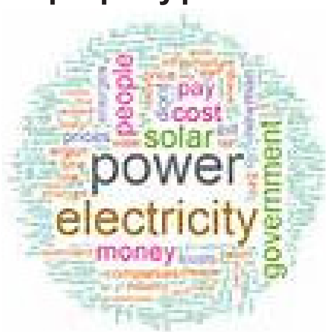
•Conduit installation and bending

Commercial electricians must take continuing education classes during their working life to keep up with changes in the field. This may involve taking courses in National Electrical Code changes and management and safety training.

An electrician must properly size conductors for the load to be served, must select the proper fuse or circuit breaker to protect the conductors, must condider the possibility of voltage drop, must consider the ambient temperature where the conductors are to be installed, and must check the ***short-circuit withstand rating*** of the conductor to make sure that a severe fault will not cause damage to the conductors.

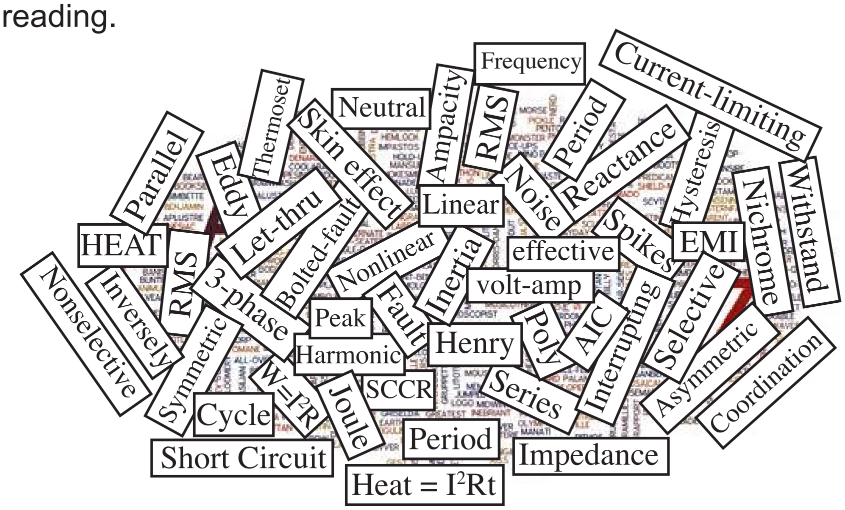
Perhaps electrical designing is not why you got into this business, but it has been said that 70% of all electrical designing is done by the electrician. While the electrical designers are busy designing the large buildings, the electrician is called upon to wire the new piece of equipment just purchased, correct Code violations, or to give a bid for an add-on, or install a larger service to an existing building, etc.

Remember, conductors are not intelligent. They don't know where they are going to be installed (in the basement, attic, soil, free air). They don't know the environment where they have been placed (wet, dry, hot, cold). They do not know how crowded it will be in the conduit or how many conductors beside them will be carrying current. They do not know how far they will be run or how long and hard they will have to work. They do not know if they will be **properly protected** and insulated from heat and moisture. Conductors aren't very smart.

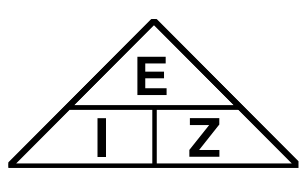


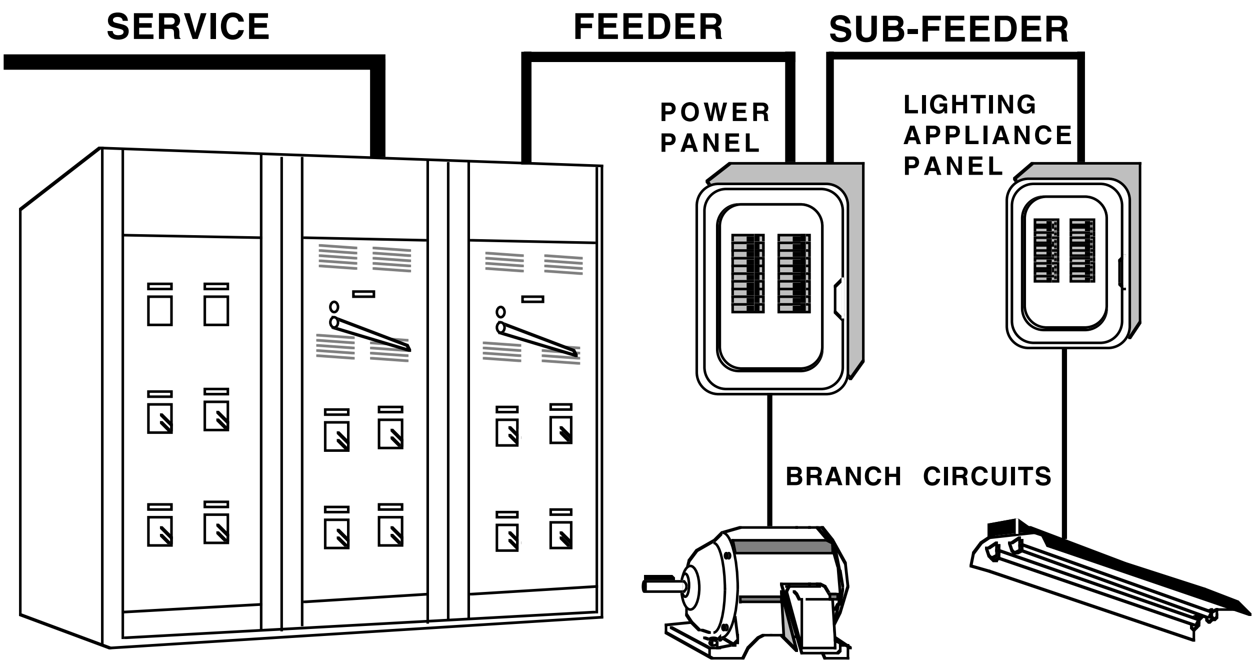
The power of words

You must understand ***what the words mean*** that you are reading.

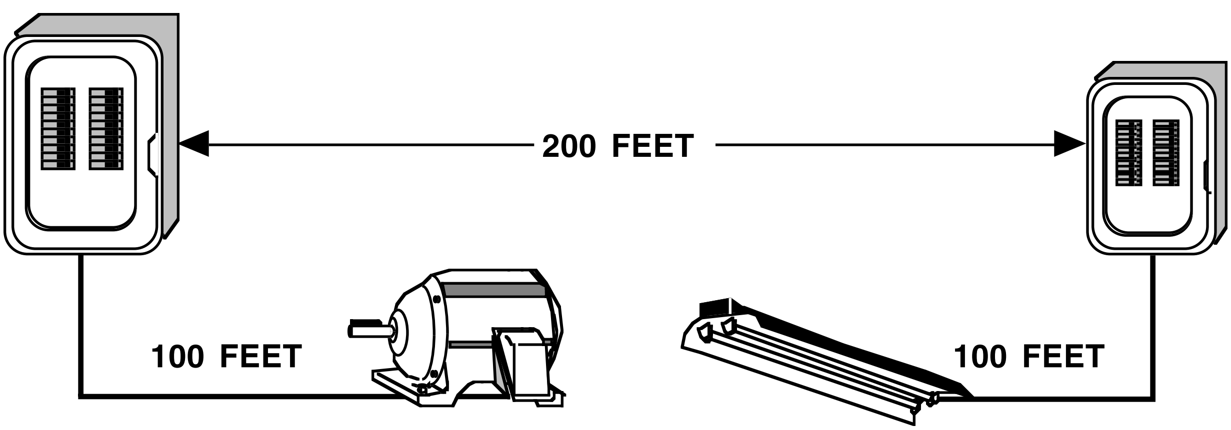


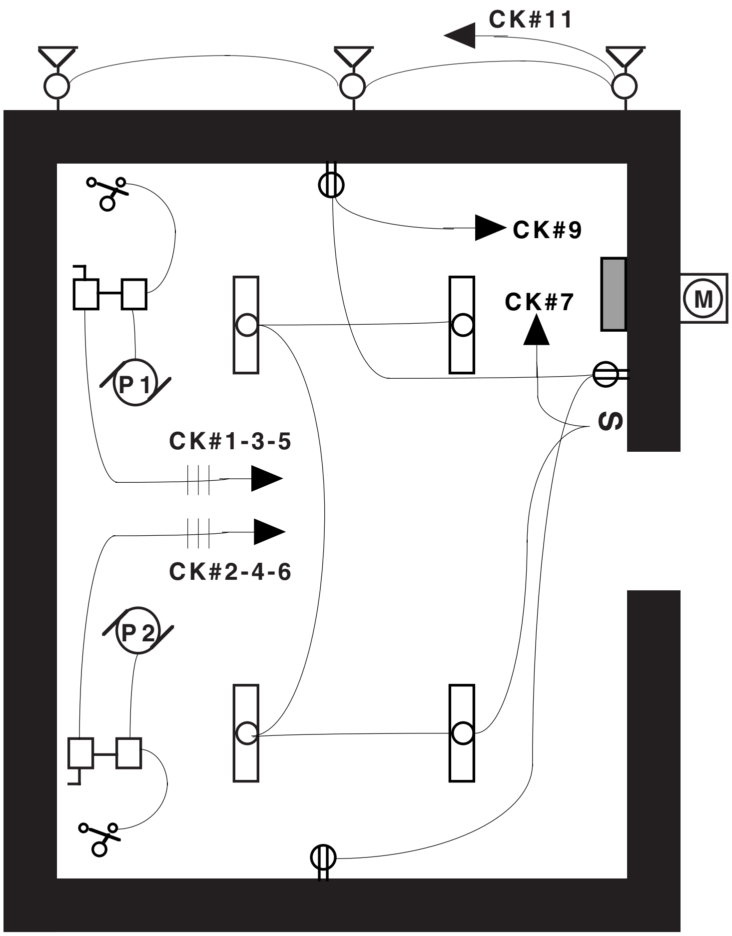
In general, Ohm's law cannot be applied to alternating-current circuits since it does not consider the ***reactance*** which is always present in such circuits. However, by a modification of Ohm's law which does take into consideration the effect of reactance, we obtain a general law which is applicable to AC circuits. ***Because the impedance, Z***, represents the combined opposition of all the reactances and resistances, this general law for AC is: $I = E \div Z$





Homeruns on branch circuits should be limited to a maximum of 100 feet for good electrical design. Careful layout of panelboard locations and use of sufficient number of panelboards will avoid the problem of long homeruns with commercial and industrial wiring installation.



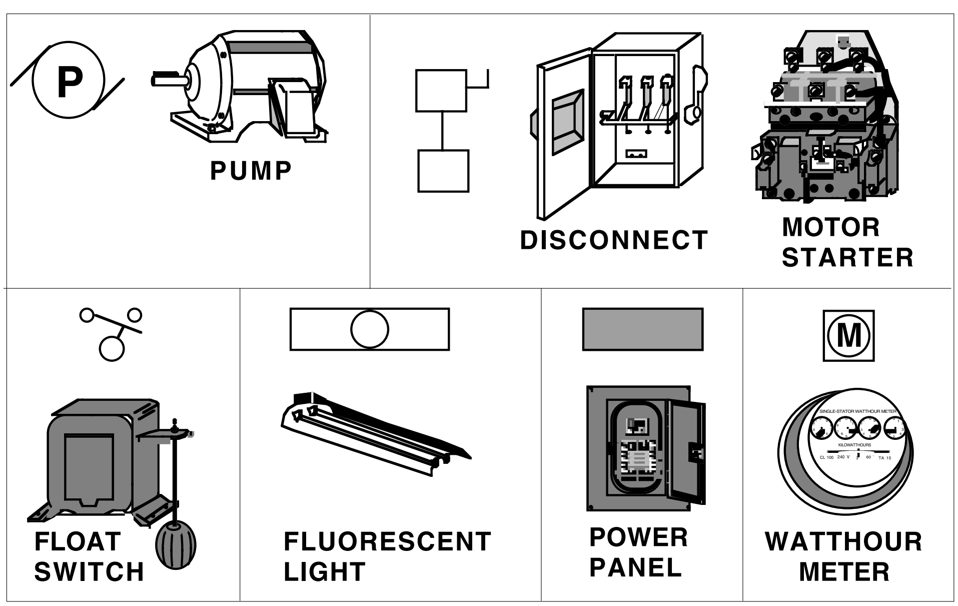


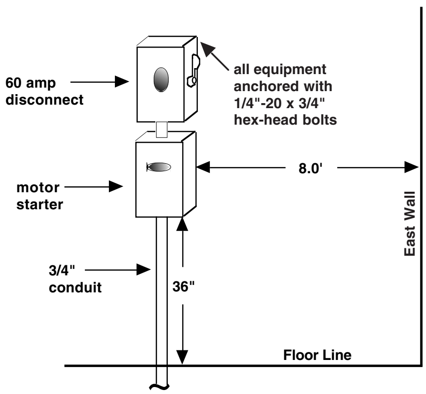
Electrical drawings will vary from neat and complete to vague and hard to understand. Very few plans contain every exact detail of the electrical system. A good knowledge of electrical installations which comes from experience will go hand-in-hand with reading electrical plans.

The floor plan drawing shows a lift station with pumps. The floor plan does not give the electrician all the details he needs, such as motor size, wire size, protection size, conduit size, etc. This information will be shown in the panelboard schedule, riser schedule, etc.

FLOOR PLAN - NO SCALE

SYMBOLS





The floor plan is drawn too small to give all the details necessary for installation. A detail drawing will give more exact measurements and needed information.

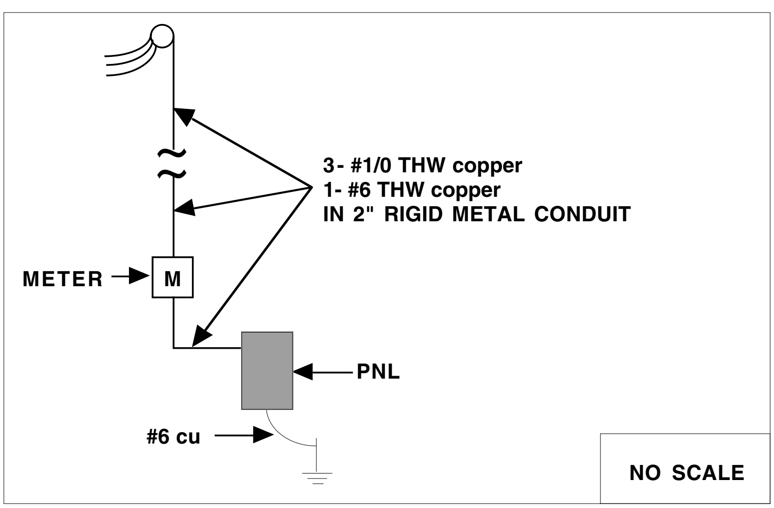
Schedules can save the electrician considerable time as they provide the needed information very quickly, rather than reading through all of the specifications.

EQUIPMENT SCHEDULE

QUANTITY	ITEM
2	10 hp 3ø 208v lift pumps
2	10 hp 3ø motor starters with control transformer
2	60 amp rated disconnects
2	Float switches Model FS-2L14729
4	Quicklight Inc. F-5649 Fluorescent lights
3	20a 120v duplex receptacles
3	Quicklight Inc. M-500-od Mercury lights
1	Single pole switch
1	150 amp 3ø 12 circuit panelboard

The equipment schedule provides information on the materials required for the installation. It does not list conduit, length of wire, fittings, etc. These quantities may vary as the electrician determines the routing of the circuits.

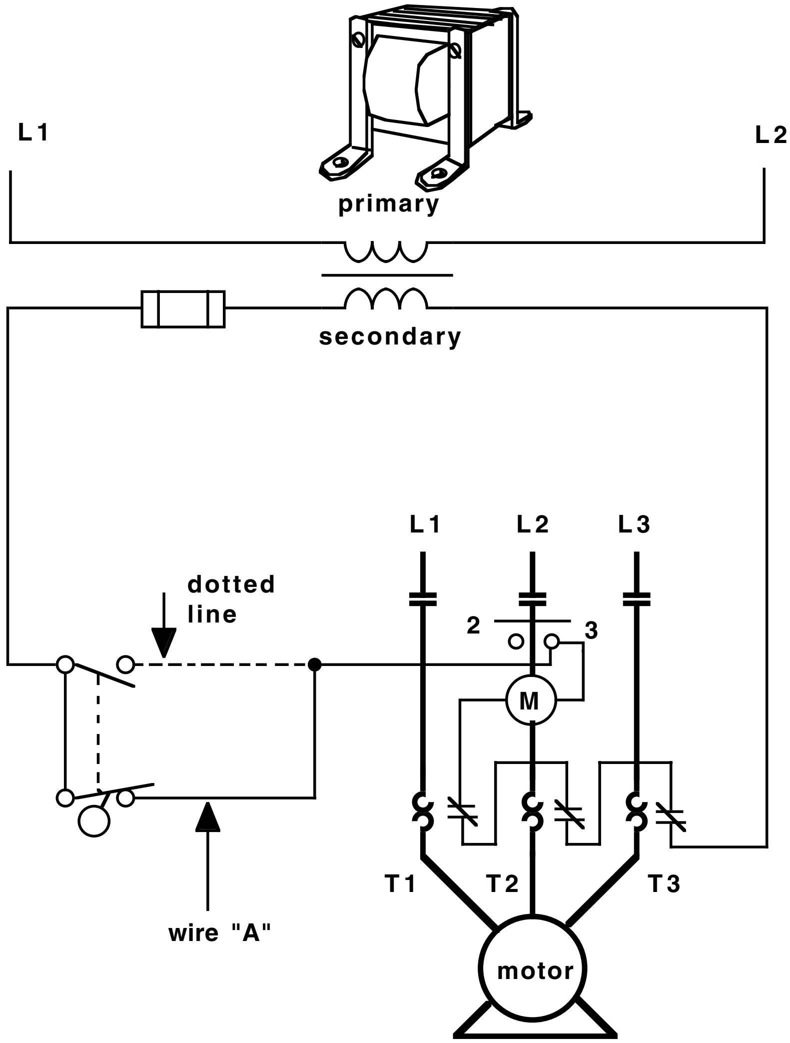
POWER RISER DIAGRAM



The riser diagram gives the needed information on the wire size, conduit size, etc.

CONTROL DIAGRAM

A control transformer reduces the line voltage to 120 volts for the controls.



The control diagram shows a float switch intended for tank operation. When the water reaches "low" level the float switch closes and starts the pump. The pumping action will continue until the water reaches the "high" level.

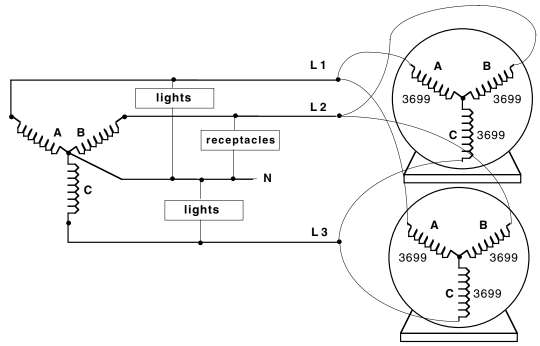
For sump pumping remove wire"A" and connect as per the dotted line. At "low" level the float switch operates and stops the pumping action. Sump pumping action will not commence until the water reaches the "high" level.

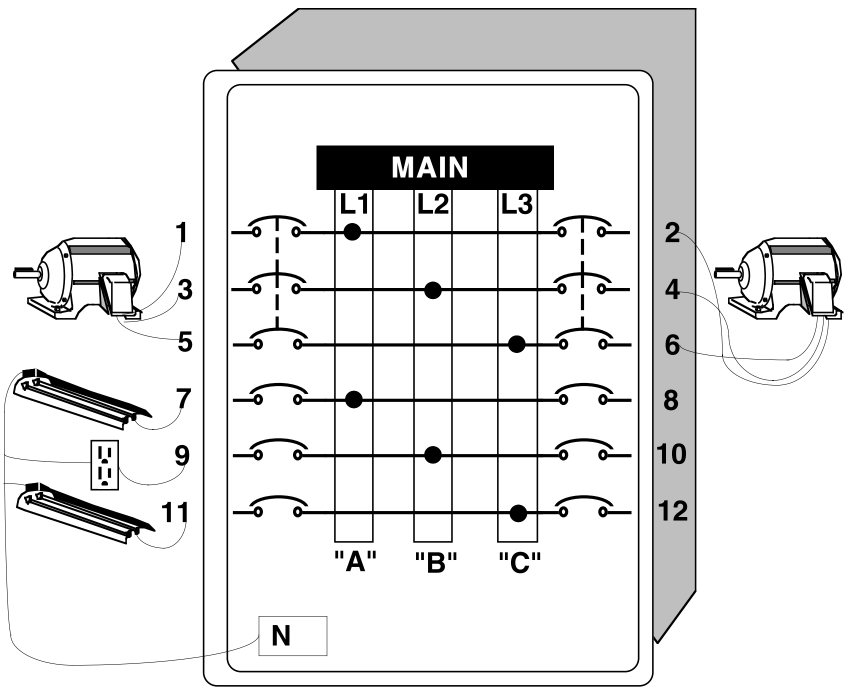
PANELBOARD SCHEDULE					
MAINS 150 PHASE 3	VOLTS 208/120			AMPERE 150	
Circuit Number	Circuit Breaker		Conductor		Serves
	Poles	Amps	Number of	Size	
1	3	80	3	3-#8	Pump #1
2	3	80	3	3-#8	Pump #2
3	—	—	—	—	Pump #1
4	—	—	—	—	Pump #2
5	—	—	—	—	Pump #1
6	—	—	—	—	Pump #2
7	1	20	2	#12	Lights
8	—	—	—	—	Spare
9	1	20	2	#12	Receptacles
10	—	—	—	—	Spare
11	1	20	2	#12	Outside lights
12	—	—	—	—	Spare

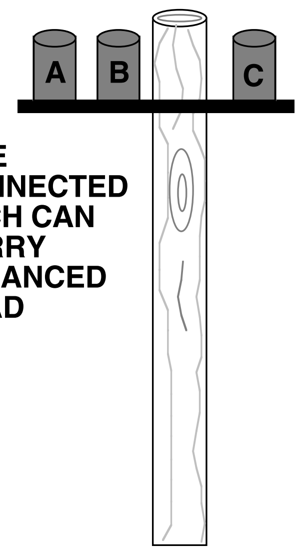
The lift station has a 150 amp panelboard with a 208/120v three-phase service. This is called a 4-wire **wye** connected secondary. It is a very common secondary as it can be better balanced.

Often the electrician is familiar with the connections in the panelboard but cannot visualize the circuit through the transformers.

LOAD BALANCE SCHEDULE					
Description	Load	L1	L2	L3	N
Pump #1	11096	3699	3699	3699	0
Pump #2	11096	3699	3699	3699	0
Lights	2400	2400			2400
Receptacles	2400		2400		2400
Outdoor lights	2400			2400	2400
TOTAL	29392	9798	9798	9798	7200







WYE CONNECTED EACH CAN CARRY BALANCED LOAD

	PANELBOARD SCHEDULE					
	MAINS 150	PHASE 3	VOLTS 240/120		AMPERE 150	
	Circuit Number	Circuit Breaker Poles	Circuit Breaker Amps	Conductor Number of	Conductor Size	Serves
	1	3	80	3	3-#8	Pump #1
HIGH LEG	2	3	80	3	3-#8	Pump #2
→	3	—	—	—	—	Pump #1
→	4	—	—	—	—	Pump #2
	5	—	—	—	—	Pump #1
	6	—	—	—	—	Pump #2
	7	1	20	2	#12	Lights
HIGH LEG	8	1	20	2	#12	Receptacles
→	9	—	—	—	—	Spare
→	10	—	—	—	—	Spare
	11	1	20	2	#12	Outside lights
	12	—	—	—	—	Spare

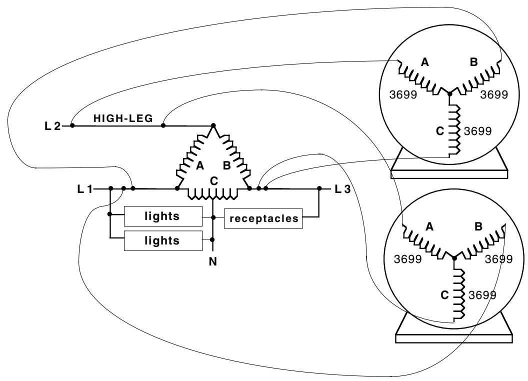
This shows the difference with the secondary now **delta** connected.

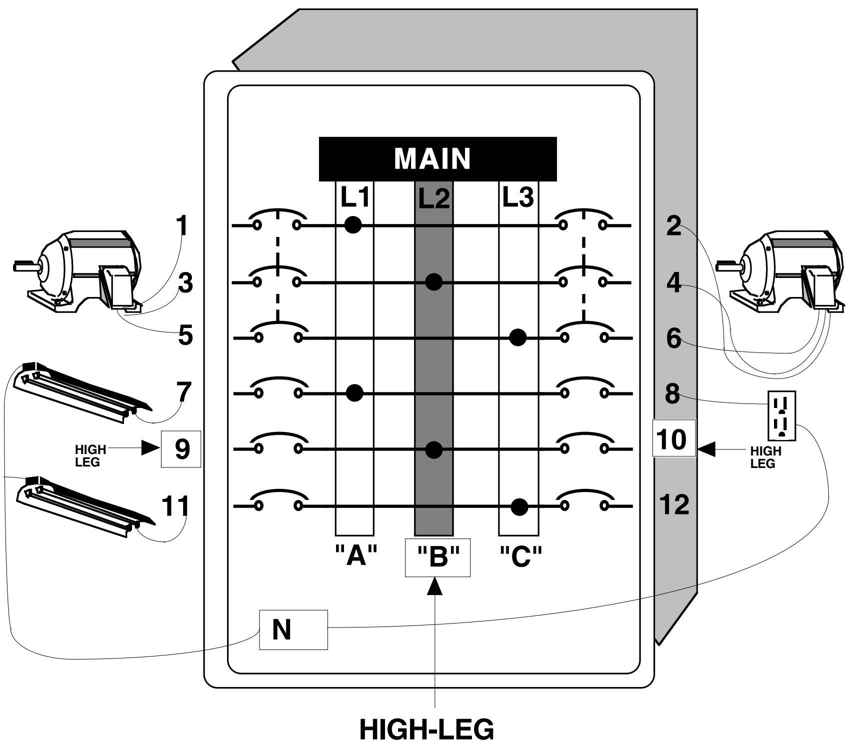
A delta connected secondary is quite the opposite when it comes to load balancing. Neutral loads can only be connected L1-N or L3-N to transformer "C".

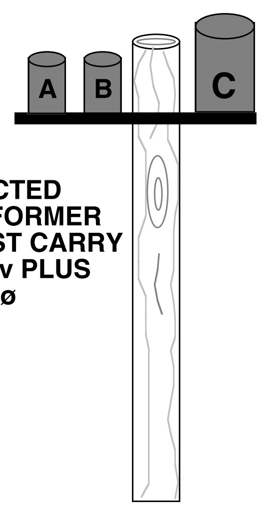
For an example, using the same lift station loads only connected delta 240/120v three-phase. 120v loads cannot connect to **L2 the high-leg**. Transformer "C" is the only one that can carry 120v loads.

HIGH-LEG

LOAD BALANCE SCHEDULE					
Description	Load	L 1	L 2	L 3	N
Pump #1	11639	3880	3880	3880	0
Pump #2	11639	3880	3880	3880	0
Lights	2400	2400	HIGH LEG		2400
Receptacles	2400	2400	HIGH LEG		2400
Outdoor lights	2400		HIGH LEG	2400	2400
TOTAL	30478	12560	7760	10160	7200

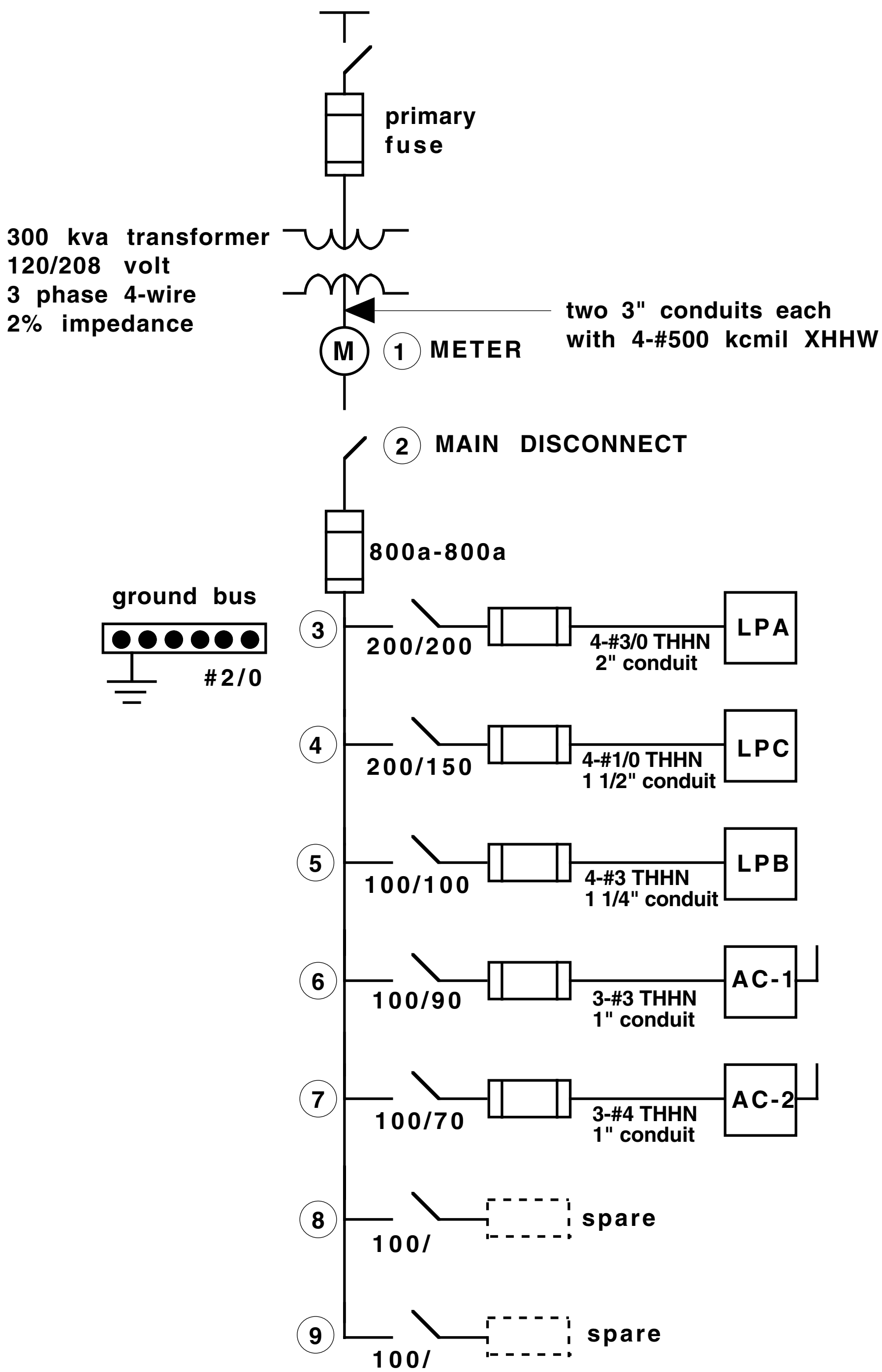






DELTA CONNECTED TRANSFORMER "C" MUST CARRY ALL 120v PLUS 1/3 OF 3ø

ONE - LINE DRAWING



The main distribution panel and another one-line drawing is shown on the following page.