Welcome To

Basic Electricity

Components of an Atom

Nucleus

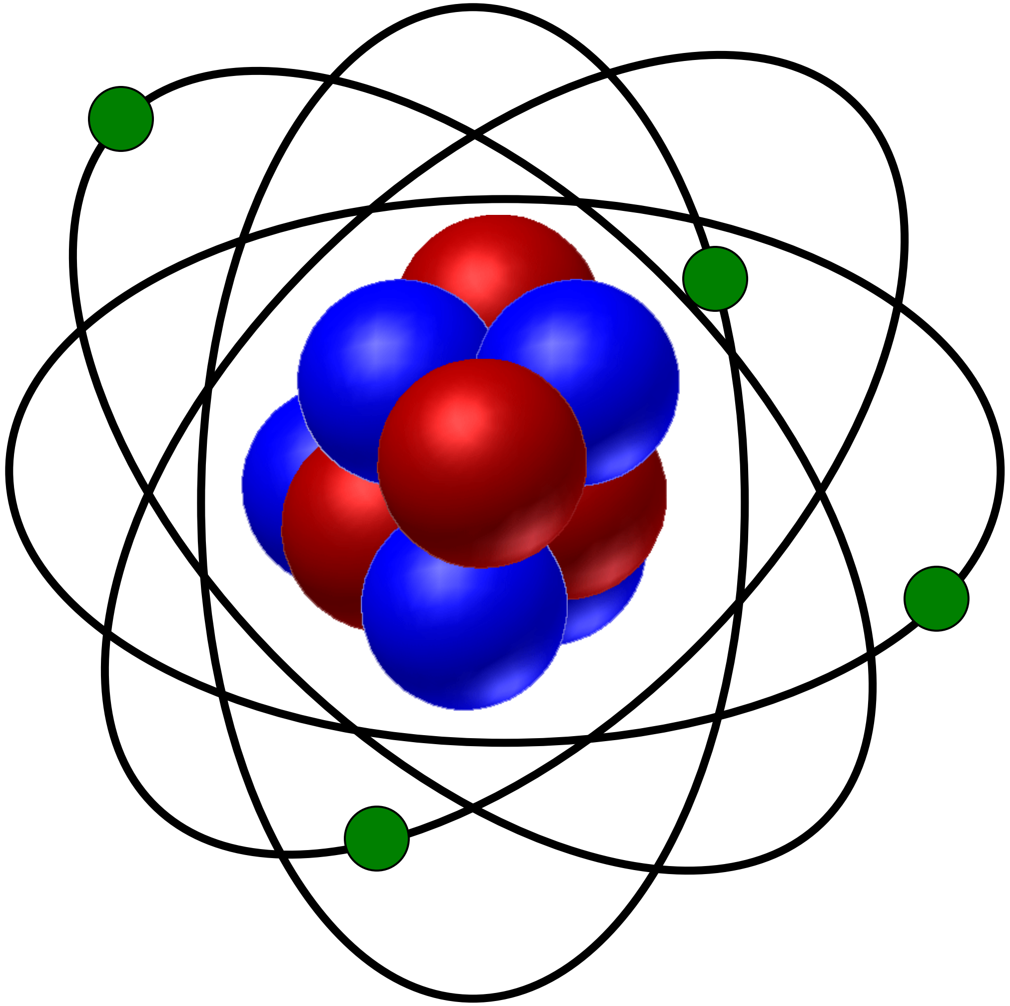
The center portion of an atom containing the protons and neutrons

Protons

Positively charged atomic particles

Neutrons

Uncharged atomic particles



Electrons

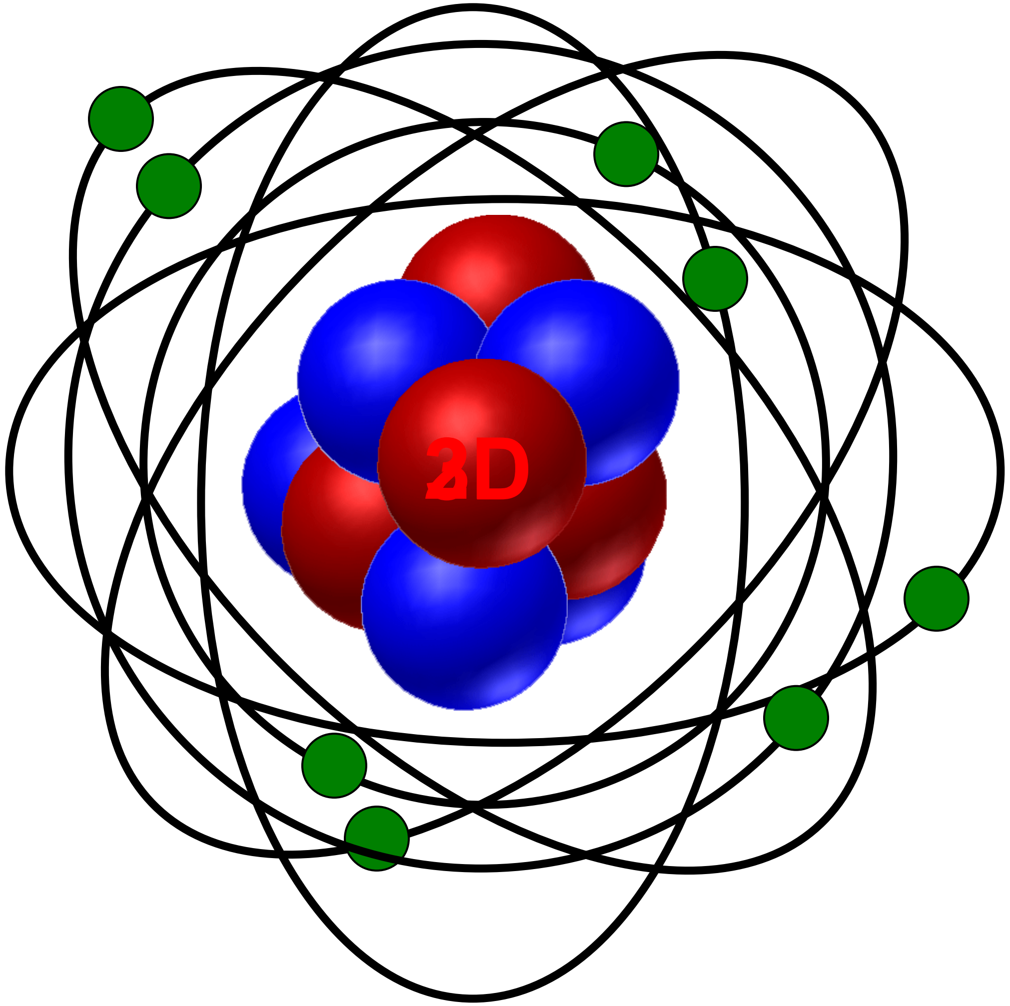
Negatively charged particles

Electron Orbitals

Orbits in which electrons move around the nucleus of an atom

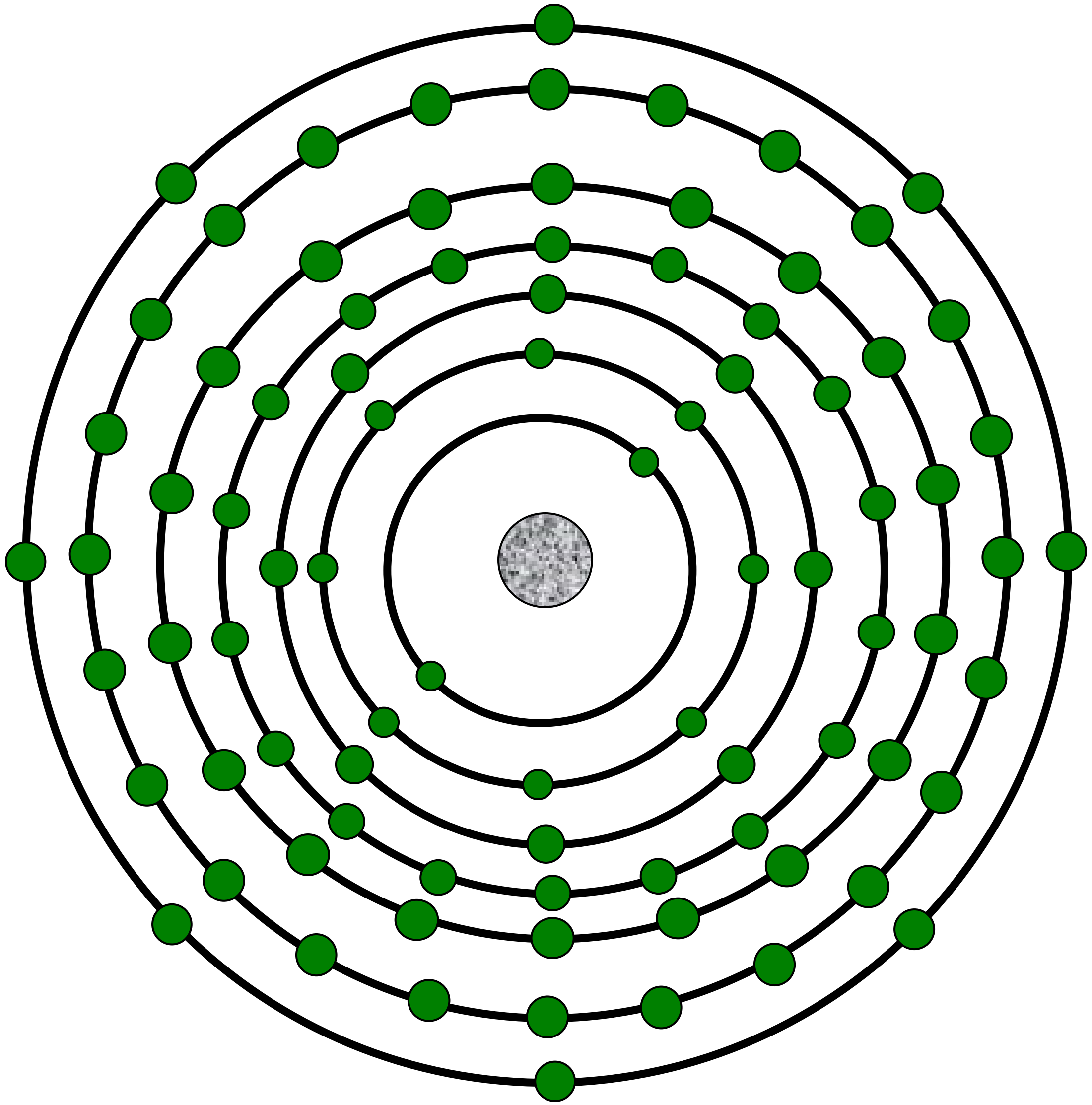
Valence Electrons

The outermost ring of electrons in an atom



Electron Orbits

Orbit Number	Maximum Electrons
1	2
2	8
3	18
4	32
5	50
6	72
Valence Orbit	8

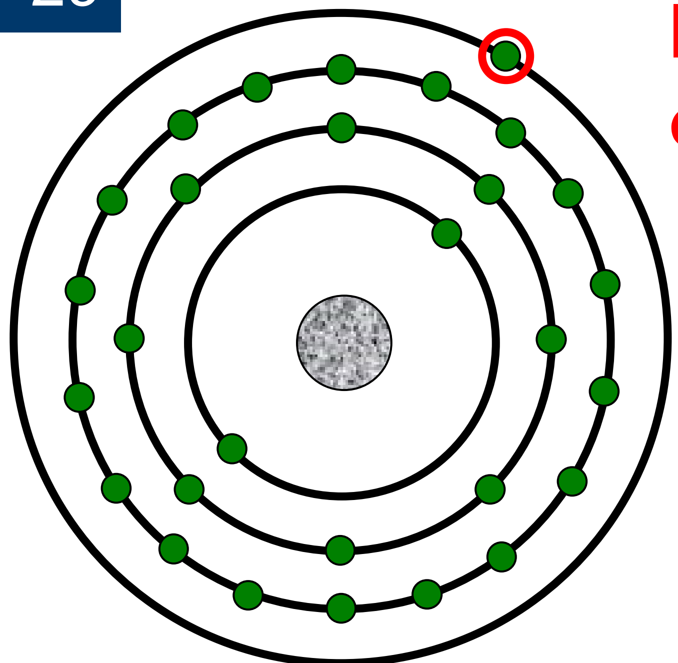


Orbits closest to the nucleus fill first

Electron Orbits

Atoms like to have their valence ring either filled (8) or empty(0) of electrons.

Copper
Cu
29

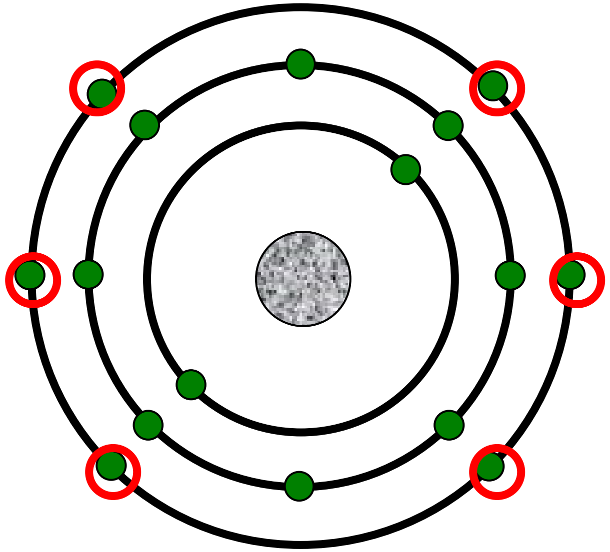


How many electrons are in the valence orbit? **1**

Is copper a conductor or insulator? **Conductor**

Why?

Electron Orbits



How many electrons are in the valence orbit?

6

Is Sulfur a conductor or insulator?

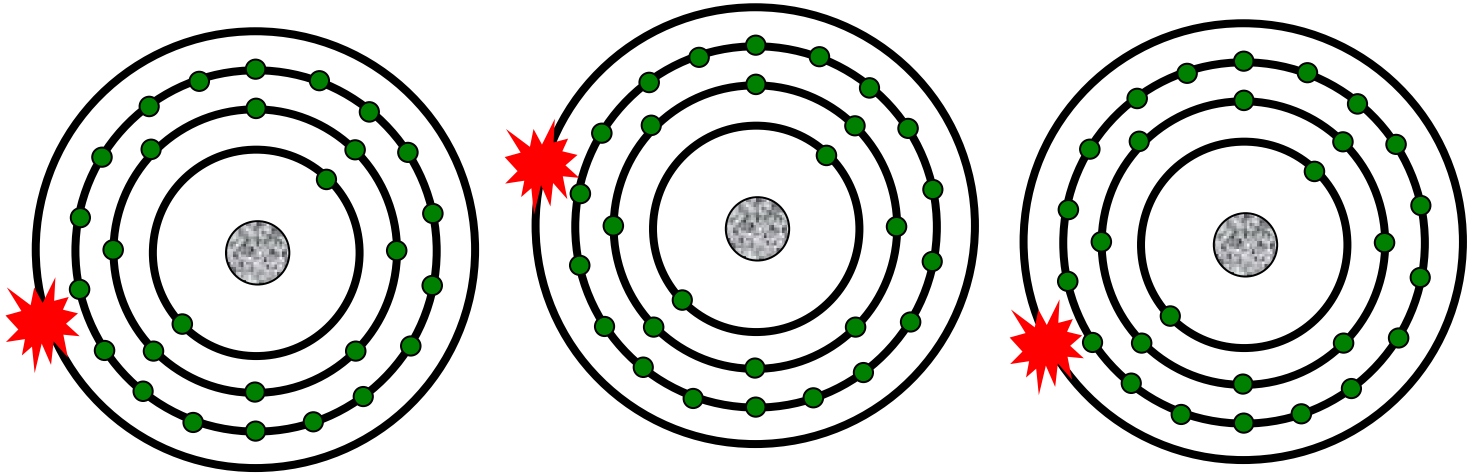
Insulator

Why?

Electricity at the Atomic Level

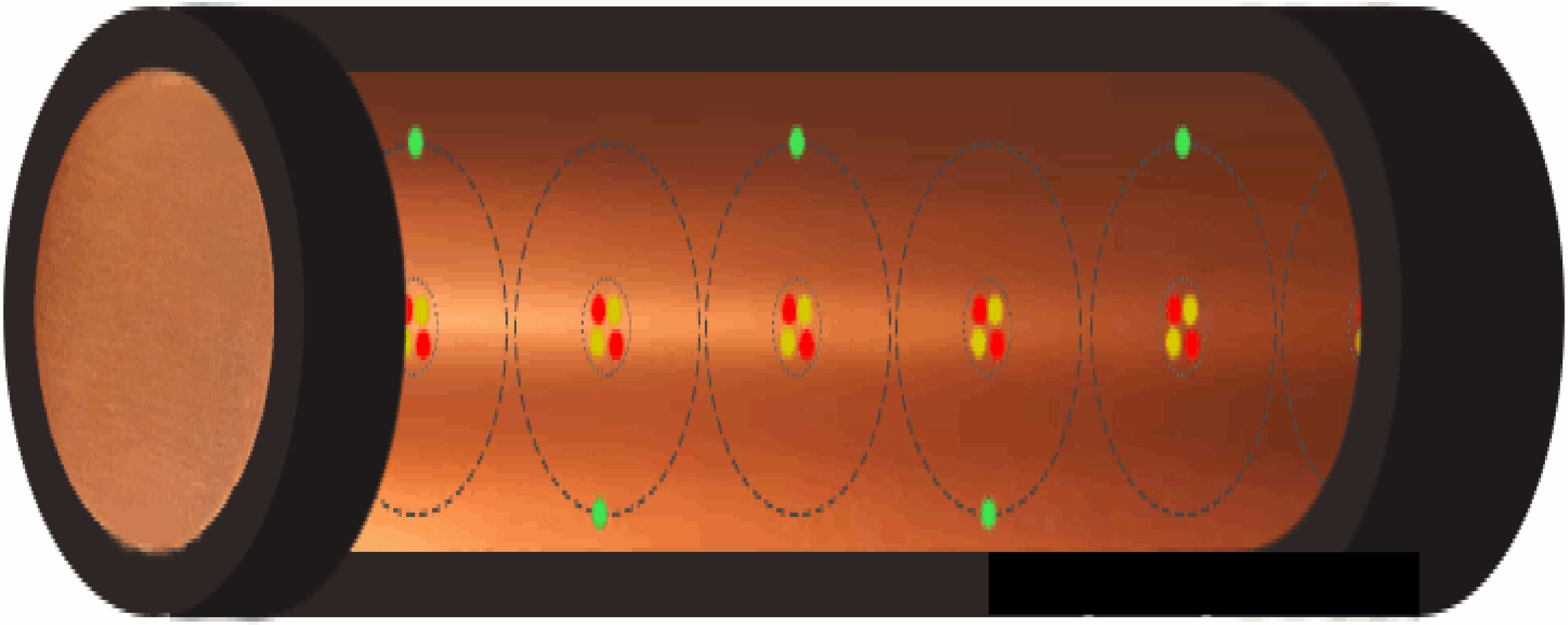
Electron Flow

Electricity is created as electrons collide and transfer from atom to atom.



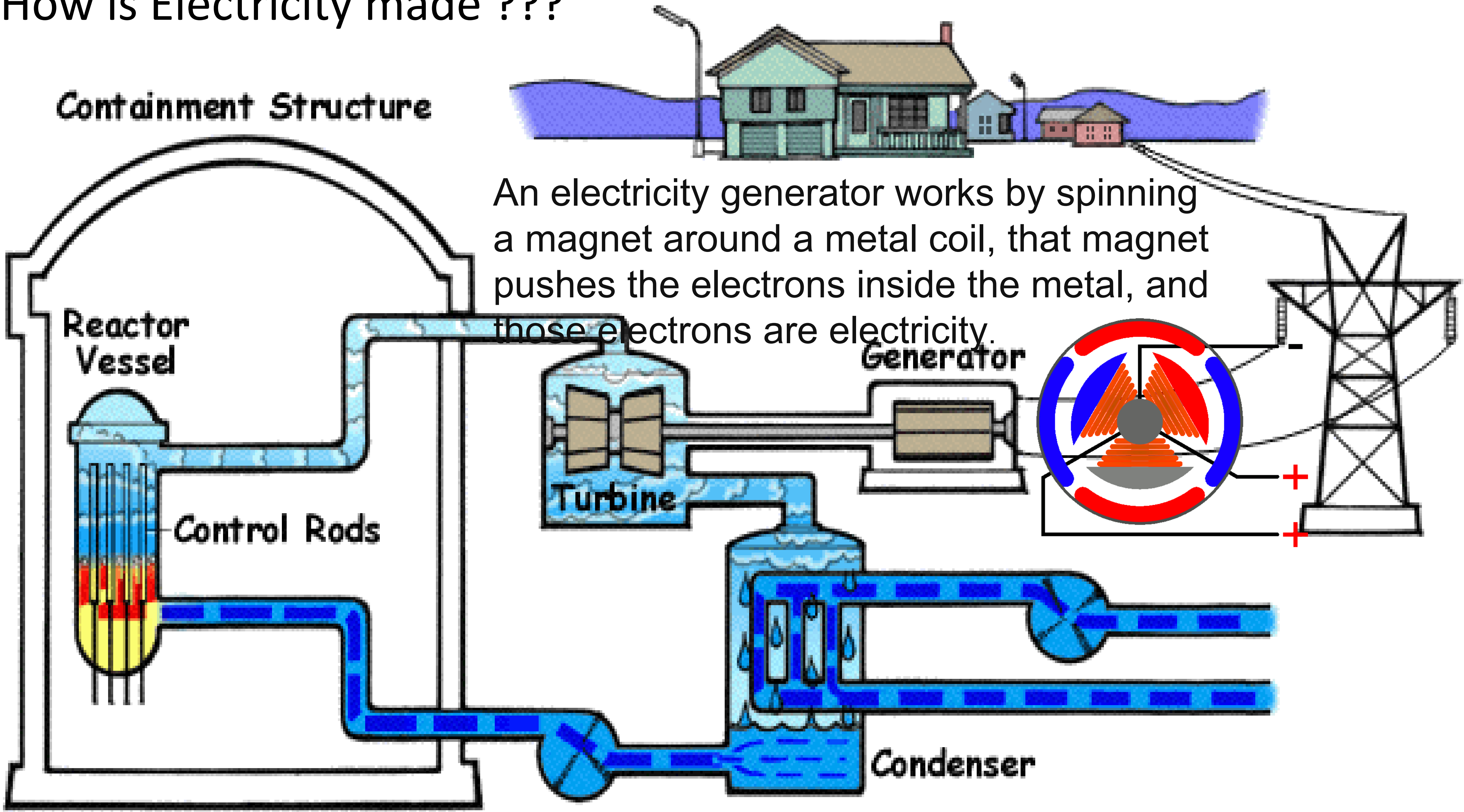
Play Animation

The flow of electricity



[redacted]

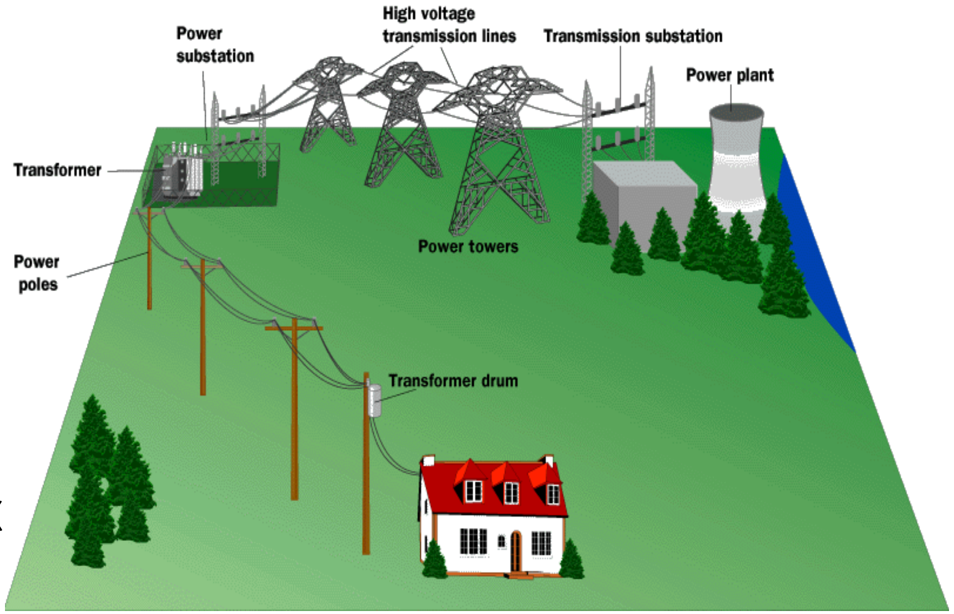
How is Electricity made ???



An electricity generator works by spinning a magnet around a metal coil, that magnet pushes the electrons inside the metal, and those electrons are electricity.

How do we get Electricity?

- Energy from one of the sources is converted by machines at the power plant to Electricity and then put onto the Electric Power Grid
- Electric Power Grid
  - Power Plants
  - Transmission Lines
  - Substations
  - Power Lines
  - Transformers
  - Electrical Wiring and Circuit Box



The four most basic physical quantities in electricity are:

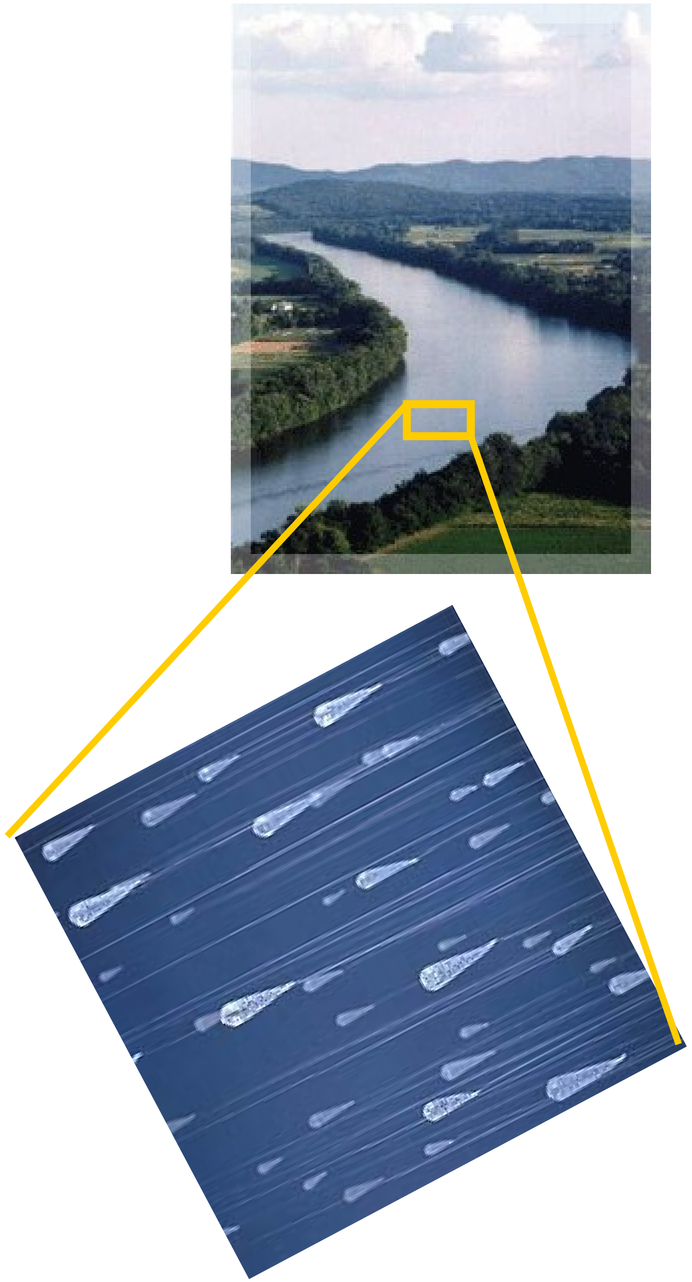
- Voltage (E)
- Current (I)
- Resistance (R)
- Power (P)

Each of these quantities are measured using different units:

- Voltage is measured in volts (V) designated as (E)
- Current is measured in amps (A) designated as (I)
- Resistance is measured in ohms (Ω) designated as (R)
- Power is measured in watts (W)

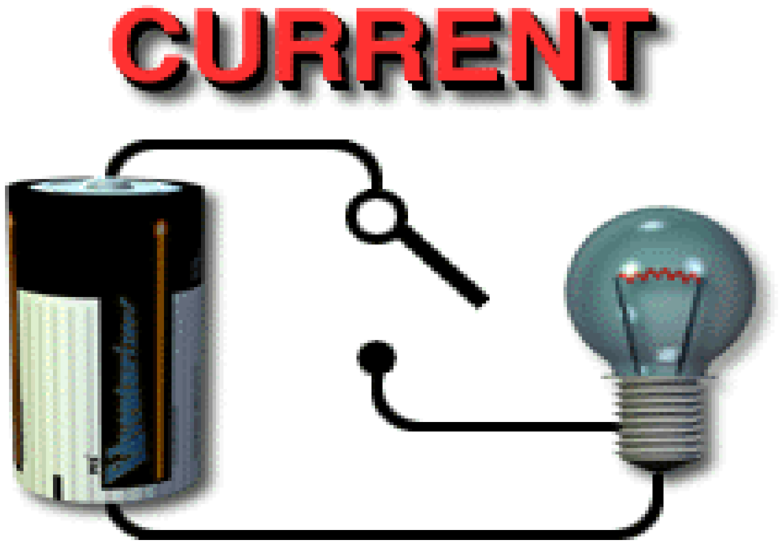
	FLUID (OUR WORLD)	ELECTRICITY
Pressure	PSI or Ft of Head	Volts (Electromotive Force)
Flow	GPM or CFS	Amperes (AMPS)
Resistance to Flow	Head Loss Feet	Resistance (OHMS)
Quantity	Gallons or CF	KWH

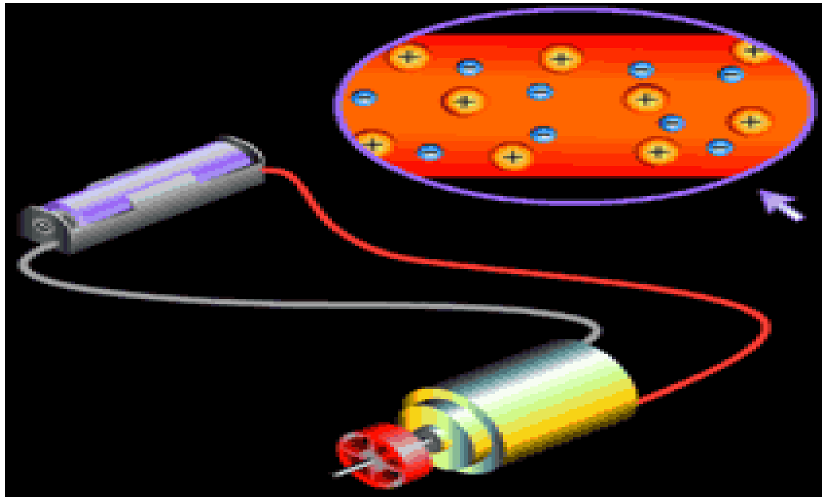
How you should be thinking about electric circuits:



Current: the actual "substance" that is flowing through the wires of the circuit (electrons!)

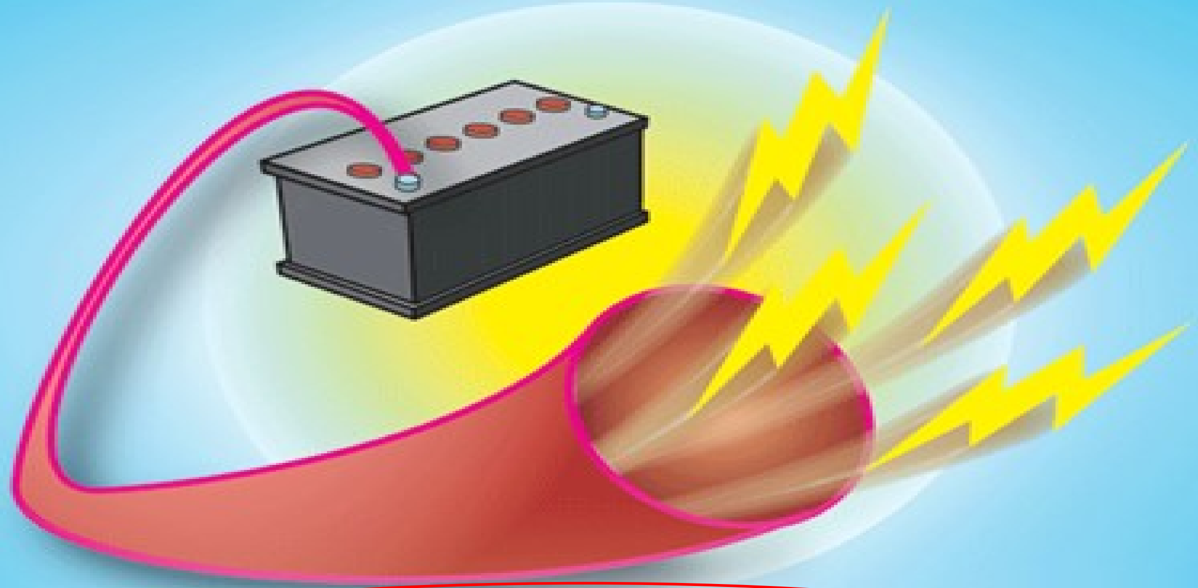
Electric Current (I)





- This is the flow of electric charge
- {In a metal conductor it is the flow of electrons}

AMPERE (CURRENT)



MEASURES THE NUMBER OF MOVING ELECTRONS (OR ELECTRIC CHARGES)

Volt

- Creates The Potential Difference
- The Electromotive Force Which Must Be Applied To Create Flow Of Electrons
- Commercial Current Is 120 V or 220 V

Amps and Volts

Electricity is to home electrical circuits as water is to home plumbing systems. The voltage is roughly equivalent to the water pressure, and the amperage, or current, to the quantity of water that flows past a given point per second. At a given pressure, less water can get through a small pipe than a large one in a given time, so the size of the pipe can be regarded as equivalent to a measure of electrical resistance — a smaller pipe has higher resistance. The higher the electrical resistance of an appliance, the lower its current will be, and resistance is often dependent on the diameter of the wires.

How you should be thinking about electric circuits:

Voltage: a force that pushes the current through the circuit (in this picture it would be equivalent to gravity)

Watts: Rate of Power

Watts: Unit of *electrical power*, the rate at which energy is being used or generated.

Watts is the Product of Volts and Amps

Volts x Amps = Watts

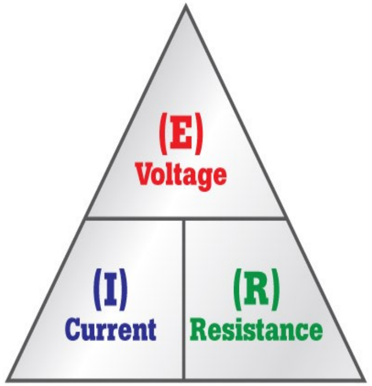
12 volts x 5 amps = 60 watts

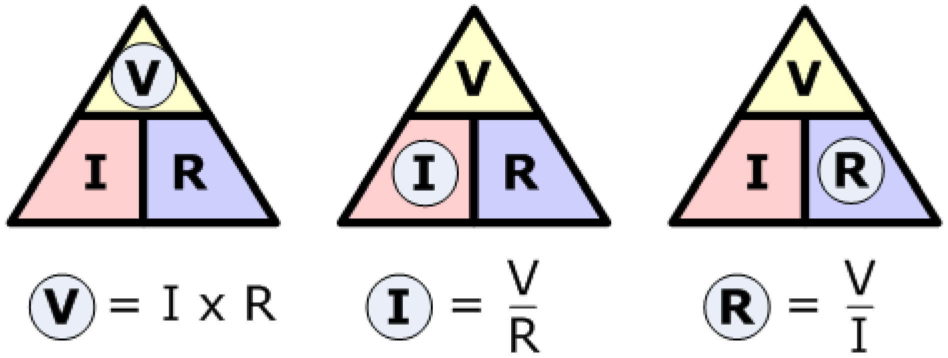
How you should be thinking about electric circuits:

<u>Resistance</u>: friction that impedes flow of current through the circuit (rocks in the river)

Resistance = Electrical Impedance

- Opposition To Flow Of Electrical Current
- Measured In Ohms
  - Ohm's Law   Current Flow= $\frac{\text{Voltage}}{\text{Resistance}}$





Finding Voltage

Ohm's Law Formula for Finding Voltage

(E) (I) (R)

Voltage = Current x Resistance

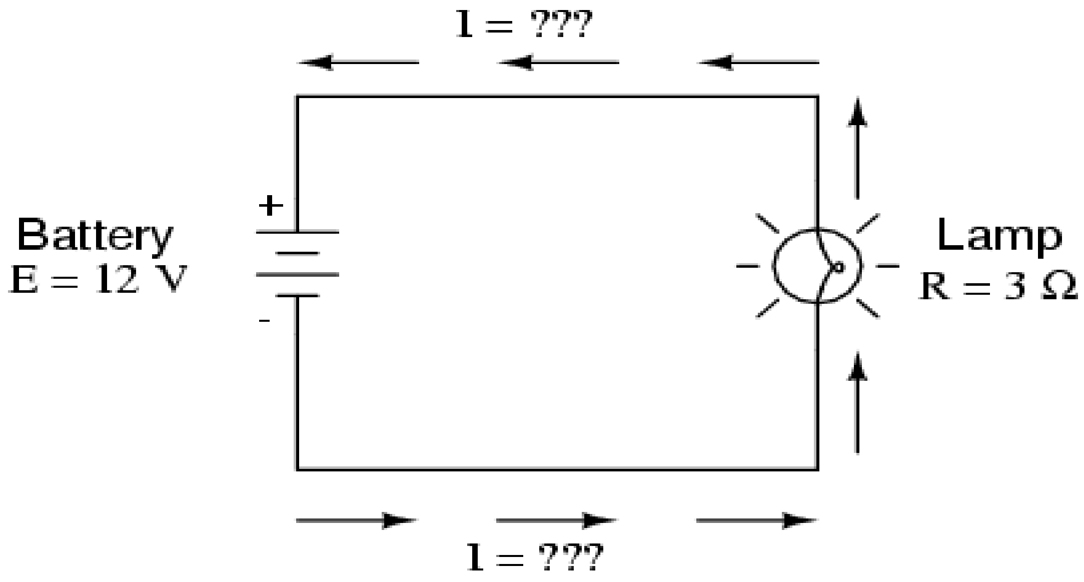
To find Voltage Multiply the **Current** times the **Resistance.**

E=I x R

Using the Magic Circle

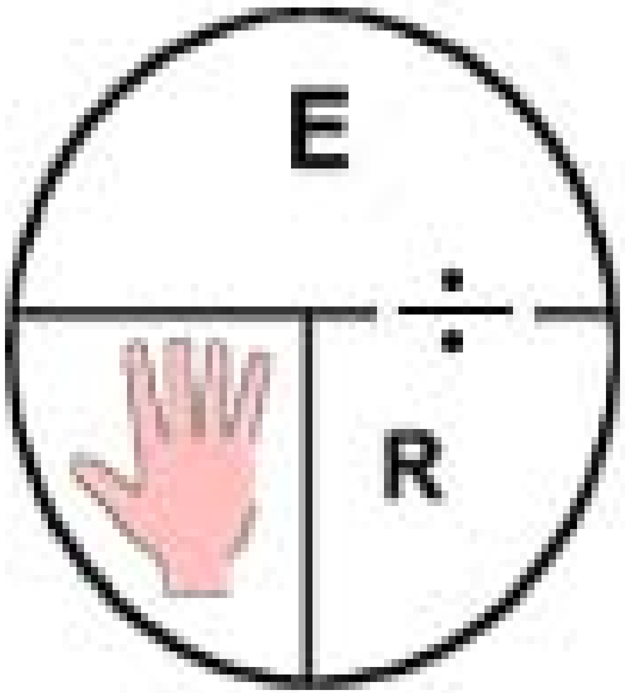
Cover the E to see the mathematical relationship between Voltage and Current

In this first example, we will calculate the amount of current (I) in a circuit, given values of voltage (E) and resistance (R):

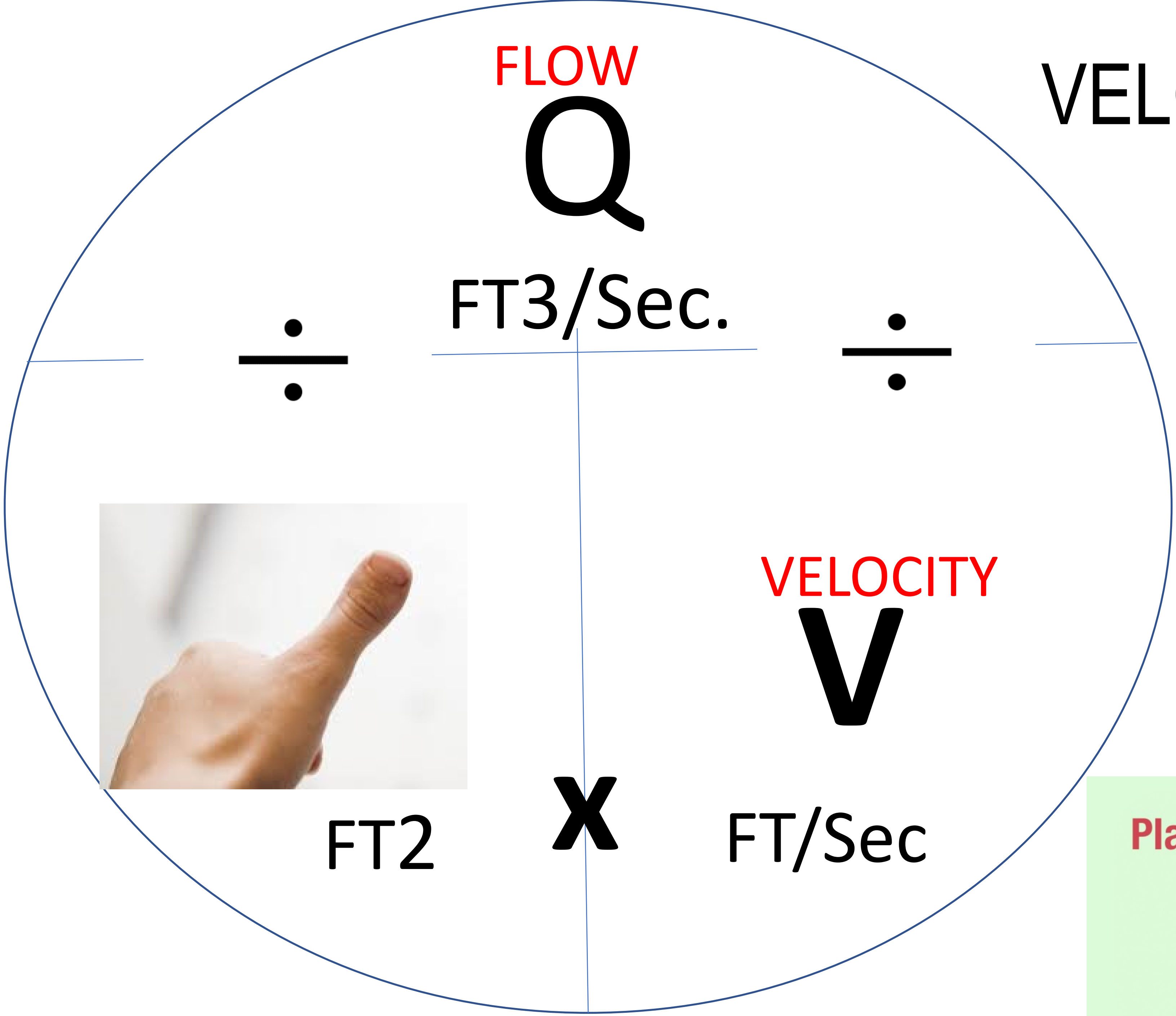


What is the amount of current (I) in this circuit?

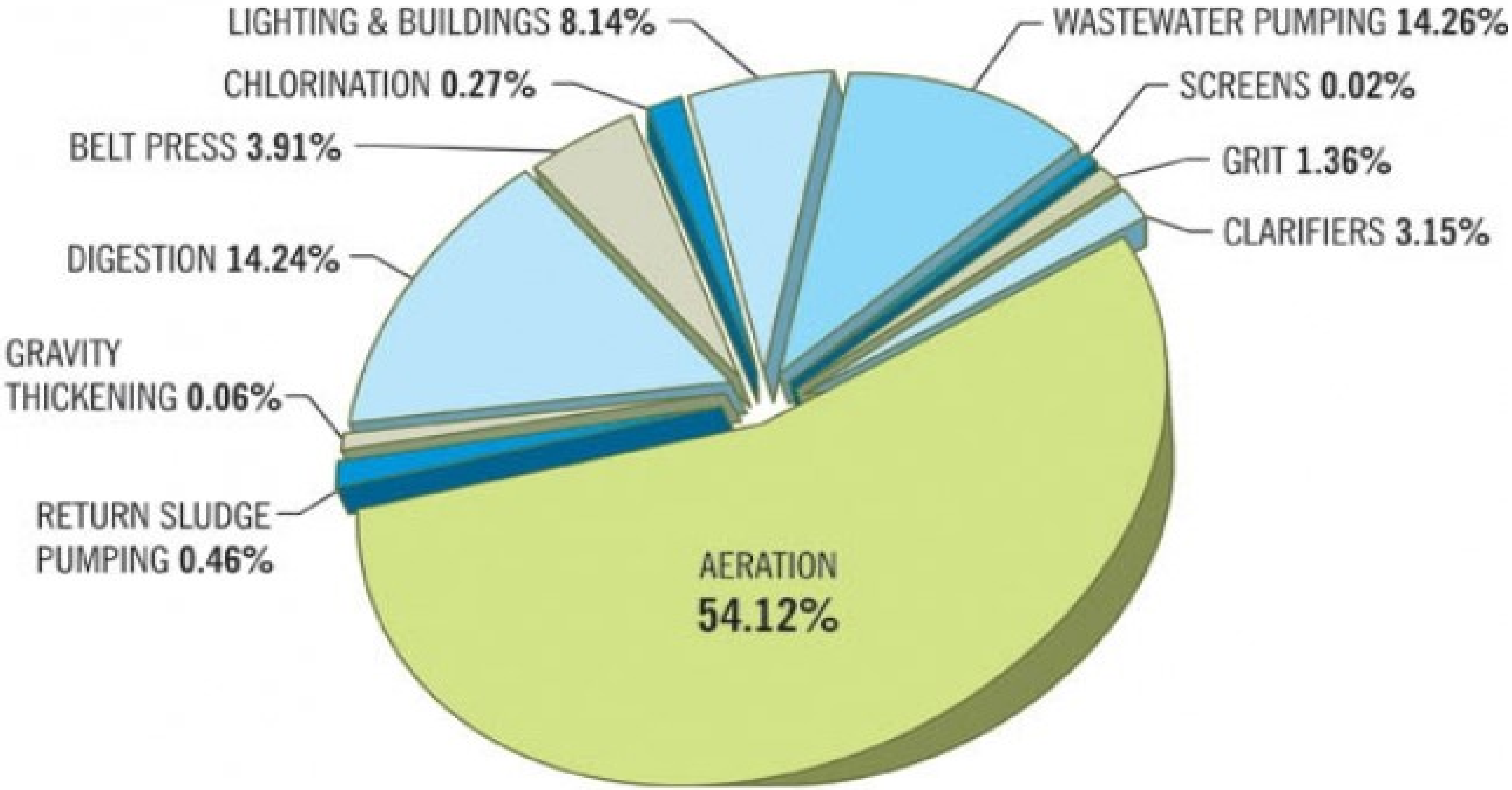
$$I = \frac{E}{R} = \frac{12\ V}{3\ \Omega} = 4\ A$$



VELOCITY


FLOW
Q
FT3/Sec.
÷
÷
VELOCITY
V
FT2
X
FT/Sec


Place your THUMB here
To Find



HOW WASTEWATER PLANTS USE ELECTRICITY

How to Calculate your Electric Cost

TAKE: 1,000,000 BTU'S / 3,412 BTU'S/KWH =

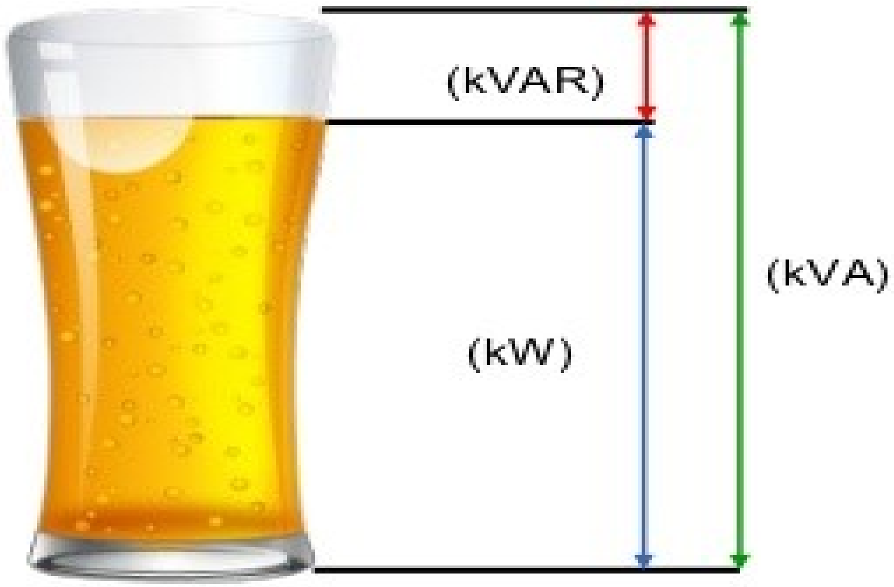
293 KHW'S

Take your KWH cost

<u>$0.07/KWH </u> x 293 KWH's =

$20.51/Million BTU'S

Power – Power Factor



Mug Capacity = Apparent Power (KVA)

Foam = Reactive Power (KVAR)

Beer = Real Power (kW)

$$\text{Power Factor} = \frac{\text{Beer (kW)}}{\text{Mug Capacity (KVA)}}$$

Utilities have to generate kVA, but consumers can only use kW!

kVAR penalties are enforced by the utility!

Power factor is an expression of energy efficiency. It is usually expressed as a percentage—and the lower the percentage, the less efficient power usage is.

What is Your Power Factor ?

•**Toledo Edison**
•A FestEnergy company

•Bill Based On: Actual Meter Reading

•October 23, 2019 T14
Account Number: 110 019 442 976
•Amount Due $77 r:27Z5
•Due Date: November 22, 2019

•Billing Period: Sep 18 to Oct 16, 2019 for 29 days
•Bill For: MAUMEE SEWAGE PLANT LUCAS CTY
COMM
•5758 N RIVER RD
•WATERVILLE OH 43566

•f i e

•To report an emergency or an outage, call 24 hours a day 1-888-544-4877. For Customer Service, call 1-800-447-3333. For Payment Options, call •1-800-995-0095. Pay your bill online at www.firstenergycorp.com
•Bill issued by: Toledo Edison, PO Box 3687, Akron OH 44309-3687

•Ehessae%:

•To avoid a 1.50% Late Payment Charge being added to your bill, please pay the **Amount Due** by the Due Date.

•The information below shows specific charges for the costs of energy efficiency, peak demand reduction, and renewable energy. These charges are not new, and are previously were consolidated with other charges on your bill.

Energy Efficiency	1,083,424 KWH x 0.000806	$873.24
Peak Demand Reduction	1,083,424 KWH x 0.000202	$218.85
Renewable Energy,_	1,083,424 KWH x 0.001144	$1,2394

•Nov 14, 2019.
Your next meter reading is scheduled to occur on or about
•Pursuant to the recent Public Utilities Commission of Ohio (PUCO) Order in Case No. 14-1297-EL-SSO, the Distribution Modernization Rider (Rider DMR) was set to zero effective for service rendered on or after September 1, 2019. The Rider DMR amounts charged between July 2, 2019, and August 31, 2019, will be refunded to customers during the October billing cycle.

•—A~court Summary F

•Previous Balance	•84,155.10
Payments/Adjustments	•-84,155.10
•Balance at Billing on Oct 23, 2019	**•0.00**
•Toledo Edison	•23,870.54
•MidAmerican Energy Services, LLC - Consumption	•53,401.96
•Total Current Charges	**•77,272.50**

•Amount Due by Nov 22, 2019 $77,272.50

•Oct 16, 2019 KWH Reading (Actual)	•6,196.395
•Sao 18, 2019 KWH Reading (Actual)_	5,8.57.825
•Difference	338.57
•Multiplier	3200
•KWH used	1,083,424
•Metered Load in KW	0.5598
•Oct 16, 2019 KVARH Reading (Actual)	2,688.683
•Sep 18, 2019 KVARH Reading (Actual)	2,556.365
•Difference	132.318
•Kilovar Hours Used	423,418
•Measured Lagging Reactive Demand	685.44
•Billed Load in KW/KVA	1,791.4
•Billed Reactive Demand	685.4

•CharcieKTfoinslolacicat

Primary TE-GPD	150.0
Customer Charge	0
Distribution Related	8,103
Component	.91
Cost Recovery	15,61
Charges	6.63
Current Consumption	23,87
Bill Charges	0.54

•BillikilifirfaratkriffofmidAmericartEnettrySdfincet3LOWReel

•MidAmerican
•M-1111V 5.111.1CIMALC
•Po Box 8019, Davenport, IA 52808
•Customer Service: 1-800-432-8574 Account Number: 343560 Rate: BILL-READY

•Billing Period: Sep 18, 2019 to Oct 16, 2019
•Adjustment: 1083424 Kwh At 0.093c Per Kwh 1,007.58
•Energy Supply: 1083424 Kwh At 4.836c Per Kwh 52,394.38
•Total MidAmerican Energy Services, LLC Current Charges 53,401.96

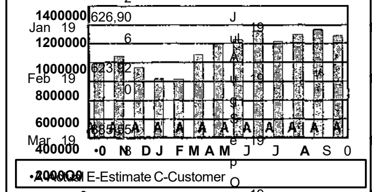
•10/11/19 Payment -84,155.10

	Previous Balance	Payments/ Adjustments	Current Charges	Amount Due
Toledo Edison	27,543.66	-27,543.66	23,870.54	23,870.54
MidAmerican Energy Services, LLC	56,611.44	-56,611.44	53,401.96	53,401.96
Total	**84,155.10**	**-84,155.10**	**77,272.50**	**77,272.50**

•Additional messages, if any, can be found on back.

•saga History

Oct 18	792,886	Apr 19	994,448
Nov 18	865,066	May 19	1,038,451
Dec 18	747,702	Jun 19	1,133,395
Jan 19	626,906	Jul 19	1,024,621
Feb 19	623,820	Aug 19	1,097,379
Mar 19	685,554	Sep 19	1,148,538
		Oct 19	1,083,424



Comparisons	Last Year	This Year
	97'1/1.1	37.1.5g

What You Need to Know !

.

Oct 16. 2019 KWH Reading (Actual)	6,196.395
Sep 18, 2019 KWH Reading (Actual)	5,857.825
Difference	338.57
Multiplier	3,200
KWH used	1,083,424
Metered Load in KW	0.5598
Oct 16, 2019 KVARH Reading (Actual)	2,688.683
Sep 18, 2019 KVARH Reading (Actual)	2,556.365
Difference	132.318
Kilovar Hours Used	423,418
Measured Lagging Reactive Demand	685.44
Billed Load in KW/KVA	1,791.4
Billed Reactive Demand	685.4

A. 0.5598 (Metered Load in KW) x 3,200 (Multiplier) = 1,791.4 (Billed Load in KW/KVA)

B. 1,791.4 x 1,791.4 = 3,214,344.73

C. 685.44 (Measured Lagging Reactive Demand) x 685.44 = 469,828

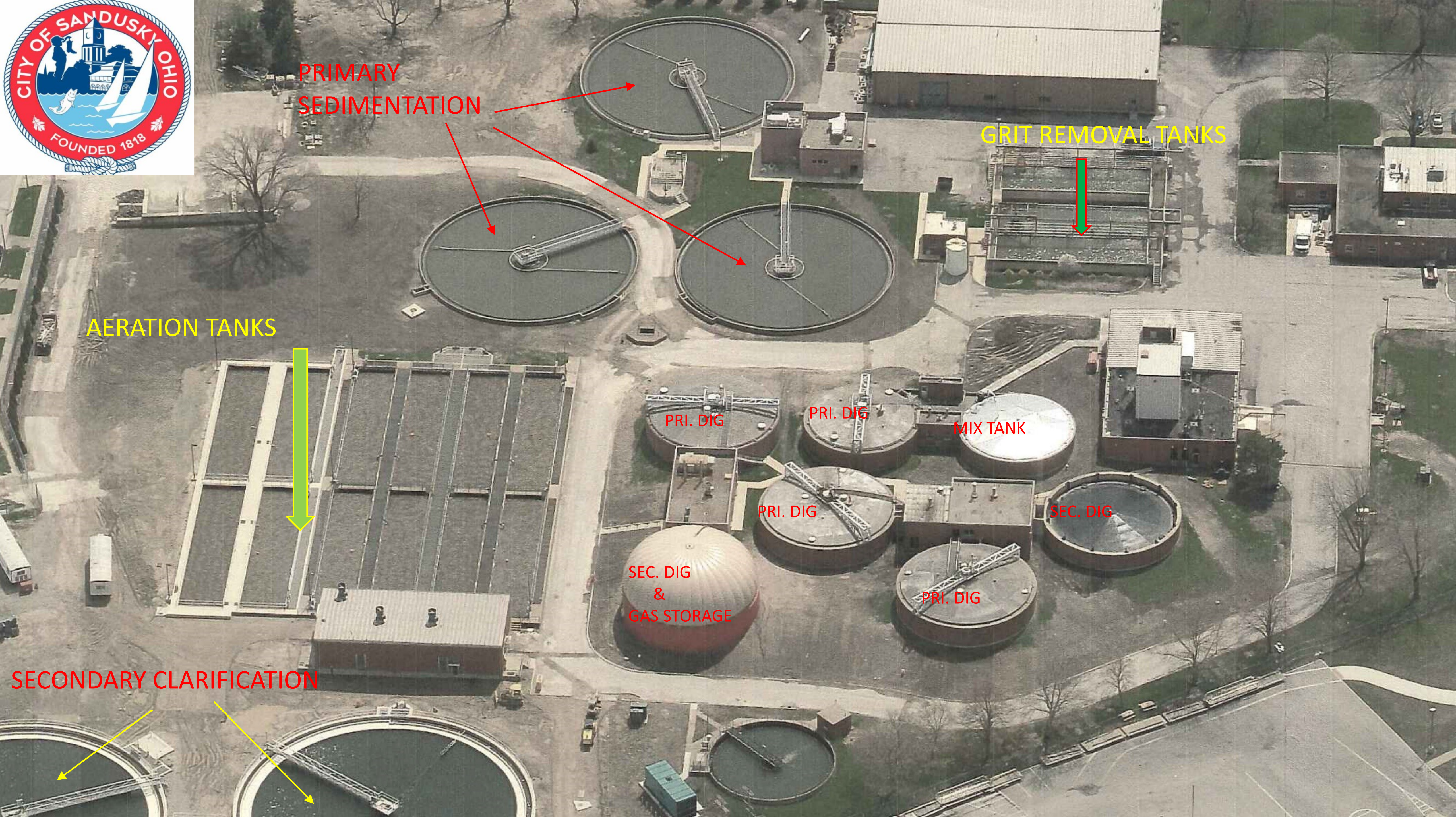
D. 3,214,344.73 + 469,828 = 3,684,172.73

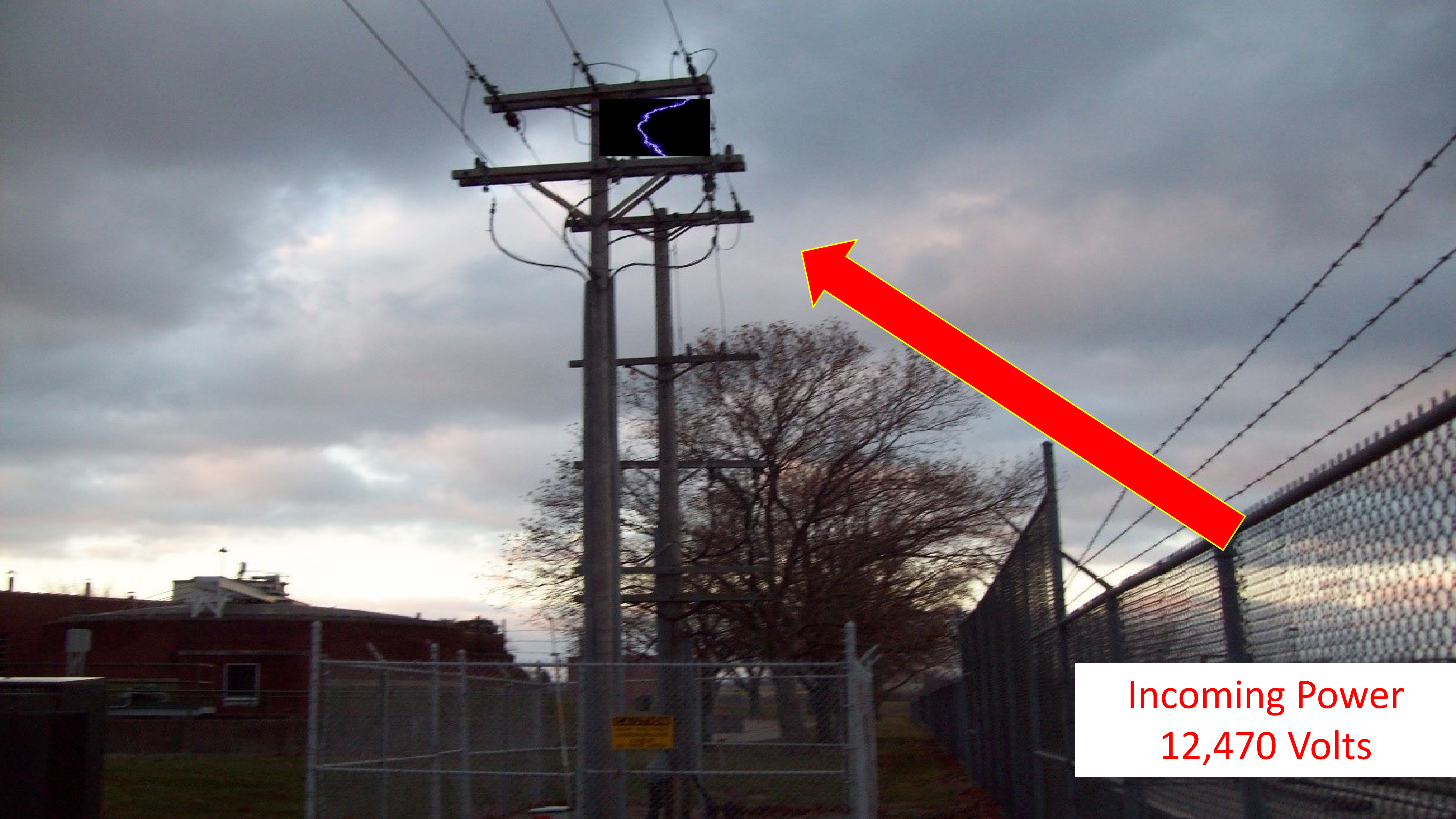
E. $\sqrt{3,684,172.73}$ = 1,919.4

F. $\frac{1,791.4 \text{(Billed Load in KW/KVA)}}{1,919.4}$ x 100 = 93.33% Power Factor

Power factor correction consists of increasing a plant's power factor so that it approaches 1, usually with a target of 0.92 to 0.95. Power factors lower than this may incur a surcharge by the electric utility supplying the plant.

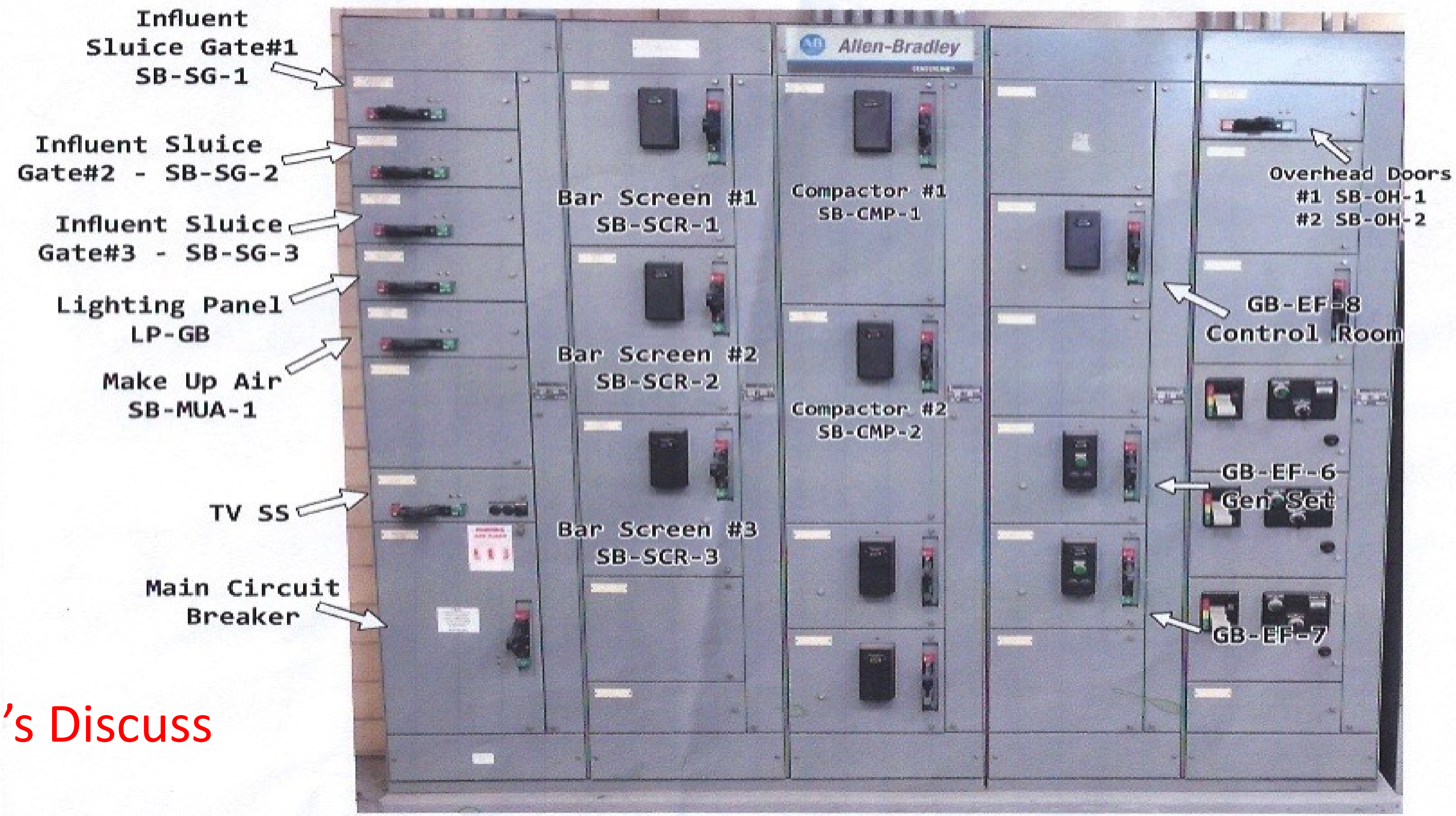
POWER FACTOR	SURCHARGE
90 - 100%	None
88 - 90%	2%
85 - 88%	4%
80 - 85%	9%
75 - 80%	16%
70 - 75%	24%
65 - 70%	34%
60 - 65%	44%
55 - 60%	57%
50 - 55%	72%
0 - 50%	80%


PRIMARY SEDIMENTATION
GRIT REMOVAL TANKS
AERATION TANKS
PRI. DIG
PRI. DIG
MIX TANK
PRI. DIG
SEC. DIG
SEC. DIG & GAS STORAGE
PRI. DIG
SECONDARY CLARIFICATION


Incoming Power
12,470 Volts

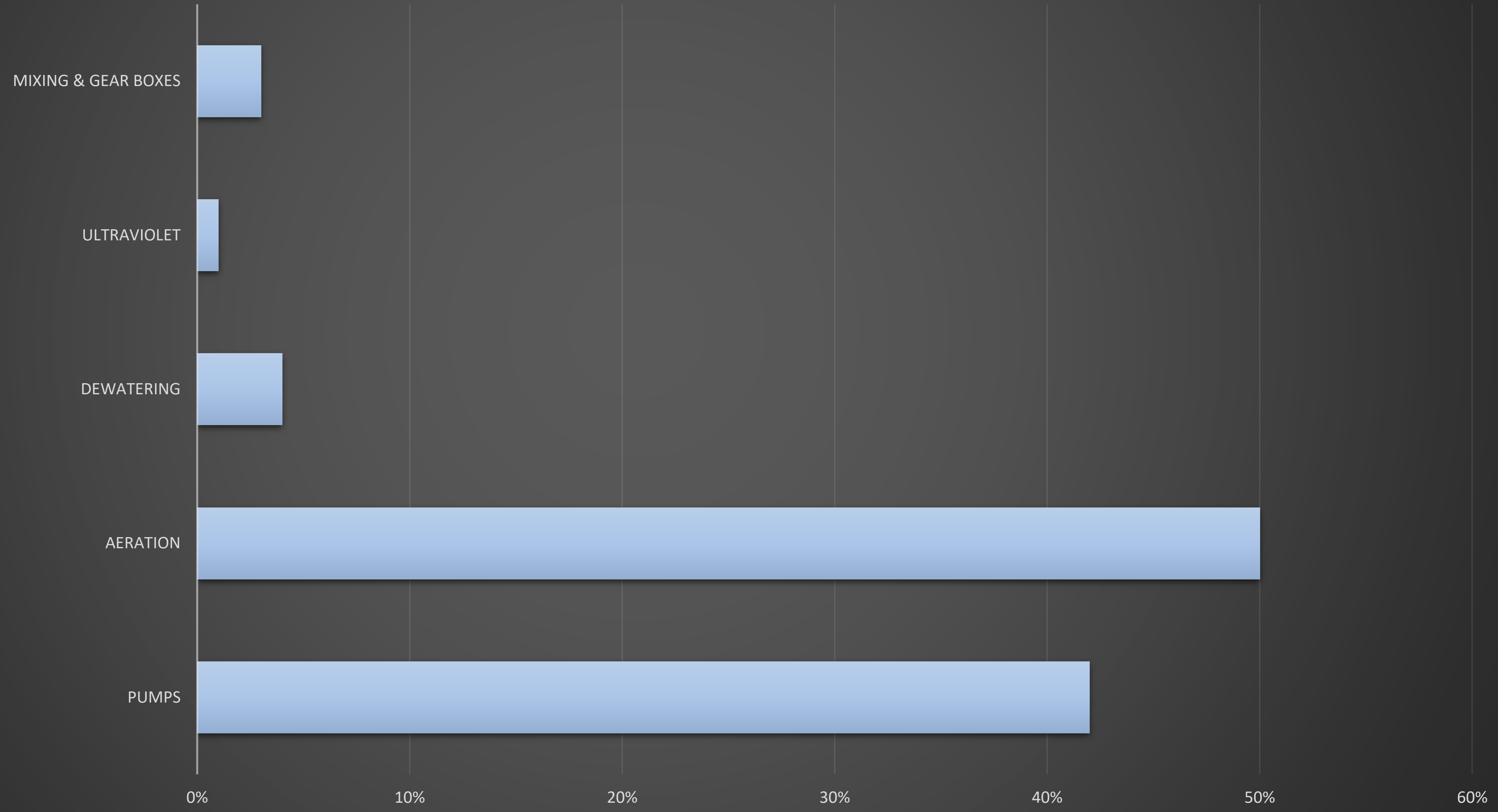

Transformer

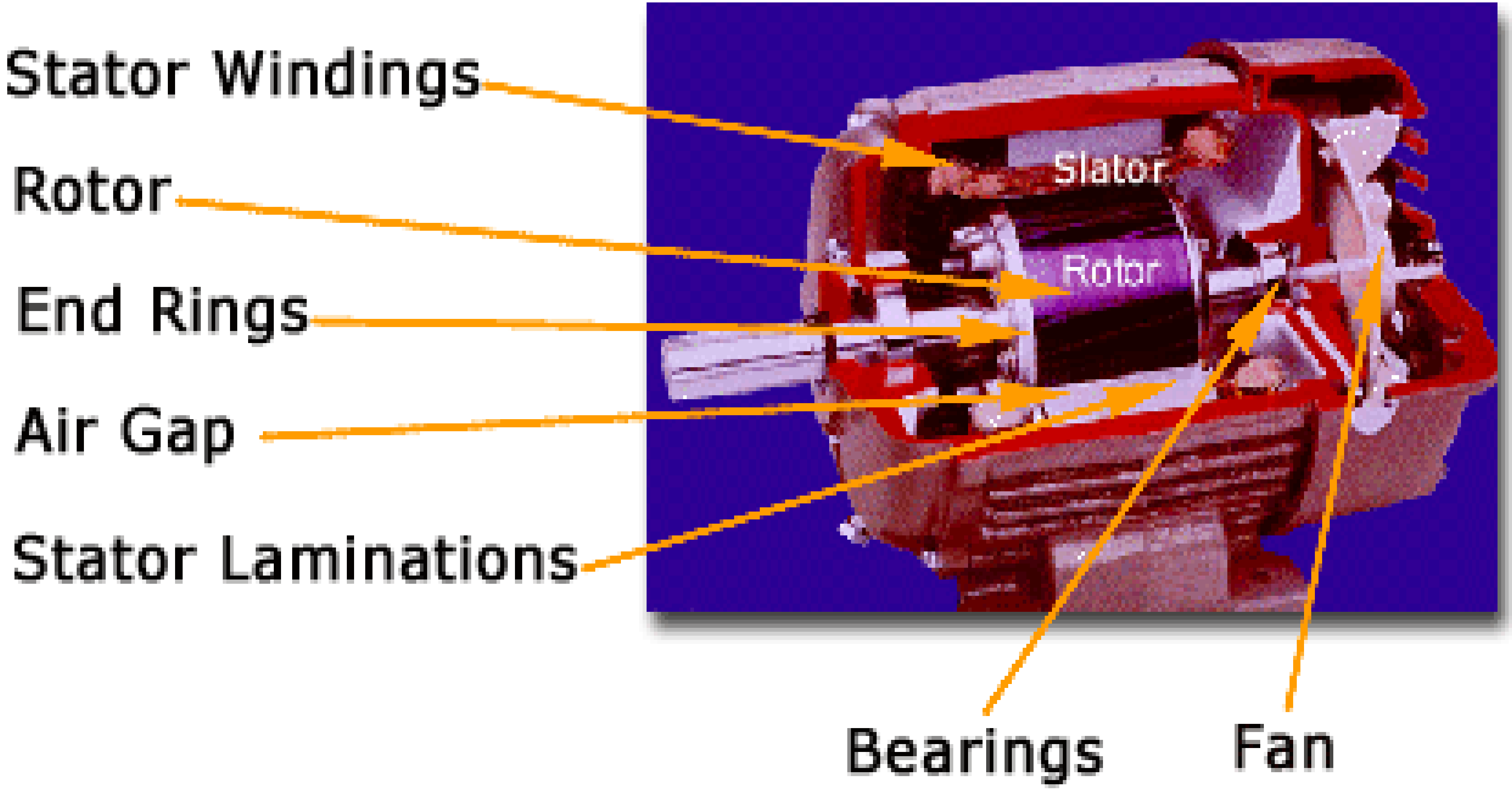
MCC-SB DeWatering Building

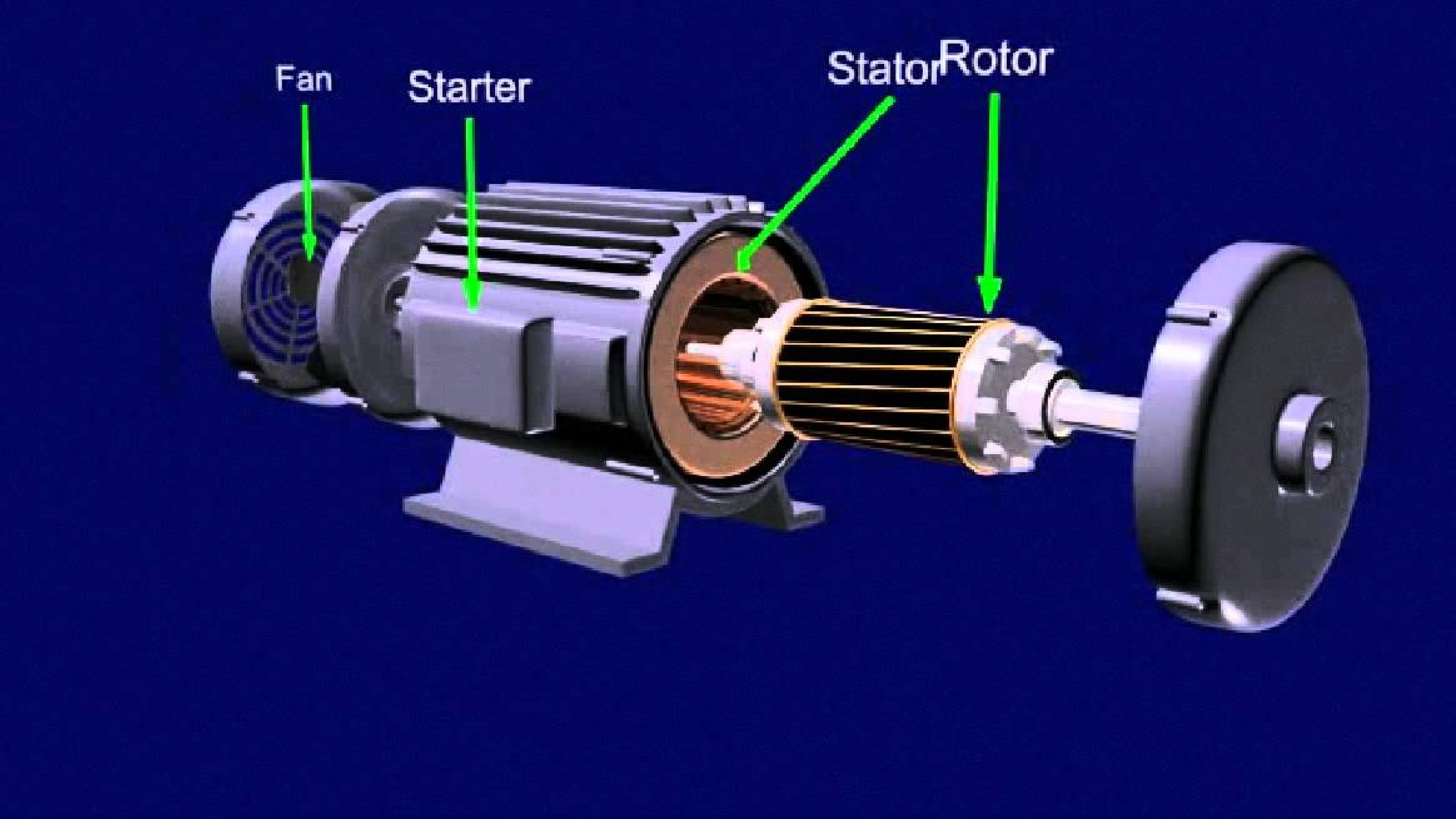


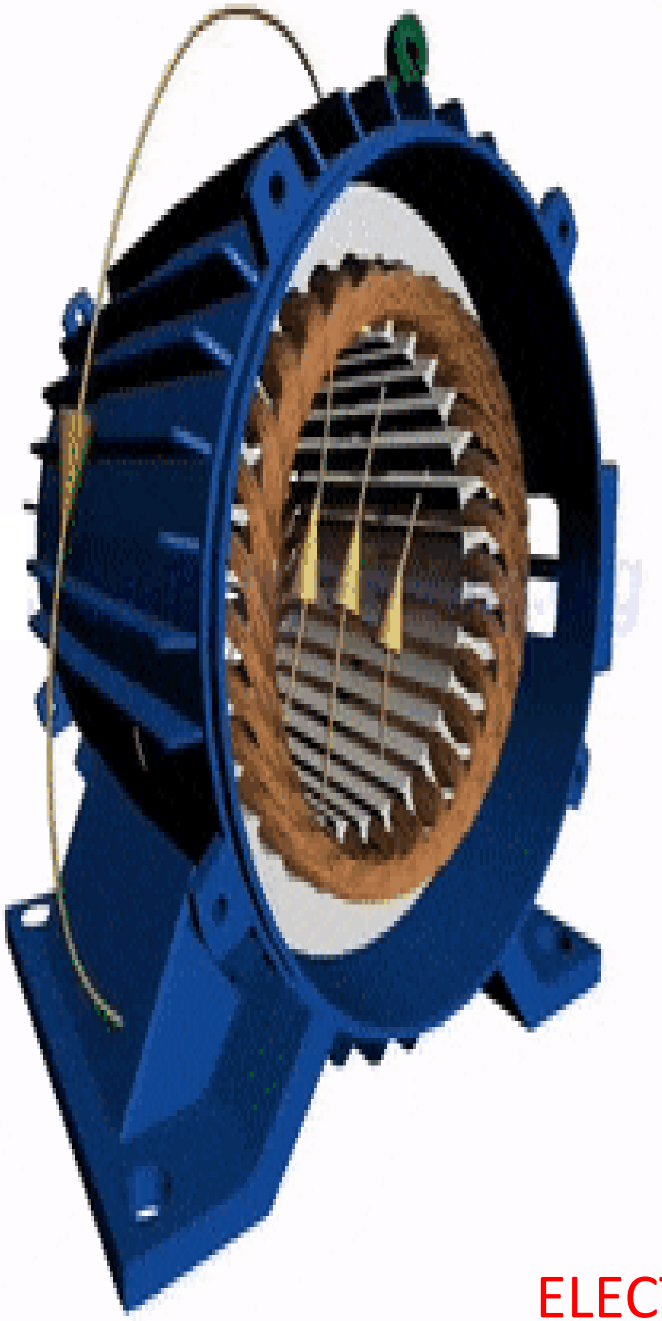
Let's Discuss

SANDUSKY ELECTRICAL DISTRIBUTION

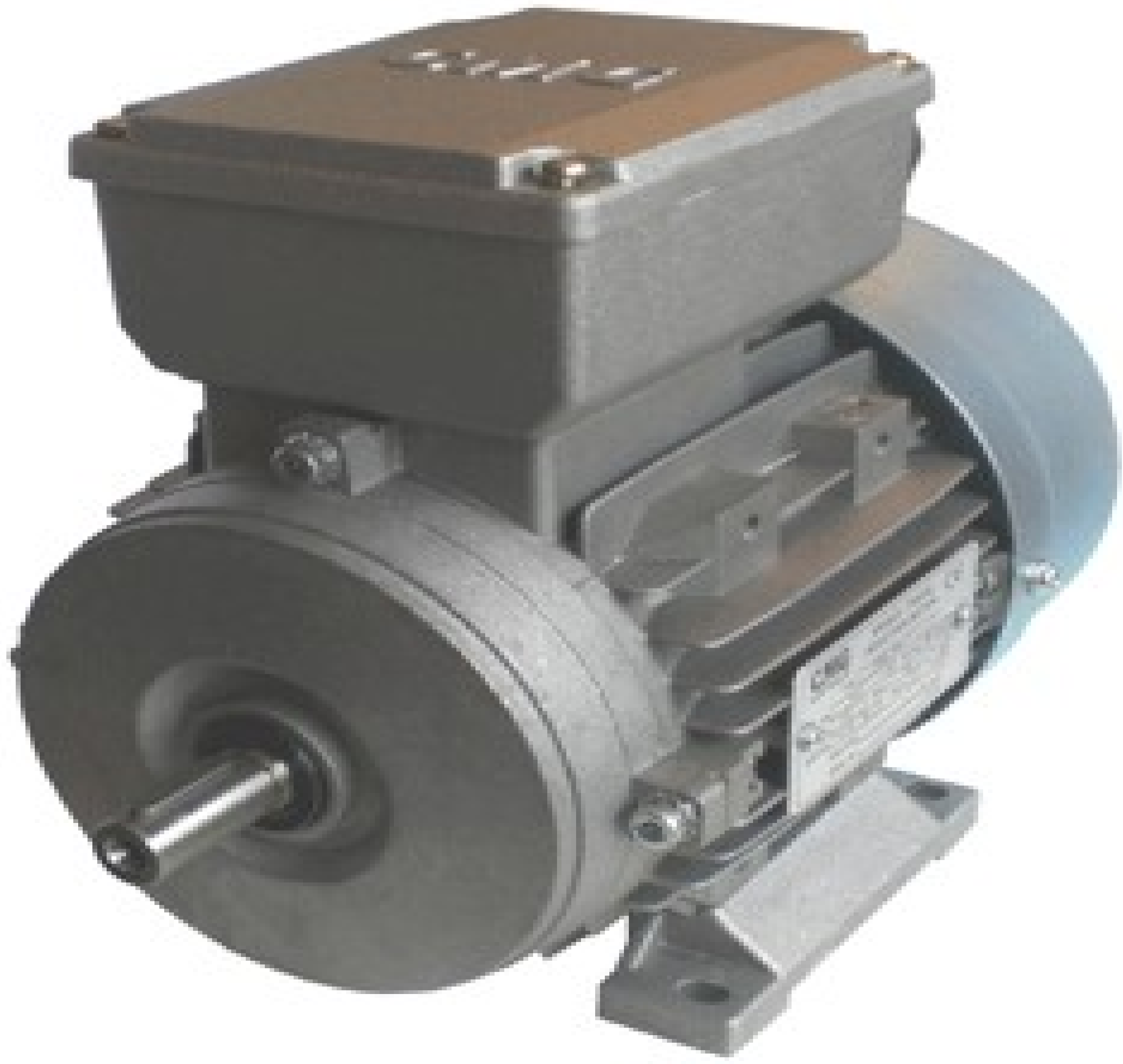



Stator Windings
Rotor
End Rings
Air Gap
Stator Laminations
Bearings
Fan
Stator
Rotor

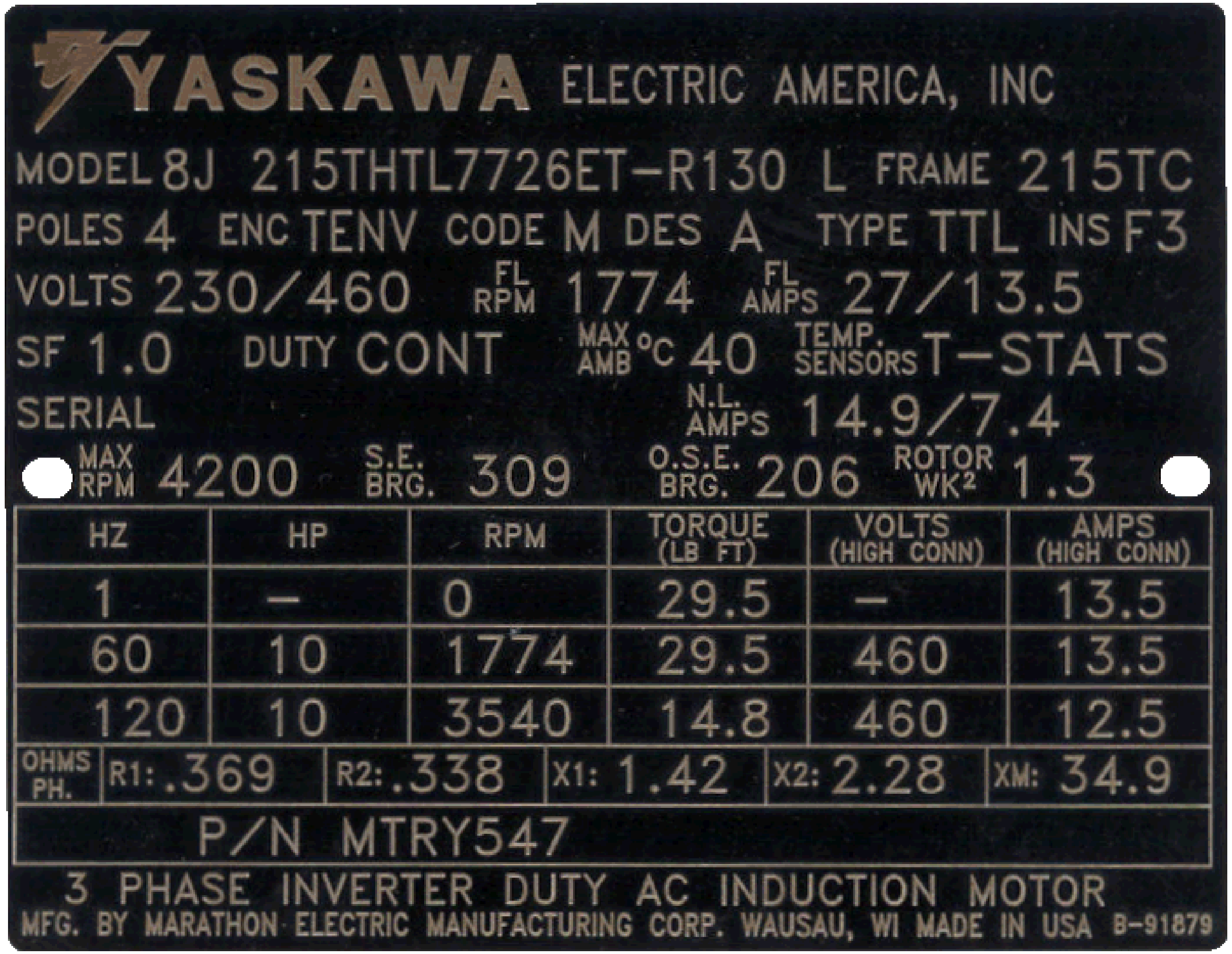

Fan
Starter
Stator
Rotor



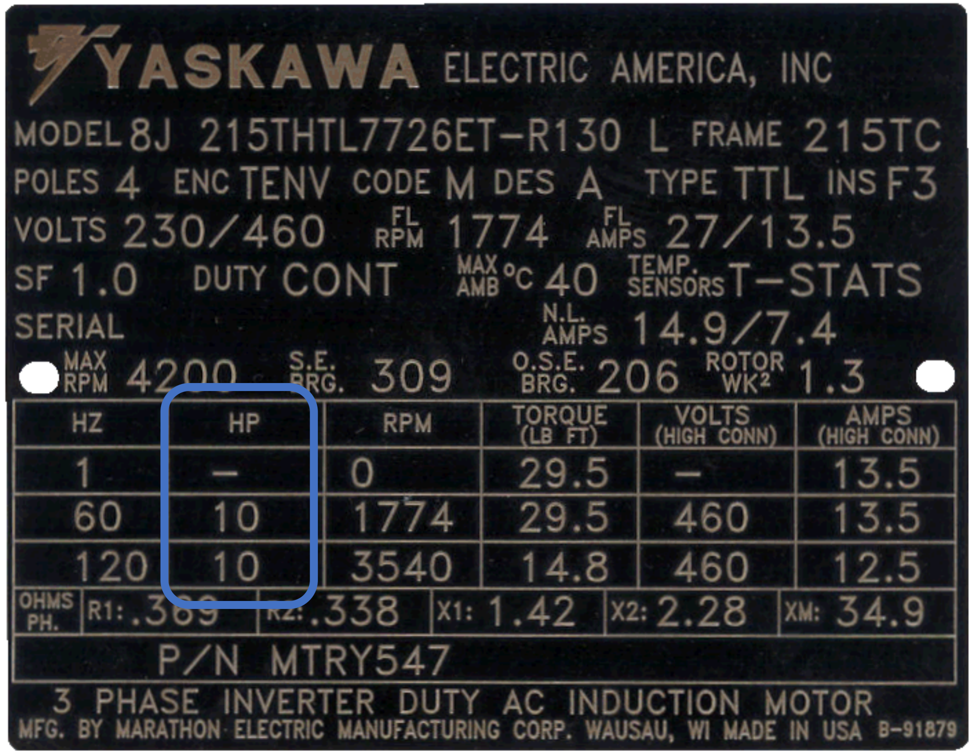
ELECTROMOTIVE FORCE



Motor Nameplate Data



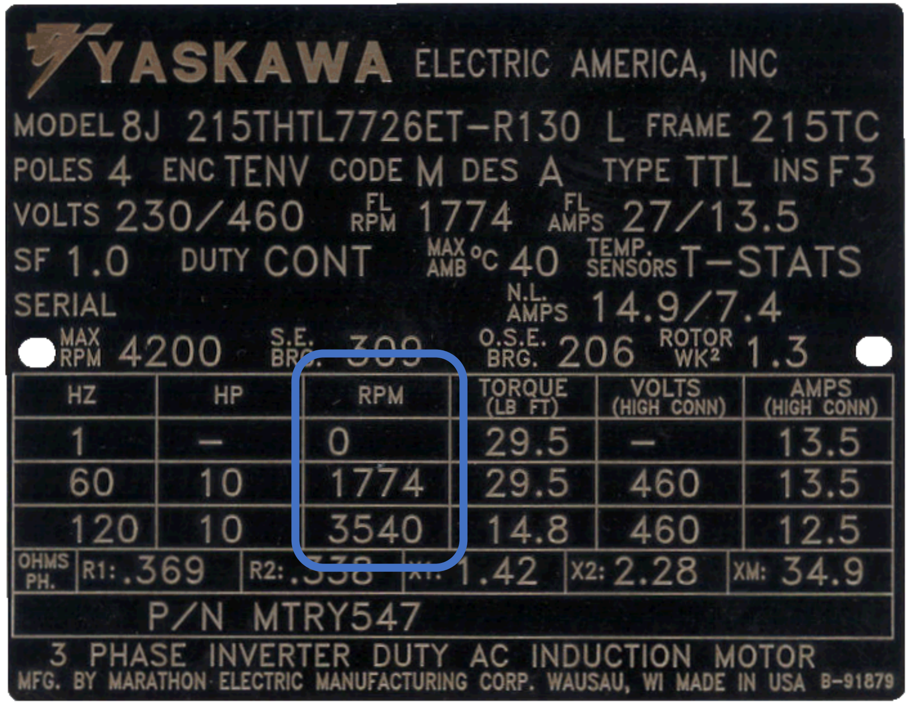
Understanding the Nameplate



<u>HP- Horsepower</u>

- The horsepower figure stamped on the nameplate is the horsepower the motor is rated to develop when connected to a circuit of the voltage, frequency and number of phases specified on the motor nameplate.

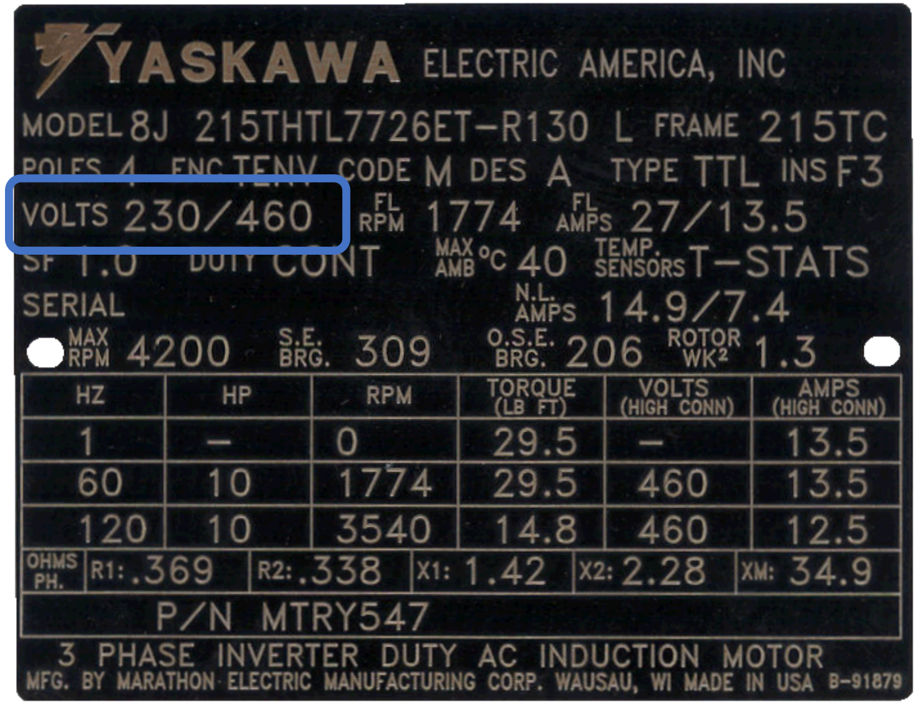
Understanding the Nameplate



<u>RPM - Revolutions per Minute</u>

- The RPM value represents the approximate speed at which the motor will run when properly connected and delivering its rated output

Understanding the Nameplate

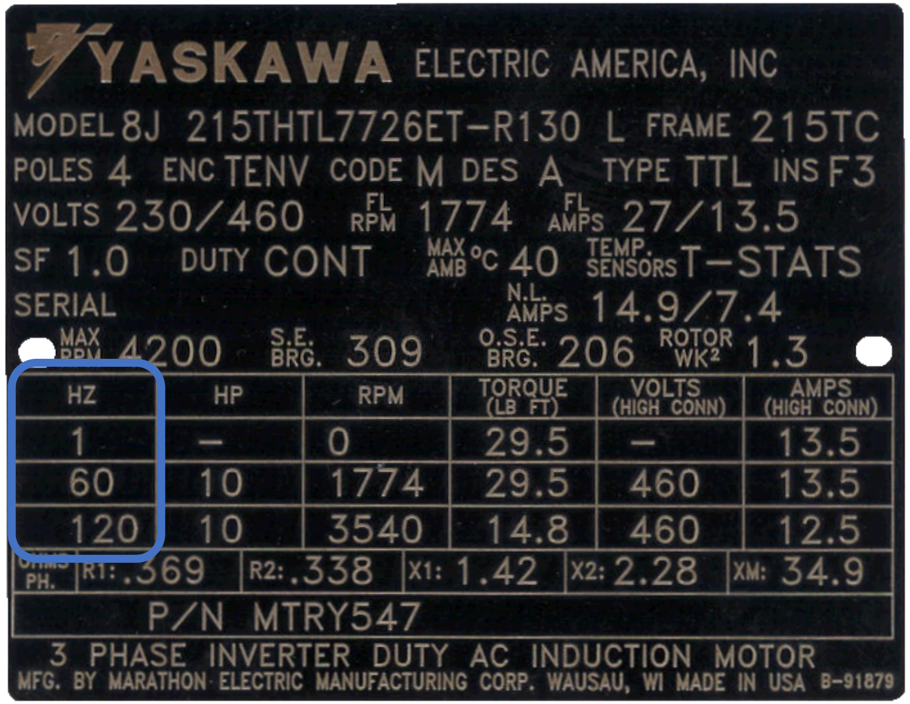


Voltage

- The rated voltage figure on the motor nameplate refers to the voltage of the supply circuit to which the motor should be connected, to produce rated horsepower and RPM.

When a motor nameplate indicates that a motor is rated 220-440, **230-460**, or. 240-480, it **means** the motor is designed to run at either the low or high **voltage** rating

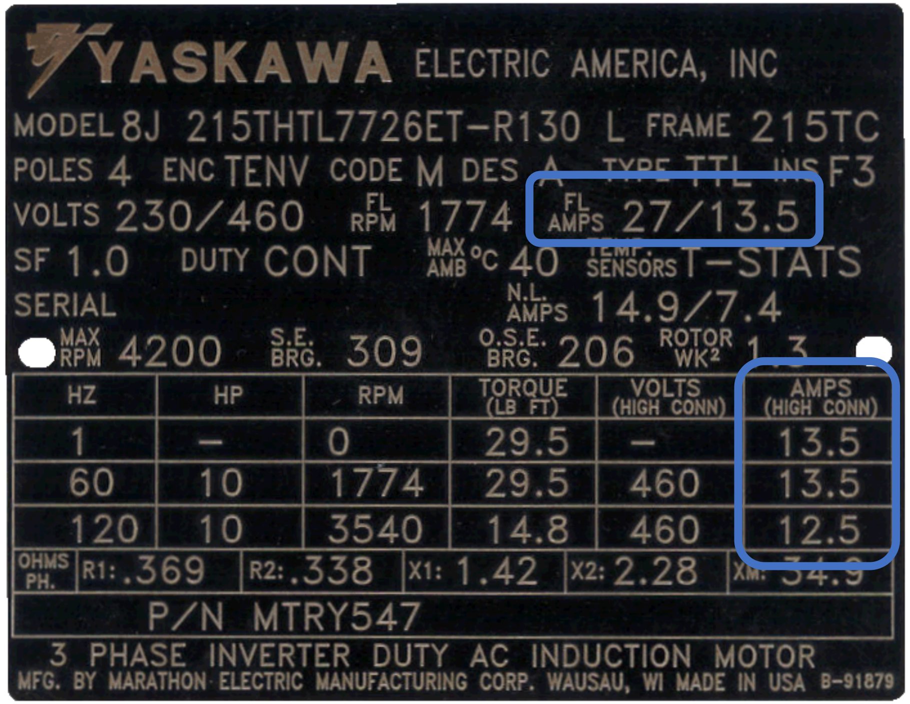
Understanding the Nameplate



Hz-Frequency

- The frequency figure on the motor nameplate describes the alternating current system frequency that must be applied to the motor to achieve rated speed and horsepower.

Understanding the Nameplate

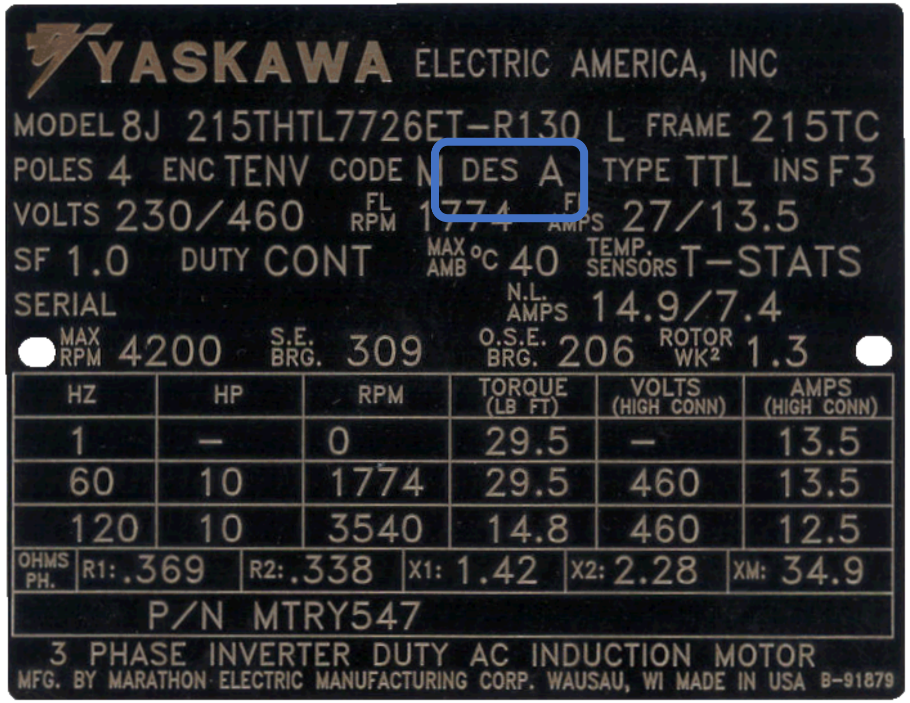


FL Amps – Full Load Amps

<u>Amps</u>

- The amp figure on the motor nameplate represents the approximate current draw by the motor when developing rated horsepower on a circuit of the voltage and frequency specified on the nameplate.

Understanding the Nameplate

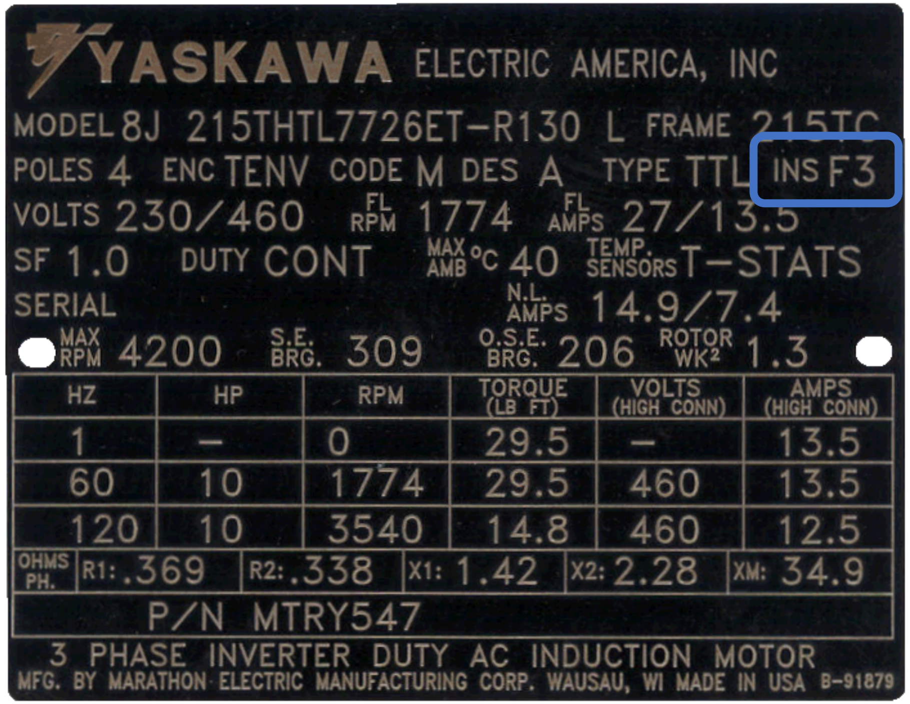


<u>NEMA Design</u>

- The NEMA Design rating specifies the speed torque curve that will be produced by the motor.

National Electrical Manufacturers Association (**NEMA**)

Understanding the Nameplate



Insulation Class

- The insulation class letter designates the amount of allowable temperature rise based on the insulation system and the motor service factor.

Insulation Class Information

- Most common insulation classes are class B and F

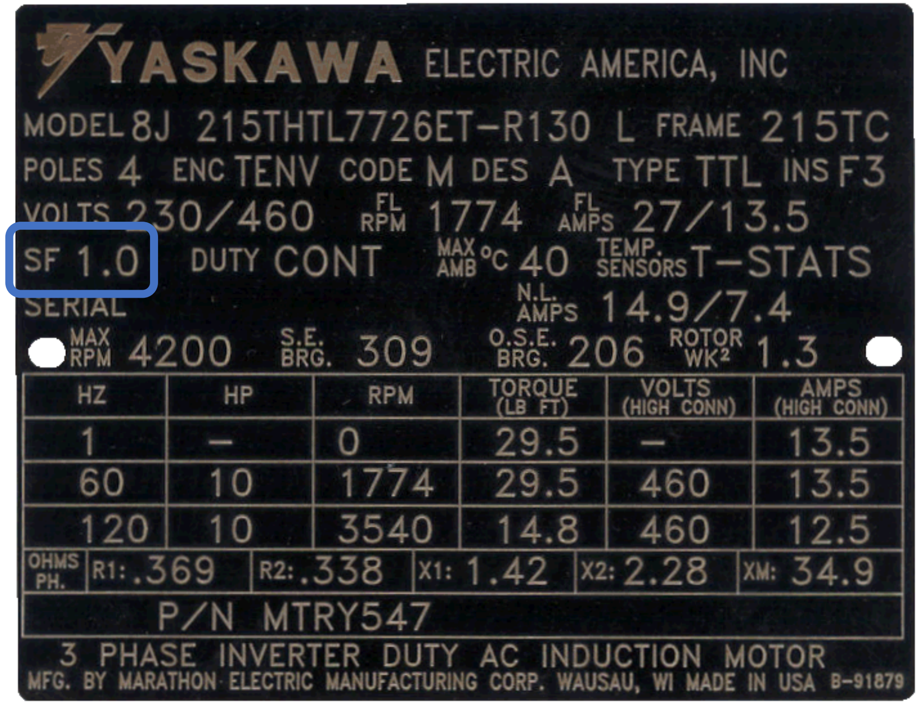
Insulation Class	Ambient Temp.	Temp. Rise	Total Temp.
A	40^oC	65^oC	105^oC
B	40^oC	90^oC	130^oC
F	40^oC	115^oC	155^oC
H	40^oC	140^oC	180^oC

40°C = 104°F 115°C = 239°F 130°C = 266°F

65°C = 149°F 140°C = 284°F 155°C = 311°F

90°C = 194°F 105°C = 221°F 180°C = 356°F

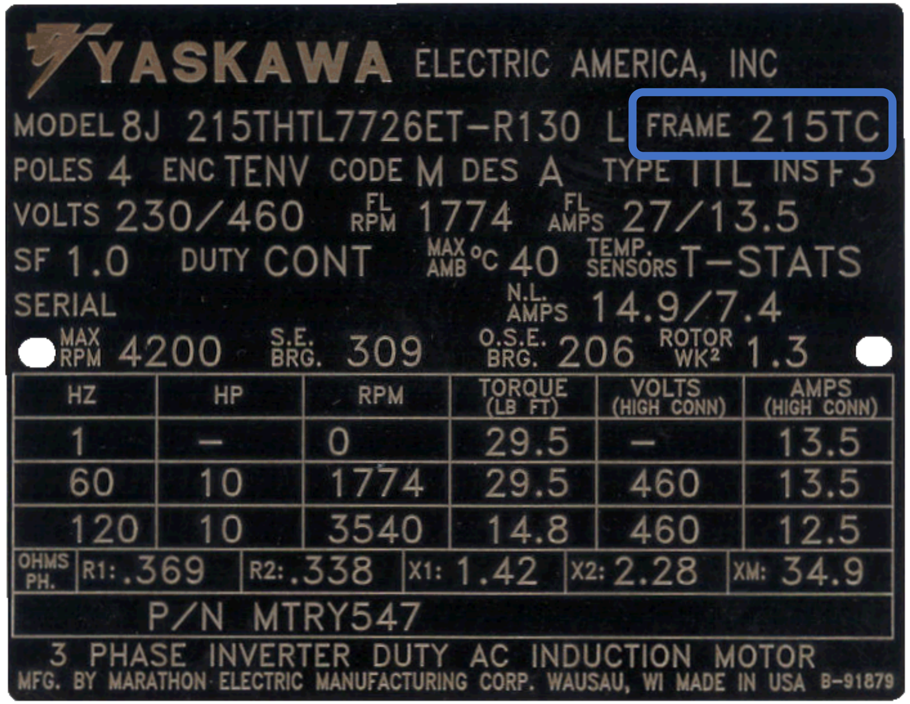
Understanding the Nameplate



S.F. - Service Factor

- The number by which the horsepower rating is multiplied to determine the maximum safe load that a motor may be expected to carry continuously
- Example - a 10HP motor with a service factor of 1.15 will deliver 11.5 horsepower continuously without exceeding the allowable temperature rise of its insulation class

Understanding the Nameplate



Frame

- The frame designation refers to the physical size of the motor as well as certain construction features such as the shaft and mounting dimensions.

There are six main causes of electric motor failures:

Over-Current

Low Resistance

Over heating

Dirt

Moisture

Vibration

1. Over-Current (Electrical Overload): In different operating conditions, electrical devices will

som ... to draw ... heir

over ... This unp

happ ... denly ar ... the

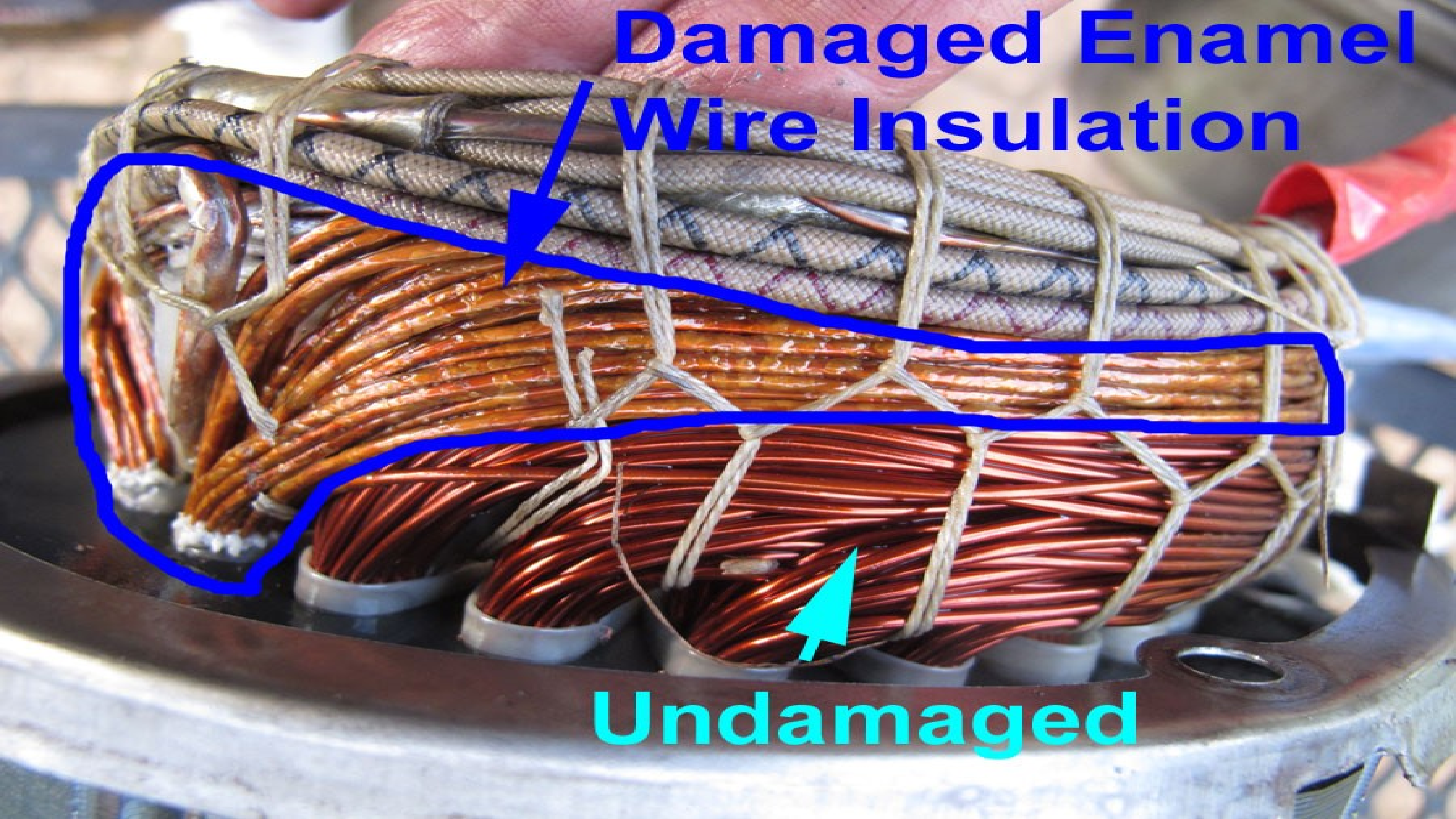
mot ... n over- ... me

devices that need to be ... vent it

from happening. These devices are usually wired in the circuits and will automatically shut down the extra amount of current flowing in the circuit.

2. Low Resistance: Most motor failu
insulation resistance. This issue is co
difficult one to tackle. In the initial sta
insulation resistance is observed to b
megaohms. After some time, the insu
degrade at an alarming level becaus
decay gradually. After a lot of researc solution has been found
which can preve There are automatic
devices that test time to time and
safeguard rotatin hat prevents such
failures. It is imp erformance is monitored
at regular interva

3. Over Heating Excessive heat in motors can cause a number of performance problems. Overheating causes the motor winding insulation to deteriorate quickly. For every ten centigrade rise in temperature, the insulation life is cut in half. It has been concluded that more than 55% of the insulating failures are caused by over heating.


Damaged Enamel
Wire Insulation
Undamaged

4. Dirt: Dirt is one of the major sources that cause damage to the electric motors. It can damage the motor by blocking the cooling fan which causes its temperature to raise. It can also affect the insulating value of the winding insulation if it settles on the motor windings. Proper steps should be taken to prevent the motors from dirt. Shielding devices are available which are used for this purpose.

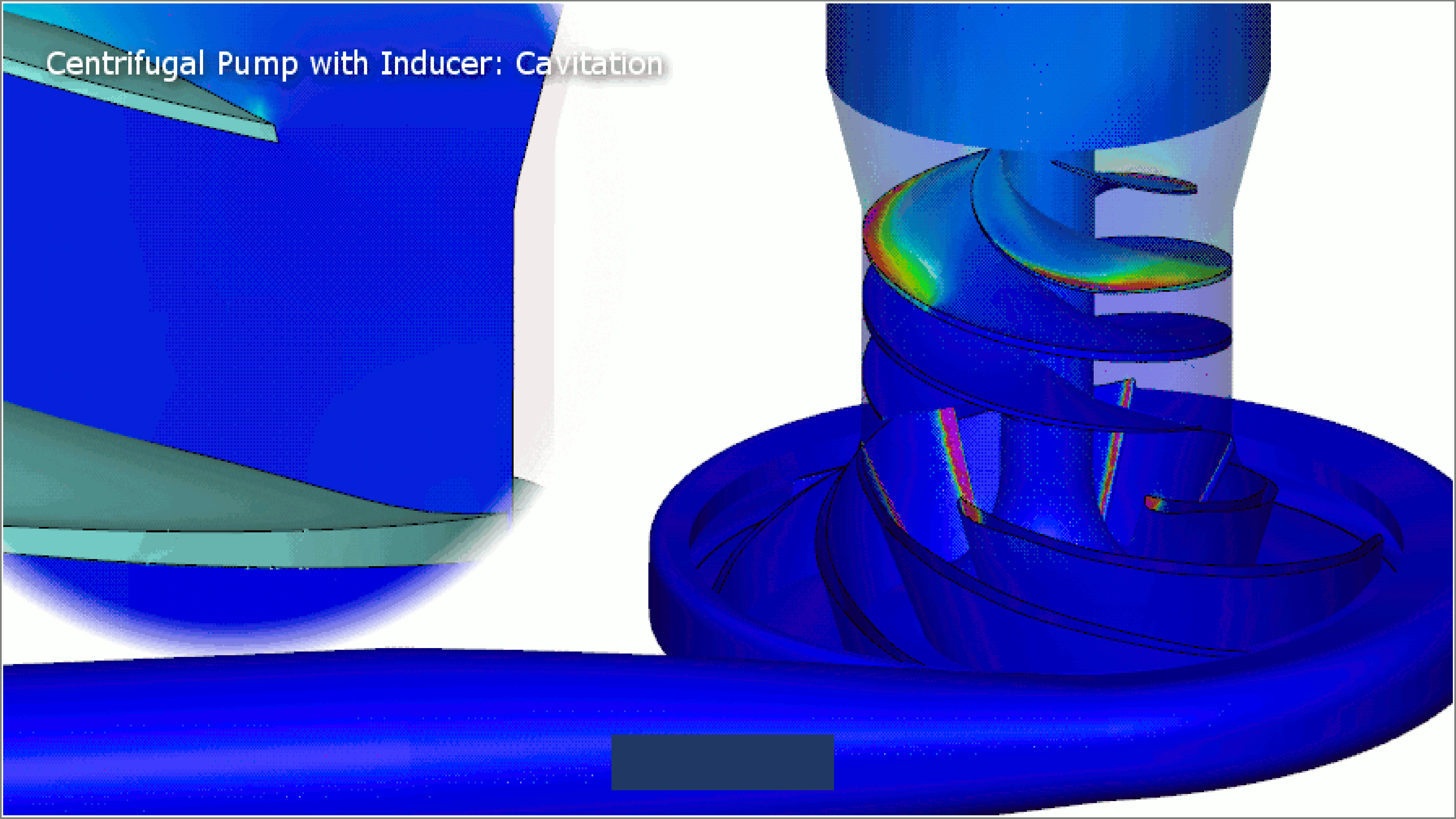
5. Moisture:

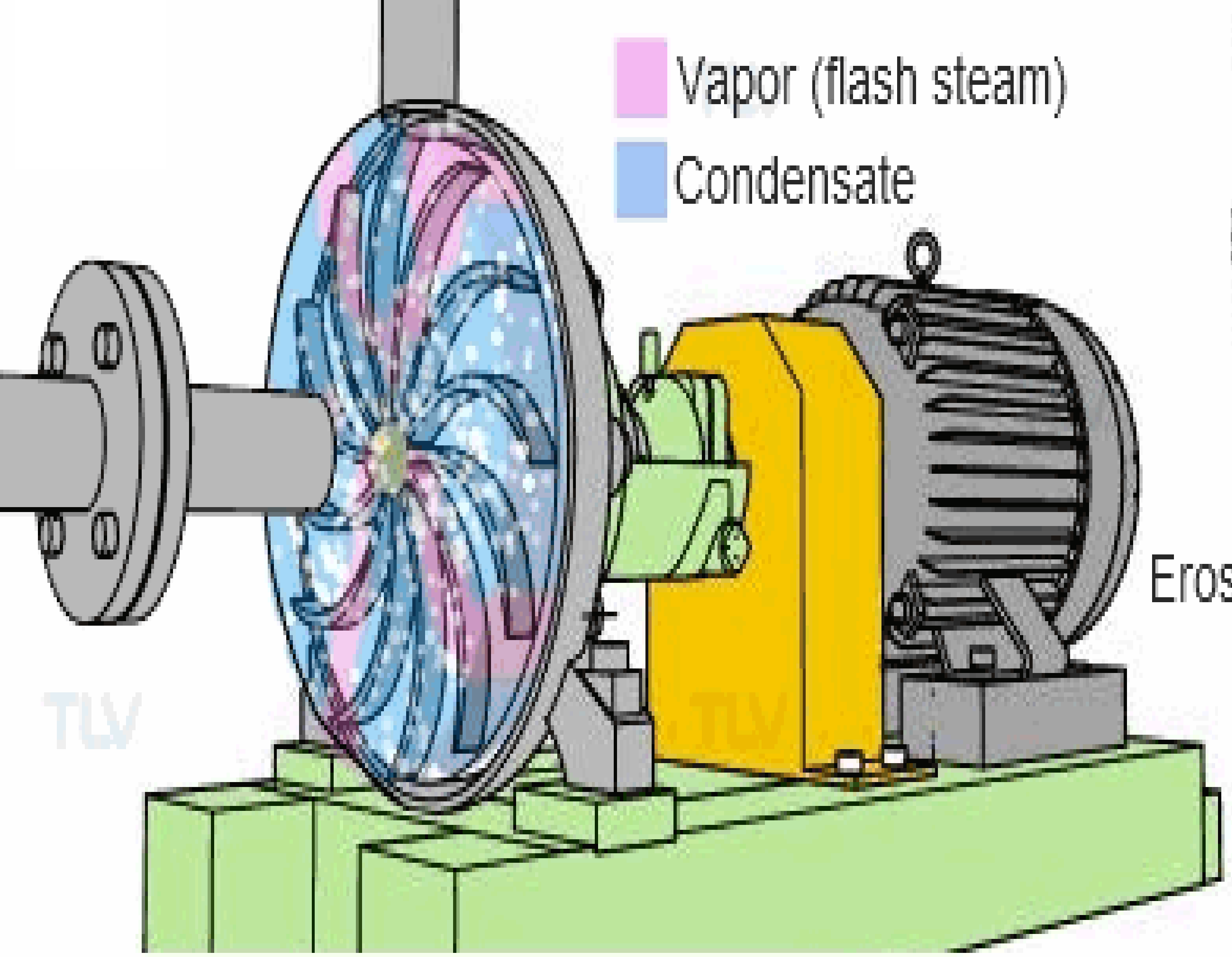
Moisture also affects the performance of electric motors. It greatly contributes in the corrosion of the motor shafts, bearings and rotors. This can lead to an insulation failure also. The motor inventory should be kept dry all the time.

6. Vibration: There are a number of possible causes of vibration, such as misalignment of the motor. Corrosion of parts can also cause the motor to vibrate. The alignment of the motor should be checked to eliminate this issue

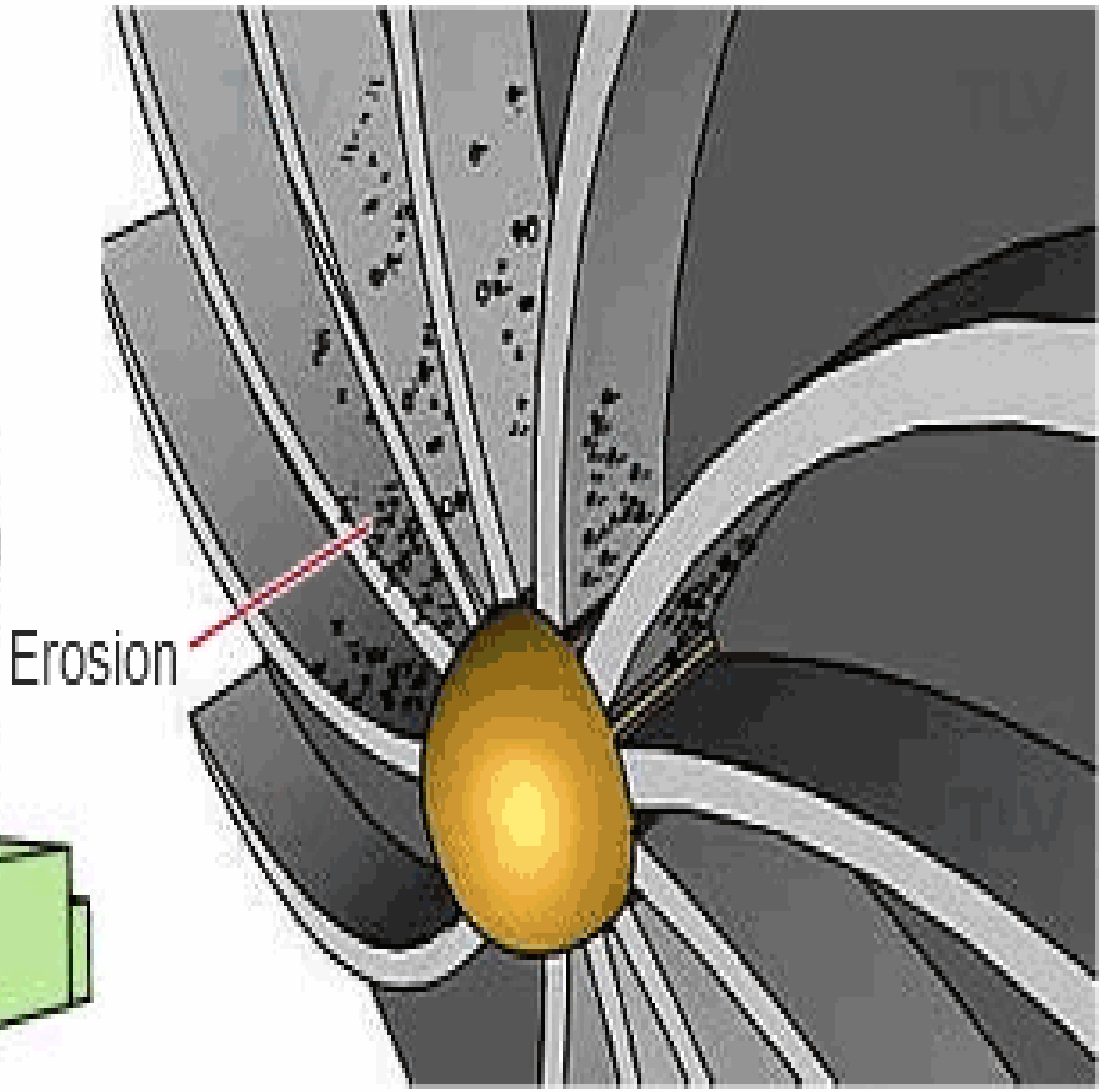
ANOTHER MAJOR REASON FOR VIBRATION IS ???

CAVITATION

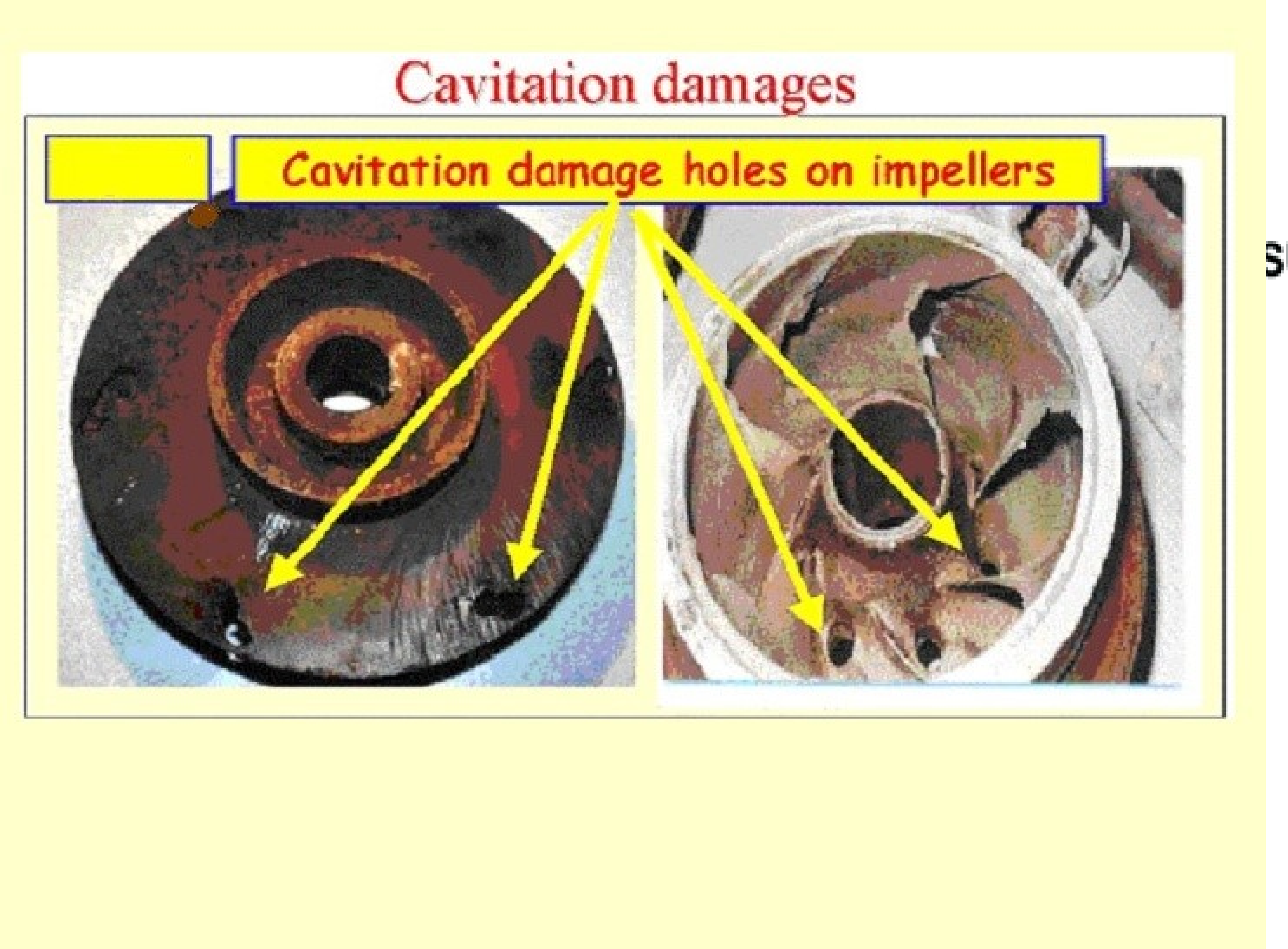

Centrifugal Pump with Inducer: Cavitation

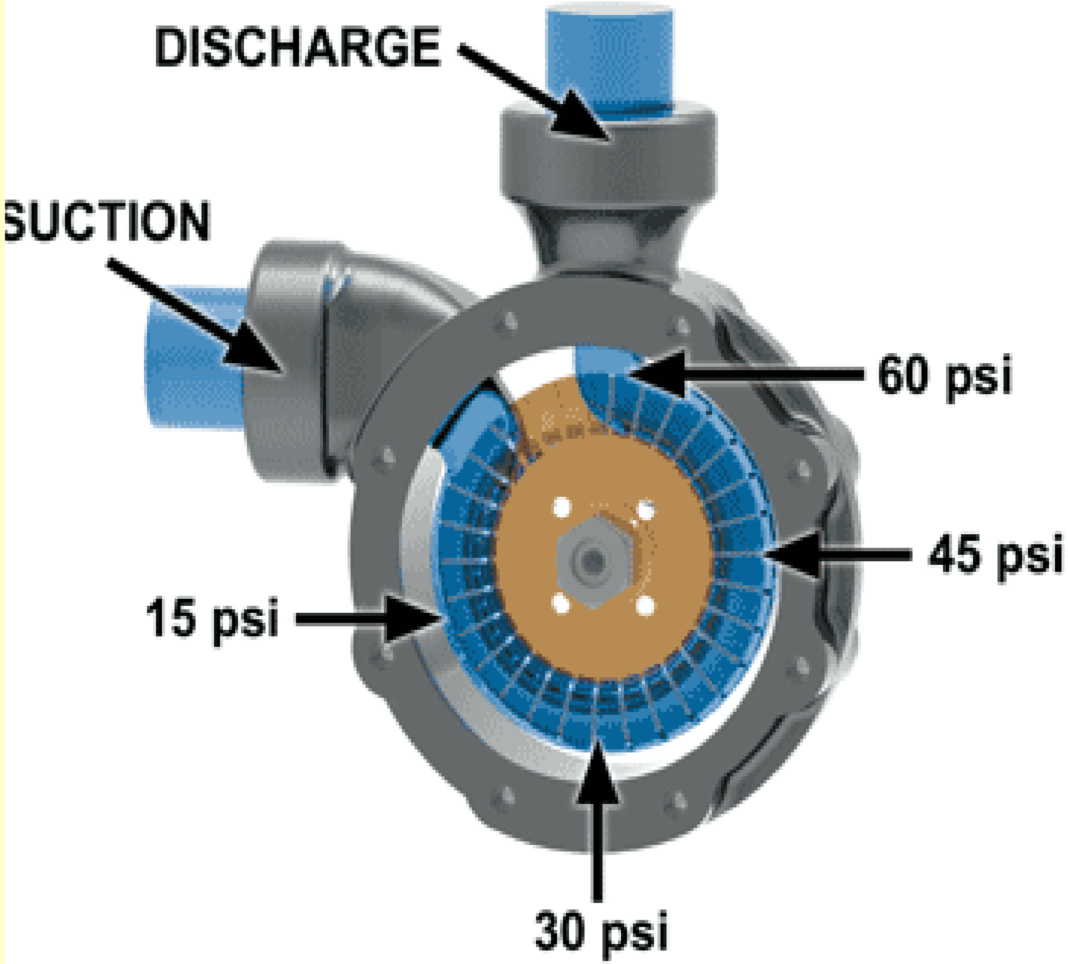


Pump oscillates due to cavitation



Damage caused to impeller


Cavitation damages
Cavitation damage holes on impellers


DISCHARGE
SUCTION
60 psi
45 psi
15 psi
30 psi

	Sample Checks on an AC Motor
	Temperature IB bearing Temperature center motor Vibration pen at painted spot Check cleanliness of motor Look at condition of junction box and cables Visually look for water on motor • Check fan with stroboscope • Listen for unusual noise
	• Measure amps • Vibration analysis with analyzer (different than pen above)
6 months	• Carefully check the base (steel) and foundation (concrete)

For example, the lifecycle energy-intensity of water in cities nationally is estimated to be 3,300-3,600 kWh per million gallons delivered and treated (Both Water and Wastewater combined).

Optimizing system processes, such as modifying pumping and aeration operations and implementing monitoring and control systems through SCADA (supervisory control and data acquisition) systems to increase the energy efficiency of equipment. EPRI (Electric Power Research Institute) has estimated that drinking water facilities can achieve energy savings of 5%-15% through adjustable speed drives and high efficiency motors and drives through process optimization and SCADA systems. In wastewater facilities, EPRI estimates that 10%-20% energy savings are possible through process optimization.

Calculating Your Own Horsepower

1. **Weigh yourself.** Find out how much you weigh in kilograms (your weight in pounds (your weight in pounds multiplied by 0.454) and write it down.

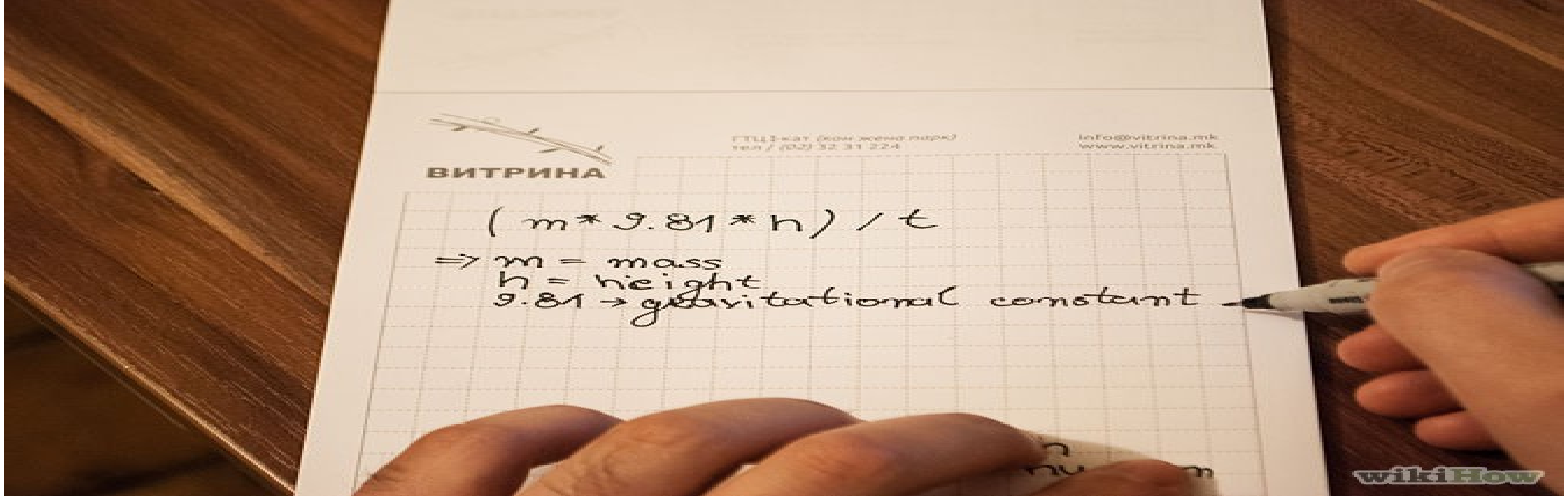
2.

Find a stairway that is free from obstructions. You'll be running up these stairs with a stopwatch, so try to find a stairway that is not frequently used.

3. **Measure the total height of the stairs from the base to the top of the stairs (the height of one stair multiplied by the number of stairs).** If you measure in feet, multiply that number by .3048 to convert to meters. Write down the height in meters.

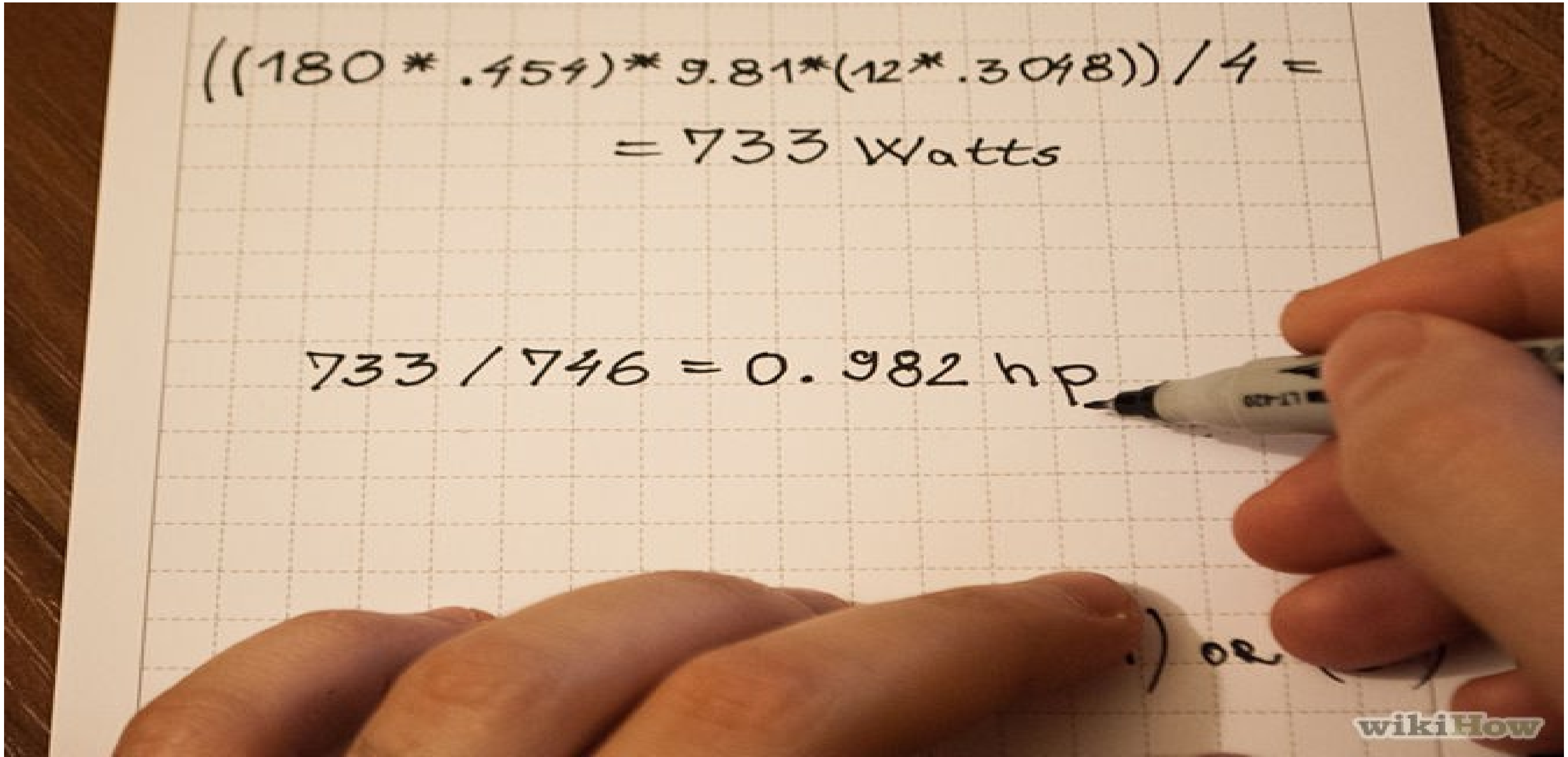
4.Keep a steady pace. Get a running start, and when your foot lands on the first step, start your stopwatch.

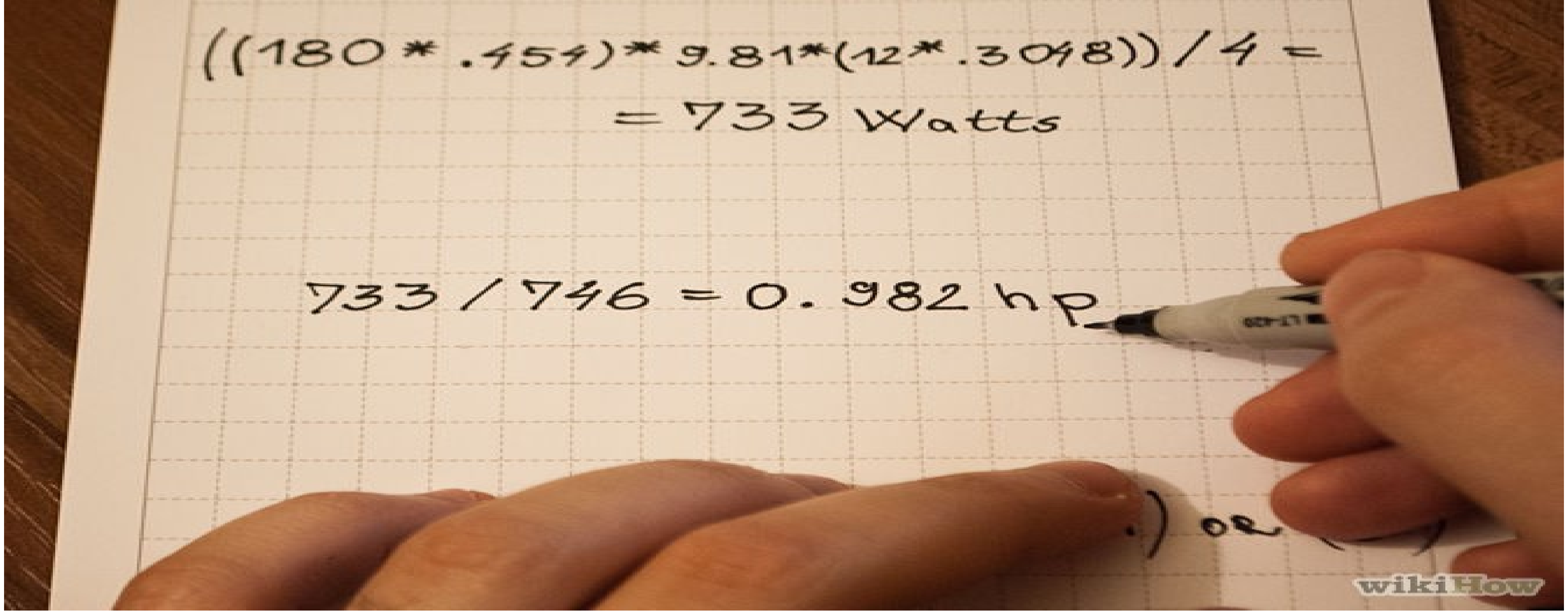
•When both feet are on the top step, stop your stopwatch. Write down the duration of your climb to the top.



5.**Calculate your Wattage.** Use the formula (m*9.81*h)/t, where m=mass (i.e., your weight in kilograms), h=height of staircase in meters, 9.81 is the gravitational constant that must be taken into account, and t=time in seconds of your climb. The resulting number you get is expressed in Watts.

Example: If you weigh 180 lbs, and you climb a 12-foot staircase in 4 seconds, that equals ((180 * .454) * 9.81 * (12 * .3048)) / 4 = 733 Watts





6. Calculate your Horsepower. Divide the number of Watts by 746 to find out your horsepower rating.

- A healthy human can generate a short burst of about 1.2hp, and a sustained output of about .1hp.

REMEMBER : TO LOCKOUT

&

TAGOUT

THANK YOU: FROM MIKE MARINGER 419 – 707 - 7559