

Understanding Power Quality

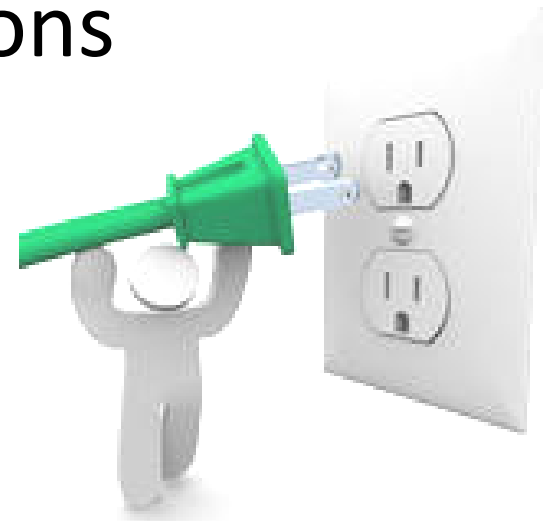


Outline

- I. Power Quality (PQ) Definition**
- II. Distribution Utility Parameters & Limits**
- III. Types of PQ Problems**
- IV. Solution to PQ Problems**

Power Quality (PQ) Definition

The quality of the **voltage**, including its **frequency** and the resulting **current**, that are measured in the Distribution System during normal conditions



Power Quality (PQ) Definition

PQ is all about

electromagnetic compatibility

- Equipment operates within its environment without causing disturbance either to itself or other equipment, or back to utility source
- End-use equipment (load) rating matches supply voltage rating and variations
- Mismatch can be avoided right from the design stage



Power Quality (PQ) Definition

PQ is all about
electromagnetic compatibility

- Utility service standards must be considered before purchase of end-use equipment for compatibility of ratings
- A mismatch is costly in terms of bridging incompatibility



Parameters and Limits

Power quality begins with knowing the characteristics of the distribution utility, its capabilities and limitations.

Customers must take note of the following parameters in determining the appropriate equipment and system design for their facilities.

Parameter	Limit/s
Frequency Variations	Frequency shall be 60 Hz , with allowable variation of 59.7 to 60.3 Hz
Service Voltages	Plus/Minus 10% of RMS Voltage Secondary Nominal Voltages 230 Volts, 400 Volts, 460 Volts Primary Nominal Voltages 13.2 kV, 13.8 kV, 34.5 kV, 69 kV, 115 kV
Voltage THD	Within 5%
Voltage Unbalance	Within 2.5%

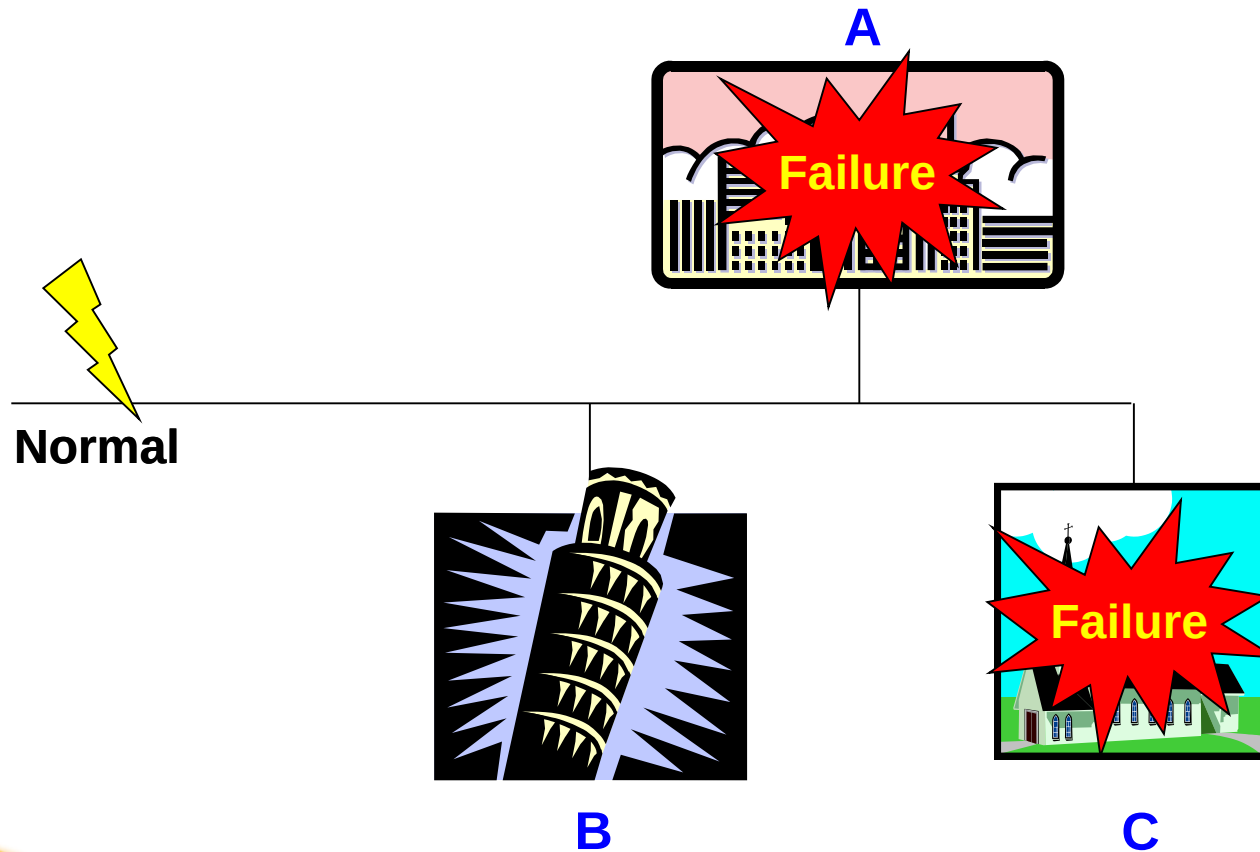
Parameters and Limits

Effect of Utility Variations on Equipment Ratings

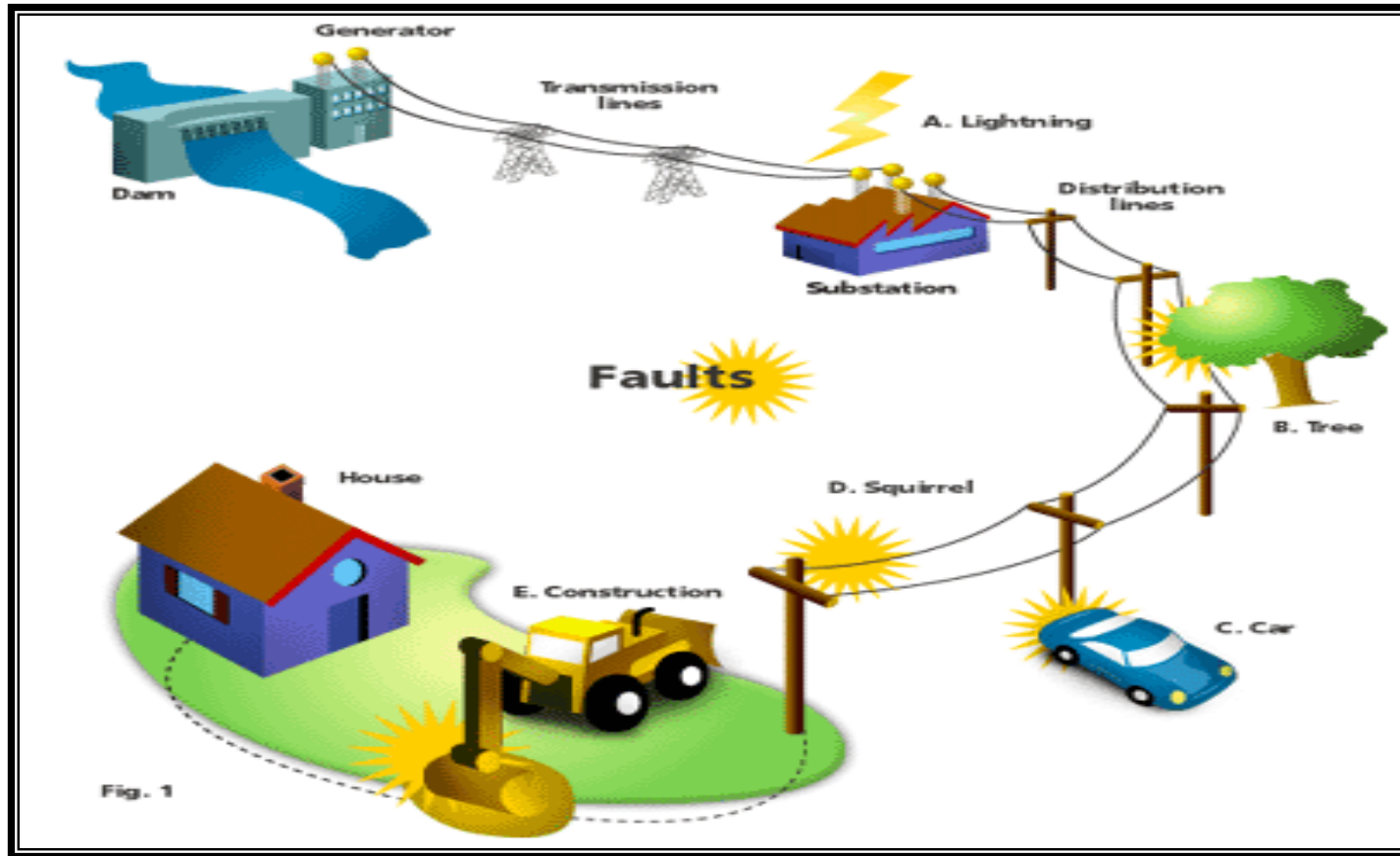
Equipment must operate satisfactorily within the -10% to +10% voltage variation of the Distribution Utility's nominal service voltage

	Voltage Variation			
	Lower Limit		Upper Limit	
Nominal Service Voltage: 230 V	207 volts	-10%	253 volts	+10%
Ex. Equipment Rating: 200 V	180 volts	3%	220 volts	27%
Ex. Equipment Rating: 220 V	198 volts	-6%	242 volts	15%
Nominal Service Voltage: 460 V	414 volts	-10%	506 volts	+10%
Ex. Equipment Rating: 440 V	396 volts	-6%	484 volts	15%
Ex. Equipment Rating: 480 V	432 volts	-14%	528 volts	5%

PQ Problem Illustrated



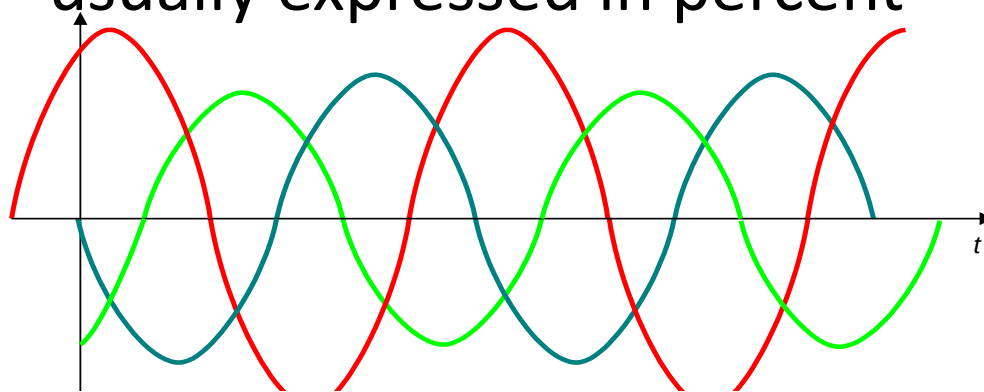
PQ Problem Illustrated



Fault/s anywhere in the network may result to power disturbances of varying magnitude and duration depending on the type and proximity of fault.

Voltage Unbalance

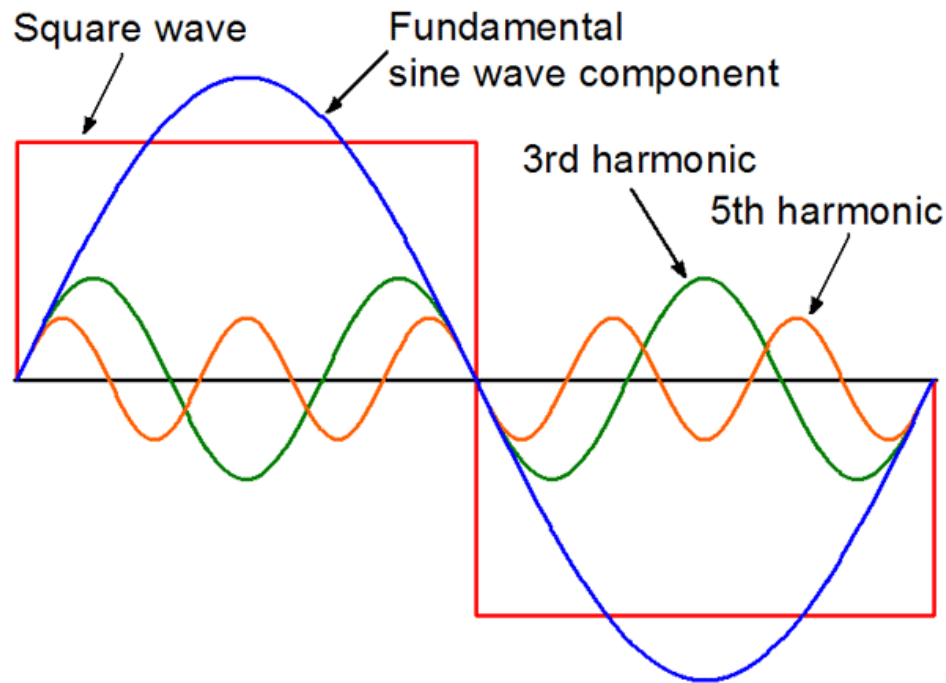
Maximum deviation from the average of the three-phase voltages divided by the average of the three-phase voltages, usually expressed in percent



- Unbalanced distribution of single phase loads
- Unstable system neutral
- One-phase out power supply

Types of PQ Problems

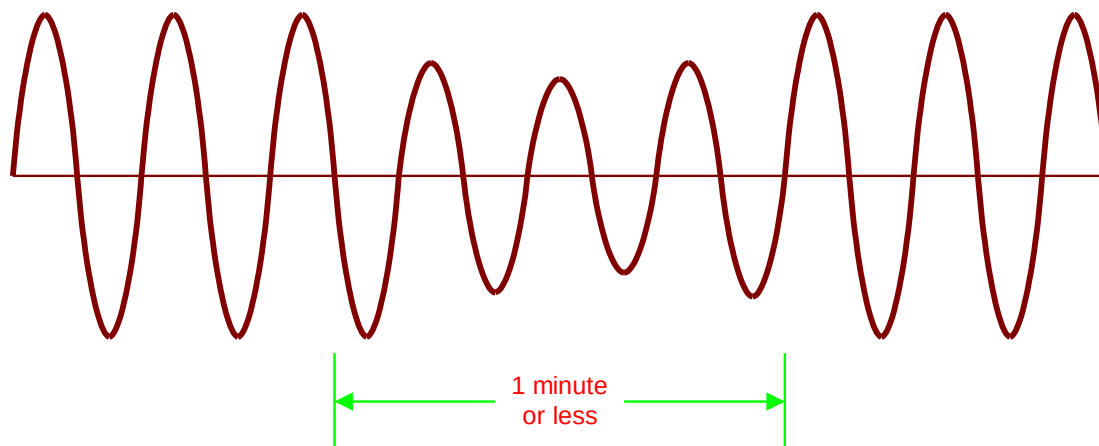
Total Harmonic Distortion (THD)



THD is the measure of the effective value of the harmonic components of a distorted waveform, that is, the potential heating value of the harmonics relative to the fundamental

Voltage Sag

A decrease in RMS voltage between 10% to 90% of the nominal value for duration from half cycle to 1 minute

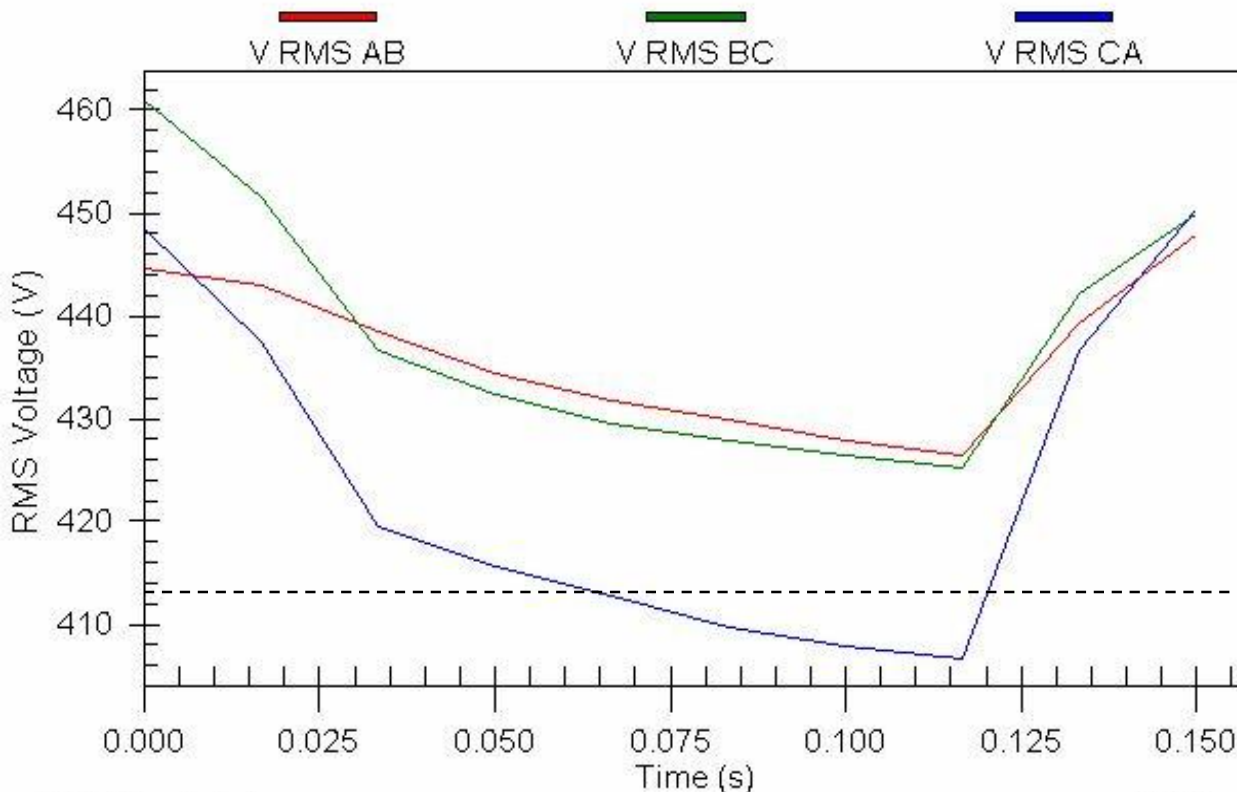


- Starting of electric motors
- Switching “on” of large loads
- Fault on either distribution, transmission or generation systems

Types of PQ Problems

Voltage Sag

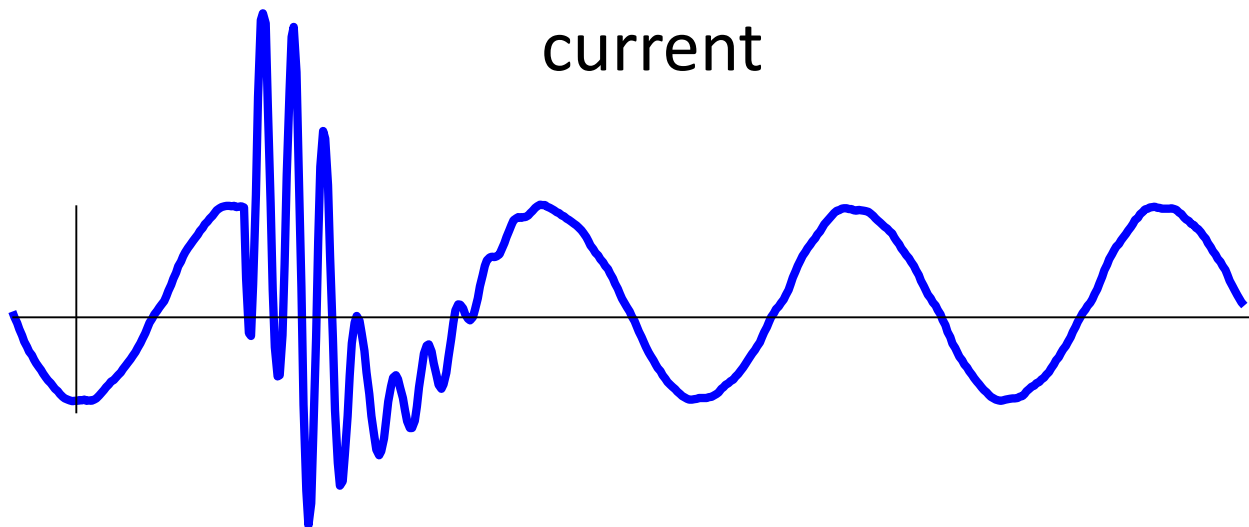
6/3/2004 14:50:13.142



- Nominal Voltage: 460V
- Magnitude: 88.41%
- Duration: 4 cycles
- Cause: Fault on the adjacent feeder

Voltage Transient

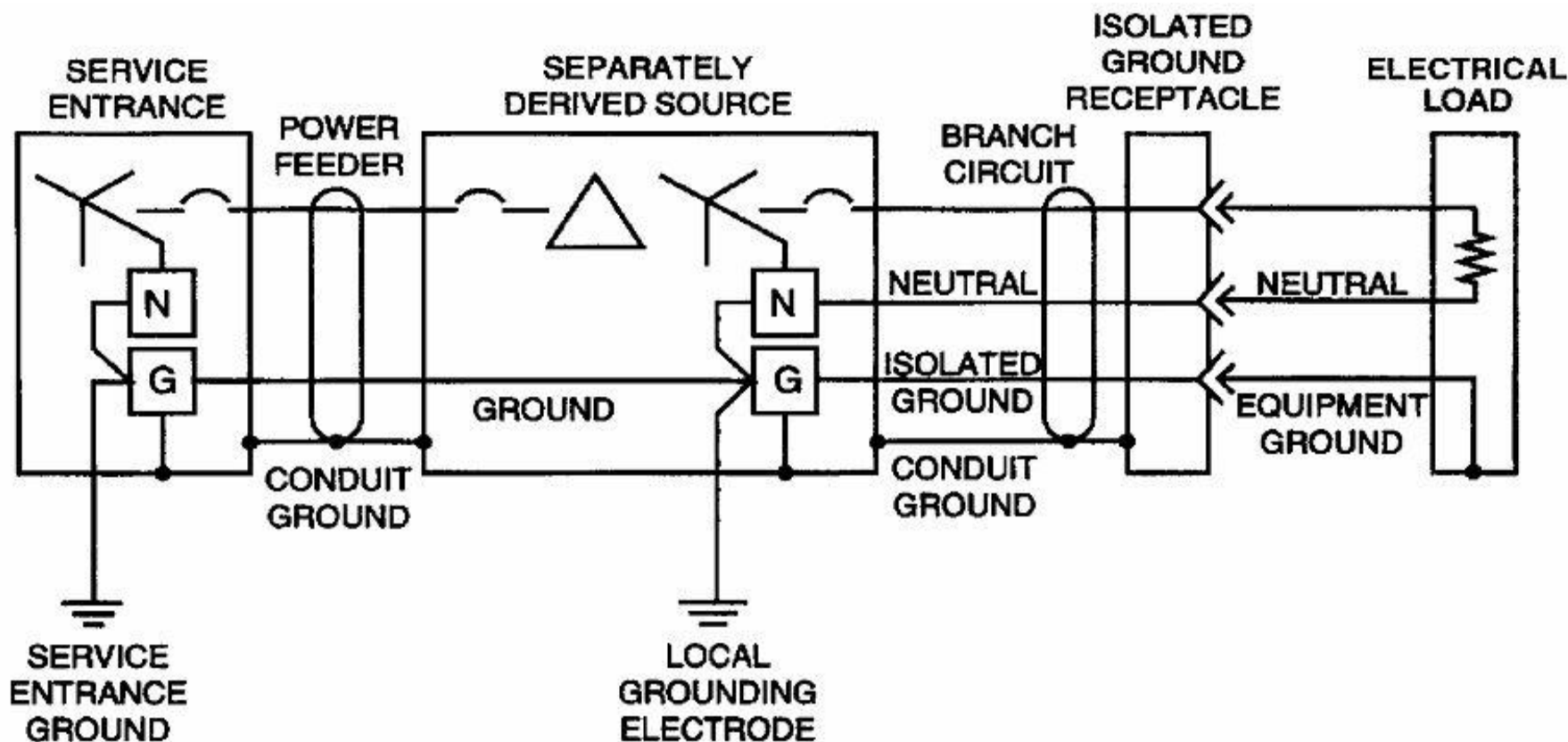
A sudden, non-power frequency change of voltage or current



- Lightning
- Load switching
- Capacitor switching

Types of PQ Problems

Proper Grounding Practices



Solutions to PQ Problems

AVR vs UPS



Can handle "fluctuations" (between plus 10% to minus 10% of nominal voltage)	Can handle "fluctuations" and power interruptions
< 2 AC Cycles	On line
Cannot handle voltage sags	Can handle voltage sags and power interruptions



Solutions to PQ Problems

UPS (Universal Power Supply)

Model	Input Voltage
DPP480-24-1	90 - 264VAC 1ph
DPP480-48-1	90 - 264VAC 1ph
DPP480-24-3*	340 - 575VAC 3ph
DPP480-48-3*	340 - 575VAC 3ph



Solutions to PQ Problems

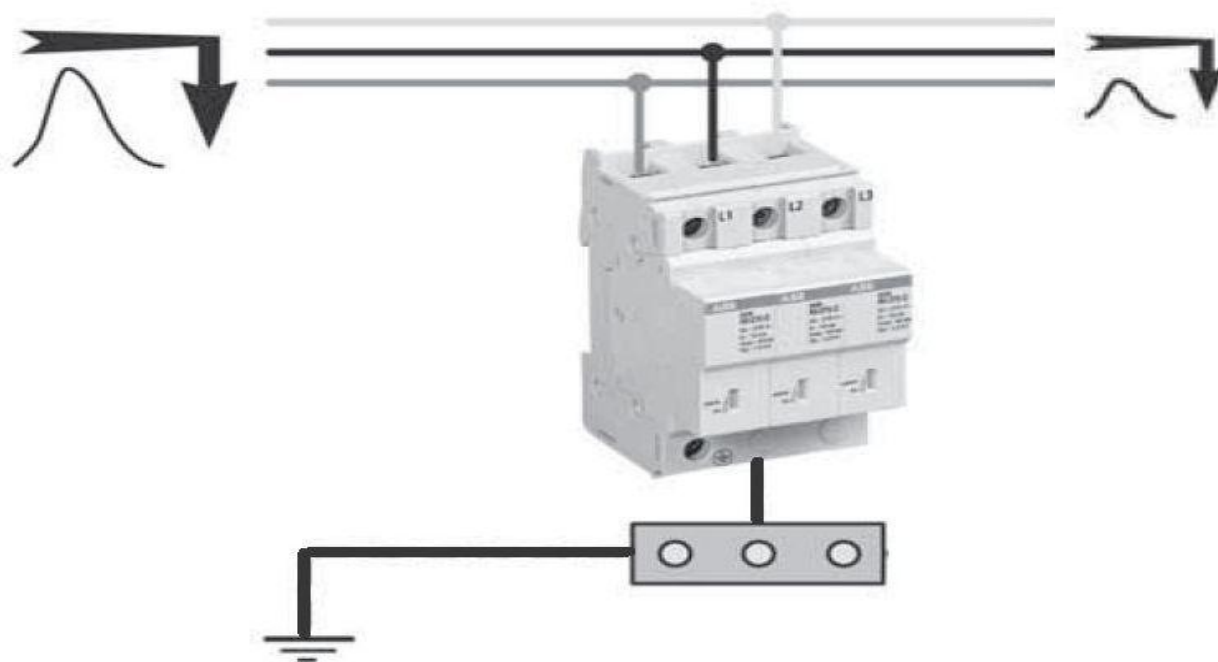
Sag Correctors

Output Current	2400 Amps
Output Capacity	1580–1996 kVA
Output Overload (Current)	150% for 30 sec, 400% for 5 sec, 600% for 0.5 sec
Efficiency	>99%
Correction Time	3 phase (87% to 50% remaining): 5 sec 2 phase (30% remaining): 5 sec 1 phase (0% remaining): 5 sec



- Provides energy during voltage sag events
- Small to large applications

Transient Voltage Surge Suppressor (TVSS)

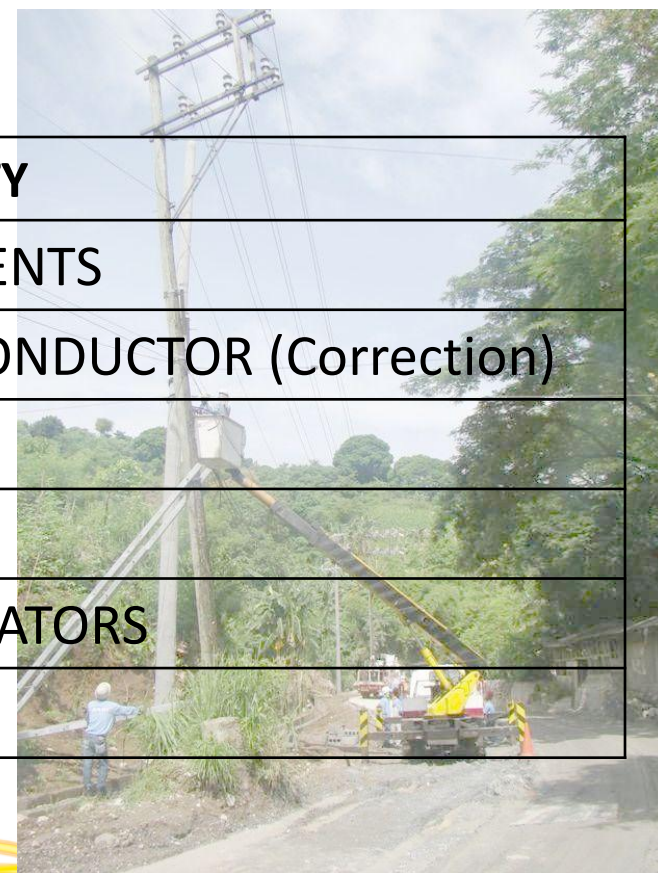


- Provides protection from transient voltage

Solutions to PQ Problems

Maintenance Activities

DESCRIPTION OF ACTIVITY
CORRECTION OF OVERHEATING LINE COMPONENTS
MISSING/CUT/DETACHED POLE GROUNDING CONDUCTOR (Correction)
TREE PRUNING
FOREIGN OBJECTS / KITE STRING REMOVAL
REPLACEMENT OF PIN / CONTAMINATED INSULATORS
INSTALLATION OF BIRD SPIKE



Solutions to PQ Problems

Pole Attachments

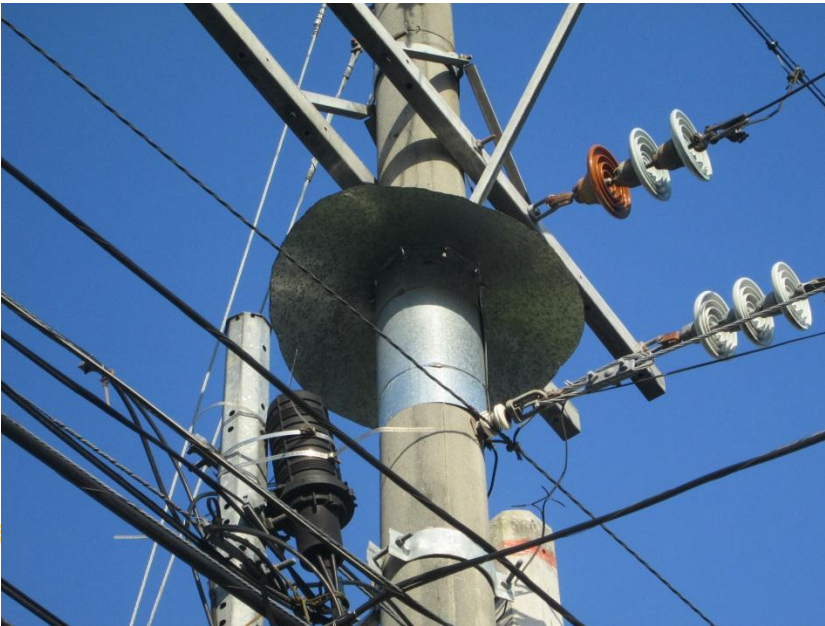
Bird spikes



Solutions to PQ Problems

Pole Attachments

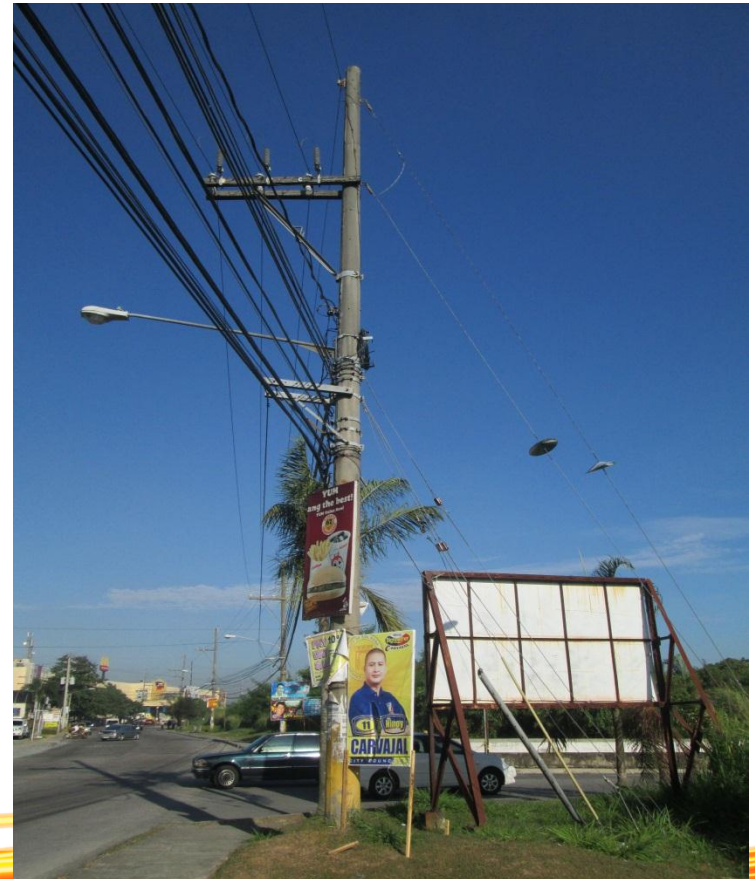
Snake cones



Solutions to PQ Problems

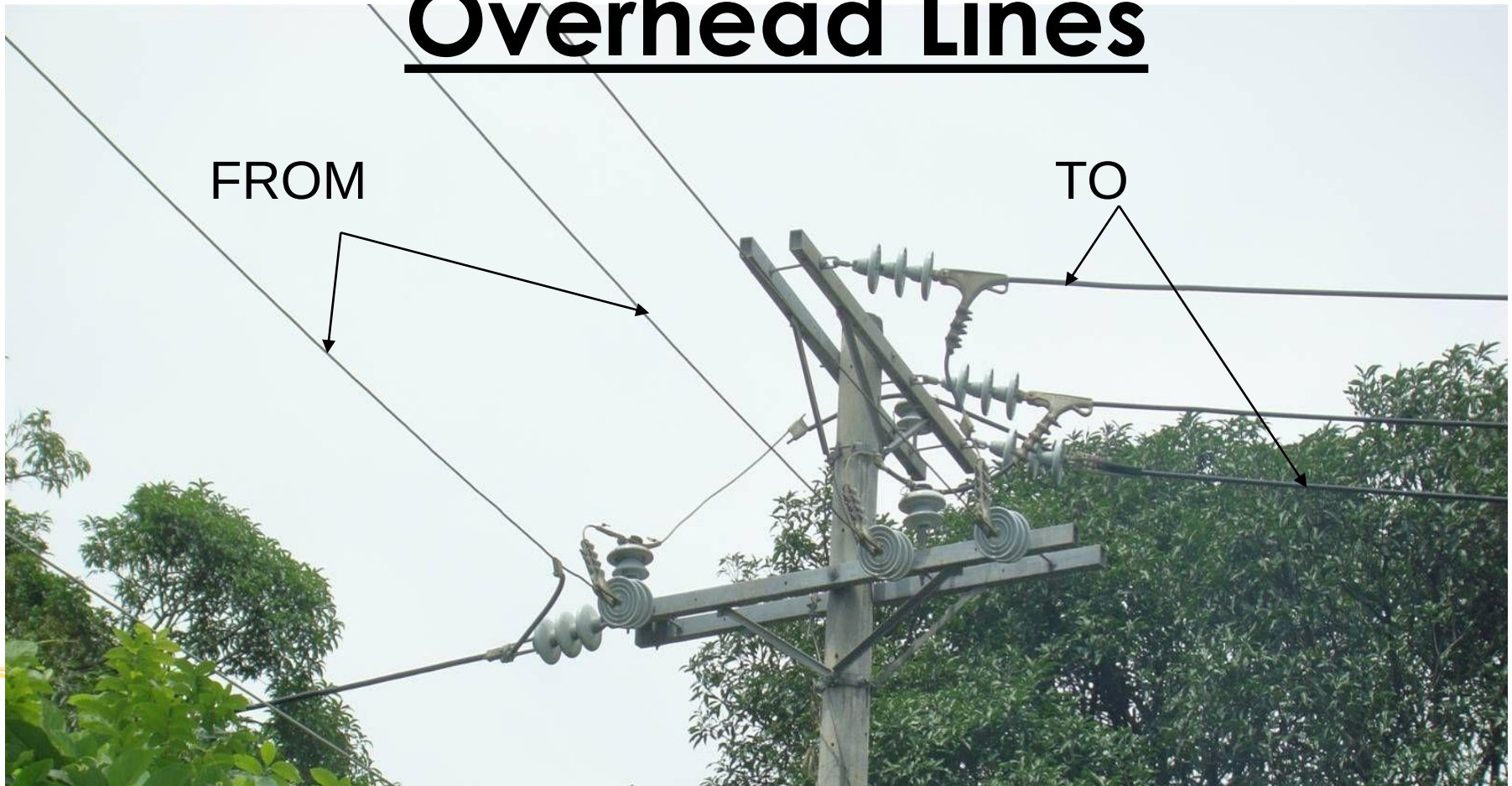
Pole Attachments

Snake cones



Solutions to PQ Problems

Overhead Lines



Solutions to PQ Problems

MERALCO SUBSTATION

- 83 MVA capacity
- Equipped with On-load Tap Changer (OLTC)

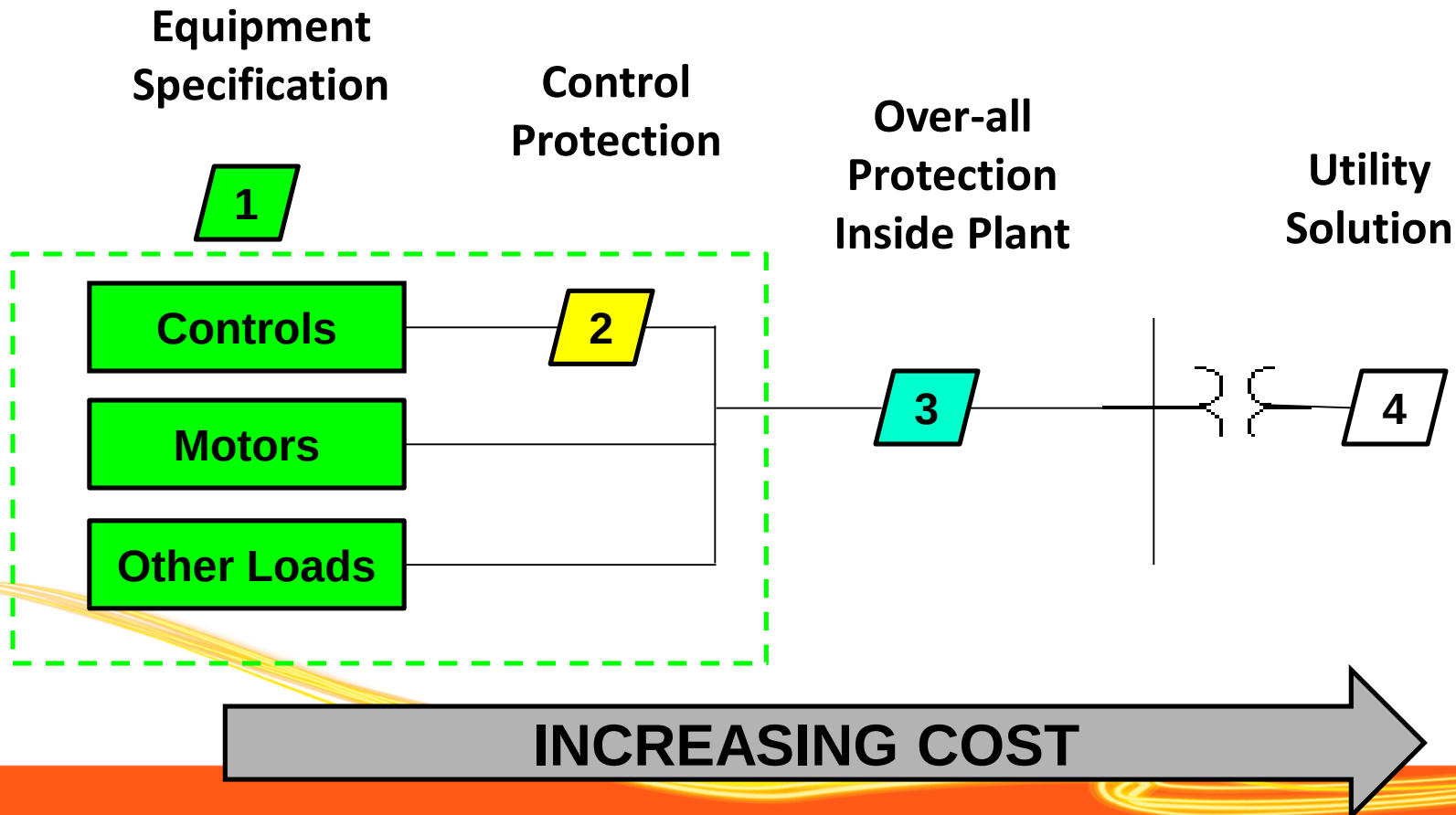


Problem Evaluation

- **Problem Category Identification**
 - **Power Measurements & Data Collection**
 - **Solution Range Identification**
 - **Solution Evaluation**
 - **Optimum Solution**
- 

Solution to PQ Problems

Solution Evaluation LEAST COST APPROACH



Even without buying PQ conditioning equipment we may already be paying for it from costs associated with current problems that our equipment are dealing with.

Thank You!