Neutral Flow

The current assumption is that neutral current flow is just part of the cost of doing business because of the high cost of locating and correcting it. Actually, it is the large number of phasing mistakes that have complicated attempts to correct it.

Imagine, as a Load Specialist, spending hours upon hours trying to define changes that needed to be made to correct high amps on a feeder only to find out that once the field personnel had done their job, the amps still existed. What they thought was ‘A’ was actually ‘C’; but where was it rolled, or where were the tags wrong? The PhaseID System offers a simple solution. Phase identify your system.

To see why neutral current is undesirable, just ask what it costs to push unused amps back to the source on the neutral line. No doubt, we do have to live with some neutral current flow. However, neutral flow will be less on a system that has been phase balanced. The savings from reduced neutral flow range anywhere from thousands to millions of dollars in wasted fuel costs, depending on the scale of your distribution system and the imbalances that exist. Here is how you calculate the savings.

Step 1: Find an example

Let’s use as a sample, one mile of #6 Copper neutral on a feeder and let’s put 50 amps of neutral flow on it as an average.

Step 2: Determine Power Loss

Now, calculate the power loss by using the formula “I squared R”, with the resistance of #6 Copper as the “R” variable. We know from tables that a mile (5,280 feet) of #6 has 2.59 ohms of resistance. This gives us 6,475 watts existing on our mile of line.

50 amps squared, then multiplied by 2.59 ohms of resistance = 6475 watts of power loss

Step 3: Convert to kWh per year

To convert the 6474 watts of power loss into kilowatts that exists on our sample line we must convert the watts into kilowatts and then multiply by the number of hours in a year.

6475 multiplied by .001, then multiplied by 8760 hours = 56,717 kilowatts of power loss per year

Step 4: Determine cost

What is the cost of producing a kWh? Let’s assume .03 cents.

56,717 multiplied by .03 = $1701.52

Step 5: Develop a headache

You have now wasted $1,701.52 dollars on one mile of line over one year. What if you have 100 feeders in your system and they all have neutral flow at this magnitude? How many feeders are there? Better yet, how many miles in every feeder? Let’s imagine the same numbers for 700 miles of lines or 700 feeder miles. The loss number increases to **1,191,064 dollars per year**.

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The numbers can get even more dramatic. Especially when you consider the fact that I squared R is the basis of the formula. You see, 10 amps x 10 amps only equals 100 but 50 x 50 equals a whopping 2500. The square is the heart of the I^2R problem and the problem is exponential as the amperage increases. The savings come when you reduce the amperage. Amperage only has to go down a little to reap huge rewards. You can see in the last column that by reducing a 50 amp neutral imbalance down to a 20 amp imbalance saves over **$1 Million**.

All kidding aside, we all know you can't completely take away neutral flow. It's part of doing business. But what if we can now reduce all of our feeders by only 20 amps because now we know which phase we're installing, moving or replacing? "I squared R" works both ways. So why not use it to our advantage?

Neutral Wire AWG	Resistance #6 Copper per Mile	Neutral Amps	Watts Lost per Feeder Mile (FM)	KWH Lost per Feeder Mile per Year	Loss in Dollars 1 Mile of #6 Copper 1 Year @ .03KWh	Loss in Dollars 700 Mile of #6 Copper 1 Year @ .03KWh	$$$ Savings by Reducing 700FM by 10 Amps	$$$ Savings by Reducing 700FM by 20 Amps	$$$ Savings by Reducing 700FM by 30 Amps
#6 CU	2.58984	10	258.984	2268.700	$68.06	$47,642.70			
	2.58984	20	1035.936	9074.799	$272.24	$190,570.79	$142,928.09		
	2.58984	30	2330.856	20418.299	$612.55	$428,784.27	$238,213.48	$381,141.57	
	2.58984	40	4143.744	36299.197	$1,088.98	$762,283.15	$333,498.88	$571,712.36	$714,640.45
	2.58984	50	6474.600	56717.496	$1,701.52	$1,191,067.42	$428,784.27	$762,283.15	**$1,000,496.63**
	2.58984	60	9323.424	81673.194	$2,450.20	$1,715,137.08	$524,069.66	$952,853.93	$1,286,352.81
	2.58984	70	12690.216	111166.292	$3,334.99	$2,334,492.14	$619,355.06	$1,143,424.72	$1,572,208.99
	2.58984	80	16574.976	145196.790	$4,355.90	$3,049,132.58	$714,640.45	$1,333,995.51	$1,858,065.17
	2.58984	90	20977.704	183764.687	$5,512.94	$3,859,058.43	$809,925.84	$1,524,566.29	$2,143,921.35
	2.58984	100	25898.400	226869.984	$6,806.10	$4,764,269.66	$905,211.24	$1,715,137.08	$2,429,777.53

Phasing Justification

There are many benefits for phase identifying your entire Utility. However, the ability to reduce neutral current probably offers the best cost justification for any phasing program. By initially reducing neutral current, the yearly power cost savings occurs every year going forward.

By accurately connecting future current loads to the correct feeder phase, the 10 year power cost savings will most likely exceed any initial phasing and ongoing phase checking costs by a huge margin.

Many Origo customers have purchased Field Probes for multiple line trucks. These Utilities have integrated phase checking into their daily maintenance work, to verify that all feeder and residential meter phases continue to match their maps.

Origo's newest G4 PhaseID System uses a Smartphone App to make phasing very intuitive, convenient, and safe. It is designed to allow lower cost non-linemen to gather many thousands of initial phase measurements on overhead lines and residential meters. For both initial and maintenance phasing, all that is required is a small handheld field probe and a Smartphone or Tablet.