

# CASE STUDY: Paralleling 3 Generators

## GenMax Application Magee Hospital in Pittsburgh, PA

*Adding a third generator to the Magee Hospital emergency system tripped the ground fault relay. The solution was to eliminate circulating harmonic by installing GenMax.*

### The Problem

Magee Hospital in Pittsburgh, PA had an emergency generating system consisting of two diesel driven generators rated at 1250kW each, both with a 4/5 pitch. A 1000kW with 2/3 pitch was added to increase the emergency capacity. When the three generators were operated together the ground-fault relay tripped. After the protection was removed, with only a 1000kW load, over 900 amps of current was measured on the neutral.

### The Challenge

When three or more generators are involved, the usual methods to deal with the 3rd harmonic, in addition to



not really solving the problem, are complex and likely not cost effective.

Several options were considered to resolve this 3rd harmonic current problem.

One was the use of line reactors. The cost to rewire the existing

installation was prohibitive. Also, because reactors would only reduce, not fully eliminate the 3rd harmonic current, this was an unviable choice.

Another option was the use of a custom built sensing and switching system to change the load connection from wye to delta when the 2/3 pitch generator came on

line. Not only was this approach expensive but the switching system created a possible failure mode and added the requirement of a regular maintenance program.

### The Solution

Harmonics Limited offered a product, the **GenMax**, which is designed to eliminate the problem of circulating 3rd harmonic current flow in ground wires, the neutral, all phases and the generator windings. **GenMax** was the perfect solution to the hospital's 3rd harmonic current problem. It was the least expensive, simple to install and passive in operation so maintenance is not an issue.



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## The Results

Harmonics Limited delivered a **GenMax** unit to a CAT dealer located in the Pittsburgh area. The HLG-1.0-48Y unit was installed at UPMC Magee Women's Hospital. The installation took less than 10 hours including lifting the unit by crane to the roof of the hospital.

The following tables shows the results of testing on the three-generator system after installation of the **GenMax**. The **GenMax** reduced the neutral of 900 amps to less than 47 amps.

Time of test readings	Voltage A/B	Voltage B/C	Voltage C/A	Amps A	Amps B	Amps C
0:00	480	479	479	280	292	275
0:15	480	479	479	270	279	292
0:30	480	479	479	345	360	350
0:45	480	479	479	311	297	270
1:00	480	479	479	266	317	266
1:15	480	479	479	282	284	300
1:30	480	479	479	580	560	550
1:45	480	479	479	540	580	540
2:00	480	479	479	550	560	570
2:15	480	479	479	546	546	538
2:30	480	479	479	534	545	550
Full load Amperes based on % load (1.0 pF) = 1205 Amperes						



Neutral Amps	Harmonic 3rd	Frequency (Hz)	KW	% Load	Applied Load
33	6.00%	60	234	23	500 kw G3 & G1
35	6.00%	60	232	23	500 kw G3 & G2
47	7.10%	60	291	29	1,000 kw G1, G2, G3
35	6.40%	60	243	24	500 kw 3ph 33 kw 1ph A G3, G2
35	6.20%	60	234	23	500 kw 3ph 33 kw 1ph B G3, G2
36	6.00%	60	239	24	500 kw 3ph 33 kw 1ph C G3, G2
35	9.90%	60	467	47	1,000 kw 3ph 33 kw 1ph A G1, G2, G3
36	9.90%	60	459	46	1,000 kw 3ph 33 kw 1ph B G1, G2, G3
37	9.70%	60	464	46	1,000 kw 3ph 33 kw 1ph C G1, G2, G3
34	9.70%	60	450	45	1,000 kw G3 & G1
35	9.70%	60	450	45	1,000 kw G3 & G2

A number of observations can be made from the tabulated data.

1. The phase-to-phase voltages are well balanced.
2. The phase currents are well balanced.
3. The maximum current in any neutral was only 47 amps, whereas it had been over 900 amps without the GenMax.
4. The 3rd harmonic current was under 10% in any neutral. This was the goal of the end user. While 10% might seem like a large 3rd harmonic current, it is 10% of 37 amps, or 3.7 amps, an insignificant current.
5. The GenMax is performing exactly as designed and specified. It has eliminated the neutral 3rd harmonic current caused by generator pitch differences.