POWER QUALITY OF MINI GENERATOR

Generator Parameter

The measurements of generator parameters have been carried out as an immediate measurement method, under two conditions, with and without a load.
These measurements were conducted 4 times, as follows:

1. Generator measurement without a load was conducted once.
2. Generator measurement with a 500 W lamp as a load.
3. Generator measurement with a 1000 W lamp as a load.
4. Generator measurement with a 1500 W lamp as a load.

Results of these measurements can be seen at:
Attachment 1: Printout min max Generator Parameter measurement results.
Attachment 2: Table 1: The Generator Parameter measurement results.

1. Generator Voltage

See Table 4.1 and Chart 4.1 as follows:

Parameter	*Generator*	*Generator Loaded*		
	WO Load	*Lamp A*	*Lamp B*	*Lamp C*
Voltage (Volt)	*206.40*	214.50	173.20	95.40

Table 4.1 Generator Voltage Table.

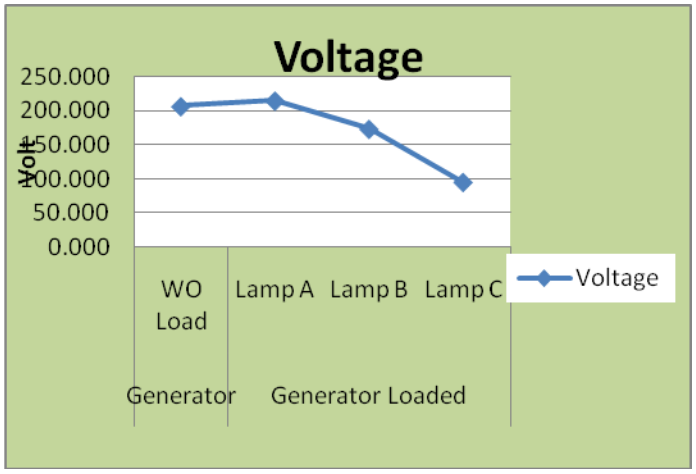

Chart 4.1 Generator Voltage Chart.

Readings:

1. Generator without load, Voltage is 206.4 V.

2. Lamp A loads the generator, Voltage is 214.5 V.
3. Lamp B loads the generator, Voltage is 173.2 V.
4. Lamp C loads the generator, Voltage is 95.4 V.

Analysis:

1. Table and chart above are showing that generator voltage without load is 206.4 V. The voltage is still in line with the minimum standard of the IEEE. (198-242 V)
2. The generator is loaded with lamp A: the generator's voltage is increasing to 214.5 V. In this case, the generator is automatically pushing its power, hence increasing the voltage. With the 500 W (lamp A) as load, the generator is able to generate a current of 2.01 A and the lamp is operating normally.

3. The generator is loaded with lamp B: the generator's voltage is dropping to 173.2 V causing the lamp to dim. After adding lamp A the total became 1500 W. The generator was not capable to handle the load, causing the voltage to drop to 63 V and the generator almost switched off.

Conclusions:

1. Generator without load, the voltage is only 206.4 V, indicating a critical voltage condition.
2. The maximum load we can apply, in order for lamp to operate normally, is only 500 W (some 62.5% of its maximum capacity).
3. Generator Voltage is unstable and if load increases the voltage tends to lower.
4. Maximum normal load range is 500 W at 200 V minimum.

2. *Generator Current*

See Table 4.2 and Chart 4.2 are as follows:

Parameter	*Generator*	*Generator Loaded*		
	WO Load	*Lamp A*	*Lamp B*	*Lamp C*
Current (Ampere)	*0*	2.01	3.57	3.84

Table 4.2 Generator Current Table.

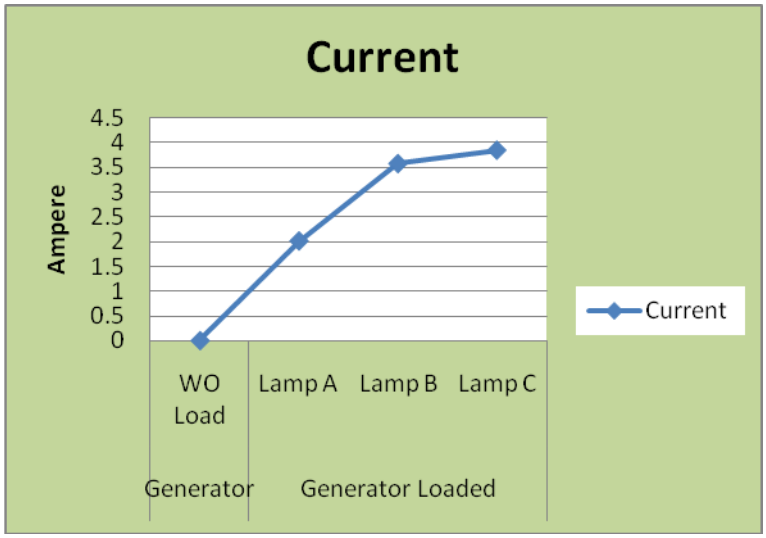

Chart 4.2 Generator Current Chart.

Readings:

1. Generator without load, current is 0.0 A.
2. Generator with lamp A (500 W), current is 2.01 A.
3. Generator with lamp B (1000 W), current is 3.57 A.
4. Generator with lamps C (1500 W), current is 3.84 A.

Analysis:

1. Lamp A loads the Generator.
   Generator current is 2.01 A, the lamp operates normally. In this case the Generator automatically pushes its power, hence the increase can accommodate the current for a 500 W lamp.

2. Lamp B loads the Generator.
   Generator voltage drops to 173.2 V with a current of 3.57 A. As a result the lamp is dimming. Then we added an additional load of 500 W (lamp A), so totally load becomes 1500 W. The Generator is incapable of handling this load. The voltage dropped to 63 V, producing 3.84 A. Generator switches nearly off.

3. *Generator Active Power*

See Table 4.3 and Chart 4.3. as follows:

Parameter	*Generator*	*Generator Loaded*		
	WO Load	*Lamp A*	*Lamp B*	*Lamp C*
Active Power	*0*	427	608	362

Table 4.3 Generator Active Power Table.

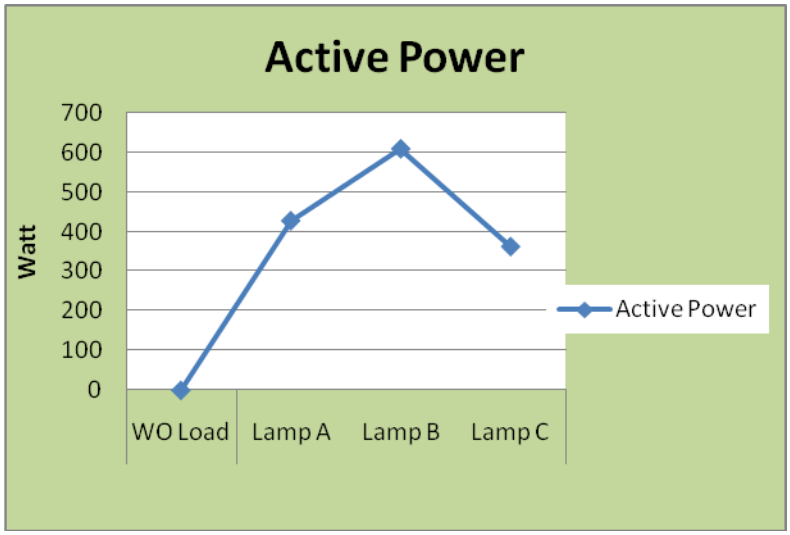

Chart 4.3 Generator Active Power Chart.

Readings:

1. Generator loaded with lamp A (500 W), Active Power is 427 W.
2. Generator was loaded with lamp B (1000 W), Active Power is 608 W.
3. Generator was loaded with lamps C (1500 W), Active Power is 362 W.

Analysis:

1. Generator supplies an Active power of 427 W for lamp A and the Voltage is 214.5 V. The lamp is normally bright.
2. Generator is loaded with Lamp B. The generator was only able to supply an Active power of 608 W (about 61% of required capacity). It is beyond generator's ability. When the load was increased to 1500 W, the generator nearly switched off.

Conclusions:

1. The Generator with an 800 W capacity is only able to handle a maximum load of 500 W.
2. Whenever the loading was increased as shown in chart 4.2, the increase of current is not linear. What this means that the generator can no longer accommodate the power needed to adjust to the load.
3.

4. *Generator Apparent Power*

See Table 4.4 and Chart 4.4 as follows:

Parameter	Generator	Generator Loaded		
	WO Load	Lamp A	Lamp B	Lamp C
Apparent Power	0	431	618	366

Table 4.4 Generator Apparent Power Table.

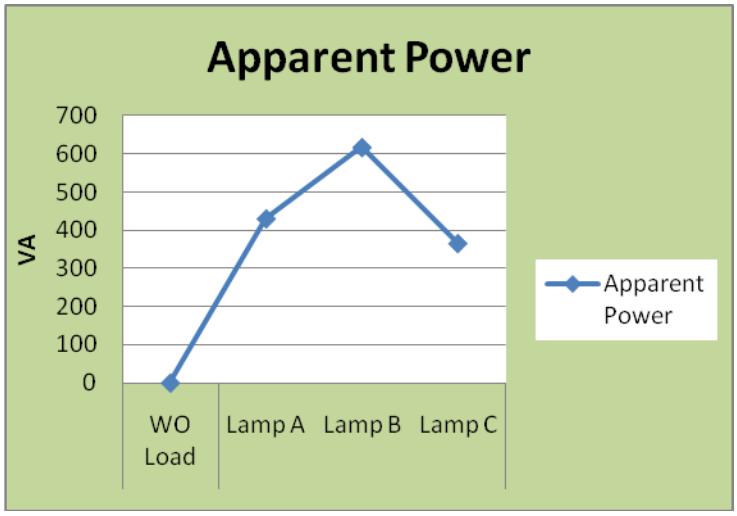

Chart 4.4 Generator Apparent Power Chart.

Readings:

1. Generator was loaded with lamp A (500 W), Apparent Power is 431 VA.
2. Generator was loaded with Lamp B (1000 W), Apparent Power is 618 VA.
3. Generator was loaded with lamps C (1500 W), Apparent Power is 366 VA

Analysis:

1. Generator supplies Apparent Power of 431 VA with lamp A as load. Apparent Power has almost the same value as Active Power, this shows that the reactive load was quite small.
2. When the generator was loaded with lamp B, the generator was only able to supply an Apparent Power of 618 VA and an Active Power of 608 W (about 61% of the 1000 W lamp). This is beyond the generator's ability. When we increased the load to 1500 W, the generator nearly switched off.

5. *Generator Reactive Power*

See Table 4.5 and Chart 4.5 as follows:

Parameter	Generator	Generator Loaded		
	WO Load	Lamp A	Lamp B	Lamp C
Reactive Power	0	26	122	145

Table 4.5 Generator Reactive Power Table.

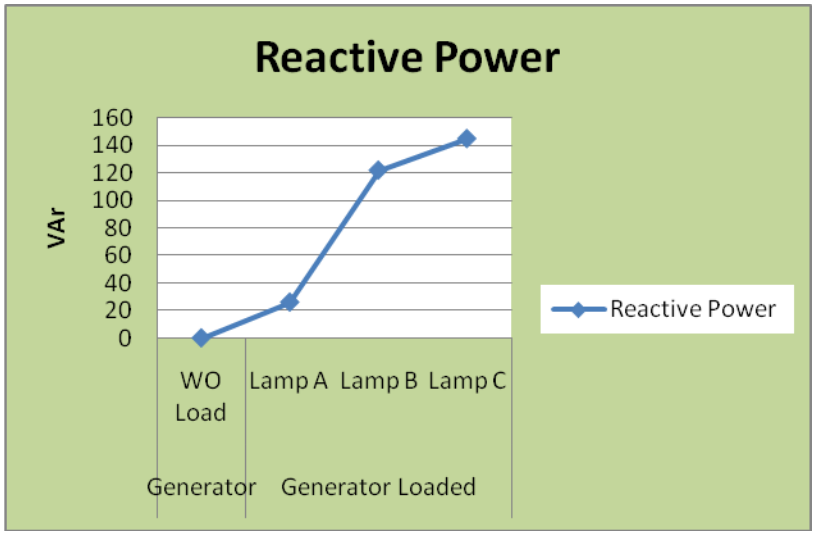

Chart 4.5 Generator Reactive Power Chart.

***Readings*:**

1. Generator was loaded with lamp A (500 W), Reactive Power was 26 VAr.
2. Generator was loaded with lamp B (1000 W), Reactive Power was 122 VAr.
3. Generator was loaded with lamps C (1500 W), Reactive Power was 145 VAr.

Analysis:

1. The more load the more its Reactive Power.
2. With a load of 500 W, the Reactive Power is small enough so it's Active. Power curve and Apparent Power curve are at the same level.

6. *Generator Power Factor*

See Table 4.6 and Chart 4.6 as follows:

Parameter	*Generator*	*Generator Loaded*		
	WO Load	*Lamp A*	*Lamp B*	*Lamp C*
Power Factor	*1*	1	0.98	0.91

Table 4.6 Generator Power Factor Table.

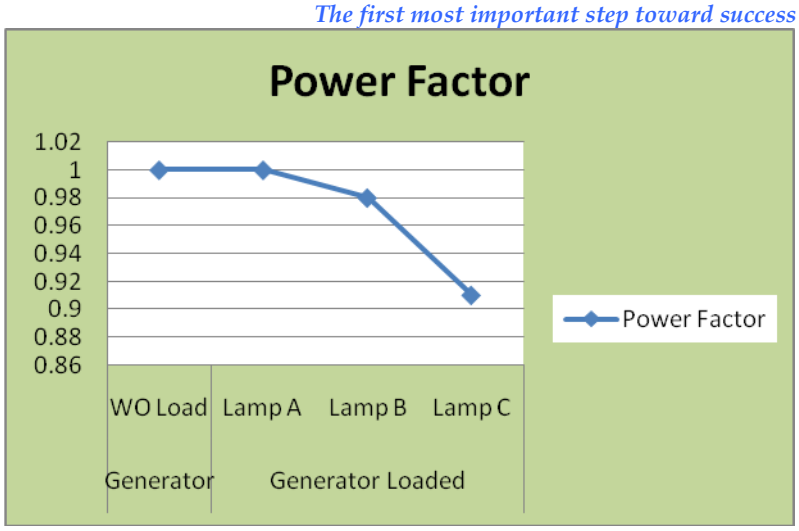

Chart 4.6 Generator Power Factor Chart.

Readings:

1. Generator without load, power factor = 1.
2. Generator was loaded with lamp A (500 W), power factor = 1.
3. Generator was loaded with lamp B (1000 W), power factor = 0.98.
4. Generator was loaded with lamps C (1500 W), power factor = 0.91.

Analysis:

1. When the generator was unloaded, there was an output voltage but draws no current, so power factor =1 since there was no phase difference between voltage and current.
2. When the generator was loaded with 500 W then it draws current, yet there was no phase difference between voltage and current so power factor = 1.
3. When the load was increased to 1000 W, the load is capacitive, so there is a phase difference between voltage and current, with a power factor of 0.98.
4. When the load was further increased to 1500 W, as shown in chart 4.6, then the power factor dropped to 0.91.

Conclusion:

The Power Factor depends on the type of load and the characteristic of the generator.

7. Generator Frequency

See Table 4.7 and Chart 4.7 as follows:

Parameter	Generator	Generator Loaded		
	WO Load	Lamp A	Lamp B	Lamp C
Frequency	49.600	46.910	50.240	50.240

Table 4.7 Generator Frequency Table.

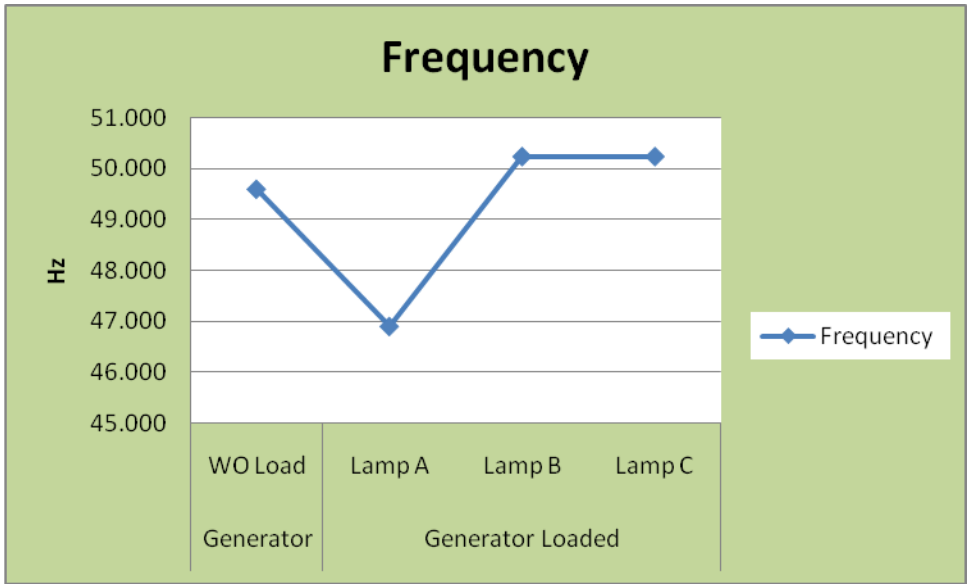

Chart 4.7 Generator Frequency Chart.

Readings:

1. Generator without load, Frequency is 49.6 Hz.
2. Generator was loaded with lamp A (500 W), Frequency is 46.91 Hz.
3. Generator was loaded with lamp B (1000), Frequency is 50.24 Hz.
4. Generator was loaded with lamp A (1500 W), Frequency is 50.24 Hz.

Analysis:

1. Without a load the generators Frequency was 49.6. When the generator was loaded the Frequency dropped to 46.91 Hz.
2. When the load was increased to 1000 W, the Frequency increased to 50.24 Hz and remained 50.24 Hz when the load was further increased to 1500 W.

Conclusion:

Generator Frequency varies with the load.

8. Generator % VTHD

See Table 4.8 and Chart 4.8 as follows:

Parameter	Generator	Generator Loaded		
	WO Load	Lamp A	Lamp B	Lamp C
% VTHD	27.000	32	31.500	29.500

Table 4.8 Generator % VTHD Table.

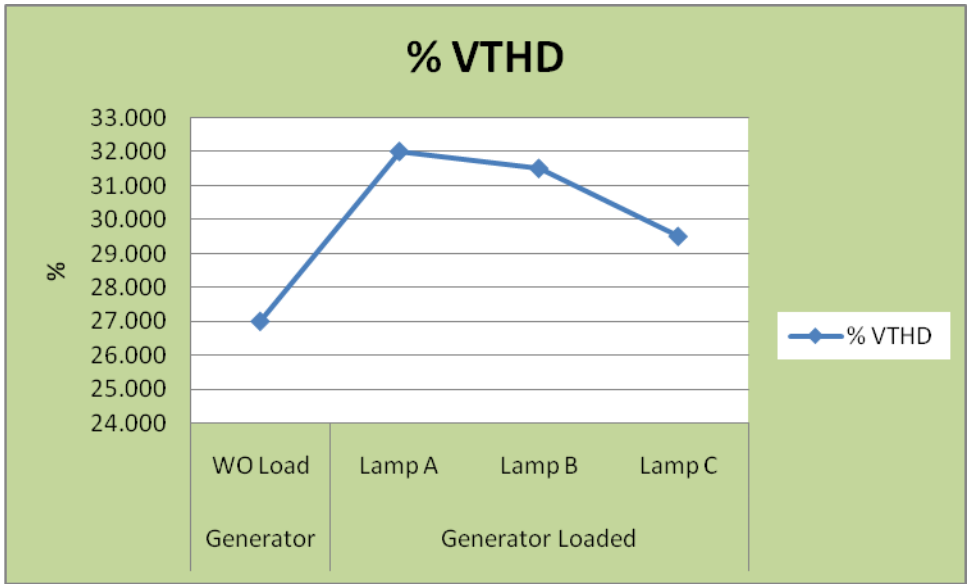

Chart 4.8 Generator % VTHD Chart.

Readings:

1. Generator without load, percentage VTHD is 27%.
2. Lamp A (500 W) loads the generator, percentage VTHD is 32%.
3. Lamp B (1000 W) loads the generator, percentage VTHD is 31.5%.
4. Lamps C (1500 W) load the generator, percentage VTHD is 29.5%.

Analysis:

1. Percentage VTHD of the generator before and after applying a load is high; almost 6 times normal IEEE standard of (% VTHD according to IEEE is 5% maximum).
2. Percentage VTHD of the generator under test is bad.

9. Generator % ITHD

See Table 4.9 and Chart 4.9 as follows:

Parameter	Generator	Generator Loaded		
	WO Load	Lamp A	Lamp B	Lamp C
% ITHD	0.000	33.3	32.100	29.200

Table 4.9 Generator % ITHD Table.

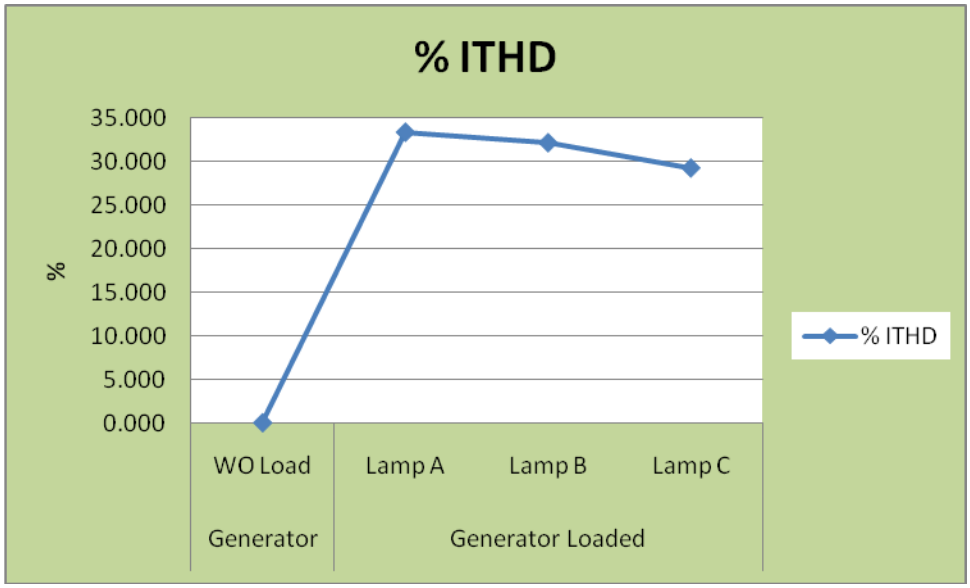

Chart 4.9 Generator Percentage ITHD Chart.

Readings:

1. Generator without load, ITHD 0%.
2. Lamp A (500 W) loads the generator, ITHD 33.3%.
3. Lamp B (1000 W) loads the generator, ITHD 32.1%.
4. Lamps C (1500 W) load the generator, ITHD 29.2%.

Analysis:

1. Generator without load: ITHD is 0%, no current flow.
2. Whenever the generator was loaded, %ITHD is twice above IEEE standards (%ITHD IEEE standard is 15% max).