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Power Quality Problems, their Power Quality (IEEE & IEC) Standards in Power System

Ami Shah, Yash Shah, Sanket Patel, Jagdish Bichve
Electrical, GTU/Sigma Institute of Engineering, Vadodara, Gujarat, India

ABSTRACT

Power Quality is a set of boundaries which allow to equipment works in intended manner without change in significance.Different Power Quality problems are initiated or generated in the system or due to non linear load .They create disturbances in the system and malfunctioning in the system happened or system not works properly.To minimize that some Disturbances some IEEE and IEC standards their .With the use of this standards we can manufacture our equipment and in results of those our system minimized such disturbances and can work properly.This paper descrirbed that different power quality problems and also the IEEE and IEC Standards which relate with Power Quality.

Keywords: IEEE(Institute of electrical & electronics engineer), IEC(International Electro technical Commission),

I. INTRODUCTION

Definition of Power Quality: "The concept of powering and grounding sensitive electronic equipment in a manner suitable for the equipment."

OR

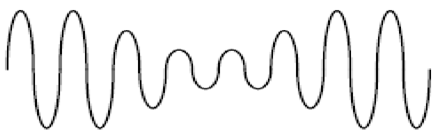
"Power quality is a set of electrical boundaries that allows a piece of equipment to function in its intended manner without significant loss of performance or life expectancy."

Power Quality Problems:

The power disturbances occur on all electrical systems, the sensitivity of today's sophisticated electronic devices make them more susceptible to the quality of power supply. For some sensitive devices, a momentary disturbance can cause scrambled data, interrupted communications, a frozen mouse, system crashes and equipment failure etc. A power voltage spike can damage valuable components. Power quality problems encompass a wide range of disturbances such as voltage sags, swells, flickers, harmonic distortion, impulse transients, and interruptions.

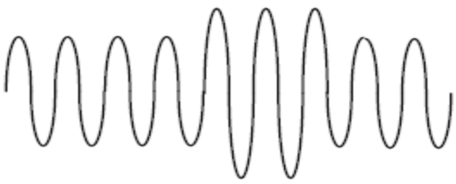
Sag:

A sag is a reduction of AC voltage at a given frequency for the duration of 0.5 cycles to 1 minute's time. Sags are usually caused by system faults, and are also often the result of switching of loads with heavy start up currents.



Swell:

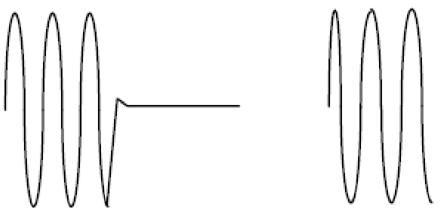
A swell is the reverse form of a sag, having an increase in AC voltage for a duration of 0.5 cycles to 1 minute's time. For swells, high-impedance neutral connections, sudden (especially large) load reductions, and a single-phase fault on a threephase system are common sources.



Interruption:

An interruption is defined as the complete loss of supply voltage or load current. Depending on its duration, an interruption is categorized as instantaneous, momentary, temporary, or sustained. Duration range of interruption types is as follows:

- Instantaneous 0.5 to 30 cycles
- Momentary 30 cycles to 2 seconds
- Temporary 2 seconds to 2 minutes
- Sustained greater than 2 minutes



Harmonics:

Harmonic distortion is the corruption of the fundamental sine wave at frequencies that are multiples of the fundamental. (E.g.,180 Hz is the third harmonic of a 60 Hz fundamental frequency; (3 X 60 = 180).

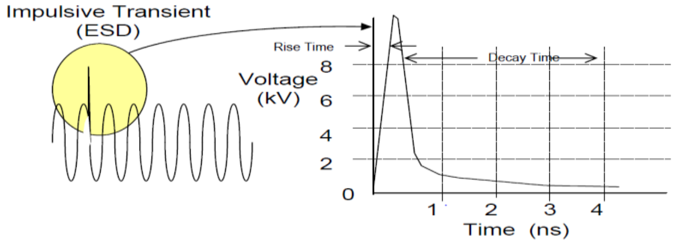
Transients:

Potentially the most damaging type of power disturbance, transients fall into two subcategories:

1. Impulsive
2. Oscillatory

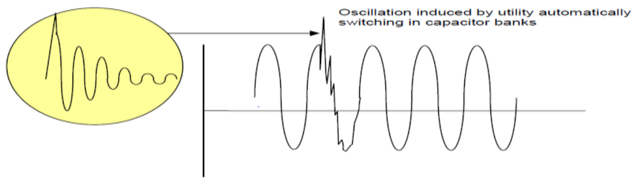
1. Impulsive:

Impulsive transients are sudden high peak events that raise the voltage and/or current levels in either a positive or a negative direction. These types of events can be categorized further by the speed at which they occur (fast, medium, and slow).s



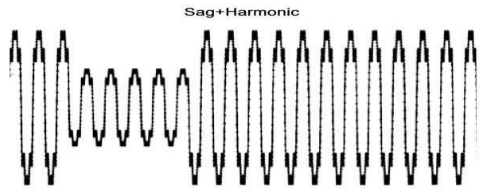
2. Oscillatory:

An oscillatory transient is a sudden change in the steady-state condition of a signal's voltage, current, or both, at both the positive and negative signal limits, oscillating at the natural system frequency. In simple terms, the transient causes the power signal to alternately swell and then shrink, very rapidly.



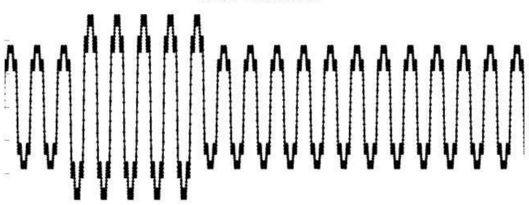
Sag with harmonics:

Here in this topic both sag and harmonic effects occur in voltage waveform which is shown in fig. Here reasons of sag are already given in above to and harmonic is also discussed in above.



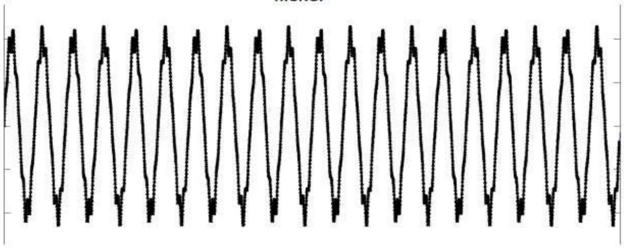
Swell with harmonics:

Here in this topic both swell effect and harmonic effects occur in voltage waveform which is shown in fig. Here reasons of the swell are already given in above and harmonic is also discussed in above



Flicker:

Flicker is defined as 'Impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time'. From a more practical point of view one can say that voltage fluctuations on the supply network cause change of the luminance of lamps, which in turn can create the visual phenomenon called flicker.



II. MATLAB PROGRAMING AND RESULTS

```
% Sine Wave
t=[0 :0.0001:0.4];
y=sin(314*t);
figure(1)
plot(t,y)
title('Pure 50 Hz Sine wave')

% Sag wave
% alpha ranges 0.1 to 0.9
t=[0 :0.0001:0.4];
alpha=0.5;
y=(1-alpha*(heaviside(t-0.05)-heaviside(t-
0.15))).*sin(314*t);
figure(2)
plot(t,y);
title('Sag disturbance');

% Swell wave
% alpha ranges 0.1 to 0.8
t=[0 :0.0001:0.4];
alpha=0.5;
y=(1+ alpha*(heaviside(t-0.05)-heaviside(t-
0.15))).*sin(314*t);
figure(3)
plot(t,y);
title('Swell disturbance');

%Interruption
%alpha ranges 0.9 to 1
t=[0 :0.0001:0.4];
alpha=0.95;
y=(1-alpha*((heaviside(t-0.05)-heaviside(t-
0.15)))).*sin(314*t);
figure(4)
plot(t,y);
title('Interruption');

% Harmonics
% alpha3,alpha 5, alpha7 range from 0.05 to 0.15
t=[0 :0.0001:0.4];
alpha3=0.15;
alpha5=0.15;
alpha7=0.15;
alpha1= sqrt(1- alpha3^2-alpha5^2 alpha7^2);
y= alpha1* sin(314*t)+
alpha3*sin(3*314*t)+alpha5*sin(5*314*t)+alpha7*sin(7
*314) ;
figure(5)
plot(t,y);
title('Harmonics');

%Transient
% t1 start, duration
% t2 end, duration
% amplitude
% fn goes from 300 to 900
fn=500;
amp= 1;
t1=0.06; t2=0.058;
```

```
ty= (t1+t2)/2
t=[0 :0.0001:0.4];
amp= 5;
t1=0.06; t2=0.058;
ty=(t1+t2)/2;
t=[0 :0.0001:0.4];
y=sin(2*pi*50*t)+amp*heaviside(t-t2)heaviside(t-
t1)).*exp(t/ty).*sin(2*3.14*fn*t);
figure(6)
plot(t,y)
title('Transient');
```

% sag+ harmonics

```
t=[0:0.0001:0.4];
alpha=0.5
alpha3=0.15;
alpha5=0.15;
alpha7=0.15;
alpha1= sqrt(1- alpha3^2-alpha5^2-alpha7^2);
y= =(1-alpha*(heaviside(t-0.05)-heaviside(t-
0.15))).*(alpha1(* sin(314*t)+
alpha3*sin(3*314*t)+alpha5*sin(5*314*t)+alpha7*sin(7
*314)) ;
figure(7)
plot(t,y)
title('Sag+Harmonics');
```

% swell+ harmonics

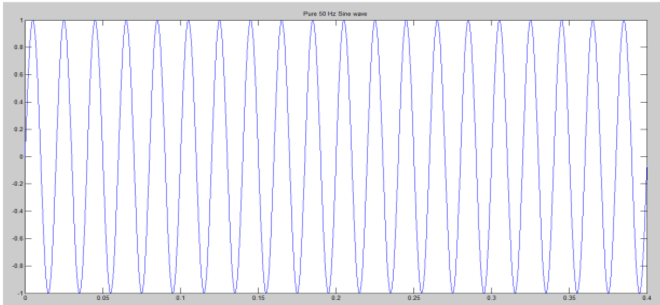
```
t=[0:0.0001:0.4];
alpha=0.5;
alpha3=0.15;
alpha5=0.15;
alpha7=0.15;
alpha1= sqrt(1-alpha3^2-alpha5^2-alpha7^2);
y=(1+alpha*(heaviside(t-0.05)-heaviside(t-
0.15))).*(alpha1(* sin(314*t)+
alpha3*sin(3*314*t)+alpha5*sin(5*314*t)+alpha7*sin(7
*314)) ;
figure(8)
plot(t,y)
title('Swell+Harmonics');
```

% Flicker
% alpha ranges 0.1to 2
% beta ranges 5 to 10

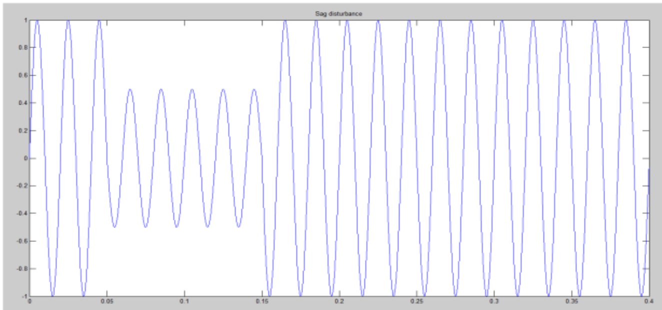
```
t=[0 :0.0001:0.4];
alpha=0.15;
beta=7.5;
y=(1+alpha*sin(beta*314*t)).*sin(314*t);
figure(9)
plot(t,y)
title('Flicker');
```

Programming Results:

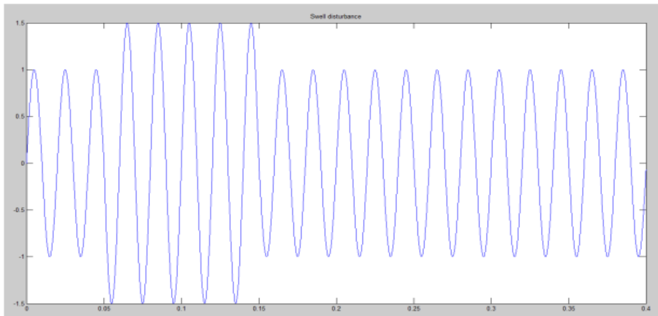
1. Pure 50 Hz sine wave



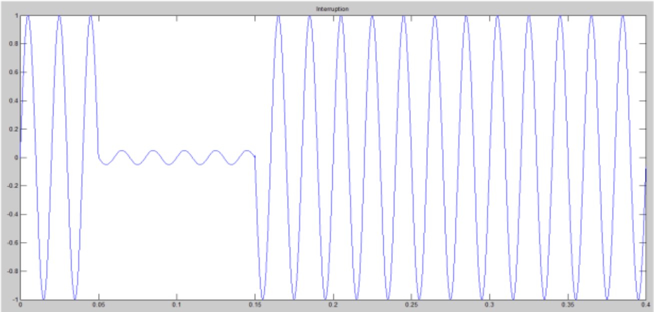
2. Sag disturbance



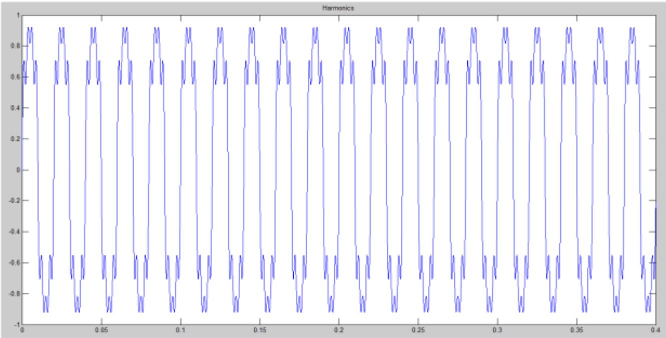
3. Swell disturbance



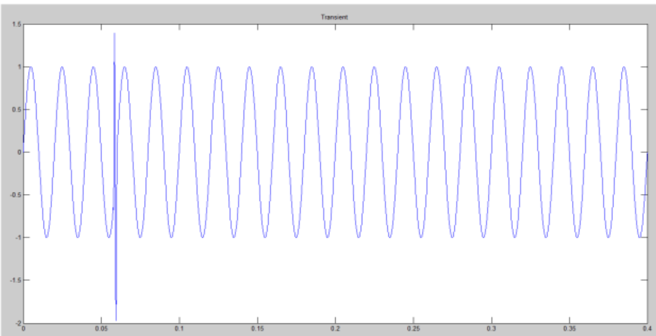
4. Interruption



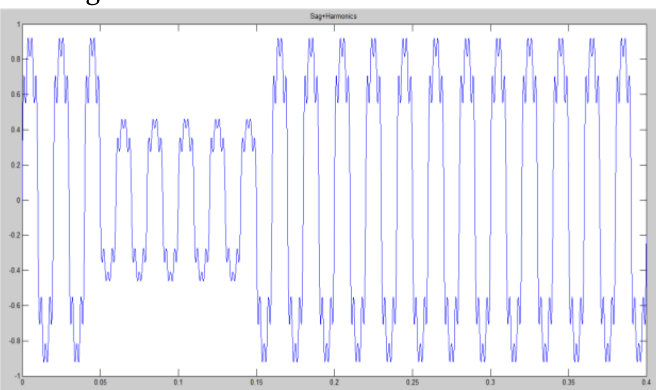
5. Harmonics



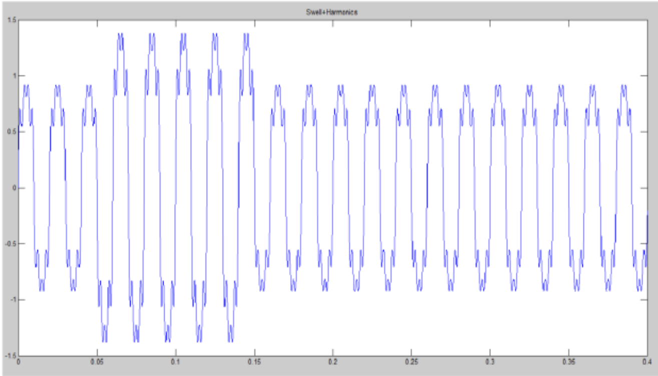
6. Transient



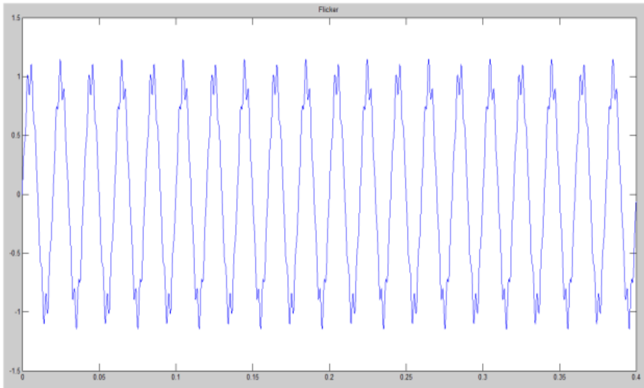
7. Sag with Harmonics



8. Swell with Harmonics



9. Flicker



III. IEEE & IEC Standards

IEEE Standards:

- **IEEE 644** Standard Procedure for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines.
- **IEEE C63.12** Recommended Practice for Electromagnetic Compatibility Limits.
- **IEEE 518** Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources.
- **IEEE 519** Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
- **IEEE 1100** Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.

- **IEEE 1159** Recommended Practice for Monitoring Electric Power Quality.
- **IEEE 141** Recommended Practice for Electric Power Distribution for Industrial Plants.
- **IEEE 142** Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- **IEEE 241** Recommended Practice for Electric Power Systems in Commercial Buildings.
- **IEEE 602** Recommended Practice for Electric Systems in Health Care Facilities.
- **IEEE 902** Guide for Maintenance, Operation and Safety of Industrial and Commercial Power Systems.
- **IEEE C57.110** Recommended Practice for Establishing Transformer Capability when Supplying Non-sinusoidal Load.
- **IEEE P1433** Power Quality Definitions.
- **IEEE P1453** Voltage Flicker.
- **IEEE P1564** Voltage Sag Indices

IEC Standards:

- **IEC/TR3 61000-2-1** Electromagnetic Compatibility — Environment.
- **IEC/TR3 61000-3-6** Electromagnetic Compatibility — Limits.
- **IEC 61000-4-7** Electromagnetic Compatibility — Testing and Measurement Techniques — General Guides on Harmonics and Inter harmonics Measurements and Instrumentation.
- **IEC 61642** Industrial AC Networks Affected by Harmonics — Application of Filters and Shunt Capacitors.
- **IEC SC77A** Low Frequency EMC Phenomena.
- **IEC TC77/WG1** Terminology.
- **IEC SC77A/WG1** Harmonics and Other Low Frequency Disturbances.
- **IEC SC77A/WG6** Low Frequency Immunity Tests.
- **IEC SC77A/WG2** Voltage Fluctuations and Other Low Frequency Disturbances.
- **IEC SC77A/WG8** Electromagnetic Interference Related to the Network Frequency.

IV. CONCLUSION

This paper described the programming of Different power quality problem in power system and also their power quality standards which have to be in consideration whenever manufactured or implemented any system.

V. REFERENCES

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