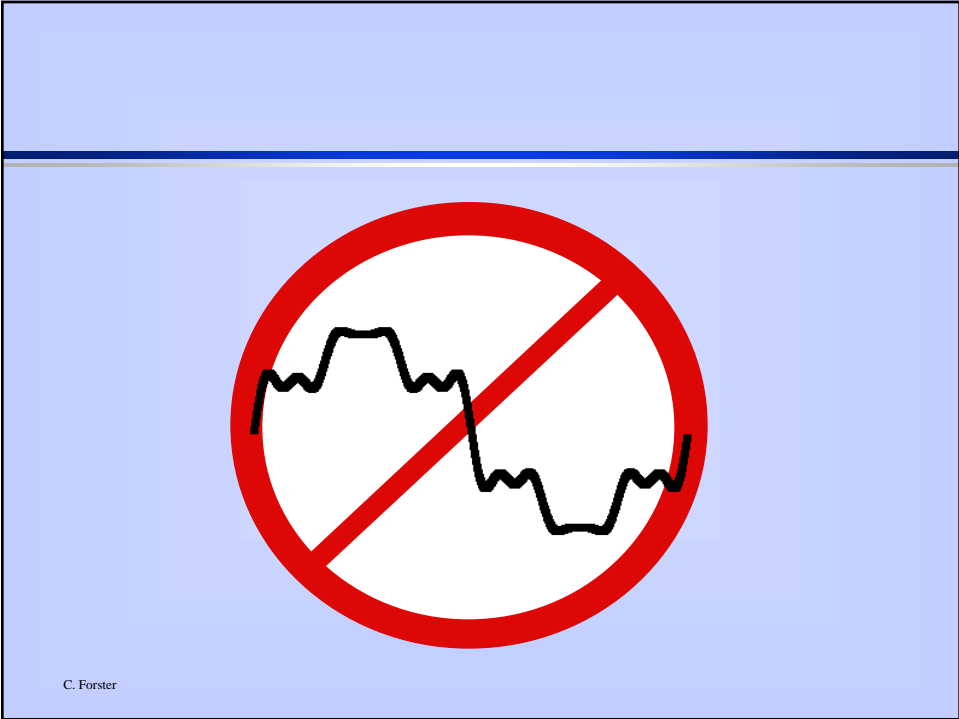



Do You Have a Problem with IEEE-519?



???????

**Do You Have a
Harmonic Problem?**

 **Forster Electrical Engineering, Inc.**
550 N. Burr Oak Ave, Oregon, WI 53575 (608) 835-9009
(608) 835-9039 fax

C. Forster

What is THD?

Total **H**armonic **D**istortion
(DF - Distortion factor)

Ratio of RMS value of harm. to RMS
value of 60 hz fundamental

C. Forster

What is TDD?

Total **D**emand **D**istortion -
The harmonic current distortion
expressed as a % of *the maximum*
DEMAND load current using a
15 or 30 minute demand period

C. Forster

What is **PCC**?

Point of **C**ommon **C**onnection

Between Utility/Customer - Usually the metering or incoming service point

For the Customer/Equipment Supplier:

Usually the point in the plant where the equipment is connected

C. Forster

Chuck's Golden Rule of Harmonics

Thou shalt not draw so much distorted current that you upset the voltage waveform

C. Forster

How to prevent breaking this rule

- * Make the source “stiffer”
- * Draw less distorted current
- * Reduce the distortion in the current drawn

How much Distortion is OK?

- * Are you a Utility?
- * Are you a Customer?

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If you are a Utility...

You must provide a
VOLTAGE at the
PCC that has distortion
less than **5% THD**

C. Forster

...usually

If you are a Customer...

You must limit your
CURRENT distortion at
the **PCC** to less than
5% THD.....usually

C. Forster

**The goal of limiting
CURRENT distortion
from the Customer is..**

**To prevent distortion of
the VOLTAGE
waveform**

**The goal is to limit the
maximum individual
VOLTAGE harmonic to
3% and the THD to 5%**

Let's look at a real Customer...

- ♥ This is a 12.47 kV **foundry** customer in Wisconsin.
- ♥ The Customer **peak demand** is 5,000 kW and 5,882 kVA
- ♥ The Utility **Supply** is 12.47 kV

C. Forster

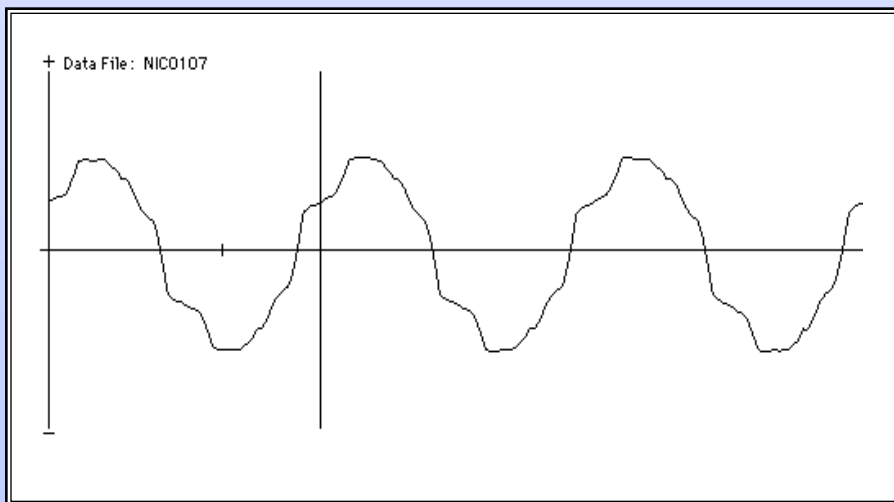
Can the customer meet IEEE-519 “CURRENT” requirements?

Assume the substation supplying the load has had **PEAK** loads over the last **12 months** equal to the **kVA rating** of the transformer.

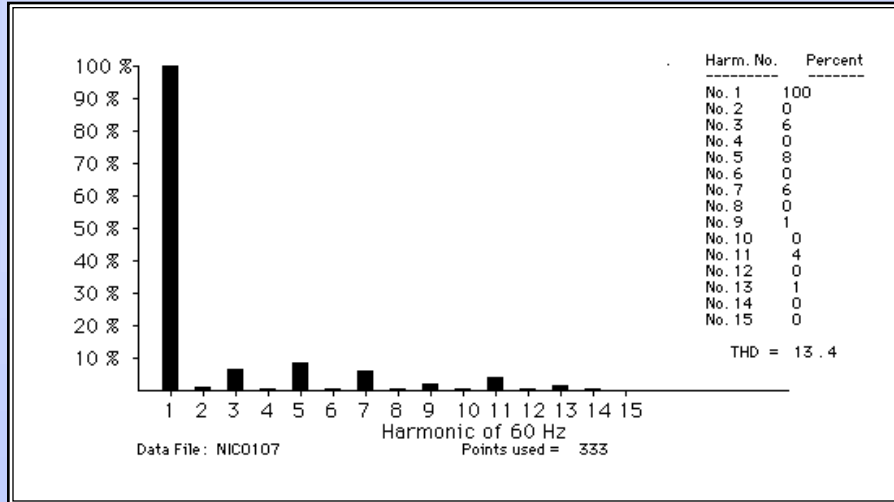
What to do first?

**Make field
measurements of
current waveforms at
the PCC**

Current waveform with 3,500 kVA load



Frequency spectrum for the above 12.47 kV CURRENT



Assuming the average
peak monthly demand
was 5,000 kW, what is
the **TDD**?

C. Forster

Some information first..

System Incoming kV **12.47** kV
Peak Monthly kWD **5,000** (Avg Pk/yr)
P.F. at Peak **0.85** (0 to 1.0)
Peak Monthly kVAD **5,882** kVAD

C. Forster

More information..

I_L (Load Amperes) **272** (Avg Pk/yr)
Isc(Short Ckt Amps) **5,500** Amperes
 I_{sc} / I_L **20** ratio
System load @ test **162** Amperes RMS

C. Forster

Using the data above..

Harm. No.	Meas. Harm. %	Load Harm. Amps	% of Peak Dem.(I _L)
3	6.59	10.68 <small>(162 x 0.0659)</small>	3.92
5	8.53	13.82	5.07
7	6.23	10.09	3.71
9	1.96	3.18	1.17
11	4.1	6.64	2.44
13	1.37	2.22	0.81 <small>(2.22 / 275 x 100%)</small>

C. Forster

Using the data above..

Harm. No.	Meas. Harm. %	Load Harm. Amps	% of Peak Dem.(I _L)
15	0.083	0.13	0.05
17	0.69	1.12	0.41
19	0.52	0.84	0.31
21	0.22	0.36	0.13
23	0.385	0.62	0.23

Measured THD (%) 13.36%

Total Demand Distortion (%) 7.95%

C. Forster

How to calculate TDD...

Harmonic number and measured **harmonic values** are from the measurement device output.

C. Forster

How to calculate TDD...

Load harmonic amperes =
Measured harmonics% times load in
amperes at the time of the test
 $(162 \times 0.0659) = 10.68$ Amps

C. Forster

How to calculate TDD...

% of Peak Demand = Load harmonic
amperes divided by peak monthly
ampere demand, expressed as %
 $(2.22 / 275 \times 100\%) = 0.81\%$

C. Forster

How to calculate THD...

Measured **THD** is the sq.
rt. of the sum of the squares
of each Measured
Harmonic in %

C. Forster

How to calculate **TDD**...

Total Demand Distortion equals the square root of the sum of the squares of each **Peak Demand** value in %

C. Forster

Did the Foundry meet IEEE-519 “CURRENT” requirements?

Yes - The maximum TDD allowed is 8.00%. This is acceptable

WAIT! - someone just
said 5% was the
CURRENT limit!

C. Forster

Check Table 10.3 in IEEE-519

Maximum Harm. Current Distortion in % of I_L

Limits for individual harmonic order (Odd Harmonics)

I_{SC} / I_L	<11	11<h<17	TDD
<20	4.0%	2.0%	5%
20<50	7.0%	3.5%	8%
50<100	10.0%	4.5%	12.0%

This is a partial copy of Table 10.3

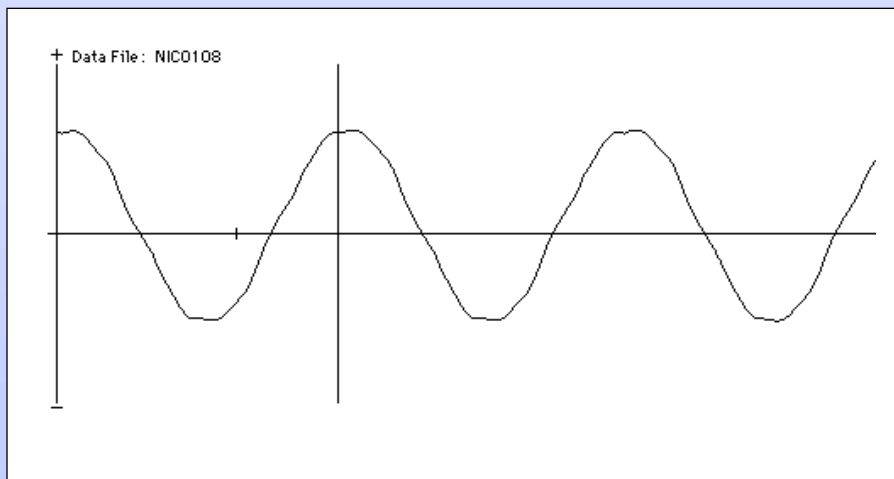
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???????

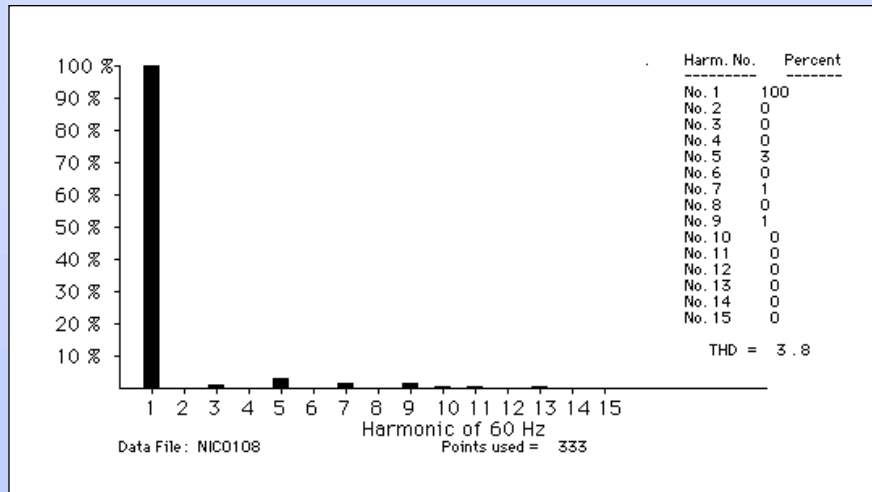
Did the Foundry load
cause the UTILITY to
exceed IEEE-519
limits?

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How did the Foundry incoming
12.47 kV **VOLTAGE** look?



Frequency spectrum for the above
12.47 kV **VOLTAGE**



Did the **UTILITY** meet
VOLTAGE distortion limits?

Yes - The THD limit was 5%
with 3.8% measured.

The 5th harmonic was 3%, the
limit was 3%.

IEEE-519 Table 11.1- Voltage Limits

Bus Voltage at PCC	Indiv. Voltage Dist. (%)	Total Voltage THD (%)
-----	-----	-----
69 kV and below	3%	5%
69 kV to 161 kV	1.5%	2.5%
161 kV and above	1%	1.5%

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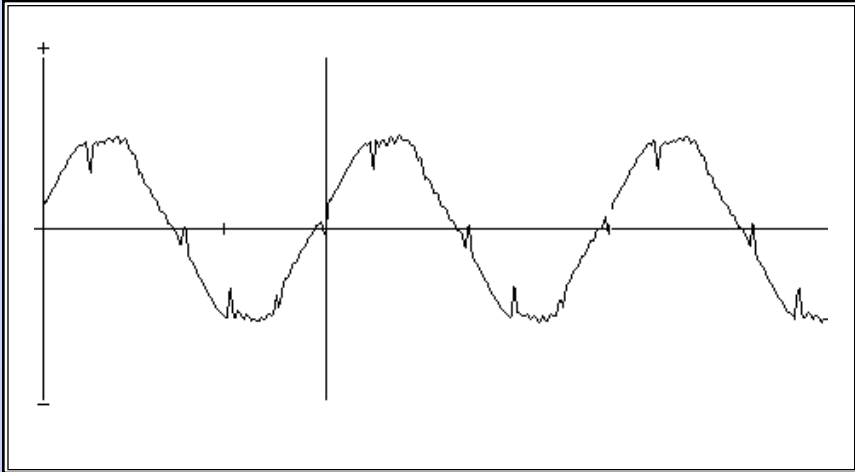
Another Topic...

Line Notching

C. Forster

Do You Have a Problem with IEEE-519?

750 kVA Induction Furnace - 480 volt
VOLTAGE waveform at input to furnace



End

C. Forster