PARSONS
Engineering Computation Sheet

Calculations

Electrical

Harmonic Study Calculation

Titanium Sponge Plant

RTI International Metals, Inc.

Hamilton, Monroe County, MS

Job Number: 444345

Revision	Date	Originator	Checker	Approved
0	7/28/08	Hrand Avanessian	JF	Jim Fuller

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1.0 Objective:

Meet Utility company (TVA)'s harmonic requirements

2.0 Assumptions:

- Use IEEE 519 harmonic should be below 5%
- PCC= Point of Common Coupling
- VSD (variable speed drive) all have harmonic filters meeting IEEE 519
- SCR on Furnace – this type of phase shifting does not produce significant harmonics
- Rectiformers by Neltran – two 12MVA have 7 stage harmonic filters in order to meet IEEE 519
- UPS – has isolation transformer and filter

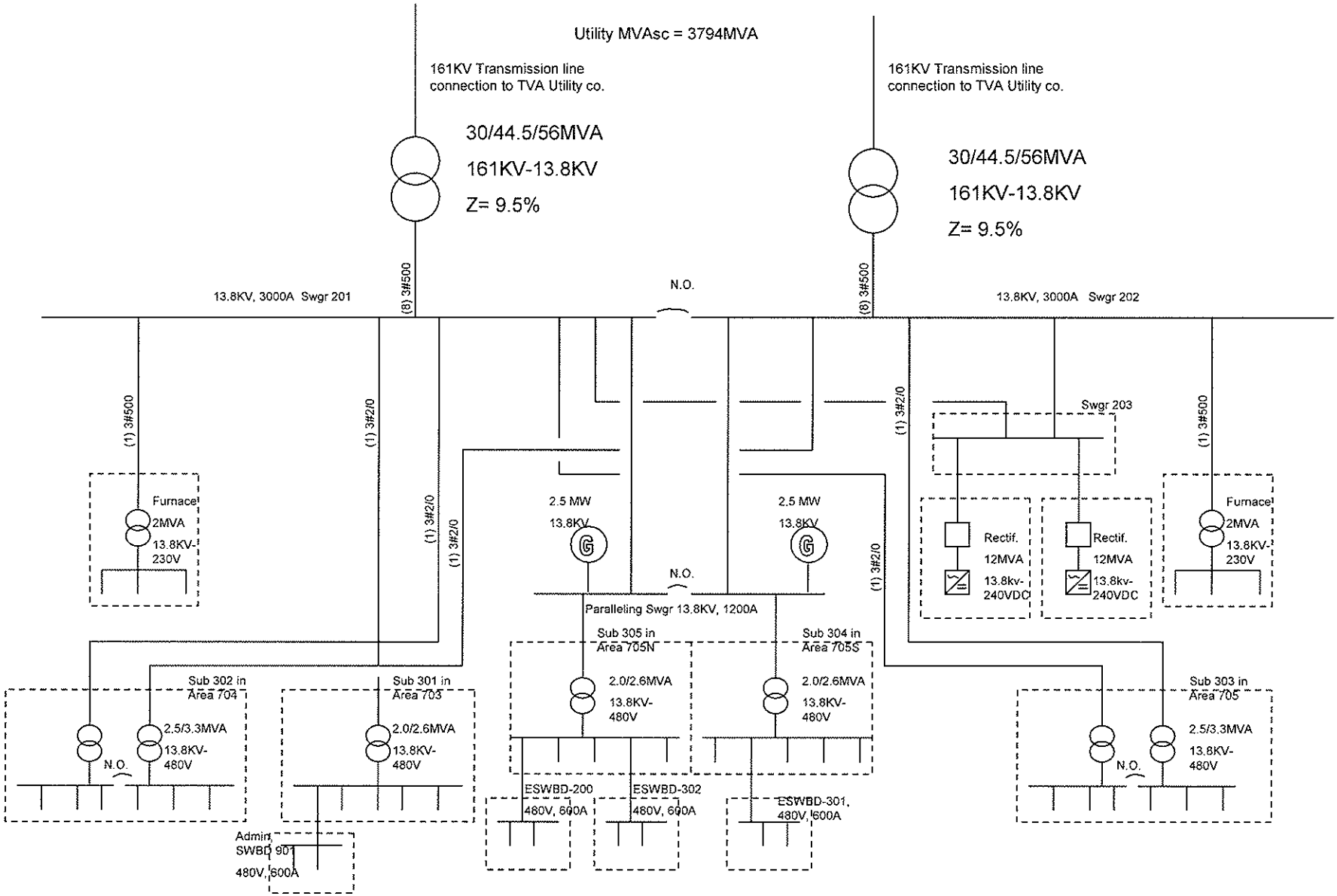
3.0 Design Basis/Criteria and References:

The Titanium factory should not produce more then 5% harmonic on to the TVA utility company or there will be penalties

4.0 Results and Conclusions:

The Titanium plant meets the limits set by TVA per IEEE 519 because the fault current or MVAsc is high making a stiff utility system and because all harmonic sources in the plant have filter to limit the harmonic current. See the attached calculations.

Main Single Line



The max. demand load current at PCC is equal to:

$I_L = 45\ MVA / (\sqrt{3}\ 161\ KV) = 161.37\ A$

$(I_{sc}/I_L) = 13,438/161.37 = 83.$

$50 < 83 < 100$

According to the Table 10.4 of IEEE Std. 519 following limits applies:

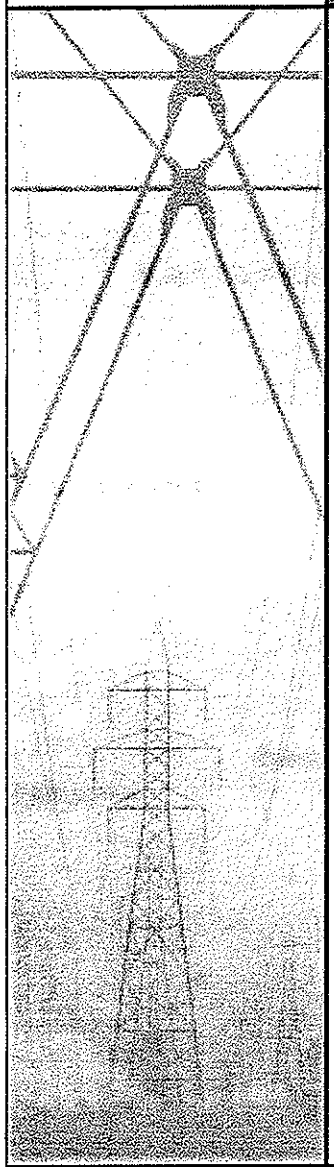
I_{sc}/I_L	<11	$11 \le h < 17$	$17 \le h < 23$	$23 < h/35$	$35 \le h$	TDD
$50<100$	5	2.25	2.0	0.75	0.35	6.0

* → Note: for even harmonics (if any), above values shall be multiplied by 0.25.

Note

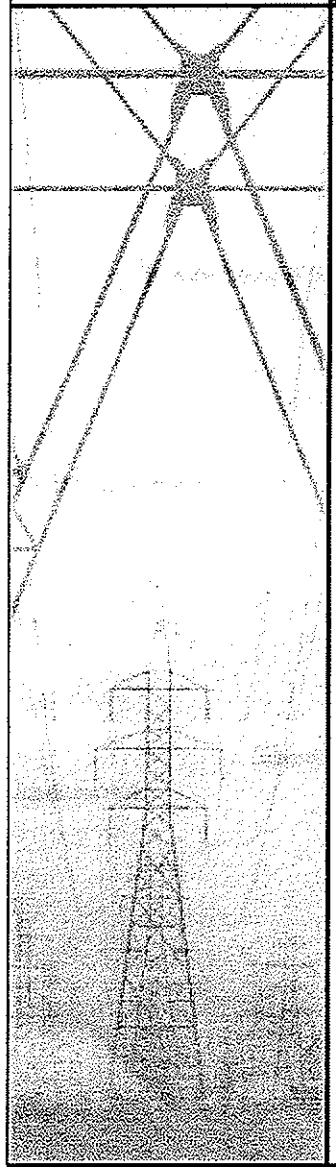
If phase multiplication is utilized (like Rectifiers) then the above values shall be multiplied by $\sqrt{q/6}$, where $q = 2m$ and m is number of pulses. (for Rectifiers $q = 2(6) = 12$, $\sqrt{12/6} = \sqrt{2}$, therefore for rectifiers above values shall be multiplied by $\sqrt{2}$). This is all according to IEEE Std. 519.

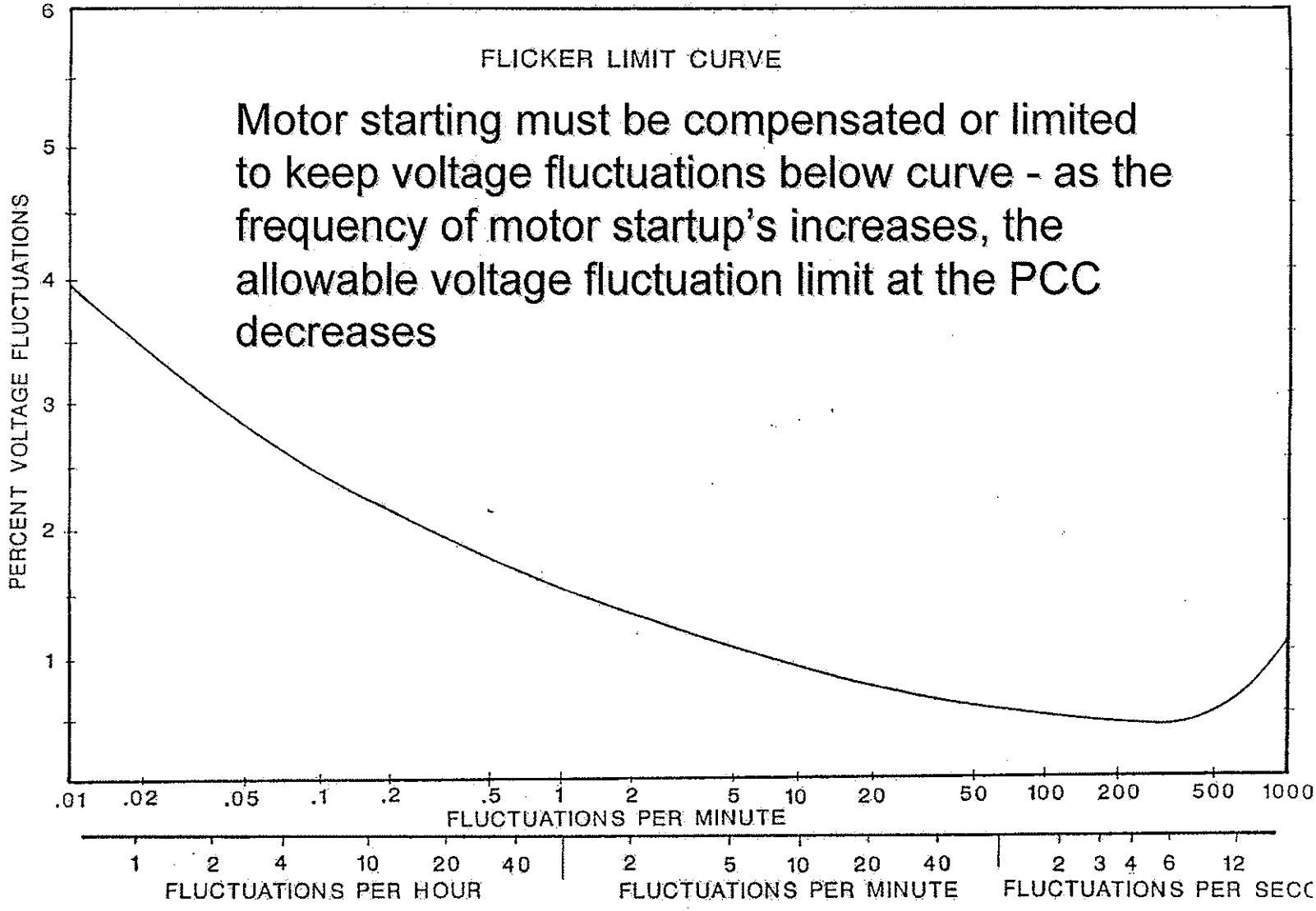
Contract Provisions Covering Unique Nature of RTI's Unique Load



- Point of Common Coupling (PCC) for Service:
  - **Hamilton, Mississippi 161-kV Switching Station**
- RTI should operate in such a manner to remain below the following limits:
  - Voltage Imbalance – RTI's phase and harmonic loading shall **not create a voltage imbalance more than 1.0% at PCC**
  - Voltage Flicker at PCC – RTI's load **shall not create flicker above IEEE 1453 PST(95) =1.0**, **and,** the maximum voltage variation due to motor starting must remain below TVA's flicker curve (see page 2)
  - Harmonic Current Distortion – RTI's load current (at PCC) **shall remain below IEEE 519 distortion limits 95% of time - Table 10-4, 50<100 row** – see page 3
- Monroe County EPA and TVA have the right to require RTI to cease production when exceeding the limits listed above

TVA's Guidelines for Voltage Disturbing Loads Provides Guidelines For Evaluating The Impact of Large Motor Operations – TVA Flicker Limit Curve





IEEE 519 – Table 10-4 For 161-kV Systems

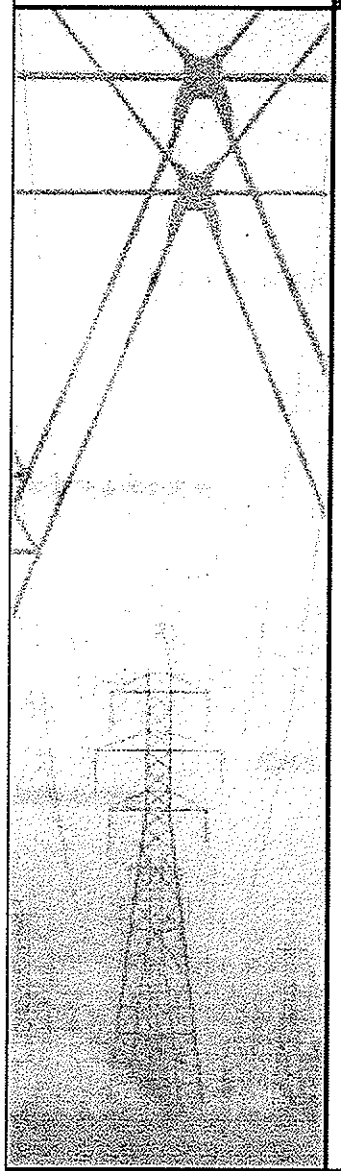


Table 10-4—Current Distortion Limits for General Subtransmission Systems (69 001 V Through 161 000 V)

Maximum Harmonic Current Distortion in Percent of I_L						
	Individual Harmonic Order (Odd Harmonics)					
I_{sc}/I_L	<11	11≤h<17	17≤h<23	23≤h<35	35≤h	TDD
<20*	2.0	1.0	0.75	0.3	0.15	2.5
20<50	3.5	1.75	1.25	0.5	0.25	4.0
50≤100	5.0	2.25	2.0	0.75	0.35	6.0
100<1000	6.0	2.75	2.5	1.0	0.5	7.5
>1000	7.5	3.5	3.0	1.25	0.7	10.0

Even harmonics are limited to 25% of the odd harmonic limits above.

Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

* All power generation equipment is limited to these values of current distortion, regardless of actual I_{sc}/I_L.

where
I_{sc} = maximum short-circuit at PCC.
I_L = maximum demand load current (fundamental frequency component) at PCC.