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# Suppression Of Maximum Demand (MD) During Parallel Operation Of Two Adjacent Traction Sub-Station(TSS)

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***Abstract:*** *Indian Railway is one of the biggest consumer of electricity, it has a largest network of electrification in India. Each Traction Sub-Station(TSS) is located at a distance of 40 to 60 K.M. from other T.S.S, each T.S.S. has its own feeding zone. Railway's avail H.T. supply on two phases only. Between two TSS there is one Neutral Section which is electrically dead & it consists of two section breaks back-to-back. There is a short neutral section of overhead line about 8-10 meters , that belongs to neither feed zone. In this paper the factor by which maximum demand (MD) of TSS is suppressed due to paralleling, when it operates parallel with other adjacent TSS. The suppressing factor have been calculated with the help of Basic electrical engineering voltage and current laws.*

***Keywords:*** *Traction Substations (TSS), Neutral Section (NS), Maximum Demand (MD).*

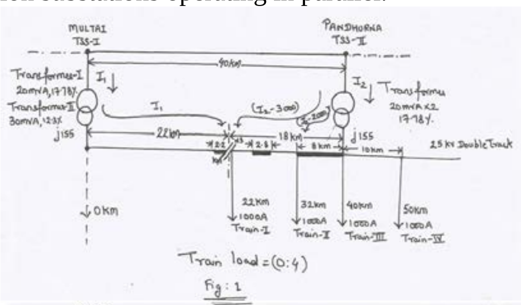
## 1. INTRODUCTION

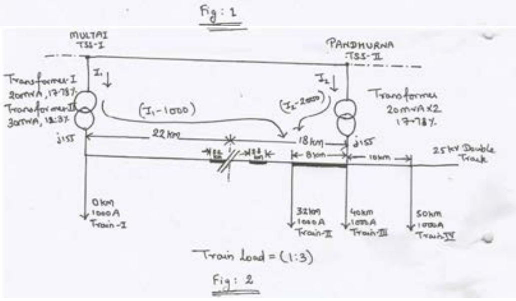
I have chosen two traction Substations where in between there is some steep gradient portion. Generally, distance between two traction substations is near about 45 to 60 KM. And, the feeding zone of each TSS is separated by Neutral Section (NS).

Neutral Section (NS) is electrically dead and it consists of two section breaks back-to-back. So that there is a short section of overhead line that belongs to neither grid.When the train having heavy commercial load or the goods trains passing through the NS at ramp-section the locomotive starts crawling because of heavy mechanical load which starts to pull the locomotive back in absence of power at NS. Hence, the railway electricity board needs parallel operation of two traction substation by providing the supply at NS to avoid crawling of locomotive. With this parallel operation of two TSS located at either sides of NS, the maximum demand of each TSS is sharing with each other, because TSS-1and TSS-2 feeding supply to either sides of NS at parallel condition. Here, we calculate the factor by which maximum demand is suppressed.

## 2. SYSTEM MODEL

A single line schematic diagram showing the assumed position of trains (Load) between the traction substations operating in parallel.




From central railway records there are some particular values of OHE (Over Head Extension) impedance which are used for relay settings.

- Single track OHE without return conductor (RC) = $0.41\angle 70^0$ Ω/km.
- Double track OHE without RC = $0.24\angle 70^0$ Ω/km.
- Single track OHE with RC = $0.70\angle 70^0$ Ω/km.
- Double track OHE with RC = $0.43\angle 70^0$ Ω/km.

Add booster transformer impedance at the rate of 0.15 Ω per booster transformer, where these are provided. We have taken a case of Multai & Pandhurna TSS, they are at 40 KM from each other. There are two Transformers at Multai-TSS capacity of one is 20 MVA having percentage impedance of 17.78 %, while the capacity of other one is 30 MVA having percentage impedance of 12.3 %.At Pandhurna –TSS both Transformers of having 20 MVA capacity with percentage impedance of 17.78 % and the line reactance of the feeder from Transformers to OHE is j155 at both TSS.Fig-1 & Fig-2,showing Multai-TSS & Pandhurna-TSS operating in parallel, in case-1 assuming train load that there is no load at Multai-TSS, and there are four trains running under Pandhurna-TSS, but because both TSS operating in parallel hence all four trains load is not only supplied by TSS-2,it is shared by TSS-1 depending on impedance of OHE. In fig-1 & fig-2, dark lines showing double track OHE between Multai & Pandhurna – TSS.

Take 20 MVA transformers at both TSS for calculations.

Transformer impedance referred to 132 KV side = $(132)^2 * 0.1778/20 = 154.89 \cong j155\ \Omega$.

Impedance of double track OHE with RC = $0.43\angle 70^0$ Ω/km.

Impedance of double track OHE with RC referred to 132 KV side = $(132)^2 * 0.43/(25)^2 = 11.98\angle 70^0 \cong 12\angle 70^0 = (3.94+j10.8)$ Ω/km.

Length of double track OHE with RC between two TSS = 8+2.8+2.2 = 13 km.(Showing by dark lines)

Impedance of double track OHE without RC = $0.24\angle 70^0$ Ω/km.

Impedance of double track OHE without RC referred to 132

KV side = $(132)^2 * 0.24/(25)^2 = 6.69\angle 70^0 \cong 7\angle 70^0 = (2.3+j6.3)$ Ω/km.

Length of double track OHE without RC between two TSS = 40-13 = 27 km.(Showing by single lines.)

<u>Case-1(Fig-1)</u> : Assuming train load 0:4 in feeding zones of above TSS. Neutral Section is closed during parallel operation of 25 KV feeding line.

$$I_1 + I_2 = 4000 \text{ A. -------- (Eq.-1)}$$

As the voltage drop in a closed loop between TSS-1 and TSS-2 is zero.

$I_1 * j155 + I_1 [19.8(2.3+j6.3) + 2.2(3.94+j10.8)] = I_2 * j155 + [(I_2-2000)*8*(3.94+j10.8)] + (I_2 3000) [2.8(3.94+j10.8) +7.2(2.3+j6.3)]$ -------------------------- (Eq.-2)

By solving equations (1) & (2 ) we get,

$I_1 = 1500.04 \cong 1500$ A.

$I_2 = 4000 – 1500 = 2500$ A.

Current drawn from TSS-2 under de-parallel condition is 4000 Ampere.

Current drawn from TSS-2 under parallel condition is 2500 Ampere.

Hence, under parallel condition $I_2$ is suppressed by a factor = 4000/2500 = <u>1.6</u>.

<u>Case-2(Fig-2)</u> : Assuming train load 1:4 in feeding zones at above TSS. Similar, as above calculation if we calculate $I_1$& $I_2$ for train load 1:4 between TSS-1 & TSS-2.In this case ,

$$I_1 + I_2 = 5000 \text{ A. -------- (Eq.-3)}$$

We will have the values of $I_1$& $I_2$ is,

$I_1 = 2139.97 \cong 2140$ A.

$I_2 = 5000 –2140 = 2860$ A.

Current drawn from TSS-2 under de-parallel condition is 5000 Ampere.

Current drawn from TSS-2 under parallel condition is 2860 Ampere.

Hence, under parallel condition $I_2$ is suppressed by a factor = 4000/2860 = 1.398 ≅ <u>1.4</u>

## 3. PREVIOUS WORK

No research work has been published in this domain. This was an arbitration case between Central Railways and Madhya Pradesh State Electricity Board (MPSEB) in which MPEB has penalized the Central Railways. In this thesis work, my target is to evaluate the factor by which Maximum Demand of TSS is suppressed due to its parallel operation with other TSS.

### 4. PROPOSED METHODOLOGY

Here, I have taken all the data from the Central Railway, India like OHE impedances for single track with or without return conductor & double track OHE with or without return conductor, percentage impedance of transformer, position of neutral section from both TSS. With the help of Basic Electrical Engineering voltage & current laws, calculate the value of current from both TSS's and compare these values at parallel & de-parallel conditions. The difference in value of current is the factor by which the maximum demand of that TSS is suppressed.

## 5. SIMULATION/EXPERIMENTAL RESULTS

By, assuming the position of trains (load) between two TSS operating in parallel and make some calculations with the help of basic electrical engineering laws i.e. KVL & KCL and make a table of suppressed factor of each case. Then calculate the average of the factor by which the M.D. gets suppressed from de-parallel condition to parallel condition MPSEB has penalized the Central Railway for parallel operation of TSS.

Here we have taken two cases for different train loads at different TSS and get the value of suppressed factor. A table for many cases of trains between above said TSS indicate the average to calculate the exact value of suppressed Maximum Demand (MD).

| Pairs of TSS operated in parallel. | Type of train combination in feed of two TSS operating in parallel. | | | | |
|---|---|---|---|---|---|
| | 0:4 | 1:3 | 1:4 | 0:3 | 1:2 |
| Suppression factor for Multai & Pandhurna TSS. | 1.6 | 1.26 | ----- | ---- | ----- |

Overall Average : 1.43
This average value is for two cases.

## 6. CONCLUSION

It explains that the Maximum Demand at both TSS has been suppressed by the factor 1.43.Therefore,for working out the unsuppressed Maximum Demand (MD) in de-parallel condition would be = 1.43 * (MD in parallel condition).

## 7. FUTURE SCOPES

After this thesis work. I am now able to evaluate the typical analysis of the technical problems between the Indian Railways and the power supplying distribution companies. It leads due further path to proceed ahead in billing solutions.

## 8. REFERENCES

1. Hand book in the matter of "CENTRAL RAILWAY – FIRST PARTY VS M.P.ELECTRICITY BOARD – SECOND PARTY." Volume -3.

2. Traction Installation Directorate – Govt. of India, Ministry of Railways – "Technical specification for control and relay panel for 25 kv ac TSS".

## 9. AUTHOR'S PROFILE

**Amit Verma** has received his Bachelor of Engineering degree in Electrical & Electronics Engineering from SRIT Engineering College, Jabalpur in the year 2007.At present he is persuing M.Tech with the specialization of Power System in Gyan Ganga college of Technology, Jabalpur. His area of interest Power system, Electrical Machine, Electrical Drives, Circuit Theory.

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