Solving the NEV Test Case Using the Current Injection Full-Newton Power Flow

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Presentation Outline

- Introduction
- The current injection method
- NEV Test System
- Results
- Conclusions

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Introduction

- DSASC - models and analytical tools for DSA
- IEEE test feeders: benchmarks and challenging real cases for DSA programs.
- This Panel discussion: NEV System.

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Current Injection Method

- Main characteristics
  - ✓ Phase coordinates
  - ✓ Complex variables written in rectangular form
  - ✓ Nonlinear current injection equations
  - ✓ Solution using Newton
  - ✓ Jacobian matrix special properties
  - ✓ Inclusion of control devices and control actions
- Initial studies for large transmission systems, positive sequence

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Current Injection Method

- **Suitable to solve DS:**

✓ **One wire to three wire + neutral**

✓ **Balanced or unbalanced**

✓ **Isolated or with any kind of grounding**

✓ **Control devices**

✓ **Radial or meshed**

- **Extended now to include any number of conductors**

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NEV System

- **Main focus:**

➢ **Neutral to earth voltages:**

- **Unbalanced operation of lines having neutral conductors**
- **Neutrals of devices and loads that may be grounded through impedances**
- **Modeling challenges**

➢ **Induced voltages on cables other than power conductors.**

- **Telecommunications cables**

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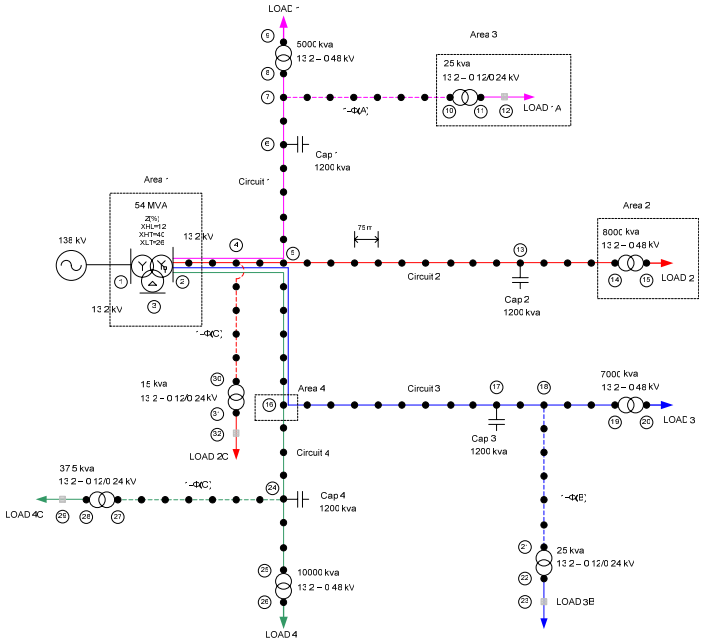
NEV System – Modelling



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NEV System – Conductors Data

Conductors ACSR	477,000 30/7	366,400 30/7	#2 7/1	1/0 6/1
GMR	0,0306 ft 0,933 cm	0,0255 ft 0,777 cm	0,00504 ft 0,0128 cm	0,00446 ft 0,138 cm
Resistence (50 °c)	0,216 Ω/ml 0,135 Ω/km	0,306 Ω/ml 0,191 Ω/km	1,65 Ω/ml 1,031 Ω/km	1,12 Ω/ml 0,70 Ω/km
Diameter	0,833 in 2,243 cm	0,741 in 1,882 cm	0,325 in 0,825 cm	0,398 in 1,011 cm
Ampacity	670 A	530 A	180 A	230 A

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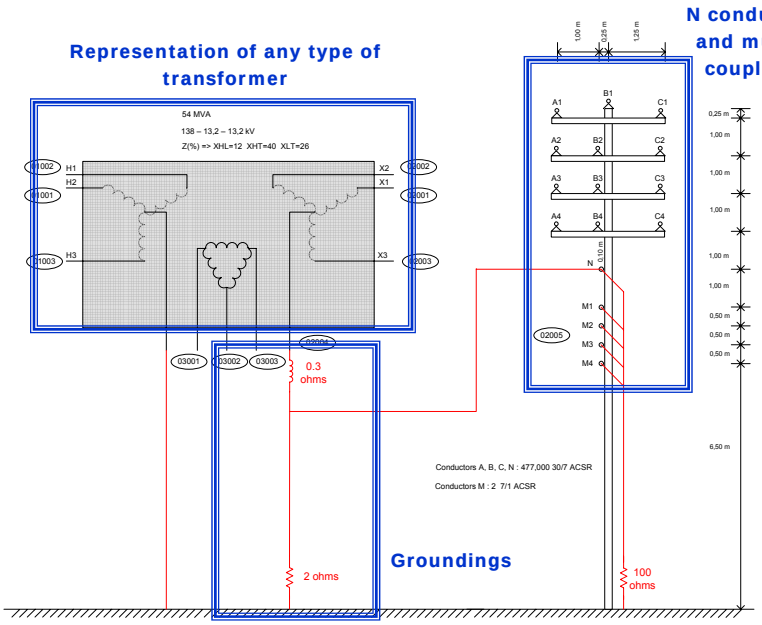
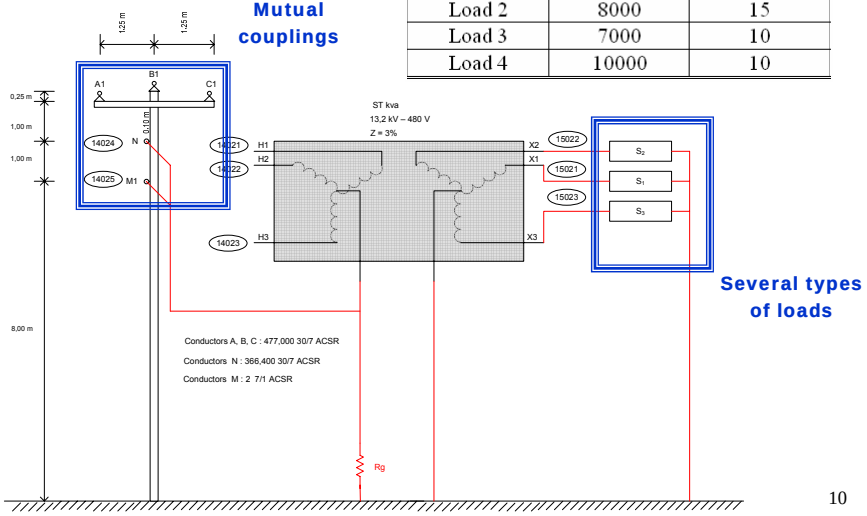
NEV System – Area 1



NEV System – Area 2

Three-phase transformer data

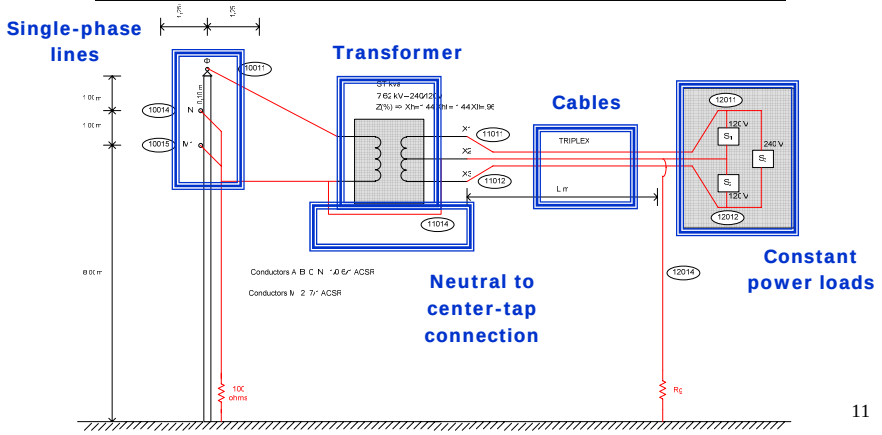
	ST KVA	Rg Ω
Load 1	5000	25
Load 2	8000	15
Load 3	7000	10
Load 4	10000	10



NEV System – Area 3

Single-phase loads, transformer and cable data

	ST KVA	Rg Ω	Cable	Distance (m)
Load 1A	25	25	1/0 AL	50
Load 2C	15	10	1/0 AL	30
Load 3B	25	50	1/0 AL	30
Load 4C	37,5	50	4/0 AL	20



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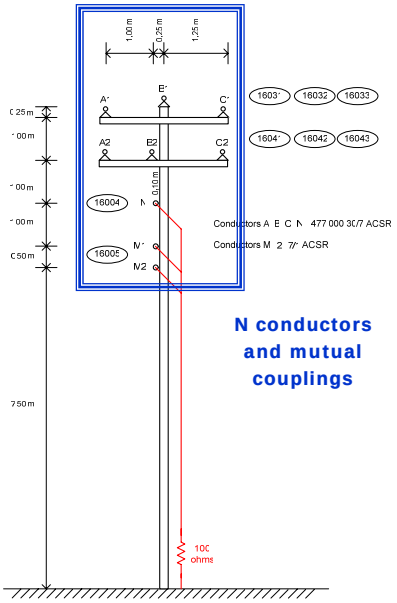
NEV System – Area 4



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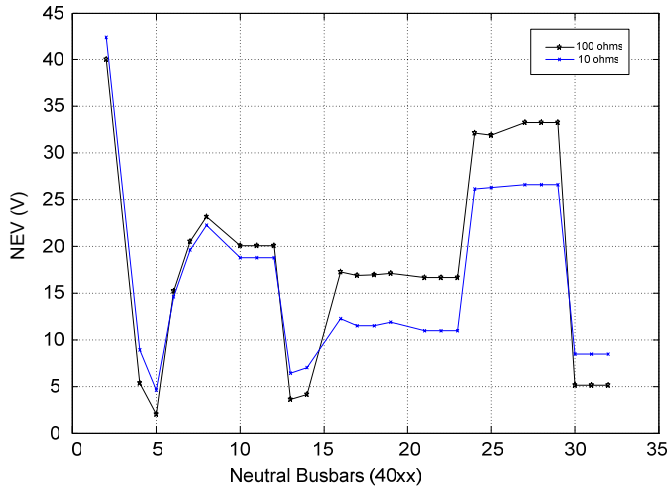
Results

Test – Change all 100 ohms neutral resistors by 10 ohms.



- **Both cases converged in only two iterations.**

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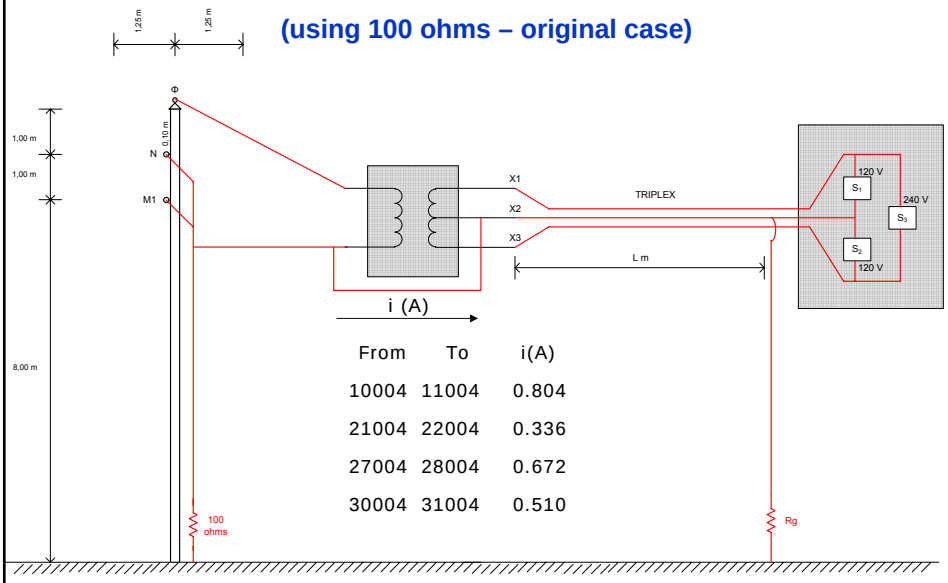
Results

(using 100 ohms – original case)



From	To	i(A)
10004	11004	0.804
21004	22004	0.336
27004	28004	0.672
30004	31004	0.510

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Conclusions

✓ Presence of some fairly high NEVs

✓ Not much sensitive to grounding resistors.

✓ A 10-fold increase in the grounding resistors: NEV increases of about 30 to 50%, depending on the circuit.

✓ It may be of interest to run comparisons with other methods

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Conclusions

✓ Challenges to program developers

✓ Multi-phase algorithms only can cope with the modeling

✓ Very good robustness and convergence properties

✓ Not difficult to converge

✓ All cases converged in only two iterations.

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Eletrobrás

THANK YOU !

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