Paris Session 2022

Considerations on resonances in low order harmonic range

SC B4/ PS1/ Q1.4

With the large number of HVDC converters being integrated to the power system what challenges are foreseen with lack of harmonized grid codes? What impact would a harmonized grid code have on the project development cost and time?

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- Different frequencies are used in Japan, two regions are interconnected via frequency converters (FC).
- The Hida-Shinano HVDC link was installed to increase the interconnection capacity in March 2021.
- The Shin-Shinano Converter station, the converter on 50 Hz side is
  - ✓ connected to the core 500 kV network through long 2 circuit overhead line.
  - ✓ having a lot of reactive power equipment and AC harmonic filters for existing BTB FC systems.
- Therefore, Temporary Overvoltages (TOVs) and low-order harmonic resonance are concerned.

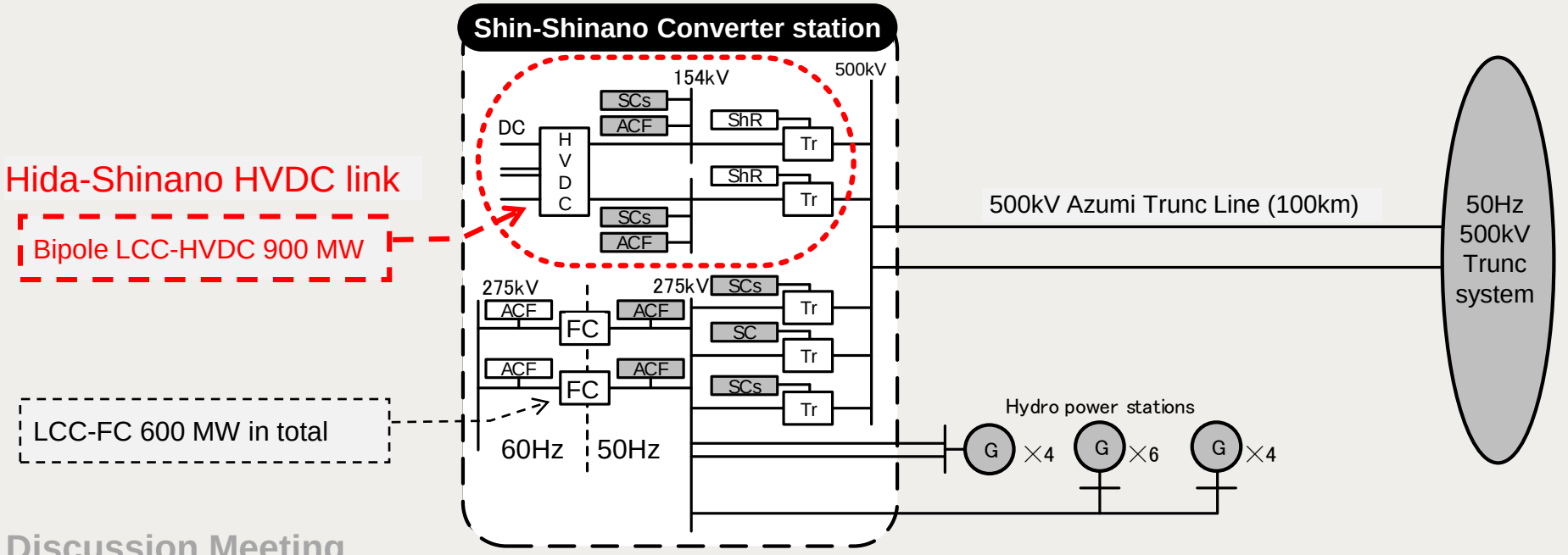

Figure 1. Shin-Shinano Converter station and adjacent AC network

- It was found that the network can be resonant at small integer harmonic order such as 2nd, 3rd or 4th in several particular network conditions(Figure 2).
- Transient studies such as transformer energisation cases or line fault cases, in such conditions as the network is resonant at low integer orders, were done.
- We found that the transiently injected harmonic current generates significant voltage distortion with very high network impedance at the low resonant frequency.

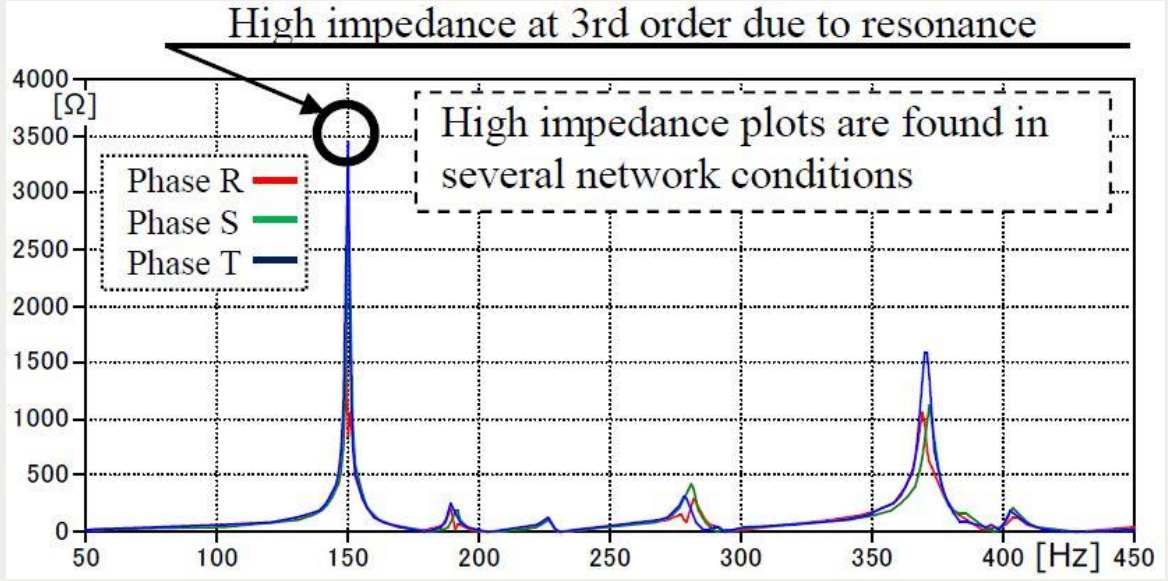

Figure 2. F-Z characteristic at Shin-Shinano converter station 500kVac bus-bar (Example of 3rd order resonance)

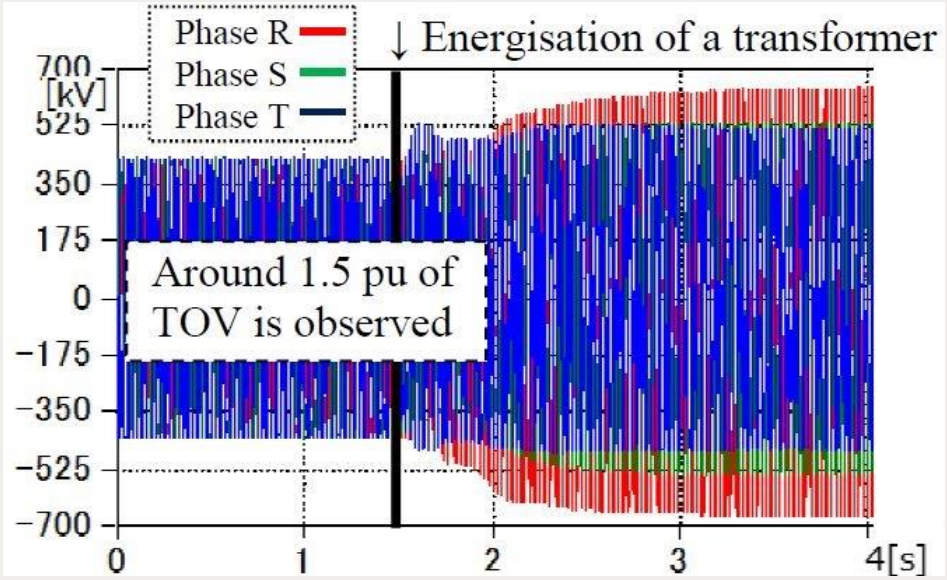

Figure 3. 500 kV bus-bar voltage on a transformer energisation network of F-Z characteristic in Figure 2

- Lowering the network impedance at resonant frequency was considered as a radical countermeasure and we decided to introduce damping resisters to AC harmonic filters.
- The network impedance at the resonant frequencies would be decreased to around one tenth as before and problems for TOVs would be solved (Figure4, Figure5).

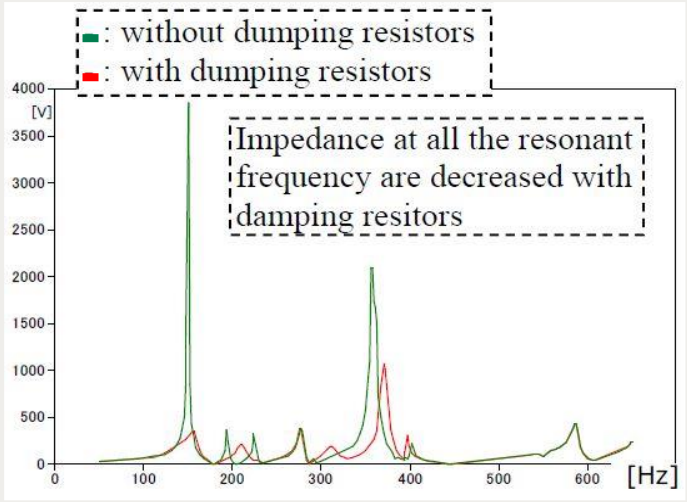

Figure 4. F-Z characteristics with and without damping resistor for filter banks

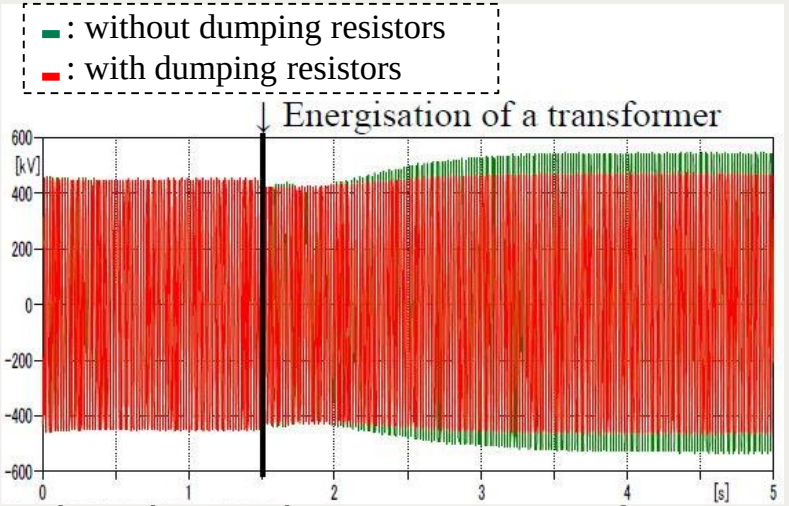

Figure 5. 500 kV bus-bar voltage on a transformer energisation with the network of F-Z characteristic with and without damping resistor

Summary

- It was found that countermeasures are necessary to avoid TOVs and low-order harmonic resonance for installing LCC-HVDC system in the Shin-Shinano Converter station.
- To avoid this concern, the introduction of damping resistors to the AC harmonic filter was effective.