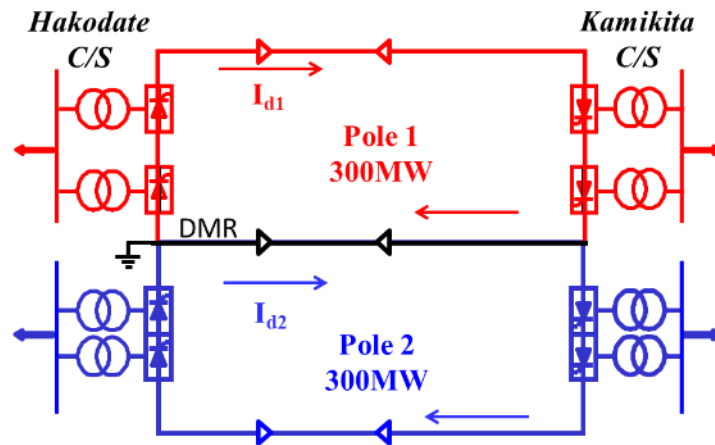
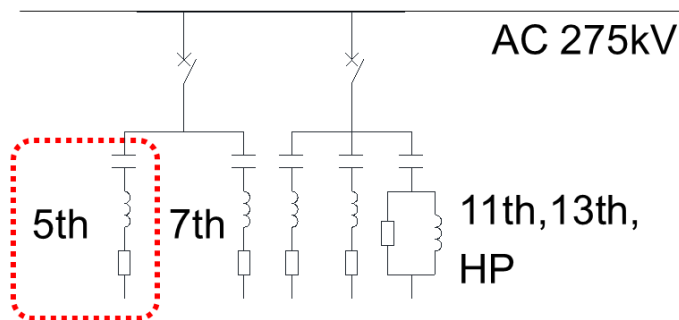


Q1.7 Are there methodologies and approaches to analyses the possible harmonic interactions and predict the scenarios with harmonic interactions?

In the contribution, we will introduce the result of the examination because the AC filter was overloaded only by the harmonics flowing from the AC system.



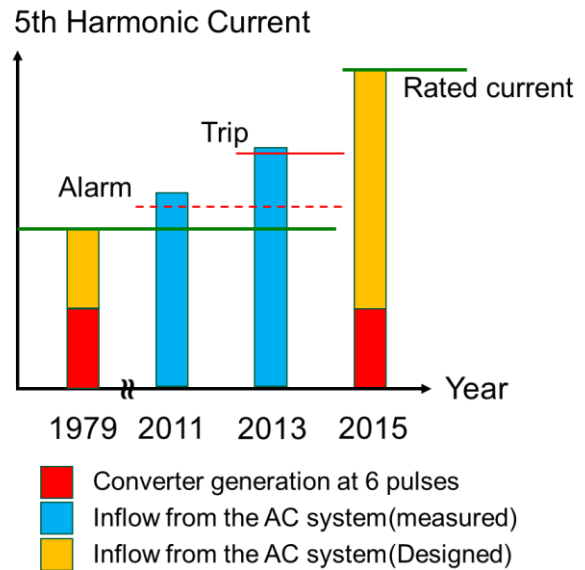
The target AC filter is the pole 1 of the Kamikita C/S side of Hokkaido-Honshu HVDC Link. The Hokkaido-Honshu HVDC link is a bipolar +/-250 kV, 300 MWx2. The purpose of installing the AC filter is to absorb the harmonics generated by the operation of the LCC converter. The AC filter is connected to the AC 275kV bus via GCB.



Since pole 1 can perform both 6-pulse operation and 12-pulse operation, a 5th filter and 7th filter are installed. Reactor and resistor (2011, right photo) are housed in the same insulator tank. Capacitors were installed on the insulator frames.

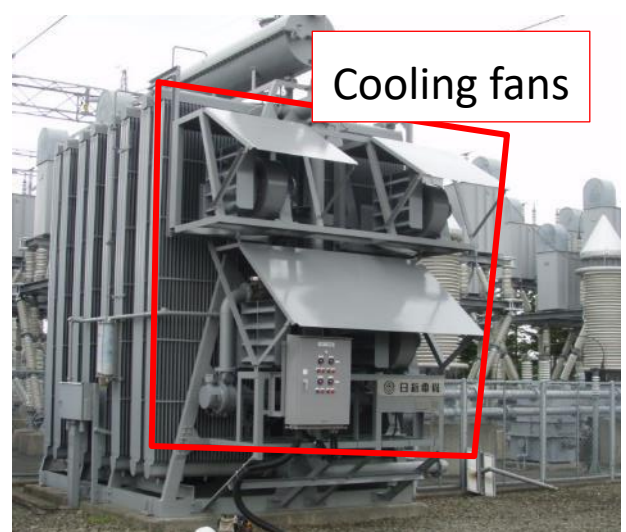


When the AC filter was installed, the harmonic current rating was designed from the value generated by 6-pulse operation (red bar) and the amount of system inflow at that time (orange bar). However, in 2011, an overload alarm occurred during 12-pulse operation where the 5th harmonic was not generated from the converter. It was found that the cause of the overload of the AC filter was an increase in inflow from the AC system. It was estimated that this was due to the enhancement of the AC system. We tried to reduce the harmonics flowing from the AC system to the AC filter, but we could not take measures by the AC system. In this state, if the converter operates in 6 pulses, the AC filter will overload trip and the converter will not be able to continue operation. Therefore, it was decided not to operate 6 pulses until 2015.



An oil cooling fan was installed in 2012 for continued use of the equipment. The cooling fan had the effect of cooling the temperature of the insulating oil more and could extend the life. After that, it was decided to take measures by replacing the equipment in 2015. The fundamental wave capacitance (32MVA) and the circuit constant (L, C and R) are the same, and only the rated harmonic current is improved. In 2013, before he could take action, we experienced a trip with an overload relay.

The new AC filter is designed to enable 6-pulse operation even when the rated harmonic current flows in consideration of the urgent system harmonic inflow. The replacement targets were capacitors, reactors and resistors. The insulator frames for the capacitor were diverted.



The above pictures are before and after the addition of the oil cooling fans in 2012. The additional work took about two weeks while the converter was in operation.



The above pictures are the AC filter after replacement in 2015. Reactors and resistors have increased in size as the harmonic rating increases. The capacitors are slightly larger. Capacitors and reactor remained OF type, and resistors were changed from OF type to dry-type.