

Extreme growth of GIC in power lines on the Kola Peninsula and in Karelia during 11 years of observations

Vladimir B. Belakhovsky¹ , Vjacheslav A. Pilipenko , Yaroslav A. Sakharov¹ , Vasiliy N. Selivanov²

¹ Полярный геофизический институт Кольского научного центра Российской академии наук

² Кольский научный центр Российской академии наук

belakhov@mail.ru

It was analyzed cases with extreme values of geomagnetic-induced currents (GIC) in power transmission lines (PTLs) on the Kola Peninsula and Karelia for 2012-2022. The GIC registration system was created by the Polar Geophysical Institute and the Center for Physical and Technical Problems of Northern Energy of the Federal Research Center KSC RAS and includes 5 stations, oriented mainly in the north-south direction. Registration of GIC has been carried out continuously since end of 2011, and by 2022 a “quasi-solar cycle” of GIC registration has formed, including 24-25 cycles of solar activity. GIC data were compared with data from PGI magnetometers at the Lovozero and Loparskaya observatories, and with data from magnetometers in the IMAGE network. Extreme values of GIC and dB/dt were compared with the parameters of the solar wind and interplanetary magnetic field, and geomagnetic activity indices.

The GIC data from the Vykhodnoy auroral station (VKH) and the Kondopoga subauroral station (KND) were considered. According to the VKH station data, 85 cases were selected as extreme events when the GIC value exceeded 30 A. The analysis shows that in most cases (60%) extreme growth of GIC occurs during CME magnetic storms, several cases occurred without magnetic storms (3%), the remaining cases are during CIR storms (37%). At the same time, there is a connection between the occurrence of extreme GIC events and the solar activity cycle. For example, in 2019 and 2020, during the years of minimum solar activity, no extreme cases were recorded. According to the KND station data, 23 extreme events were selected when the GIC value exceeded 10 A. According to the KND station, extreme GIC values are observed in 87% of cases during CME storms and in 13% of cases during CIR storms.

The greatest GIC values occur during substorms (negative magnetic bays associated with the development of the western electrojet). At the same time, the development of vortex current systems during a substorm (Pi3/Ps6 geomagnetic pulsations) can make a noticeable contribution to the growth of GIC for power lines oriented in the north-south direction. The Pc5 pulsations and SSC events lead to medium (~20 A) and low values of GIC. An analysis of GIC during strong magnetic storms over 11 years of observations is presented: March 17-18, 2013 [1], June 28-29, 2023 [2], March 17-20, 2015, September 7-8, 2017, May 27-29, 2017, etc.

1. Belakhovsky V.B., Pilipenko V.A., Sakharov Y.A., Selivanov V.N. Characteristics of the variability of a geomagnetic field for studying the impact of the magnetic storms and substorms on electrical energy systems // Izvestiya, Physics of the Solid Earth. 54 (2018). № 1. P. 52-65.

2. Belakhovsky V., Pilipenko V., Engebretson M., Sakharov Ya. and Selivanov V. Impulsive disturbances of the geomagnetic field as a cause of induced currents of electric power lines // Journal of Space Weather and Space Climate. 2019. 9. A18.