

# **Space Weather Effects on Mid-Latitude Railways: a Statistical Study of Anomalies observed in the Operation of Signaling and Train Control Equipment on the East-Siberian Railway**

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The end result of a long chain of space weather events beginning on the Sun is the induction of currents in ground-based long conductors as power lines, pipelines and railways. Intense geomagnetically induced currents (GIC) can hamper rail traffic by disturbing signaling and train control systems. In few cases induced voltages were believed to have affected signaling equipment in Sweden [Jansen et al., 2000] and in the North of Russia [Belov et al., 2005]. GIC threats have been a concern for technological systems at high-latitude locations due to disturbances driven by electrojet intensifications. However, other geomagnetic storm processes such as SSC and ring current enhancement can also cause GIC concerns for the technological systems. Objective of this report is to continue our research [Ptitsyna et al., 2005] on possible influence of geomagnetic storms on mid-latitude railways and to perform a statistical research in addition to case studies. This will help in providing a basis for railway companies to evaluate the risk of disruption to signaling and train control equipment and devise engineering solutions. In the present report we analyzed anomalies in operation of automatic signaling and train control equipment, occurred in 2004-2005 on the East-Siberian Railway located at mid-latitudes (latitudes: 51N-56N; longitudes: 96E-114E). The anomalies consist mainly in unstable functioning and false operations in traffic automatic control systems (rail chain, switches, locomotive control devices, etc.), often resulting in false engagement of railway tracks (red signals instead of green). Our results revealed seasonal effect in relative numbers of anomalies (on one train) similar to the one observed in geomagnetic activity. It was also found an increase of the daily duration of anomalies (total duration of anomalies observed daily in various railway divisions) by 3-4 times during big geomagnetic storms (local geomagnetic index  $A > 30$ ). It was found a significant correlation during characteristic storm time period (10-20 days) of the daily sum of durations of false operations

in signaling and train control equipment with indexes of geomagnetic activity. Special attention was paid to false operations not related to recognized technical malfunctions. This kind of anomalies is most likely to be GIC-related. Analysis of linkages between these anomalies and geomagnetic conditions in 2004, done by epoch method, showed a clear increase in Dst and Ap values by a factor  $\sim 4-5$ , in the days when the anomaly occurred, in comparison with the average level of the whole year. It follows that the anomalies occurred during main phase of geomagnetic storm.

Reference:

Jansen, F., R. Pirjola, and R. Favre, Space weather, hazard to the Earth? *Swiss Reinsurance Company, Zurich*, 2000.

Belov A.V., S.P. Gaidash, E.A. Eroshenko, V.L. Lobkov, Kh.D. Kanonidi, V.D. Kuznetsov, and V.V. Fomichev. Influence of the great geomagnetic disturbances on the northern railways operating. *2<sup>nd</sup> European Space Weather Week, the Netherlands, Nov 2005.*

Ptitsyna N.G, V.V. Kasinskii, N.N. Lyahov, L. Dorman, G. Villorresi, N. Iucci. Relationship between geomagnetic disturbances and failures in railway automatic signaling and train control equipment. *2<sup>nd</sup> European Space Weather Week, the Netherlands, Nov 2005.*