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## **Failures by Voltage Distortion and The Limits for Harmonic Currents of Electric Appliances**

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### Abstract

The waveforms of voltages that include harmonic elements are non-sinusoidal, namely, distorted. As distorted voltages cause problems with electric equipment, harmonics is one of the most important elements in power quality.

This paper introduces the status of voltage distortion and failures caused by voltage distortion in Japan, the limits for harmonic currents emitted by electric equipment as issued by the Japanese government and their effects.

The number of failures caused by voltage distortion in the electric power distribution system in Japan was increasing in the 1980s. A fire caused by voltage distortion occurred in a public museum in 1994; this incident received significant coverage from some newspapers. The causes of voltage distortion were the harmonic currents emitted by electric home appliances such as television sets. After a detailed investigation on the status of voltage distortion and the technical difficulties in reducing harmonic currents and so on, the Japanese government issued two types of limits for harmonic currents in 1994. One is a set of limits for home appliances and general-purpose equipment, based on the IEC standard. The other is a set of limits for large consumers supplied with electricity by voltage including and higher than 6.6 kV. The voltage distortion and the number of failures in Japan have been decreasing after the sets of limits were issued.

Recently, home appliances such as washing machines and refrigerators have been changing their source circuits to variable speed drive (VSD) and the ballast circuit in lighting equipment has been changing from magnetic to electric. Because such kinds of appliances have the same types of circuits as television sets, the number of harmonic current sources has been increasing. The ratio of VSD equipment in Japan is higher than that in other countries. If the limits had not been issued, the voltage distortion and the number of failures would have increased. Because it took three or four years before the effects of the limits appeared, the governments in the other countries had better take measures before problems caused by voltage distortion become more obvious.