International Comparison of 50/60 Hz Power (1996-1999)

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Abstract

An International Comparison of 50/60 Hz Power is described. The traveling standard was an electronic power transducer which was tested at 120 volts, 5 amperes, 53 hertz, at five power factors (1.0, 0.5 lead, 0.5 lag, 0.0 lead, and 0.0 lag). Fifteen National Metrology Institutes from six Metrology Regions participated in the comparison.

Summary

In 1994, the National Institute of Standards and Technology (NIST) agreed to serve as the pilot laboratory to run an International Comparison of 50/60 Hz Power. After consultation with other National Metrology Institutes (NMIs), it was decided to perform the comparison at 53 hertz – close to the power frequency of most countries, but far enough away to avoid annoying beat frequency problems. Five points were selected to test the amplitude and phase measuring capabilities of the power standards at each NMI: 120 volts and 5 amperes at power factors 1.0, 0.5 lead, 0.5 lag, 0.0 lead, and 0.0 lag (where lead/lag indicates that the current waveform leads/lags the voltage waveform).

The traveling standard selected was a commercial electronic ac-power-to-dc-voltage converter based on the time-division-multiplier operating principle. With 120 V, 5 A applied at 1.0 power factor, the nominal output of the converter is 10 V dc. The traveling standard selected was the more stable of two such instruments monitored in the NIST Power Laboratory for several years prior to the comparison. Participants were asked to monitor several test parameters that could influence the results. These include frequency, voltage, current, power factor, temperature, humidity, and the zero offset and ± dc reference voltages of the traveling standard.

The original intent was to complete the comparison within three years. With 15 interested participants, it was decided to send the traveling standard to two NMIs before returning it to NIST. Because of scheduling constraints, this procedure was not always followed. Two NMIs withdrew from the comparison after making measurements. Two additional NMIs asked to be included near the end of the third year, so the test period was extended to three and a half years. With 15 NMIs contributing from six Metrology Regions, this is the largest international comparison of electric power to date.

The overall results are given in figure 1, where the plotted value for each NMI is its difference from the mean of the NIST values measured before and after shipment to that NMI. Differences are given in proportional parts (μW/W) and error bars represent the combined standard uncertainty (k=1) for each measurement. In the final paper, the NMIs will be identified and a brief description of their power standards will be provided.

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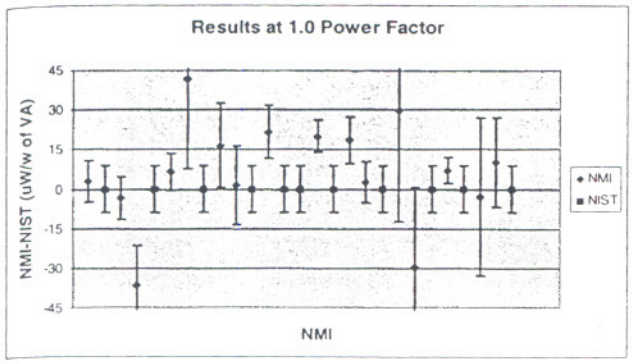

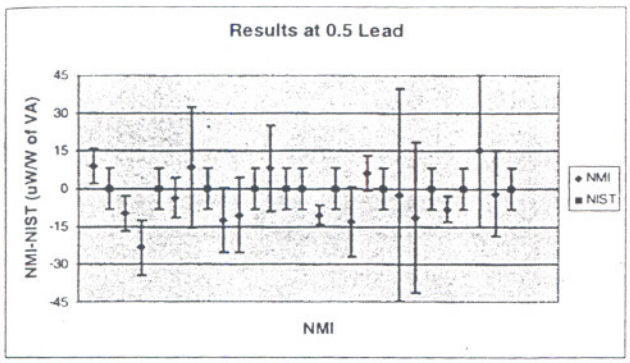

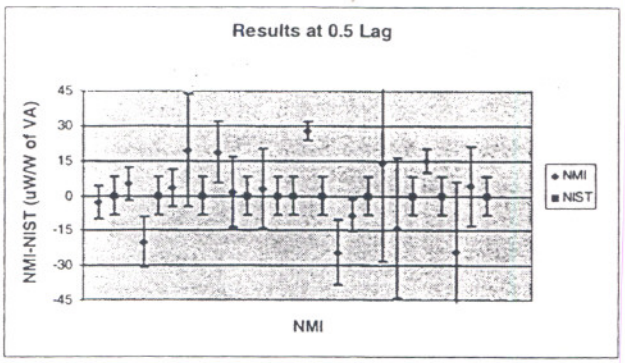

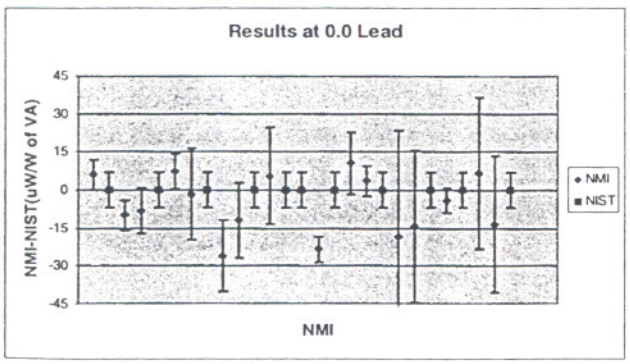

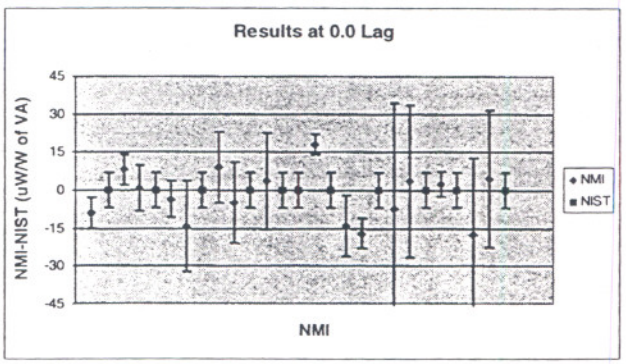

Figure 1. Preliminary Results of the International Comparison of 50/60 Hz Power. Plots show differences from NIST (in μW/W of applied volt-amperes, VA). Error bars represent the combined standard uncertainty (k=1). NMIs will be identified in the final paper.