TEST CONDITIONS AND EQUIPMENT FOR DETERMINING THE ENERGY STAR® QUALIFICATION STATUS OF IMAGING EQUIPMENT PRODUCTS

February 16, 2005

The following test conditions shall be applied to the Operational Mode (OM) and Typical Electricity Consumption (TEC) imaging product test procedures of the ENERGY STAR Office Equipment Program. These cover copiers, digital duplicators, fax machines, mailing machines, multifunction devices, printers, and scanners.

Below are the ambient test conditions that must be established when performing the energy or power measurements. These are necessary in order to ensure that outside factors do not affect the test results, and that test results are reproducible. Specifications for test equipment follow the test conditions. This document concludes with a discussion of differences between this draft and the existing ENERGY STAR test conditions for printers and fax machines, upon which this draft is based.

I. TEST CONDITIONS

General Criteria

Supply Voltage*:	North America: Europe: Australia/New Zealand: Japan:	115 (± 1%) Volts AC, 60 Hz (± 1%) 230 (± 1%) Volts AC, 60 Hz (± 1%) 230 (± 1%) Volts AC, 50 Hz (± 1%) 230 (± 1%) Volts AC, 50 Hz (± 1%) 100 (± 1%) Volts AC, 50 Hz (± 1%)/60 Hz (± 1%)
Total Harmonic Distortion (Voltage):	< 2% THD	
Ambient Temperature:	23°C ± 5°C	
Relative Humidity:	10 – 80 %	
Line Impedance:	< 0.25 ohm	

(Reference IEC 62301: Household Electrical Appliances – Measurement of Standby Power, Sections 3.2, 3.3)

***Supply Voltage**: Manufacturers shall test their products based on the market in which the models will be sold. Manufacturers must ensure that qualifying products marketed and sold in any region as ENERGY STAR do not exceed the TEC or OM values declared to ENERGY STAR (and stored in the ENERGY STAR database) at the standard mains voltage and frequency conditions of that region. For equipment that is sold in multiple international markets and therefore rated at multiple input voltages, the manufacturer must test at and report all relevant voltages and power consumption levels if it intends to qualify the product as ENERGY STAR in the respective markets. For example, a manufacturer that is shipping the same printer model to the United States and Europe must measure and report the TEC or OM values at both 115 Volts/60 Hz (or 230 Volts/60Hz) and 230 Volts/50 Hz.

II. TEST EQUIPMENT

The goal of the test procedures is to accurately measure the TRUE power consumption[1] of the product. This necessitates the use of a **True RMS** power or energy meter. There are many such meters available,

[1] True power is defined as (volts)x(amps)x(power factor), and is typically reported as Watts. Apparent Power is defined as (volts)x(amps) and is usually expressed in terms of VA or volt-amps. The power factor for equipment with switching power supplies is always less than 1.0, so true power is always less than apparent power. Accumulated energy measurements sums power measurements over a period of time and so also need to be based on measurements of true power.

and manufacturers need to exercise care in selecting an appropriate model. The following factors must be considered when selecting a meter and conducting the test.

Frequency Response
In selecting a meter, the frequency response rating is an important issue to consider. Electronic equipment that contains switching power supplies introduces harmonics (odd harmonics typically up to the 21st). If these harmonics are not accounted for in power measurement, the result will be inaccurate. EPA recommends that manufacturers use meters that have a frequency response of at least 3 kHz; this will account for harmonics up to the 50th, and is recommended by IEC 555.

Resolution
Meters used to report direct power measurements shall provide resolution of 0.1 W or better.

Accuracy
Measurements made with these procedures shall in all cases have an accuracy of 5% or better, though manufacturers will usually achieve considerably better than this. With knowledge of the power levels of current imaging products and the meters available, manufacturers can calculate the maximum error based on the reading and the range utilized for the reading. As this maximum error will be added to the measurements, there is an incentive to utilize relatively more accurate equipment.

Calibration
Meters must have been calibrated within the last 12 months to ensure accuracy.

Discussion of Changes

The above testing conditions and equipment specifications were adapted from the test conditions in the Version 3.0 ENERGY STAR Printer/Fax specification. They were further informed by the recently-revised Version 4.0 ENERGY STAR Monitor specification, the ITI Imaging Product Working Group's recommendations,[2] and stakeholder comments received over the last year.

Goals when revising these test conditions were as follows:

- Provide for as many common elements between the TEC and OM test procedures as possible.
- Create common conditions for all imaging product types.
- Require only as much in potentially expensive equipment and test facilities as is necessary.
- Allow for the testing to be done in an ordinary office environment.

I. Test Conditions

Power Conditions

The tolerance on the supply voltages is now 1% rather than the 4% in the existing printer/fax procedure. As manufacturers typically test for international compliance, they will already have a regulated AC power supply. The tolerance on frequency in the existing specification was 3%; regardless, EPA does not think such variation in frequency is found at manufacturer facilities. IEC 62301 also specifies a 1% tolerance for both voltage and frequency. THD was reduced from <5% to <2%; the ImTech proposal suggested <3%. Line Impedance was left unchanged at < 0.25 ohm.

[2] ENERGY STAR ImTech Working Group, presentation to ENERGY STAR Imaging Product meeting, April 16, 2003. Available on the ENERGY STAR Products in Development Web site: www.energystar.gov/productdevelopment

Environmental Conditions

For temperature, the current ENERGY STAR Copier and MFD test procedures specify 21 ± 3 C, and the Printer/Fax and Scanner test procedures specify 25 ± 3 C. The ImTech proposal was 23 ± 5 C, which covers the combined range of the existing specifications, and also matches the requirement of IEC 62301. Each of these was endorsed by some stakeholders. Other stakeholders referenced ISO 554 which allows for 23 ± 2 C (and 50 ± 10% relative humidity). EPA has selected the 23 ± 5 C range, which exactly covers the existing ranges and matches the IEC 62301 requirement.

For humidity, the existing Printer/Fax and Scanner test procedures do not comment and the Copier and MFD test procedures limit it to 40 - 60%. The new Monitor specification allows 30 - 80%. The ImTech proposal advocates increasing it to 10% - 80% or eliminating it entirely. The above text adopts the 10% - 80% suggested in the ImTech proposal. EPA is interested in any compelling data or reasons why it should not be eliminated. It is understood that high humidity can interfere with proper functioning. Since manufacturers are conducting these tests, they will not choose humidity conditions that adversely affect their products.

Other Conditions

The Copier and MFD test procedures specify a 2-foot minimum distance from the nearest wall. This requirement has been eliminated from the above text.

The existing specifications required a 12-hour minimum stabilization time. Many stakeholders commented that this was unnecessary, or at a minimum, overly long. The new TEC test procedure provides for an hour of sleep time before the active job measurements are taken, providing that much stabilization, and no recovery from off is included, which is probably the value most sensitive to the unit's prior conditions.

II. Test Equipment

The test equipment portion of this test conditions document has not changed appreciably from the previous ENERGY STAR imaging product requirements.

Accuracy

The TEC and OM test procedures explicitly calculate the potential error and add that to the measurement or calculated value. This is done to ensure that overly inaccurate measurements to not undermine the imaging specification, while avoiding rigid prescriptions for test equipment, particularly in the context of imaging equipment, which spans a wide range of capacity and modes. In practice, accuracy is expected to be within 2%.

Crest Factor

The Printer/Fax test procedure contains the following statement about crest factor. EPA intends to eliminate this discussion of crest factor from the Imaging Equipment test Conditions.

> Crest Factor
> A previous version of EPA's testing procedure included a requirement that manufacturers utilize a meter with a crest factor greater than eight. As many Partners pointed out, this is not a useful or relevant requirement. The following paragraphs are meant to discuss the issues relating to crest factor and to clarify the intent of the initial statement. Unfortunately, EPA cannot provide a specific equipment requirement because testing is as much art as it is science. Manufacturers and testers will have to exercise judgement, and draw on people well versed in testing issues, to select an appropriate meter.

It is important to understand that electronic equipment such as printers and fax machines typically draw current in a waveform different from typical sinusoidal current.[3] While virtually any meter can measure a standard current waveform, it is more difficult to select a meter when irregular current waveforms are involved.

It is critical that the meter selected be capable of reading the current drawn by the printer or fax machine without causing internal peak distortion (i.e., clipping off the top of the current wave). This requires a review of the meter's crest factor,[4] and of the current ranges available on the meter. Better meters will have higher crest factors, and more choices of current ranges. When preparing the test, the first step should be to determine the peak current (amps) associated with the printer or fax machine being measured. This can be accomplished using an oscilloscope. A current range must be selected that will enable the meter to register the peak current. Specifically, the full scale value of the current range selected multiplied by the crest factor of the meter (for current) must be greater than the peak current reading from the oscilloscope. For example, if a meter has a crest factor of 4, and the current range is set on 3 amps, the meter can register current spikes of up to 12 amps. If the measured peak current is only 6 amps, the meter would be satisfactory. However, if the current range is set too high in order to register peak current, then it may lose accuracy in measuring the non-peak current. Therefore, some delicate balancing is necessary. Again, with more current range choices and higher crest factors you will get better results.

[3] The crest factor for a sinusoidal 60 Hz current waveform is always 1.4. The crest factor for a current waveform associated with equipment containing a switching power supply will always be greater than 1.4 (though typically no higher than eight). The crest factor of a current waveform is defined as the ratio of the peak current (amps) to the RMS current (amps).

[4] The crest factor of a watt meter is often provided for both current and voltage. For current it is the ratio of the peak current to the RMS current in a specific current range. When only one crest factor is given, it is usually for current. An average True RMS Watt meter has a crest factor in the range of 2:1 to 6:1.