Hewlett-Packard DesignJet 5000/5000PS – Print Permanence Ratings

Joshua Greene of the Archives of Milton H. Greene in Florence, Oregon with a 1954 photograph of Marilyn Monroe printed on 100% cotton base Hahnemühle William Turner paper with an HP5000PS printer and the high-stability HP UV pigmented inkset. <www.archiveimages.com>

Printer Description: Available in a number of configurations in 42-inch and 60-inch printing widths, the HP5000 and the Adobe PostScript enabled HP5000PS are 6-ink (CcMmYK) roll-fed printers capable of printing up to 1200 x 600 dpi resolution. Shipped with a choice of either dye-based or pigmented inks, Hewlett-Packard supplies ink change-over kits that make it possible for the user to switch the printer's type of ink. Prices for the HP5000 series printers range from $8,995 for the 42-inch non-PostScript model to $18,995 for the 60-inch PostScript enabled unit. The Hewlett-Packard DesignJet 5500-series printers introduced in mid-2002 are faster-printing versions of the 5000-series printers; both employ the same HP pigmented and dye-based ink sets and both provide the same print permanence ratings for the various types of media.

Display Permanence Ratings and Dark Storage Ratings (Years Before Noticeable Fading and/or Changes in Color Balance Occur)[1]

Paper, Canvas, or Film Media Printed with Hewlett-Packard Inks	Displayed Prints Framed Under Glass[2]	Displayed Prints Framed With UV Filter[3]	Displayed Prints Not Framed (Bare-Bulb)[4]	Dark Storage Stability Rating at 73°F & 50% RH (incl. Paper Yellowing)[5]	The > symbol indicates "more years" than the number listed and that the tests are continuing. Paper/Canvas Description
Printed with HP Pigmented "UV" Inks					
HP Durable Image Gloss UV	**>200 years**[6]	>200 years	now in test	>200 years	Fast drying, high-gloss photo paper
HP Productivity Photo Semi-Gloss	**>200 years**	>200 years	now in test	>200 years	Instant-dry, semi-gloss photo paper
HP Studio Canvas	**>200 years**[7]	>200 years	now in test	>200 years	Coated 100% cotton fine art canvas
HP Canvas Matte	**>200 years**	>200 years	now in test	>200 years	Coated 100% cotton fine art canvas
HP Heavyweight Coated Paper	**>100 years**[8]	>100 years	now in test	>100 years	Matte surface paper
3M® Changeable Opaque Imaging Media	**>200 years**[9]	>200 years	now in test	>200 years	High-gloss photo paper
HP Photo Rag by Hahnemühle	**240 years**	>200 years	now in test	>200 years	100% cotton base matte surface paper
HP Watercolor Paper by Hahnemühle	**165 years**	>200 years	now in test	>200 years	50% cotton base matte surface paper
Printed with HP Dye-Based Inks					
HP Photo Imaging Gloss	**11 years**	now in test	now in test	now in test	Fast drying, high-gloss photo paper
HP Heavyweight Coated Paper	**2 years**	now in test	now in test	now in test	Matte surface paper

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Notes on These Tests:

1) Display Permanence Ratings (DPR) are based on accelerated light stability tests conducted at 35 klux with glass-filtered cool white fluorescent illumination with the sample plane air temperature maintained at 24°C and 60% relative humidity. Data were extrapolated to a display condition of 450 lux for 12 hours per day using the Wilhelm Imaging Research, Inc. "Visually-Weighted Endpoint Criteria Set v3.0." and represent the years of display for easily noticeable fading, changes in color balance, and/or staining to occur. (See: Henry Wilhelm, "How Long Will They Last? An Overview of the Light-Fading Stability of Inkjet Prints and Traditional Color Photographs," IS&T's 12th International Symposium on Photofinishing Technology, sponsored by the Society for Imaging Science and Technology, Orlando, Florida, February 2002: <http://www.wilhelm-research.com/articles_ist_02_2002.html>.) High-intensity light fading reciprocity failures in these tests are assumed to be zero. Illumination conditions in homes, offices, and galleries do vary, however, and color images will last longer when displayed under lower light levels; likewise, the life of prints will be shortened when displayed under illumination that is more intense than 450 lux. Ink and paper combinations that have not reached a fading or color balance failure point after the equivalent of 100 years of display are given a rating of "more than 100 years" until such time as meaningful dark stability data are available (see discussion in No. 5 below).

2) In typical indoor situations, the "Displayed Prints Framed Under Glass" test condition is considered the single most important of the three display conditions listed. All prints intended for long-term display should be framed under glass or plastic to protect them from staining, image discoloration, and other deterioration caused by prolonged exposure to cigarette smoke, cooking fumes, insect residues, and other airborne contaminants; this precaution applies to traditional black-and-white and color photographs as well as inkjet and other types of digital prints.

3) Displayed prints framed with ultraviolet filtering glass or ultraviolet filtering plastic sheet generally last longer than those framed under ordinary glass. How much longer depends upon the specific print material and the spectral composition of the illuminate, with some ink/paper combinations benefitting a great deal more than others. A few products even show reduced life when framed under a UV filter because one or more of the image dyes or pigments is disproportionately vulnerable to fading caused by UV radiation, resulting in more rapid changes in color balance than occur with the glass-filtered and/or the bare-bulb illumination conditions. For these tests, Acrylite OP-3 acrylic sheet, a "museum quality" UV filter supplied by Cyro Industries, is used. Keep in mind that the major cause of fading with most digital and traditional color prints in indoor display conditions is visible light and although a UV filter may slow fading, it will not stop it.

4) Illumination from bare-bulb fluorescent lamps (with no glass or plastic sheet between the lamps and prints) contains significant UV emissions at 313nm and 365nm which, with most print materials, increases the rate of fading compared with fluorescent illumination filtered by ordinary glass (which absorbs UV radiation with wavelengths below about 330nm). Some print materials are affected greatly by UV radiation in the 313–365nm region, and others very little. "Gas fading" is another potential problem when prints are displayed unframed, such as when they are attached to kitchen refrigerator doors with magnets, pinned to office walls, or displayed inside of fluorescent illuminated glass display cases in schools, stores, and offices. Field experience has shown that, as a class of media, microporous "instant dry" papers used with dye-based inkjet inks can be very vulnerable to gas fading when displayed unframed and/or stored exposed to the open atmosphere where even very low levels of ozone and certain other air pollutants are present. In some locations, displayed unframed prints made with microporous papers and dye-based inks have suffered from extremely rapid image deterioration. This type of premature ink fading is not caused by exposure to light. Polluted outdoor air is the source of most ozone found indoors in homes, offices and public buildings. Ozone can also be generated indoors by electrical equipment such as electrostatic air filters ("electronic dust precipitators") that may be part of heating and air conditioning systems in homes, office buildings, restaurants, and other public buildings to remove dust, tobacco smoke, etc. Electrostatic air filtration units are also supplied as small "tabletop" devices. Potentially harmful pollutants may be found in combustion products from gas stoves; in addition, microscopic droplets of cooking oil and grease in cooking fumes can damage unframed prints. Because of the wide range of environmental conditions in which prints may be displayed or stored, Display Permanence Ratings for the bare-bulb illumination condition will not be listed for paper/ink combinations of known susceptibility to gas fading. Therefore, prints made with microporous papers and dye-based inks should always be displayed framed under glass or plastic.

5) Prints stored in the dark may suffer slow deterioration that is manifested in yellowing of the print paper, image fading, changes in color balance, and physical embrittlement, cracking, and/or delamination of the image layer. These types of deterioration may affect the paper support, the image layer, or both. Each type of print material (ink/paper combination) has its own intrinsic dark storage stability characteristics; some are far more stable than others. Rates of deterioration are influenced by temperature and relative humidity; high temperatures and/or high relative humidity exacerbate the problems. Long-term dark storage stability is determined using Arrhenius accelerated dark storage stability tests that employ a series of elevated temperatures (e.g., 57°C, 64°C, 71°C, 78°C, and 85°C) at a

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Notes on These Tests (continued from previous page):

constant relative humidity of 50% RH to permit extrapolation to ambient room temperatures (or other conditions such those found in sub-zero, humidity-controlled cold storage preservation facilities). Because many types of inkjet inks, especially those employing pigments instead of dyes, are exceedingly stable when stored in the dark, the eventual life of prints made with these inks may be limited by the instability of the paper support, and not by the inks themselves. Due to this concern, as a matter of policy, Wilhelm Imaging Research does not provide a Display Permanence Rating of greater than 100 years for any inkjet or other photographic print material unless it has also been evaluated with Arrhenius dark storage tests and the data indicate that the print can indeed last longer than 100 years without noticeable deterioration when stored at 73°F (23°C) and 50% RH. Arrhenius dark storage data are also necessary to assess the physical and image stability of a print material when it is stored in an album, portfolio box, or other dark place. The Arrhenius data given here are only applicable when prints are protected from the open atmosphere; that is, they are stored in closed boxes, placed in albums within protective plastic sleeves, or framed under glass or high-quality acrylic sheet. If prints are stored, displayed without glass or plastic, or otherwise exposed to the open atmosphere, low-level air pollutants may cause significant paper yellowing within a relatively short period of time. Note that these Arrhenius dark storage data are for storage at 50% RH; depending on the specific type of paper and ink, storage at higher relative humidities (e.g., 70% RH) could produce significantly higher rates of paper yellowing and/or other types of physical deterioration.

6) Glass-covered light stability tests with HP Durable Image Gloss UV had reached ">400 years" at the time of this publication and tests are continuing. However, until long-term Arrhenius dark storage data are available for this paper, the prints will be rated as ">200 years."

7) Glass-covered light stability tests with HP Studio Canvas had reached ">380 years" at the time of this publication and tests are continuing. However, until long-term Arrhenius dark storage data are available for this paper, the prints will be rated as ">200 years."

8) Glass-covered light stability tests with HP Heavyweight Coated Paper had reached ">300 years" at the time of this publication and tests are continuing. However, Arrhenius dark storage data indicate that this paper is more prone to yellowing in the dark than the other HP media listed and, until additional Arrhenius data are available, the prints will be rated as ">100 years."

9) Glass-covered light stability tests with 3M® Changeable Opaque Imaging Media had reached ">380 years" at the time of this publication and tests are continuing. However, until long-term Arrhenius dark storage data are available for this paper, the prints will be rated as ">200 years."

10) Some inkjet prints made with dye-based inks have poor humidity-fastness when stored or displayed in commonly encountered conditions of high relative humidity (e.g., 70% RH and higher). With some materials, humidity-induced deterioration can occur very quickly when the prints are in a warm and humid environment – sometimes within only a few days after printing. These problems may include one or more of the following:

    a) Ink bleeding (gradual lateral ink diffusion)
    b) Density changes (increases or decreases)
    c) Color balance changes
    d) "Bronzing" in high-density areas
    e) Sticking and ink transfer