Photo Book Permanence and Durability Standards and Their Impact on the Fulfillment Industry

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Abstract

Standardized testing and reporting of image permanence and durability performance using ISO standardized methods allows photo fulfillment companies to assess and promote product performance in a way that is easily comparable by both professional fulfillment laboratories and consumers. A previous paper reviewed standards being developed to test the performance of printed pages. This paper will focus on the development of a test method standard for photo book durability that will provide a common testing platform for photo book producers to help create high quality products in this important growth category.

Introduction

ISO Technical Committee 42 (TC42) on Photography, Working Group 5 continues to move forward in the development of standards relating to the physical properties and image permanence of photographic materials. These standards are aimed at providing test methods for the measurements of stability and durability of the substrates and materials used to produce photographic images of all types. With the growth of digital imaging and new digital print materials in addition to traditional silver halide materials, new tests methods were developed to cover the new print technologies of ink jet, thermal dye transfer, and electrophotographic media. Further, these new technologies, especially electrophotographic, have resulted in the convergence of the production of images from the traditional photographic sources with those using graphic arts technologies. A detailed discussion of standards recently published was reported in a previous paper [1]. This paper will focus on the development of a test method standard for photo book durability that will provide a common testing platform for photo book producers to help create high quality products in this important growth category.

Overview of Photo Book Standard

The standard currently under development to define test methods for the permanence and durability of photo books consists of several key sections. One section deals with mechanical stress tests which are integral to the physical integrity of the photo book. Another deals with image permanence and applies standards previously developed by TC42-WG5 towards the pages and covers of photo books. The final section in the body of the standard addresses the unique issues faced by a closed photo book during storage. Finally, there are several informative annexes that provide useful information and a normative annex dealing with material interactions. Each of the three main sections and the normative annex will be discussed in detail here. It should be emphasized that this standard is still under development so some modifications to the tests described here are still possible.

Mechanical Stress Tests

The physical integrity of a photo book is of prime importance to any end user. There are a number of factors that determine the robustness of a photo book and so several tests are included to verify that the book's physical integrity is sound. These include both tests directed at the physical integrity of individual sheets and tests directed at determining the strength of the assembled book itself. Both individual sheets and covers are tested for abrasion using appropriate methods developed by either ISO, ASTM or other organizations. These tests measure the likelihood of a cover or page being damaged if something is rubbed against it repeatedly. In addition, individual sheets and covers are tested for their susceptibility to peeling and delamination.

Just as important as the physical integrity of the individual pages and the cover is the strength of the fully assembled photo book. The tensile page-pull test measures initial strength of page attachment. Also, the adhesive force of the book binding is tested. This helps insure that the book is strong enough to last for long time periods to preserve the memories that people have included in them.

Image Permanence Tests

There are four key factors that govern image permanence [2]. And the photo book standard mandates testing for all four factors using the current test method standards created by ISO [3]. These are ISO 18936 - Imaging materials — Processed colour photographs Methods for measuring thermal stability, ISO 18937 - Imaging materials — Photographic reflection prints — Methods for measuring indoor light stability, ISO 18941 – Imaging materials — Colour reflection prints — Test method for ozone gas fading and ISO 18946 - Imaging materials — Reflection colour photographic prints — Method for testing humidity fastness. These tests help to insure the integrity of covers and pages so images are adequately preserved.

Durability of Closed Books

Photo books are stored differently than individual pictures. While this may make the image permanence requirements of individual pages less stringent, it introduces new potential problems that need to be evaluated. These include blocking, page deformation and warp. Blocking is the undesired adhesion between sheets of printed material that occurs under moderate pressure, high temperature, or high humidity, while in storage or in use that leads to undesirable effects such as delamination, paper splitting, tearing, ferrotyping (which is a change in surface gloss resulting from intimate contact with another surface, often associated with high humidity), image transfer, colorant migration, changes in hue, degradation of sharpness or edge deformation. Because blocking is a function of three factors (temperature, pressure and humidity) whose interactions are not well characterized and because photo books can be stored under a diverse range of environmental conditions, the blocking test is carried out under three different conditions designed to cover this wide range (see Table I).

Table I Summary of the three test conditions used for the closed book blocking test

Use Case Simulated	Temperature	Relative Humidity	Pressure	Duration
Long term storage (hot/dry)	50°C	20%	1 kPa	2 days
Long term storage (warm/humid)	25°C	85%	1 kPa	2 days
Short term vehicle storage	60°C	25%	0.5 kPa	8 Hours

The dimensional stability of a photo book can also be impacted by the environmental storage conditions. This is evaluated by measuring how much page flatness (waviness) changes after exposure to high humidity for four hours. Book warp is also important and is evaluated after storage for four weeks at low, medium and high humidity.

Material Interaction Test

Some chlorinated, nitrated, or acetate plastic sheeting, such as plasticized polyvinyl chloride, cellulose nitrate, and cellulose acetate, have historically been shown to be incompatible for use in photographic applications. The committee did not think it was appropriate to ban the use of all these materials, many of which have been used successfully in photo book applications, but also recognized that there are certain materials that could negatively interact with photo books and reduce their longevity. Therefore, a material interaction test was designed to help identify materials that are not suitable for use in photo book construction. Samples are treated at 50C and 50% RH for two weeks and evaluated for noticeable physical disruption and/or colorimetric changes. It was noted during testing that some dry electrophotographic systems were more likely to show a signal than other imaging systems tested. Given that the dry electrophotographic system was the most sensitive, it was initially recommended to mandate using this as a test proxy for new materials being evaluated. However, it was pointed out by the committee that it was not appropriate to restrict the use of a new material based on it having a negative reaction with a dry electrophotographic system if a different imaging system is being used to construct the photo book. In this case, only the imaging system being used needs to be tested but materials that pass the test with dry electrophotoghic systems should be suitable for use with any other imaging systems.

Conclusions

This paper has provided a summary of the photo book permanence and durability standard currently under development from ISO Technical Committee 42 Working Group 5. It is expected that this standard will benefit the photo fulfillment industry by facilitating "level playing field" comparisons that can be used to promote the long term longevity benefits of photo books. Proper use of the permanence and durability standards in product promotions can increase the awareness of the value of these products and result in the growth of printing.

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Author Biography

Stuart Gordon received a B.S. in chemistry from Rensselaer Polytechnic Institute and a M.S. in chemistry and a M.Eng. in chemical engineering from Cornell University. He is currently the Director of Image Permanence at Kodak Alaris. He previously worked for Eastman Kodak Company where he held a variety of positions in silver halide-based image capture and color hard copy research and development. He has been awarded nine US patents and has written numerous internal and external technical reports. He is certified as a six sigma black belt. He has served as the papers chairman and program chairman for IS&T's International Symposium on Photofinishing Technology and as the general chair for the International Symposium on Technologies for Digital Photo Fulfillment. In 1996, he received a service award from IS&T and in 2010 he was awarded with senior membership. He is currently a member of the ISO Technical Committee on Photography and is directly involved in the ANSI/IT-9 and ISO Working Group 5 Committees on color print stability and physical properties

A Guide for the Assessment and Mitigation of Bleed, Gloss Change, and Mold in Inkjet Prints During High-humidity Conditions

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Abstract

The purpose of this project was to define the absolute ceiling limits for time and relative humidity (RH) combinations at room temperature to prevent damage to inkjet printed materials in museums, libraries, and archives when they are inadvertently exposed to short-term high-humidity conditions (under 28 days). Unintentional elevated humidity exposure can occur during HVAC malfunctions, transport, following water emergencies, and in uncontrolled storage or exhibition areas. Previous research has shown that colorant bleed, gloss change, and mold germination are the three most common forms of inkjet deterioration during high-humidity conditions. In order to provide collections care professionals with the necessary information to mitigate all three deterioration types, time limits for each needed to be compiled into a single, concise guide. Data on ink bleed and mold germination limits were collected from previous research, while the gloss change data required further experimental investigation. Gloss change experiments were performed with dye on polymer-coated RC paper, as previous studies have shown this ink/paper combination to be particularly sensitive to gloss change during exposure to elevated humidity. During the tests, samples were exposed to a series of time and RH variations. The results showed that while prints can be sensitive to gloss change at elevated humidities, inkjet prints are even more sensitive to colorant bleed, which is therefore the limiting factor. A guide for RH deterioration mitigation was developed and can now be used to predict how prints have or will respond to elevated humidity exposure for times less than 28 days. While all inkjet print types should be safe at humidities at or below 65% for up to 28 days, relative humidity exposures above 80% should be avoided at all costs as the most sensitive print types will likely be damaged within 24 hours. The guide provides predictive times to damage for RH values between 65% and 80% that can be interpolated to determine risk at these intermediate conditions.

Introduction

The purpose of this project was to define the absolute ceiling limits for time and relative humidity (RH) combinations to prevent noticeable bleed, gloss change, and mold germination in inkjet printed materials in collections when they are inadvertently exposed to short-term high-humidity conditions (under 28 days). Unintentional elevated humidity exposure can occur during HVAC malfunctions, transport, following water emergencies, and in uncontrolled storage or exhibition areas. Previous research has shown that colorant bleed, gloss change, and mold germination are the three most common forms of inkjet deterioration during high-humidity conditions [1]. In order to provide collections care professionals with the necessary information to mitigate all three deterioration types, time limits for each needed to be compiled into a concise chart. The chart is intended to assist institutions during, or in preparation for potential, adverse circumstances. Results may also benefit manufacturers of inkjet materials as well as artists and photographers who use this medium.

Inkjet printed materials have included a wide variety of ink, coating, and support combinations since their commercial popularization in the 1980s. These variations in materiality have a significant effect on how inkjet prints will respond during exposure to adverse environmental conditions, with certain combinations experiencing more severe degradation than others. A majority of inkjet printed materials in collections are not identified at the level necessary to know which prints are most at risk for disfiguring decay. For this reason, collection care protocols may need to be built around the most sensitive inkjet print type per deterioration force, in this case high humidity. This approach ensures that all inkjet printed materials in collections, whether identified or not, would be protected during high-humidity exposure.

Materials and Methods

Constructing the high-humidity deterioration mitigation chart involved a four-step approach.

1. Choosing the parameters for temperatures, relative humidities, and times.
2. Collecting the previously defined limits for ink bleed and mold germination.
3. Determining the gloss change limits through experimental investigation.
4. Creating the final guide to prevent damage to inkjet collections during short-term high-humidity exposure.

Chart Parameters

The chart parameters were determined, in part, from Salesin's previous bleed limit research [2]. This investigation looked at colorant migration in inkjet printed materials at temperatures between 15° and 35°C, humidities between 60% and 90% RH, and times from 1 to 28 days. The relative humidity and time parameters remained the same for this new guide, while temperature was fixed at 25°C. This temperature was chosen because prior bleed experiments showed 25°C produced the greatest bleed [2].

Table 1: Chart layout with previously defined bleed and mold germination limits

		90% RH	80% RH	70% RH	60% RH
25°C	**Bleed**	1 day	1 day	21 days	*no risk*
	Gloss Change				
	Mold	4 days	13 days	*no risk*	*no risk*

Table 1 shows the initial limits collected from Salesin's bleed report [2]. Mold germination limits were determined using IPI's Dew Point Calculator, which has an incorporated Mold Risk Factor predictor [3]. The gloss change limits would be filled in by the following experiments.

Gloss Change Methodology

The authors know of no existing standard or generally accepted method for evaluating gloss change in inkjet printed materials. While ISO 18901 (*Imaging materials – Processed silver-gelatin type black-and-white films – Specifications for stability*) provides a test procedure for evaluating gloss change in traditional photographic negatives, motions picture films, etc. in direct contact with each other, it does not take inkjet materiality into consideration nor contact with enclosures [7]. It also uses the extremely high temperature of 40°C. The gloss change methodology used in this project was instead based on a previous study performed at IPI [4]. This study examined gloss change in various inkjet printed materials that were stacked with a variety of interleaving, weighted, and incubated at the single, extreme condition 30°C and 90% RH for seven days. Results from this study primarily informed sample selection and preparation for this new project, but could not be used to fill in the above chart as they used only one temperature, humidity, and time condition.

Generally, gloss change is caused by either abrasion or a combination of high humidity, temperature, pressure, and time. Because the abrasion-induced gloss change is a function of print type, abrader, and weight, it is not considered in this project, which is solely focused on high-humidity issues. Gloss change by high humidity, temperature, pressure, and time is often referred to as ferrotyping because the same forces are used in the latter. The primary difference is that ferrotyping is an intentional process and affects the entire print surface. The gloss changes being considered in this project are unintentional, non-uniform, and disfiguring forms of damage. Note that these gloss change experiments are not accelerated aging tests, but are instead meant to replicate real world, worst-case scenarios, where inkjet printed materials may experience short-term exposure to elevated humidity.

Sample Selection and Preparation

In order to produce a guide that would be useful for all collections of inkjet prints, research focused on the print type most sensitive to these forms of damage from the entire history of inkjet printing and did not target current technologies and materials, which may be significantly more stable than those previously available. Testing the most sensitive materials resulted in the production of conservative data necessary for mitigating inkjet print deterioration during these conditions. This sensitive material is polymer-coated RC prints [4].

Table 2: Prints selected for investigation

Sample	Paper Type	Colorant
1	Polymer RC-1	Dye
2	Polymer RC-2	Dye
3	Chromogenic	Dye

Table 2 lists the test samples. Two different polymer-coated RC paper brands were tested with each being printed on a different printer. Dye printers were used as these were most often used with this paper type. Chromogenic prints have been shown to undergo gloss change during high-humidity exposure and were meant to serve as a reference point for comparison.

***Figure 1:** Target used during all gloss change experiments.*

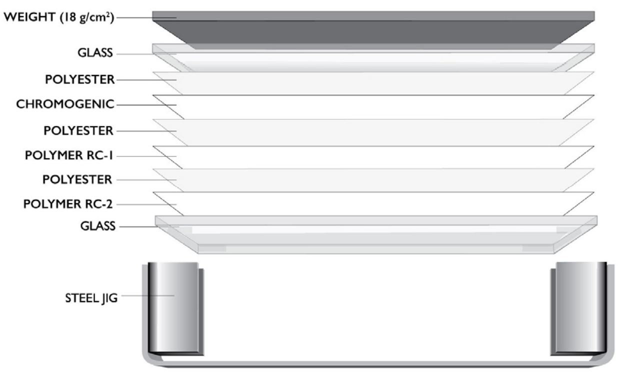
A printed target (Figure 1) was chosen over unprinted samples in order to provide better visual comparison of changes in gloss as well as to insure that the area most likely to experience gloss change (printed or unprinted) was included. It consisted of black (Dmax), mid-tone gray, and white (Dmin) areas. Inkjet samples were printed in-house following recommended printer settings and used CMYK inks for the two printed areas. Chromogenic samples were obtained at a local photograph laboratory. Samples were cut into 12 x 2 centimeter strips and labeled verso with permanent marker. All samples were created in duplicate, including controls, and were preconditioned to 21°C and 50% RH for one week prior to experiment initiation.

Initial gloss readings were recorded separately for black, gray, and white areas for each sample with a Gardner micro-TRI-gloss meter. Because both polymer-coated RC and chromogenic samples measured as "glossy" before and after incubation, all targets were evaluated using a 20° angle of incidence light as per ISO 2813-2014 (*Paints and varnishes – Determination of gloss value at 20 degrees, 60 degrees, and 85 degrees*) [8]. A measuring template was created to ensure consistency in recording.

Polyester film was used as the surface in contact with the prints. It was selected for two reasons. First, it was shown to induce gloss change in previous work, and second, it is the recommended enclosure material for use in direct contact with inkjet prints [4, 1]. Polyester is also known to block to chromogenic prints at the conditions used in this experiment, so it acted as a positive control.

Samples were stacked in a steel specimen jig as shown in Figure 2. A strip of polyester was placed on top of each print. Glass slides sandwiched the paper and interleaving stack. A weight of 18gr/cm^2 (1.76 kPa) was placed on the stack to represent the average load experienced by photographs in an album at the bottom of a stack of albums [4]. All samples were tested in duplicate in separate jigs.

Figure 2: Jig stacking order



Experiment Conditions

Test conditions were chosen to provide gloss change data for the final chart and to reflect real-world reactions to short-term high-humidity exposures.

Table 3: Experiment conditions

Temperature	Relative Humidity
25°C	90%
25°C	80%
25°C	70%
25°C	60%

Table 3 lists the four test conditions. The first set of samples were incubated at 90% RH, if any of the samples showed noticeable gloss change a new set of samples were incubated at 80% RH, and so on for 70% and 60% RH until no changes were seen for a particular humidity level. Each ran for 28 days with duplicate jigs being removed after 1, 2, 4, 7, 14, 21, and 28 days. Jigs were placed in the center of an ESPEC LHL-122 Humidity Cabinet on a wire rack with adequate room between jigs for air circulation. Duplicate jigs were removed at the end of their incubation period and moved to a 21°C, 50% RH room for 24 hours before disassembly and assessment.

Unincubated control samples were stacked in the same manner as the test samples and kept at 21°C and 50% RH for the extent of the experiment. A second set of untested controls were created and left un-stacked in a 21°C/50% RH environment to provide a baseline to measure visual responses against.

Results

Visual Assessments

In order to reduce variability, one person made the visual assessments. Tables 4, 5, and 6 list the visual assessments. The rating scale indicates noticeable gloss change with "Y" and no noticeable gloss change with "N". If either duplicate sample showed noticeable gloss change the incubation time was assigned a "Y" in order to provide the most conservative assessment. Similarly, if either brand of polymer-coated RC underwent noticeable gloss change, the incubation time for polymer-coated RC was assigned a "Y".

Noticeable gloss change was selected for the visual assessment, as it is a conservative approach and is more consistent and definable than objectionable gloss change. While measureable gloss change would have been the most conservative parameter, it does not necessarily reflect a change that can be seen with the naked eye and therefore is not the concerning condition. Furthermore, as will be discussed, quantitative gloss meter analysis did not provide consistent data with which to draw measureable gloss change conclusions.

Table 4: Noticeable gloss change at 25°C and 90% RH

Sample	1 day	2 days	4 days	7 days	14 days	21 days	28 days
Polymer RC	Y	Y	Y	Y	Y	Y	Y
Chromogenic	Y	Y	Y	Y	Y	Y	Y

Table 4 lists noticeable gloss change after incubation at 25°C and 90% RH. All samples at this condition showed noticeable gloss change after 1 day of incubation. The degree of gloss change was severe. Gloss change was also irregular and blotchy and was only seen in the black (Dmax) areas. The entirety of the black area experienced this gloss change. No noticeable gloss change was seen in either the mid-tone gray or white areas, up to and including 28 days of incubation. Of additional note was a milkiness seen in the black areas of the polymer-coated RC samples after only 1 day of exposure at 90% RH. This milkiness increased in intensity as exposure time continued. It was most extreme in sections of the black areas that did not appear to stick to the polyester. Areas that experienced temporary sticking showed an increased glossiness but no milkiness. The milkiness was not seen in the gray or white areas nor was it seen in any of the chromogenic samples. This effect was unexpected, but since this was a real-time test, and not an accelerated test, the effect must be considered relevant and important and is therefore included in determining the limiting time to damage at the various test conditions.

Table 5: Noticeable gloss change at 25°C and 80% RH

Sample	1 day	2 days	4 days	7 days	14 days	21 days	28 days
Polymer RC	Y	Y	Y	Y	Y	Y	Y
Chromogenic	N	N	N	N	N	N	N

Table 5 lists noticeable gloss change after incubation at 25°C and 80% RH. Polymer-coated RC samples underwent noticeable gloss change after 4 days of incubation at these conditions. Gloss change in samples incubated at 80% RH was less severe than samples incubated at 90% RH. While gloss change was also irregular and blotchy at 80% RH, it did not cover the entirety of the black area as it had at 90% RH. Instead, gloss change was found only along the edges of the samples. The milkiness was also noticeable in the polymer-coated RC samples after 1 day of incubation at 80% RH. While the degree of milkiness did increase with time, it was not as noticeable as in samples exposed to 90% RH. Once again, milkiness was not seen in the gray or white areas nor was it seen in the chromogenic samples. However, even though the gloss change was not seen until 4 days, the limiting time to damage is based on the 1 day to milkiness.

Table 6: Noticeable gloss change at 25°C and 70% RH

Sample	1 day	2 days	4 days	7 days	14 days	21 days	28 da ys
Polymer RC	N	N	N	N	N	N	N
Chromogenic	N	N	N	N	N	N	N

Table 6 shows the visual assessments after incubation at 25°C and 70% RH. No noticeable gloss change was seen in either the polymer-coated RC or chromogenic samples up to and including those incubated for 28 days. There was also no milkiness seen in any of the samples exposed to 70% RH. Because the 70% RH test showed no changes to the samples, the 60% RH tests were dropped and RH conditions below 70% are considered safe for up to the maximum 28 day period of the project.

While chromogenic samples were expected to undergo changes in gloss more readily and severely than polymer-coated RC prints, results show that they fair far better under all test conditions. This is an unexpected result and cannot be explained. In addition, and contrary to prior reports [4], colorant density does appear to increase a technology's propensity to undergo surface modification. While the white and gray areas did not experience gloss change under any of the tested conditions, the black areas, where ink density is greatest, experienced severe gloss change and milkiness. Colorant density should be taken into consideration for future surface modification testing on inkjet printed materials.

Gloss Meter Data

Gloss unit measurements were taken before and after individual incubation periods in hopes of providing a quantitative account of changes during high-humidity exposure. Tables 7, 8 and 9 list the initial (0 days) and final (1-28 days) gloss units for incubated samples. While gloss meter data for the chromogenic samples did follow a clear trend, the inkjet samples did not. At the 90% RH condition, the milkiness of the samples may have had a confounding effect on the gloss readings. For the 80% RH samples, the gloss changes were small and only along the edge of the samples. This made the gloss change immeasurable by the instrument. Both of these issues made the gloss measurements too unreliable to draw conclusions. The visual assessments ultimately provided a much better assessment of the changes to the samples.

Table 7: Gloss unit measurements at 90% RH

		0 days	1 day	2 days	4 days	7 days	14 days	21 days	28 days
Polymer RC-1	Bl	61	52	53	56	55	48	60	47
	Gr	40	35	36	36	36	30	37	48
	W h	58	51	50	48	50	49	49	51
Polymer RC-2	Bl	62	51	46	67	62	54	48	35
	Gr	62	58	51	49	49	47	47	51
	W h	67	63	58	59	58	57	57	57
Chromogenic	Bl	77	67	66	56	60	61	55	55
	Gr	78	60	53	58	62	55	47	49
	W h	79	68	65	63	58	60	64	62

Table 8: Gloss unit measurements at 80% RH

		0 days	1 day	2 days	4 days	7 days	14 days	21 days	28 days
Polymer RC-1	Bl	61	54	47	49	48	50	48	49
	Gr	40	38	35	37	39	36	36	37
	Wh	58	53	51	51	54	53	53	51
Polymer RC-2	Bl	62	60	52	54	52	53	55	56
	Gr	62	62	60	59	58	57	59	58
	Wh	67	64	64	63	62	58	63	62
Chromogenic	Bl	77	69	60	65	66	66	62	62
	Gr	78	71	65	67	61	67	66	68
	Wh	79	71	67	64	66	66	64	66

Table 9: Gloss unit measurements at 70% RH

		0 days	1 day	2 days	4 days	7 days	14 days	21 days	28 days
Polymer RC-1	Bl	61	59	59	58	57	57	58	55
	Gr	40	40	38	39	38	40	39	37
	Wh	58	55	55	52	53	54	55	51
Polymer RC-2	Bl	62	64	66	65	64	62	62	63
	Gr	62	64	65	64	64	62	61	62
	Wh	67	66	67	67	65	64	73	64
Chromogenic	Bl	77	75	75	71	74	71	72	71
	Gr	78	75	75	73	73	71	73	72
	Wh	79	73	76	73	72	73	73	71

Guide for RH deterioration mitigation

Table 12: Inkjet print deterioration risk during short-term exposure to elevated humidity

		90% RH	80% RH	70% RH	60% RH
25°C	Bleed	1 day	1 day	21 days	***no risk***
	Gloss Change/ Milkiness	1 day	1 days	***no risk***	***no risk***
	Mold	4 days	13 days	***no risk***	***no risk***

Table 12 combines data from the gloss change experiments with previous data collected on bleed and mold germination. The chart shows how long it will take the most susceptible inkjet printed materials to undergo a specific deterioration type during elevated humidity. This "miner's canary" approach provides the most conservative parameters to prevent disfiguring damage within inkjet collections during short-term adverse environmental conditions. Users can use the table to estimate whether their prints have been or will be put at risk. For example if a collection of inkjet prints has been exposed to 80% RH for 2 days they would need to be immediately removed from the adverse environment and then inspected for signs of colorant bleed, milkiness, or gloss change.

In real life situations, however, humidities will rarely be exactly at one of the values listed in the chart above and interpolations between the RH values and corresponding times to failure may be needed. To interpolate between humidity values in the table, such as for a 77% RH, select the next higher RH value in the chart to guide the decision making process. In this example, the time to damage at 80% should be assumed, as it will be the most conservative approach. However, because the differences between times to damage, or even “no risk”, can be extreme between two RH values in the chart, some estimating between values may be useful, especially in times of emergency, when a wide variety of response and recovery activities need to be managed and prioritized.

Since the limiting factor below 70% is ink bleed and the Salesin reported that bleed did not occur below 65% RH, then that value may be used as the safe RH limit instead of 60% RH.

Conclusions

- While prints can be sensitive to gloss change at elevated humidities, inkjet prints are even more sensitive to colorant bleed, which is therefore the limiting factor.
- These results are based on the most sensitive print types, other print types, such as pigment inks on matte surface paper, may be much more resistant to bleed and/or gloss change.
- The guide for RH deterioration mitigation can be used to predict how prints have or will respond to short-term elevated humidities less than 28 days
- Relative humidity exposures above 80% should be avoided at all costs as the most sensitive print types will likely be damaged within 24 hours
- All inkjet print types should be safe at humidities at or below 65% for up to 28 days
- If materials are inadvertently exposed to high humidity conditions, they should be removed to a safe environment as soon as possible and immediately assessed for bleed and gloss change

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