

# An Investigation Into the Cause and Cure of Random Toning in Newspaper Printing

by John MacPhee\*

**Abstract:** A series of tests was carried out in an endeavor to determine the root cause of the seemingly random problem of toning in offset printing of newspapers. The work, which took place over a nine month period, included printing and platemaking experiments in five different newspaper plants and two different commercial printing plants. The printing plates used were primarily of the wipe-on diazo type. The makeup and processing of these plates are reviewed along with the practices which are unique to newspaper printing. Following a definition of terms and a description of the problem, a theoretical model is postulated, which explains the steps or chain of events which lead to this particular printing failure mode. The experimental results are then reviewed, and in doing so the rationale of the theoretical model is developed step by step. Two obvious solutions to the problem accrue from these arguments, along with some additional insights into the behavior and importance of the desensitizing agents used in the lithographic process. A procedure, in flow chart form, is also included for determining if the potential for this mode of failure exists in a given plant.

## Introduction

Lithography is much like the English language: while it has a common thread, its form varies considerably from one user group to the next. Thus, lithography as practiced in newspaper printing differs in many respects from, say, the lithography practiced in publications printing. As a result it is not surprising that offset newspaper printing has its own set of limitations and problems. Perhaps the biggest problem that has plagued this branch of offset is random toning, which one user recently characterized as "a bugaboo that has been with offset since day one" (King, 1986). The purpose of this paper is to report on the results of an investigation of this problem, which was started by the writer in March of 1986, as a result of accepting an invitation to give a general talk on toning at the Metro Users Association meeting in Dallas, Texas on April 7, 1986.

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In order for the general reader to fully understand the frustrating aspects of this problem, and the methods and logic used in the investigation, a knowledge of the unique characteristics of the equipment, supplies, and practices used in newspaper printing is essential. For this reason this paper starts off with a section devoted to just that, entitled background information. This is followed by a section which defines the various forms of toning. The specific problem addressed here, random toning, is then described.

The results of this investigation consist of a hypothesis which sets forth the chain of events which lead to the occurrence of the above problem. This hypothesis is presented in a separate section. The last two sections of the paper describe the experimental work carried out and summarize the results and conclusions of the investigation. The arguments and logic on which the hypothetical chain of events were based are given in the summary section along with a list of remedies and a test for determining if the potential for random toning exists in a given plant.

### Background Information

This section contains background information which is considered key to viewing the subject problem in the proper perspective. This material is divided into two categories: a listing of the unique features of the lithographic newspaper printing process, which are pertinent, and a description of the type of printing plate used most commonly.

#### Unique Features of Newspaper Printing

There are many characteristics of offset newspaper printing which set it apart from other segments of the printing industry. Those which are pertinent to this problem are listed as follows:

1. Many newspaper presses employ "ink train" or "inker feed" dampening systems — which means that dampening solution is fed to the plate via the inking system, rather than being applied directly to the plate by a separate roller train.
2. Almost all newspaper presses use either an alkaline or neutral fountain solution. Thus the "gum and etch" acid type fountain solution, containing gum arabic, is hardly ever found.

3. Almost all newspaper presses are designed to carry more than a single plate on the plate cylinder. In fact a double width press has two plates around and four across for a total of eight plates per cylinder.
4. News inks are quite "soupy" compared to the inks used in other forms of printing. Also news inks never really "dry" but are simply absorbed by the uncoated stock.
5. The run lengths for news sections generally fall in the range of 5,000 to 100,000 impressions. Thus plate costs represent a larger fraction of total job cost than in, say, publications printing.
6. Most newspapers use wipe-on plates which are coated with a light sensitive diazo compound. The coating may be applied up to two or three days prior to exposure and development.
7. Printing is carried out at very high speeds (over 2000 feet per minute in some cases) and most pressrooms are not air conditioned.
8. Normal practice is not to gum plates following a press stop. (One of the main reasons why newspaper printers switched to alkaline type fountain solutions in the early 1970's was because they supposedly eliminated the need to gum plates.)
9. On large double width presses, it is quite common to run so-called dummy plates. These plates have zero image area. In some plants they are made from unexposed coated plates while in others they are always made from uncoated or as-received plates.
10. The day-to-day repetitiveness or relative standardization of newspaper printing, plus the extreme importance of getting the job out every day by a deadline leads to the creation of a truly production environment. As a result standby or alternative equipment and supplies are considered essential to cope with unseen failures or disruptions. Thus it is more the rule than exception that newspaper printers will purchase consumables from two or more suppliers, either using mixed supplies at the same time or switching back and forth from one to the other fairly often.

## Type of Plates Available

Before proceeding to describe the type of plates used in newspaper printing, it may be helpful to review the full range of lithographic plate types. Figure 1 shows one way in which the various types can be classified. As indicated, today all high production lithographic printing is carried out using photographic plates. Furthermore, at least in the U.S., surface plates predominate. Although it is not indicated in Figure 1, photographic plates can be either negative working (i.e. made from a negative film) or positive working (i.e. made from a positive film). In the U.S. almost all printers use negative working plates while the converse is true in Europe.

The vast majority of lithographic plates used today in the U.S. are made from thin sheets of aluminum which range in thickness from about .006 inches up to .020 inches. Generally the aluminum is grained as the first step in plate manufacturing. One of four graining methods can be used: ball, brush, electro-chemical, or chemical. As shown by the scanning electron microscope micrographs in Figure 2 these methods produce quite different surface topographies — with ball graining producing the roughest surface and chemical the smoothest or most knobby. Although brush graining leaves a finer finish than ball graining, it has the same type of sharp crevices. For this reason brush grained plates are sometimes given an electro-chemical etch as well, to smooth out the surface. Because ball graining is a batch process, it is seldom used any more, except for original plates where the image is hand drawn by an artist.

Before going on to discuss newspaper plates, one other characteristic of lithographic plates should be mentioned: the type of photosensitive coating used. Three types have been used for lithographic plates in general: bichromated colloids, diazos, and photopolymers (Sturge, 1977). Coatings of bichromated colloid coatings are now obsolete. Presensitized plates can have either of the latter two types of coating while wipe-on plates generally use a diazo coating because of the ease of processing. Because most newspapers use wipe-on plates it follows that the photo-sensitive coating they employ is a diazo compound. However, these compounds are very reactive with aluminum (Jewett and Case, 1955). Thus to prevent the decomposition of the applied or wiped-on coating, it is necessary to seal or passivate the aluminum surface by applying a protective treatment. One of the earliest methods used was to dip the aluminum into an aqueous solution of sodium silicate which reportedly works well on both unanodized (Jewett and Case, 1955) and anodized (Fromson, 1965) surfaces.

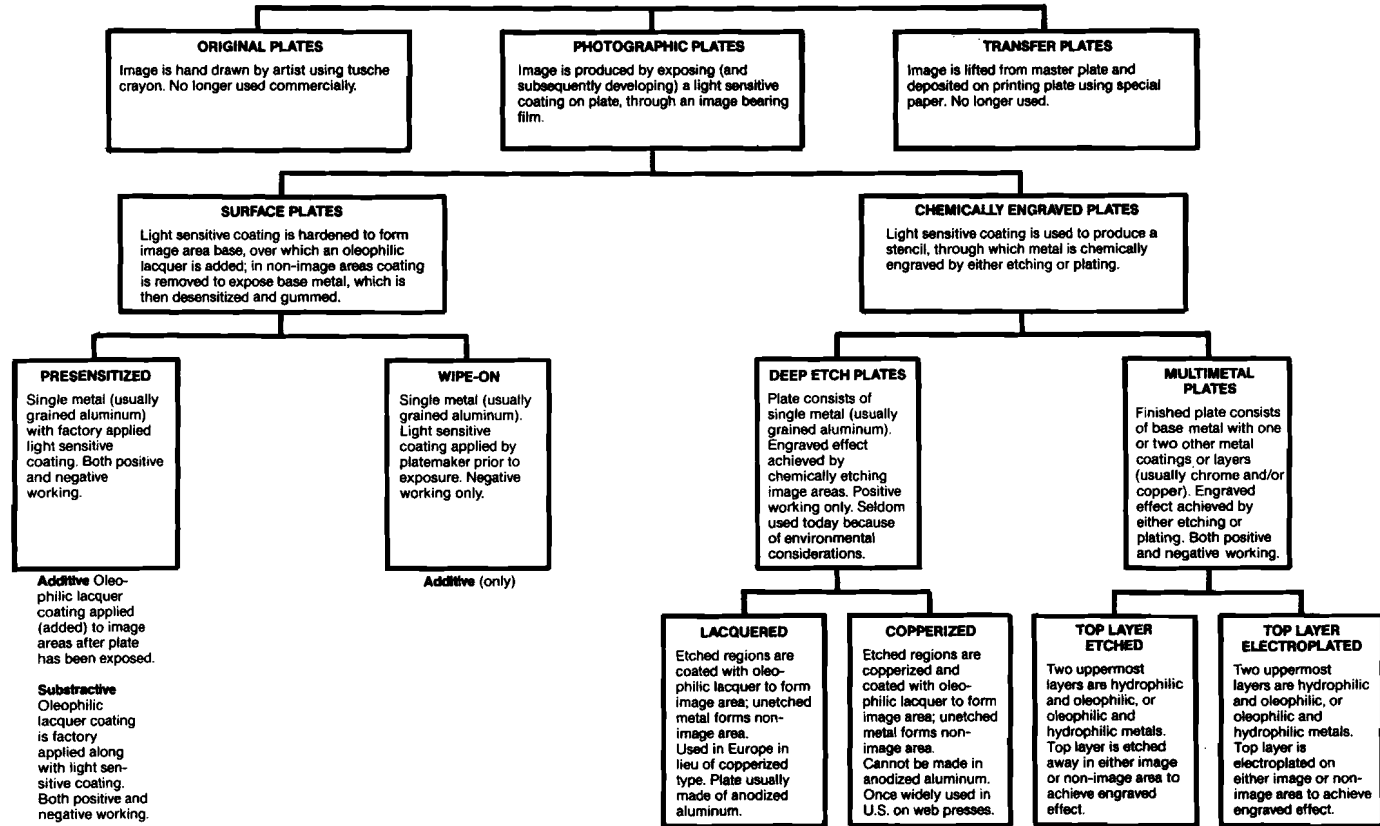
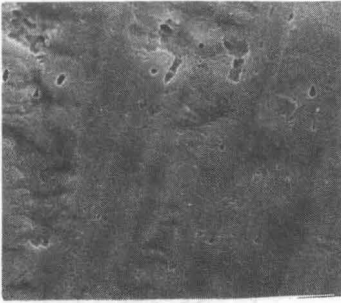
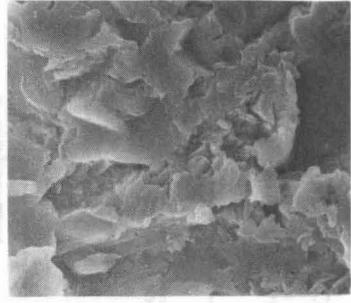


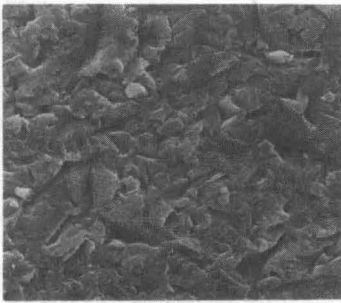
Figure 1 One Method of Categorizing Plates



(a) Mill Finish

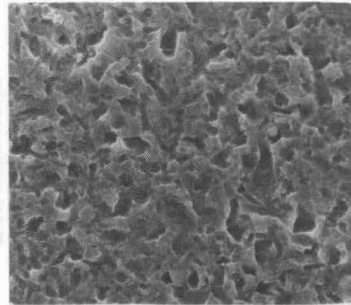


(b) Ball

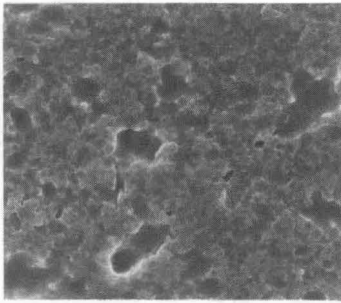


(c) Brush

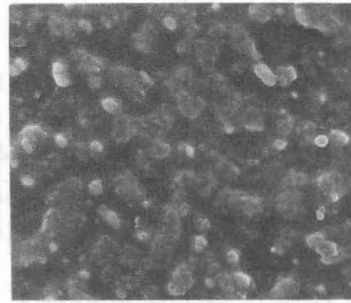
30 microns



(d) Electro Chemical



(e) Brush/Electro Chemical



(f) Chemical

Figure 2 Comparison of Topography of Mill Finish with Various Types of Graining Used on Aluminum Plates.

## Plates Used by Newspapers

The typical newspaper plate is received as a thin sheet of aluminum, cut to size. Most likely it has a brush grained anodized surface, to which has been applied a protective treatment of sodium silicate to seal or passivate the plate. This is illustrated in Figure 3(a).

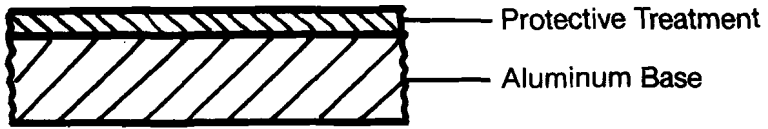
In the printing plant the plate is stored until ready for use, at which time a roll coater is used to apply a thin film of diazo. This is shown in Figure 3(b). Because of the volumes involved, plates are generally coated 1 - 2 days in advance.

The platemaking process, whereby a blank coated aluminum sheet is converted to a press-ready image bearing plate, consists of four steps which are outlined in Figure 4 and described below. The first step in the platemaking process is to expose the image areas of the plate to high intensity ultraviolet light — which is accomplished by covering the plate with a negative film or mask. Upon exposure the diazo in the image areas is converted into an insoluble gunk which is ink receptive but which is also more or less invisible. In the next step, the image is developed by removing the mask and scrubbing the surface with an aqueous pigmented emulsion which accomplishes two things. First the bulk of the unexposed diazo is easily removed from the non-image areas by the aqueous phase, by virtue of being water soluble. Second the oil or lacquer phase of the emulsion "inks up" the image areas, rendering them visible to the user. If lacquer is used, it also serves to harden the insolubilized diazo for greater wear resistance.

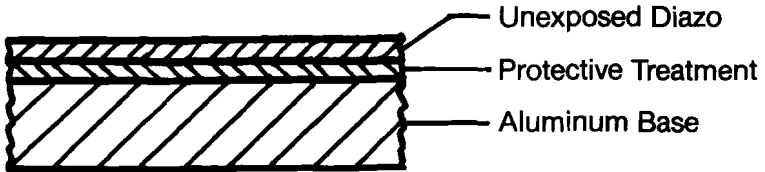
In Step 3 of the process, the plate surface is flooded with water to flush away the developing emulsion and the unexposed diazo. As shown in Figure 3(c), the plate that emerges from Step 3 could be run on the press in that the image areas are developed and ink receptive, and the non-image areas are water receptive (since the silicate treated surface has been uncovered by the removal of the unexposed diazo). However such a plate is easily soiled (by fingerprints) during handling. Thus to keep the plate clean, a finish coating of gum arabic, AGE, or the like is applied in Step 4. The completed plate, ready for press, is diagrammed in Figure 3(d).

### Definition of Terms

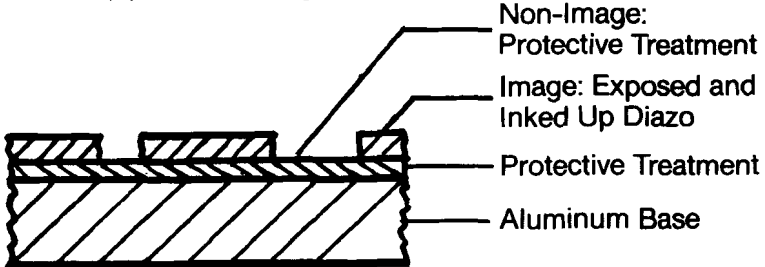
In the context of this paper, toning is the term used to describe the general problem of having ink where one doesn't want it, i.e. on the non-image surface. This can arise from one of three causes and therefore three additional terms will be used to define and discriminate between these three different conditions as follows:



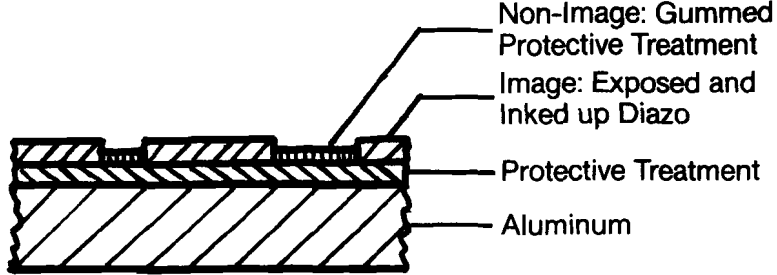
(a) As Received



(b) After Coating

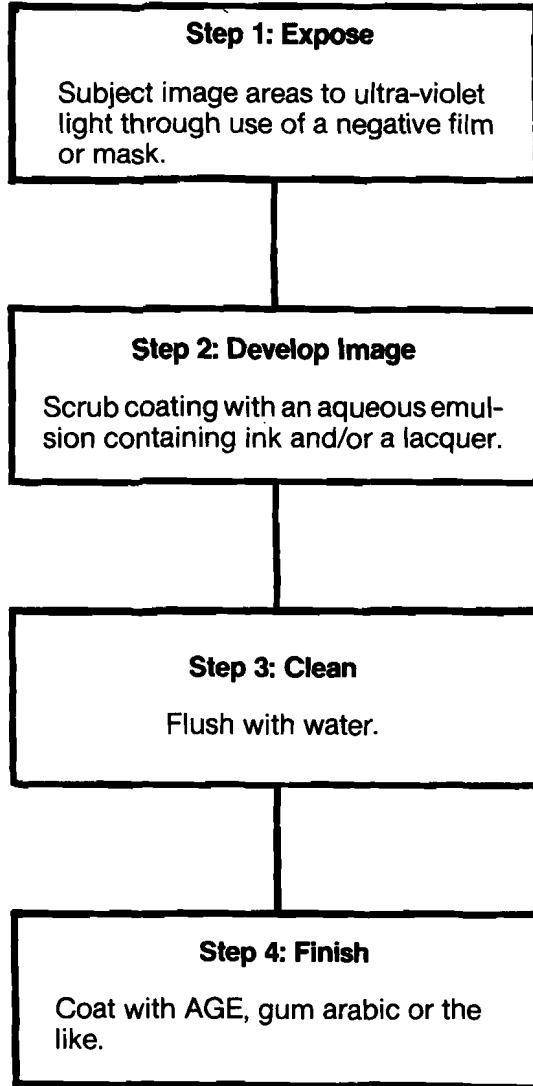


(c) After Image Development



(d) Ready for Press

**Figure 3 Exaggerated Sections Showing Surface Layers on Plate During Various Stages of Processing**



**Figure 4** Steps in the Typical Platemaking Process Employed with Wipe-on Plates.

1. Tinting - Toning due to ink particles suspended or emulsified in the fountain solution. Cannot be eliminated by honing and desensitizing an affected area.
2. Scumming - Toning due to ink particles bonding to non-image areas. Caused by loss of thin layer of desensitizing agent. Can be eliminated temporarily by honing and desensitizing an affected area.
3. Dry-up - Toning due to improper ink - water balance. Too much ink or not enough water. Can be corrected by a change in feedrate of water and/or ink.

### The Problem of Random Toning

In preparing for the presentation at the 1986 Metro Users Association meeting, the writer surveyed a number of newspaper printers and their suppliers. From this survey the following summary emerged as a definition of the very difficult and frustrating problem, which plagues almost all newspaper printers (at one time or another), and which the writer has dubbed "random toning" (MacPhee, 1986):

1. The fault is that an unwanted tone appears in the non-image areas. (Refer to Addendum for further details.)
2. The fault only occurs on a restart after the plate has been in use for some time.
3. There is no pattern as to where on the press a plate will be affected. For example, only one plate on a cylinder may go bad.
4. The tone cannot be washed off easily or at all. However, if a small area is honed and regummed, that portion will print clean.
5. Over the course of a year, there are periods when the problem suddenly occurs for no apparent reason and then just as suddenly goes away.
6. In some areas, the problem appears to crop up at the change from cold to warm seasons while in other areas there is no pattern at all.

## Hypothesis to Be Proven

The essence of this paper is contained in this section and the two which follow. The writer's investigation of the subject problem consisted of a wide variety of tests, described in the following section, which led to a postulated chain of events, which is outlined below.

First, however, it should be pointed out that, given the above definitions and problem description, it should be quite clear that the problem of concern is one of scumming, that is of ink particles bonding to non-image areas of the plate. That is, the basic problem or fault is that the fountain solution is no longer able to maintain the film of desensitizing agent on the non-image surface. However the delay in the onset of the failure suggested that two effects were at play, one of which involved some sort of wear mechanism (MacPhee, 1986). The wear mechanism would also account for the random occurrence of the problem on press.

As a result of the experimental work carried out, a postulated chain of events leading to random toning failure, was developed, as set forth in Figure 5. It shows that there are five steps involving two faults, one of which is a wearout type mechanism. The first fault or failure occurs sometime after the plate has been coated, when some of the unexposed diazo reacts with the aluminum substrate — becoming insoluble and ink receptive (Step 1). The extent to which this reaction takes place depends on storage time, temperature, and relative humidity — which explains why the fault does not always occur.

The presence of reacted diazo does not lead immediately to a problem because it is masked by the layer of adsorbed gum arabic, applied during the finishing operation (Step 2). However, during printing the layer of gum is gradually worn away (Step 3). When enough gum is worn away, and the press is stopped long enough to allow the plate to dry (Step 4), scumming will occur following a restart (Step 5). The test results and the arguments and logic on which the postulated chain of events is based will now be reviewed.

## Experimental Work

In general, the work carried out can be divided into four categories: analysis of selected plate samples, rub tests, printing tests on commercial presses, and experience and tests on newspaper presses. The test procedures, along with the results, are described in the the following paragraphs.

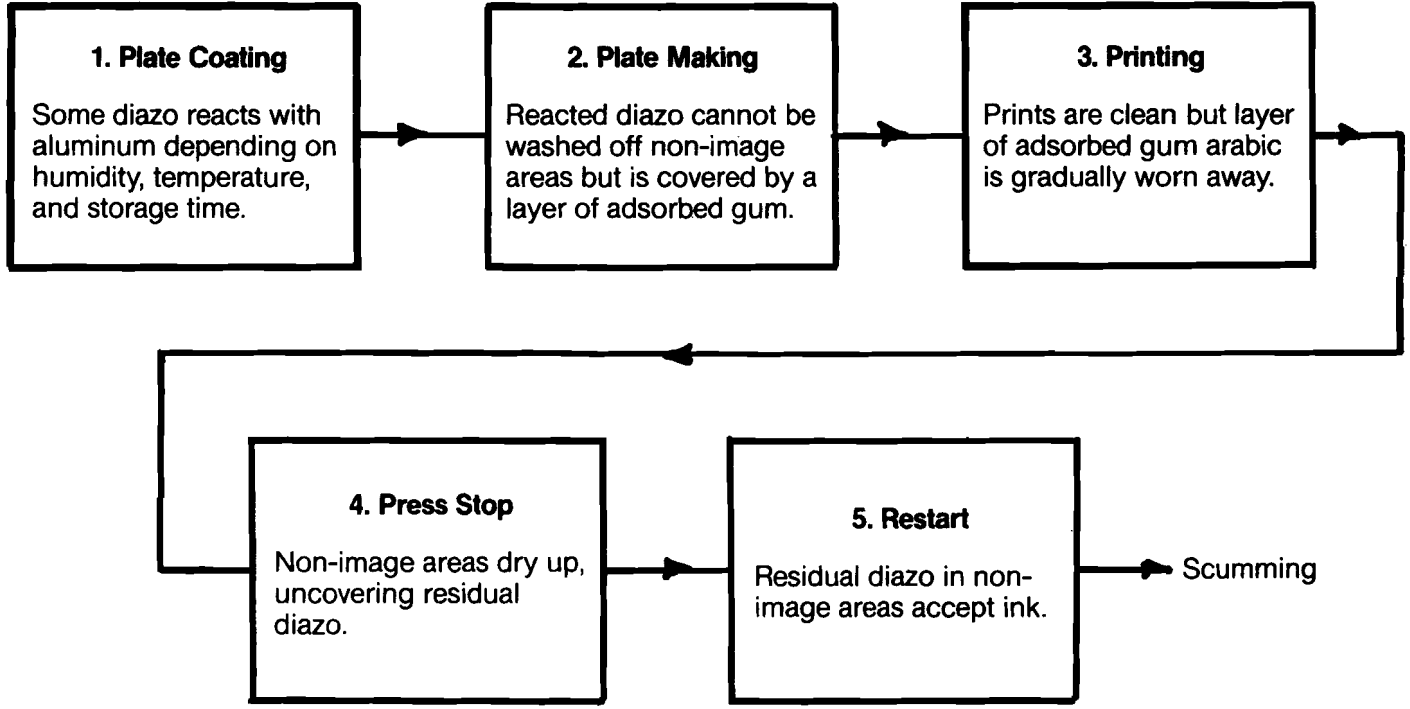


Figure 5 Postulated Chain of Events Leading to Random Toning Failure

## Analysis of Plate Samples

Selected plate samples were analyzed with a scanning electron microscope for evidence of mechanical wear while energy dispersive system X-ray microanalysis was used in an effort to detect differences in levels of reacted diazo on failed and normal samples. It should be kept in mind that this latter method is limited to elements having an atomic weight greater than twelve. Efforts were also made to determine the relative amounts of gum arabic on the surface of failed and normal samples using two different techniques. By and large these efforts were fruitless. The one exception, albeit a negative finding, was that no evidence of mechanical wear was evident in a sample which had been run for 80,000 impressions. This result is shown by the micrographs in Figure 6.

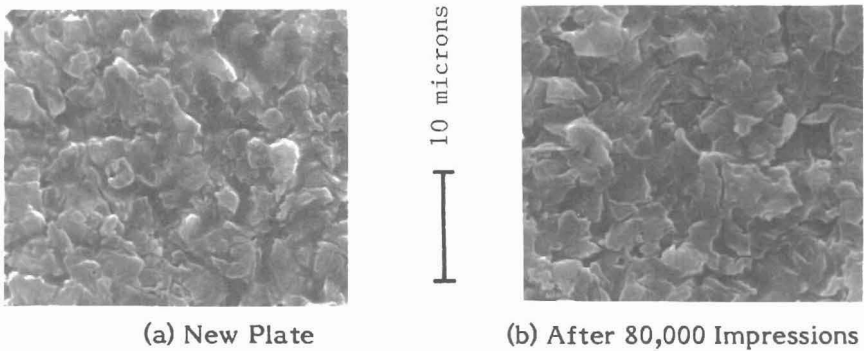


Figure 6 Micrographs Which Indicate No Mechanical Wear of Non-Image Area of Typical Newspaper Plate

## Rub Tests

This type of test derives its name from the procedure used, whereby a small amount of ink is rubbed onto the surface of a plate sample. A wad of absorbent paper or cloth, soaked with fountain solution, is then rubbed over the surface in an attempt to remove or lift off the ink. The exact procedure used in these tests differed slightly from the procedure used by others. For example Mappin (Mappin, 1986) recommends an additional preapplication of fountain solution to the test area and rubbing in the ink only after the fountain solution has dried. In all of the rub tests reported

here, ink was applied as the first step, on the theory that this was a better simulation of the inking-dampening sequence which occurs on newspaper presses equipped with ink train dampening systems.

In general, the rub tests were used in lieu of, rather than in conjunction with, press tests. Consequently, very little measure was obtained on how well on-press performance of plates correlates with the results of rub tests. In spite of this, the rub test results provided valuable insights.

Table I summarizes the results of the more pertinent rub tests. The tests carried out on plate sample #1 were typical of the tests run at the very onset of the investigation using typical acid, alkaline, and neutral fountain solutions, along with samples from new and used newspaper plates. Various attempts were made to produce a failed or scummed plate including soaking samples in water, covering them with a wet sponge, and mechanically cleaning with a brush. In all cases the plate samples would clean up, even when using tap water in place of fountain solution. Plate sample #2 was from a newspaper that was experiencing catastrophic failures on press. A second exposure (using a different film) and development had produced a highly visible phantom image on this sample — indicating a high level of residual diazo. This sample provided a sharp contrast to plate sample #1 in that it failed under all conditions of the rub test. Thus these first two test results indicated the following:

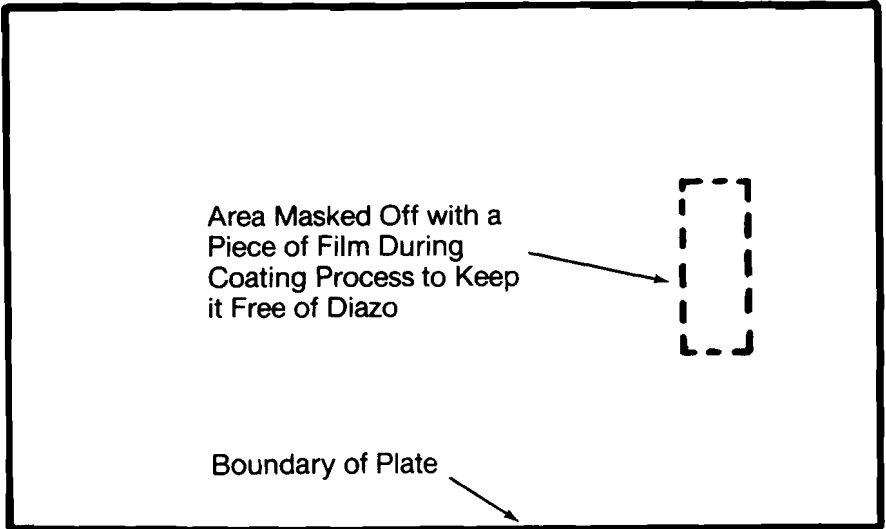
1. Under normal conditions, the plates used on newspaper presses are extremely tough and can tolerate large variations in fountain solution chemistry. Similarly, the positive performance of the ungrained back side of plates (e.g. sample 1-C) showed that a properly matched ink and fountain solution are very forgiving of plates.
2. If enough residual diazo is present on the non-image surface, a plate will fail regardless of the type of fountain solution used.

Samples #3-7 show the effects of gum, graining, residual diazo, and exposure to moisture and warm air. Except for sample #5, all of these plates were coated with an area masked off so as to produce an area which had not received a film of diazo coating. As shown in Figure 7, this area provided a means of visually detecting the amount of diazo remaining (i.e. not washed off) in the normal non-image areas after development. This method of evaluating the amount of residual diazo present is preferred over the one of exposing the plate a second time through a different film, in that in the latter method, the phantom image

Table I Summary of Rub Tests

Plate Number	Test Area	Surface Conditions			Type of Fountain Solution	Other Conditions	Results
		Type Grain	Coated & Developed?	Gummed?			
1	a	Brush	Yes	Yes	All	Refer to Text	Cleaned Up
	b	Brush	No	No	All		Cleaned Up
	c	None	No	No	All		Cleaned Up
2	a	Brush	Yes	Yes	All	Residual diazo very visible	Scummed
3	a	Brush/EC	Yes	Yes	Neutral	Residual diazo very visible	Cleaned Up
	b	Brush/EC	No	Yes	Neutral		Cleaned Up
4	a	Brush/EC	No	No	Neutral	Residual diazo not visible	Cleaned Up
	b	Brush/EC	Yes	No	Neutral	Kept moist 1 hour <sup>(1)</sup>	Cleaned Up
	c	Brush/EC	Yes	No	Neutral	Kept moist 2 hours <sup>(2)</sup>	Scummed
	d	Brush/EC	Yes	Yes	Neutral	Kept moist 1-17 hours <sup>(1)</sup>	Cleaned Up
5	a	Chemical	Yes <sup>(2)</sup>	No	Neutral	Kept moist 1-17 hours <sup>(1)</sup>	Cleaned Up
6	a	Ball	Yes	No	Neutral	Residual diazo barely perceptible	Scummed
	b	Ball	No	No	Neutral	Exposed to 90°F air for 1 hour	Cleaned Up
7	a	Brush/EC	Yes	No	Neutral	Exposed to 90°F air for 1 hour	Scummed
	b	Brush/EC	Yes	No	Neutral	Control Plate	Cleaned Up

- Notes: 1. Samples were exposed to moisture prior to development.  
2. Presensitized plate used in commercial printing (3M Viking).



**Figure 7** Diagram of Test Plate Used to Obtain Visual Indication of the Amount of Residual Diazo Present After Exposure and Development.

thus formed (if residual diazo is present) is not permanent, but fades upon further exposure to ambient light. The results of this second group of rub tests can be summarized as follows:

3. Examination of samples 3a-b show that modest levels of residual diazo will not scum if gummed.
4. Comparison of samples #4a-d shows that if an otherwise good coated plate is exposed to a moistened paper tissue for 1 hour prior to development, the diazo coating will react and cause scumming, following development, provided that it is not gummed (Sample 4c). However, if gumming is included in the platemaking process, scumming will not occur (Sample 4d). This response to moisture exposure, which is shown by the photographs in Figure 8 was not limited to any particular brand of plates.
5. Sample #5 showed that a presensitized plate of the type used in commercial printing is not subject to degradation by exposure to moisture, even after 17 hours exposure.

6. Sample #6 showed that a ball grained plate, with its very rough surface, behaves no differently — that is, even if it is ungummed it will clean up provided that no residual diazo is present. Also, this ball grained sample had no more residual diazo than brush grained samples made at the same time.
7. Sample #7 showed that a good plate could be made to fail by subjecting it to 90° Fahrenheit air for one hour prior to exposing and developing it.

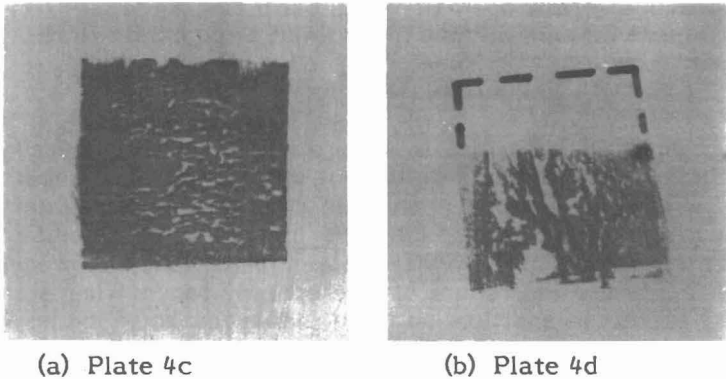


Figure 8 Results of Rub Tests on Plates Exposed to Pads of Moistened Tissue. Darker area in (a) is scummed region and corresponds to pad area. Dotted line in (b) outlines upper half of pad area which was gummed and therefore did not scum.

The observant reader may wonder why a seemingly key rub test was not run — on an ungummed test plate with a visible amount of residual diazo present. The explanation is that by the time the hypothesis in Figure 5 had been proven by the test on a commercial press, described below, the warm humid season had passed and it was no longer possible to create a bad plate with normal processing. In fact this is one reason why efforts were made to simulate the problem by exposing rub test plates to moisture and temperature, as with plates 4c, 4d, 7a, and 7b in Table I.

### Commerical Press Tests

These might be considered the most valuable tests in that they disclosed the important role of gum in the postulated failure scenario. The tests, carried out on a sheetfed press equipped with a ductor type dampening system were modeled after the scum cycle tests run at GATF during the 1970's. In the GATF procedure plain water was employed as the fountain solution and the following sequence was used (DeJidas, 1986):

- (i) Print 100 good sheets.
- (ii) Roll up plate solid.
- (iii) Resume normal operation until plate cleans up.
- (iv) Repeat (ii) and (iii) nine more times to complete first scum cycle.
- (v) Repeat (i) - (iv) until plate no longer cleans up.

The number of scum cycles to failure was taken as a measure of the effectiveness of the desensitizing agent used. In the tests run by the writer, a newspaper fountain solution and ink were used along with newspaper plates and the procedure was modified by immediately rolling up the dry test plate. This change in procedure was made because the failure of interest only occurs when starting up a dry plate. In addition, no more than a few scum cycles were run. In all, three groups of tests were run, which are summarized in Table II. In Group I, "bad" gummed plates were used while "bad" ungummed plates were employed in Group II. The gummed plates proved indestructible while the ungummed plates failed (scummed) immediately in the coated areas, but not so in the uncoated areas. These two groups of tests provided the first evidence that the wearing away of gum is the mechanism which triggers the failure being investigated. These tests also inferred that the protective gum film applied during the last stage of platemaking is far more durable than previously realized.

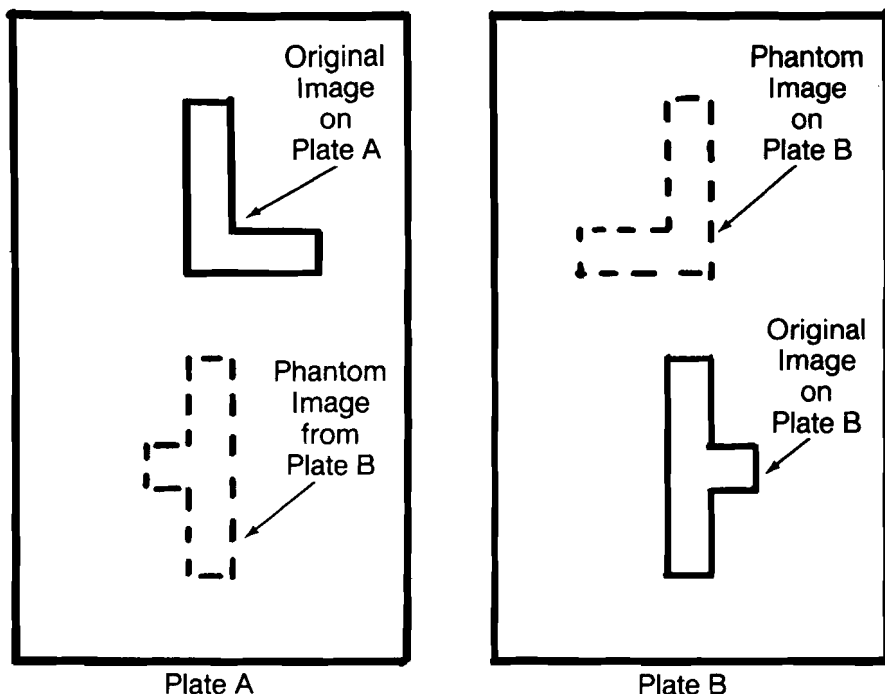
The Group III tests were undertaken to confirm the Group II results, using machine coated and developed plates. The results were inconclusive because of the unexpected appearance of phantom images which were negative and wrong-reading! These were traced to an apparent reaction between pairs of plates which had been stored in face to face contact. This is illustrated in Figure 9. Although the phenomenon cannot be explained, it would appear that face-to-face non-image areas reacted whereas no reaction took place in a non-image area which had been stored face-to-face with an image area. Although the original objective of this group of tests could not be achieved, the results were of value in suggesting that a chemical reaction is involved in the mechanism which leads to the presence of residual diazo.

Table II Summary of Commerical Press Tests

Test Group	Description of Plates Used	Results
I	Machine coated with areas masked off. Normal exposure and development, with gum. Residual diazo very visible.	Always cleaned up - even after scrubbing, soaking, and letting stand over night without regumming.
II	Hand coated with some areas left bare. Normal exposure and hand developed, no gum. Residual diazo visible in varying degrees.	Uncoated areas cleaned up immediately. Coated areas could not be cleaned up on press.
III	Machine coated with areas masked off. Normal exposure and development, no gum. Residual diazo barely perceptible.	Inconclusive due to appearance of negative wrong-reading image. Refer to text.

Experience and Tests on Newspaper Presses

A final series of tests on a newspaper press had been planned, to demonstrate the key role of the gum finish. However, by the time this was attempted, the warm and humid summer season had passed and it was no longer possible to produce plates with any appreciable amount of residual diazo. Thus the hypothesis given in Figure 5 has yet to be demonstrated by printing with test plates on a newspaper press. Nevertheless, much useful information was gained from newspaper press tests, which are summarized in the following eight paragraphs.



**Figure 9** Simplified Diagram of Reaction Between Plates Stored Face-to-Face. Reaction between the two plate surface coatings produced wrong-reading negative phantom images during printing. Phantom images printed clean while adjacent areas toned.

All of the printing tests described were run on double width newspaper presses equipped with ink train brush dampeners.

1. **Sensitivity of Diazo Coating.** The very first printing tests run on a double width newspaper press were aimed at confirming the sensitivity or ink receptance of unexposed and exposed diazo coating. The two test plates used (blank, as-received) were hand coated through a mylar stencil so as to produce a circular and diamond shaped coated area on each plate. One plate was exposed in the normal way but

not developed while the other plate was left as is. Further, the region of each plate containing the diamond shaped pattern was handgummed. The plates were mounted and the press started up in the normal manner. Because this was a color makeready, the press was only run for less than 1000 impressions with the results given in Table III.

Table III Diazo Sensitivity Test Results

Test Area	Gummed Region	Ungummed Region
Unexposed Diazo	Cleaned Up	Perimeter of Area Printed Clearly
Exposed Diazo	Cleaned Up	Entire Test Area Printed Clearly

These results demonstrated that exposed diazo is indeed ink receptive and that it can be blinded by an overcoating of gum. In theory, neither unexposed diazo area should have printed. The fact that the perimeter of the ungummed and unexposed diazo area printed is attributed to its thinner coating (at the stencil border) and its 45 minute exposure to pressroom lights while mounted on the press, prior to startup. (A separate test showed that exposing a machine coated plate to pressroom lighting for 45 minutes produced a reading of Step 1 on the sensitivity guide, following normal development.)

2. **Relative Importance of Exposure to Light and Dryup During a Stop.** Early on there was some uncertainty over what event, during a press stop, would cause plates to sometimes tone on a subsequent startup. Two possibilities existed: dryup of the plate, and exposure of the dry plate to pressroom lights. In order to determine which event was significant plates were masked with a wet sponge and with a dry piece of cardboard during a stop, at a time in the summer when random toning was occurring on a fairly regular basis. Upon restarting, the unmasked areas of the plates did indeed fail to clean up. Furthermore, the area masked by the sponge moistened with fountain solution printed clean, while the dry masked area also toned. This indicated that dryup is the mechanism which causes a degraded or "worn" plate to tone on a restart.
3. **Significance of Fountain Solution Temperature.** During the summer one newspaper plant was experiencing random toning on a fairly regular basis. A check of the temperature

of the fountain solution in the fountain pans showed that it was consistently 60 degrees Fahrenheit at the start of the morning run and gradually increased to about 80 degrees Fahrenheit by the time the run was over. Because this relatively large temperature rise represented a potential cause of the problem, a test was run whereby a separate circulator was installed to maintain a constant temperature of 60 degrees Fahrenheit in one pan throughout a run. Random toning was experienced nevertheless, which showed that high fountain solution temperature was not the culprit.

4. **Immunity of Dummy Plates.** The practice followed in preparing dummy plates varies considerably from plant to plant. In some cases as-received plates are used, while in others dummy plates are made by developing unexposed coated plates. In still others, the as-received plates are only gummed. A very important piece of evidence was the experience of one plant where personnel are very careful to use only dummy plates that have been gummed but not coated. Although this plant had experienced random toning, the problem had never occurred on a dummy plate — thus indicating that diazo coating is a necessary condition to the problem.
5. **Runability of a Ball Grained Plate.** One theory often heard is that the grained surface on the plates makes it impossible to wash away all of the unexposed diazo, during the development process. It was reasoned that if this were true then a ball grained plate, with its much coarser surface (see Figure 2), would be much more apt to tone. To test this theory a ball grained plate was coated, exposed, and developed in the normal manner — except that the plate was not gummed. When the plate was installed and the press started up in the normal manner it printed clean, proof that all of the diazo had indeed been washed out of the non-image areas. (This test was run after the warm humid season had passed and random toning was not being experienced on production plates.)
6. **Effect of Post-Exposure.** Ed Klepacki of Precision Lithograining Corporation had stated (Klepacki, 1986) that years ago when ball grained plates were the industry standard, just about everyone experienced problems in completely cleaning the non-image areas during development. At that time it was discovered that resistance to toning could be greatly improved by post-exposing a developed plate. The most widely accepted explanation as to why this was effective is that the light

energy polymerizes the gum finish, which results in a better bond to the non-image area. Thus the wear life of the gum coating is extended. This treatment has been recommended (Truitt, 1986) as a solution to the current problem of random toning on newspaper presses. Furthermore there is no question that it works with some gum finishes. The writer observed a press run where one half of a test plate was post-exposed in the manner recommended in the above reference — during a summer period when random toning was occurring. The post-exposed half of the test plate printed clean for the entire run while the other half toned following a press stop.

7. Efficacy of Gumming After a Shutdown. One practice unique to newspaper printing is that plates are not normally gummed following a press stop. However, a number of the plants visited did gum plates during periods when random toning was a frequent occurrence. In addition, the writer observed a press run where selected plates were gummed following a stop. All of this experience demonstrated that random toning will not occur if plates are gummed whenever the press is shutdown for an appreciable period.
8. Efficacy of Commercial Grade Presensitized Plates. A supply of 3M Viking plates was obtained for newspaper printing tests. This brand is typical of the grade of presensitized plates which exhibit great reliability on press in commercial printing. One such test plate was used each day, for about a two week period, in the same location on a newspaper press that was experiencing random toning. Although standard plates on the same cylinder failed often during the test period, the presensitized plates ran clean the entire time. The success of these plates was attributed to their superior protective treatment, rather than simply to the fact that the diazo coating was factory applied. This was demonstrated by making one test plate by washing off the unexposed factory applied coating and applying the standard diazo coating used by the newspaper. No residual diazo was detected on this plate.

## CONCLUSIONS

### Analysis and Rationale

Based on the results of the experimental work described in this paper, it is concluded that random toning results from the chain of events described in Figure 5. This premise is based on four key conditions as follows:

1. The plate must have been allowed to dry.
2. The layer of gum applied during finishing has been worn away.
3. The non-image surface uncovered by wearout of the gum is ink receptive due to the presence of residual or reacted diazo.
4. The unwanted presence of residual diazo is due to a chemical reaction between unexposed diazo and aluminum.

The arguments in support of each condition are set forth below.

**Arguments in Support of Condition 1: The Plate Must Be Allowed to Dry.**

1. Toning never occurs while running but only if there has been a relatively long stop.
2. Wet and dry mask test — during a problem period on press, toning was prevented by laying a wet sponge on the plate during a stop. A dry mask had no effect.

**Arguments in Support of Condition 2: The Layer of Gum Has Been Worn Away.**

1. Problem can be eliminated by gumming plates after shutdown.
2. Some type of wearout is indicated by the fact that failure only occurs after plates have been used for some time.
3. Micrographs show no evidence of mechanical wear.
4. Failure will occur immediately if gum is not applied to plate on which residual diazo is visible.
5. Post-exposing non-image areas pushes out the time to failure.
6. New plates were found to be indestructible in laboratory tests.

**Arguments in Support of Condition 3: Residual Diazo is Present.**

1. Double exposure and masking tests show rough correlation between failures and presence of unwanted diazo product.
2. When gum was left off, toning occurred immediately in coated area but not in uncoated area of problem plates.
3. In several plants where dummy plates are kept separate and are never coated, dummy plates do not fail.

#### Arguments in Support of Condition 4: Residual Diazo is the Product of a Chemical Reaction.

1. Seasonal nature of failure suggests that temperature and absolute humidity are factors.
2. Residual diazo need not be exposed to produce a failure, yet unexposed diazo is not ink receptive.
3. Moisture pad test.
4. Failure of plates stored face-to-face (as in Figure 9).
5. Coarseness of grain does not appear to be a factor.

#### Test for Presence of Problem

It must not be forgotten that toning describes the very general problem of having ink appear where it is not wanted and that there are many causes which produce many variations. The particular problem addressed in this paper, dubbed "random toning" by the writer, is peculiar and particularly troublesome to newspaper printers. However because other toning problems can occur, it is important to be able to determine whether a given problem is of the type described here. Accordingly, a test shown in Figure 10 in flowchart form, was devised. This test can be expressed in words to the effect that there is a high probability that random toning will or can occur if an ungummed image area of a developed plate fails to clean up, in contrast to satisfactory performance of an ungummed as-received area on the same plate. Put another way, if both test areas fail, then the problem is not the random one described here.

#### Fixes or Solutions to the Problem

Although several obvious solutions or fixes to the problem of random toning are brought out in the text, a complete list of those found to work in practice is as follows:

1. Gum plates after stopping. This definitely solves the problem but does involve additional work by the press crew.
2. Use plates with a better protective treatment. This may require the use of presensitized plates and almost certainly will increase plate costs.
3. Post-expose plates. Depending on the finish used, this technique extends gum wearout time. Although it does not completely eliminate the problem, this remedy has proven adequate in many installations.

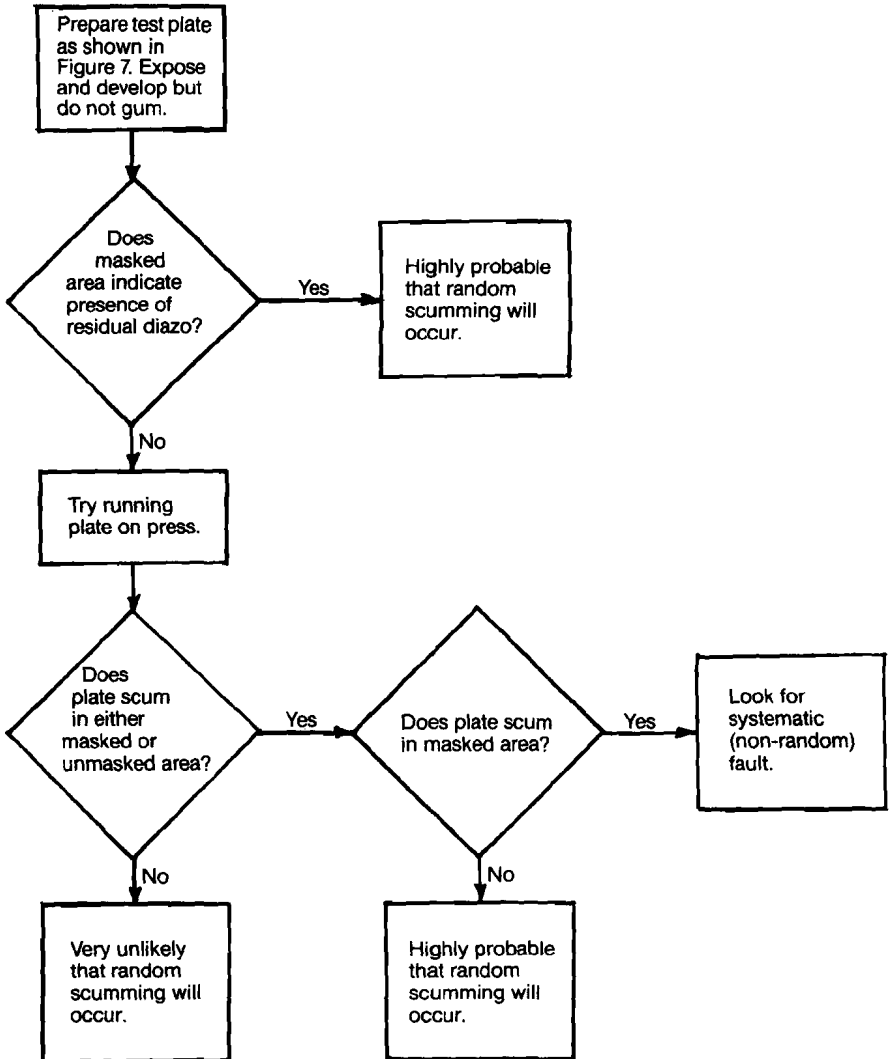


Figure 10 Test For Determining Potential For Occurrence of Random Toning. Note that it is important to leave test plate ungummed.

4. Rollup plates with ink when stopping the press. This technique frequently works but is not a surefire solution. The fact that it works at all is attributed to the theory that the plate is prevented from completely drying out by moisture trapped in or by the ink.

## Observations

In retrospect this investigation produced few surprises. The one finding that constitutes new knowledge, at least to the writer, is that the time or work required to wear or dissolve away the gum finish on the non-image area of a plate is far longer than previously thought. That is, rather than taking only a few hundred impressions, it appears that the wearout time is 25-50,000 impressions. Finally, it must be admitted that all of the evidence cited in support of the conclusions is circumstantial. This is because of the fact that by the time the problem had been analysed, the warm humid weather had passed and it was no longer possible to make "bad" plates. Thus it was not possible to run test plates on a newspaper press to demonstrate the validity of the conclusions. It is hoped that this gap can be filled in the coming summer.

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#### ADDENDUM

Observations made of typical toned plates and prints, using an optical microscope and densitometer were inadvertently omitted from the text. They are included here for the sake of completeness and because they are considered important. During one production run, toning was observed on plates printing black, yellow, and magenta. The following density readings were made on sample sheets, from which were calculated equivalent halftone areas using the Yule-Nielson Equation and an assumed value of 2.7 for  $n$ .

<u>Color</u>	<u>Density of Solid</u>	<u>Density of Unwanted Tone</u>	<u>Equivalent Halftone Area</u>
Black	96	6	8.9%
Yellow	55	9	20%
Magenta	76	1	2%

The black plate was examined by an outside laboratory using an optical microscope. They reported that the scum consisted of dots 5 - 10 microns in diameter, with an average spacing of about three diameters. Such a spacing for a square lattice produces a dot area of 8.8%. The good agreement of this number with the equivalent halftone area is most likely fortuitous. Beyond this, the observations do provide some insight into the dot-like structure of the bonded material which appeared as scum, and attest to the small amount needed to produce a problem.