



MEMJET®

PRINT QUALITY ARTEFACTS *Reference Guide*

PRINT QUALITY ARTEFACTS REFERENCE GUIDE

This Print Quality Artefacts Reference Guide:

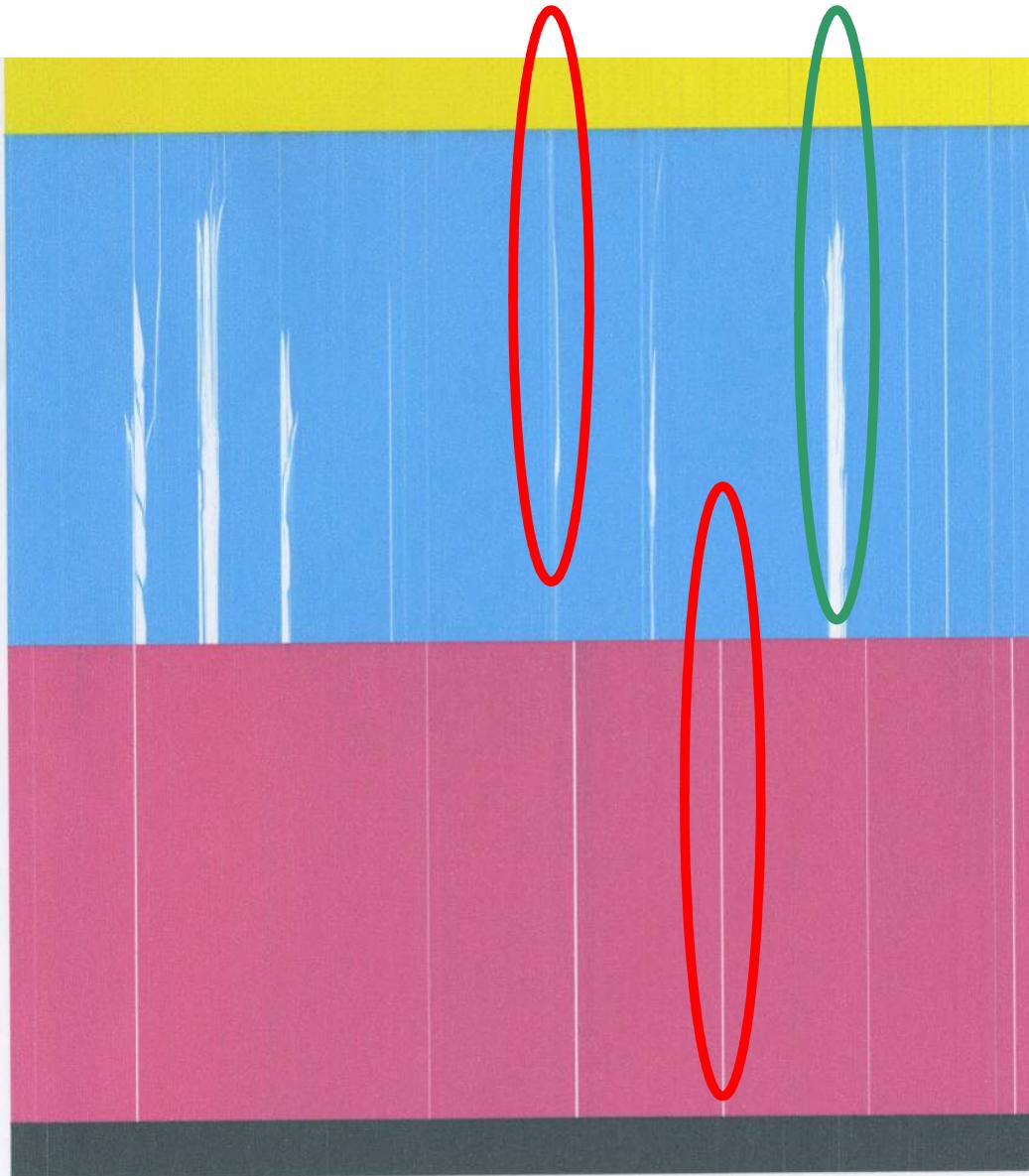
- Is a catalogue of printing artefacts that may be observed when printing with the Remora printhead cartridge on various printing platforms.
- Is intended to be used within Memjet Commercial partner organisations to:
 - identify known printing Artefacts and avoid unnecessary duplication of failure analysis efforts
 - help identify new Artefacts so that appropriate reporting, failure analysis and corrective actions can be instigated.
- Has been divided into two sections:
 - a **Design** section containing Artefacts that can be attributed to print engine design
 - a **Field use** section containing Artefacts that are mostly seen in the field
- Provides for each artefact:
 - a pictorial example
 - a brief description
 - a list of possible causes
 - where appropriate, advice on preventive and/or corrective actions

Notes:

- Where artefacts may appear in both **Design** and **Field Use** sections they have been duplicated using different numbers.
- Acronyms are described in the [Glossary](#).

Design

PQ ARTEFACT 1 – GENERAL BUBBLE RELATED NOZZLE OUTS



Description: nozzles not printing (white areas). Persistent from plot to plot. May change width within plot ("flame" pattern – circled in green).

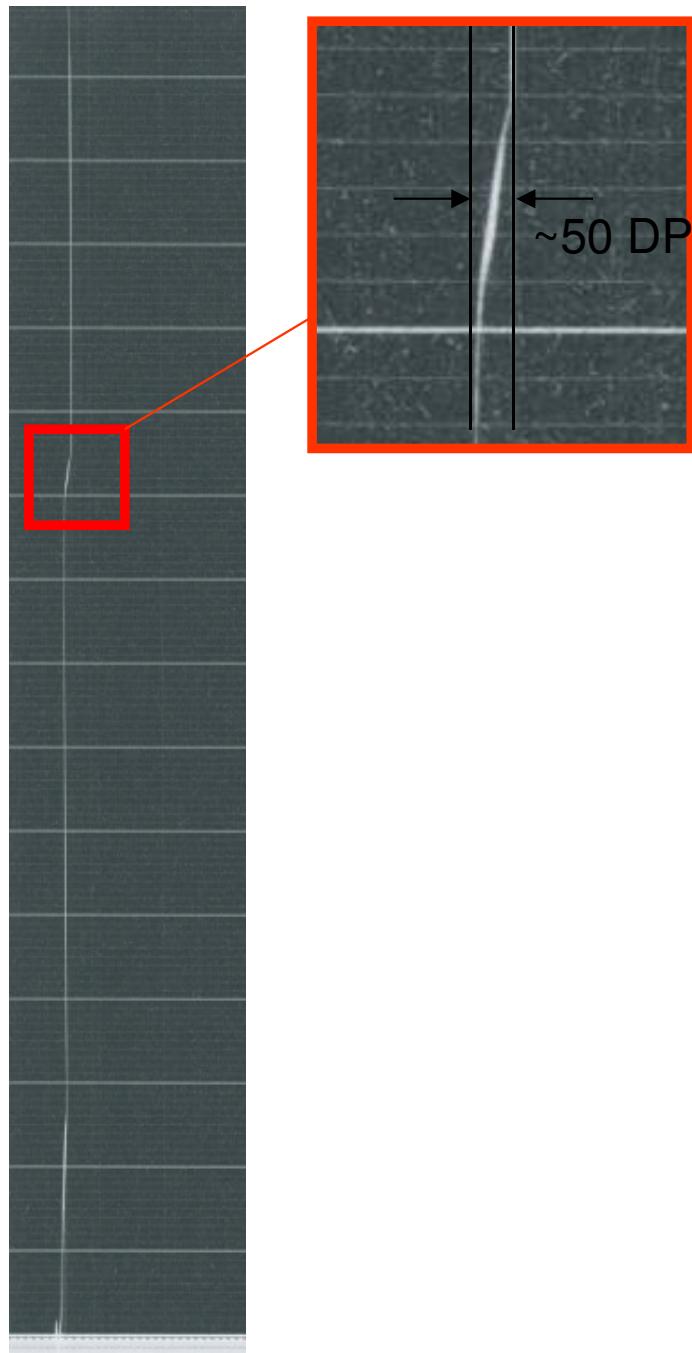
Causes: Bubbles of air block ink from getting to nozzles. Air can come from:

- a) IDS introducing air into the PH
- b) PH gulping through nozzles.

What to do:

- a) Adjust priming flow rate to clear bubbles.
- b) Reduce supply pressure.

PQ ARTEFACT 2 – MEANDERING BUBBLES



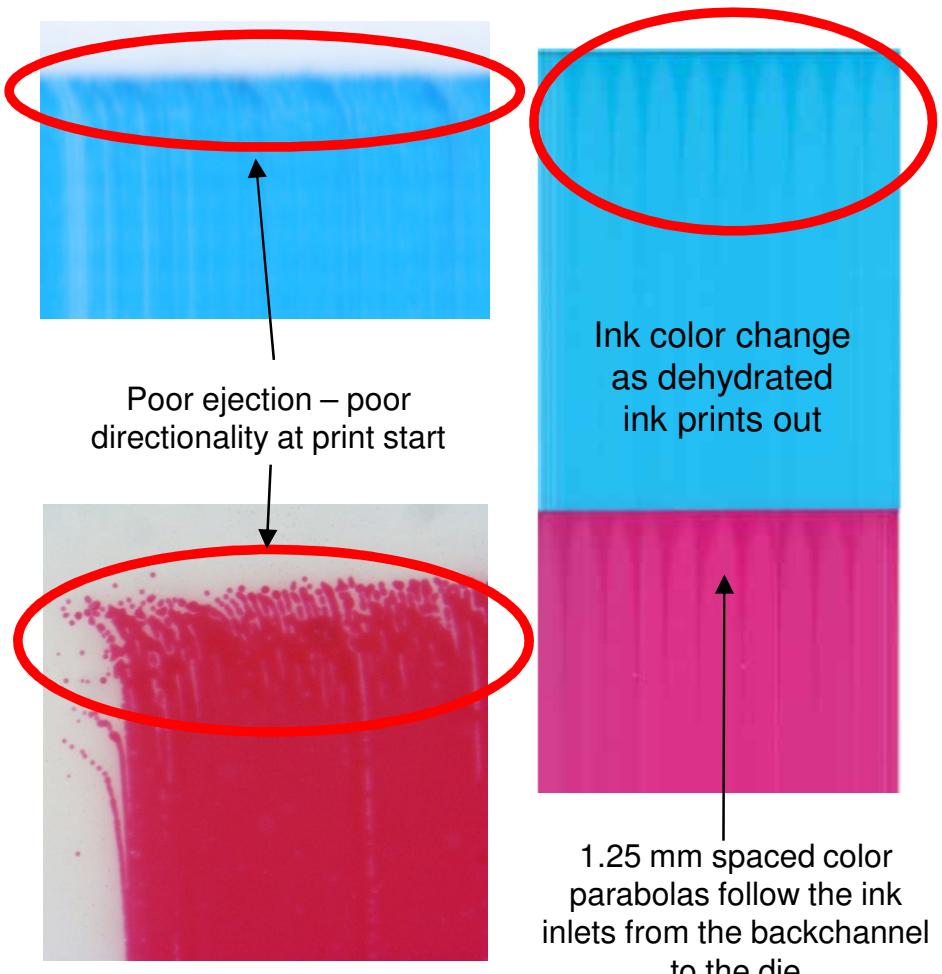
Description: A nozzle-out section which appears as a near-vertical line, but which travels across the X-direction of a print.

Cause: Similar causes as for PQ Artefact 1. This type of bubble motion indicates that the bubble is in the backchannel of the printhead.

What to do:

- a) Priming flow rate does not clear bubbles. Increase it until it does
- b) Pressure drop greater than PH bubble point.

PQ ARTEFACT 3 – INK DEHYDRATION



Description: color change, poor directionality at the start of nozzle firing, non-ejection.

Cause: Dehydration. Loss of water in the ink increases its viscosity, making it more difficult to fire the nozzles (more energy required).

There are two main manifestations:

- a) Dehydration during printing of first page
- b) Dehydration appearing in subsequent pages

What to do:

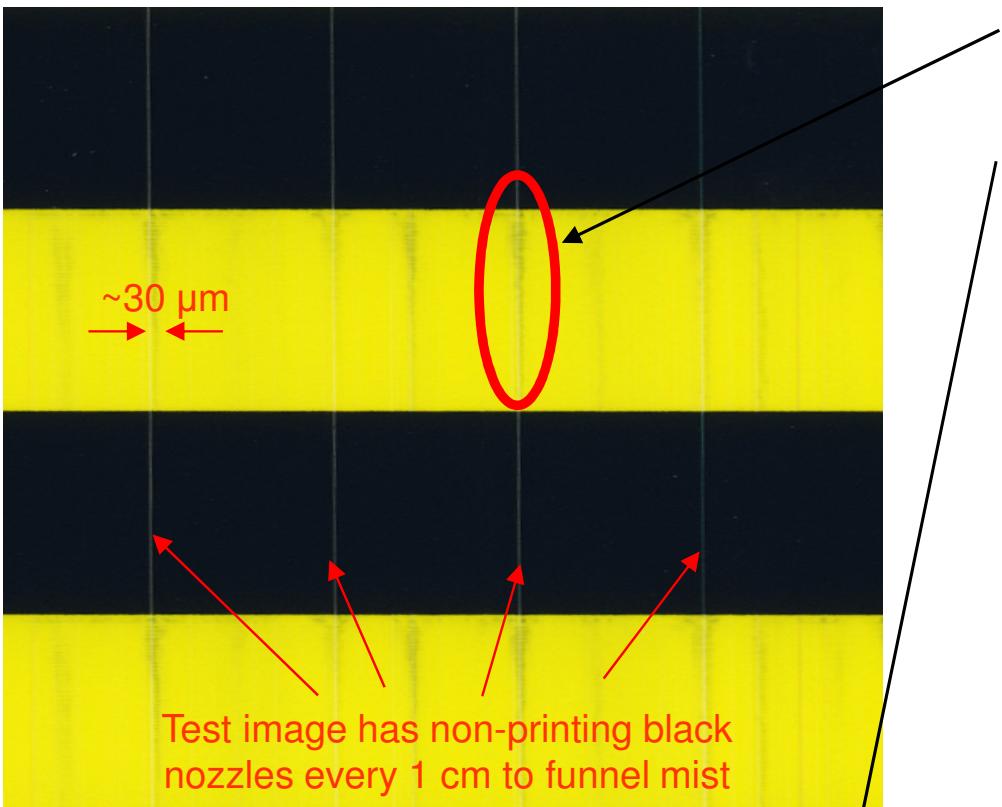
- a) - Remove cause of air flow past the PH when not printing
 - Check nozzle moisture content (maintenance algorithm).
- b) Enable KWS/IPS, check air flow past nozzles.

Table from SBR Application Note

Water content	Condition	Ejection effects	Visible artefact
	Fully hydrated	Normal	None
	Ink color change	Normal with reduced water content causing increased dye loading	Locally intensified colors
	Poor ejection	Low velocity due to increased ink viscosity, reduced volume, poor directionality	Misting and incorrect color
	Non-ejection Beading occurs	None, due to increased viscosity	No image

PQ ARTEFACT 4 – MISTING

Leading Edge of Print



Description: Fine mist of ink from upstream print area falls on downstream print area of page. Deposited mist is concentrated at discontinuities such as at die boundaries and at edges of area fills.

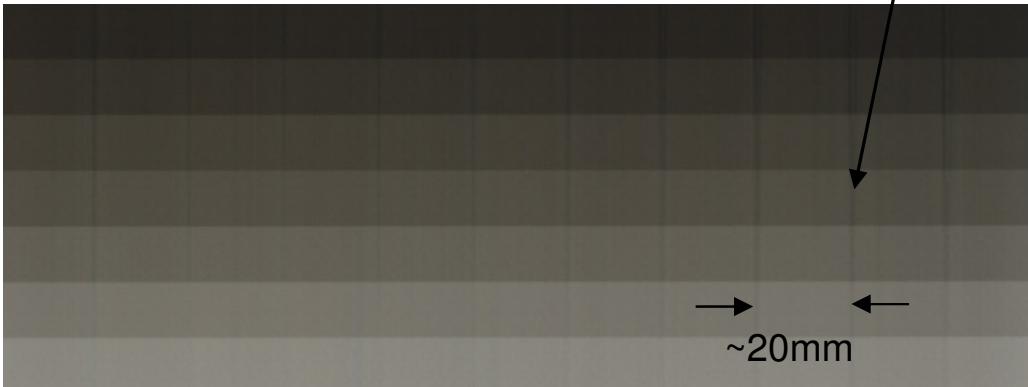
The example image (known as “bumble bee”) is a specially constructed image that is effective in showing black mist, channels it at gaps spaced 1 mm apart, and then deposits it while printing yellow horizontal bars.

Cause: Poor break off of the tails of the ejected ink drops results in very small droplets that have very little momentum. This mist would like to follow the air flow caused by the moving paper, but is aerodynamically trapped by the waterfall of ejecting ink droplets until it finds a break in the waterfall (at die ends or where no nozzles are ejecting).

What to do:

- Check PH supply voltage
- Check flow on upper plate area (before and after PH)
- Check supply pressure to PH (low pressure reduces droplet size and increases misting)

Example showing mist trails at die boundaries



PQ ARTEFACT 5 – OD OR COLOR VARY (SUBOPTIMAL PULSE WIDTH)

Leading Edge of Print

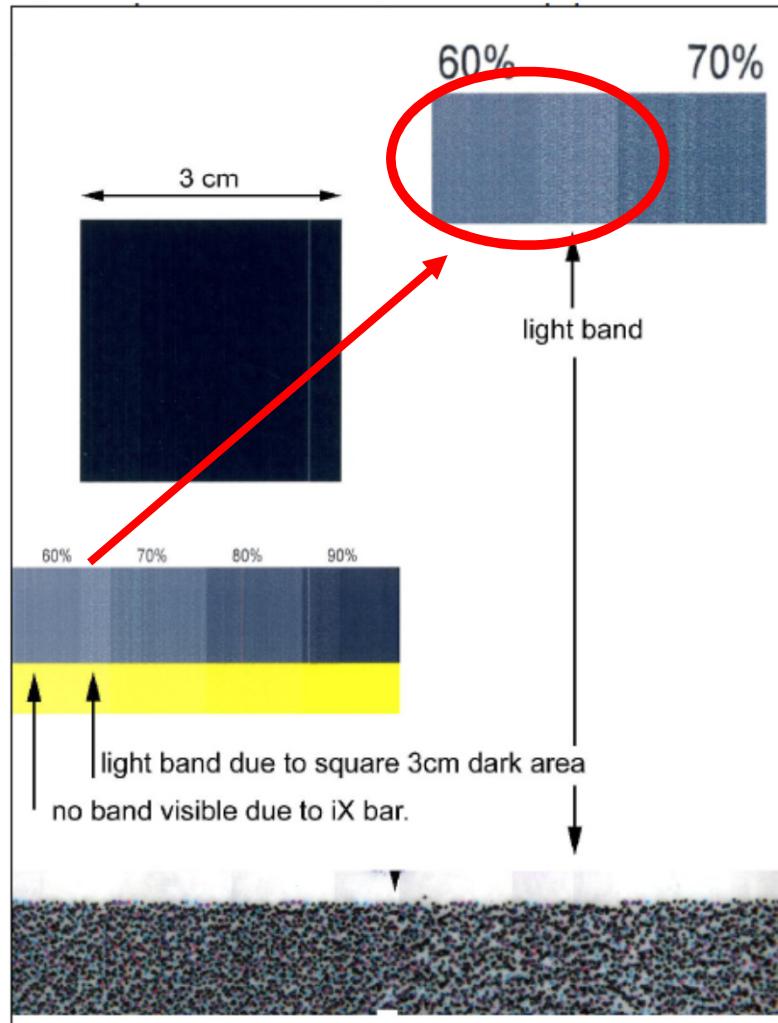


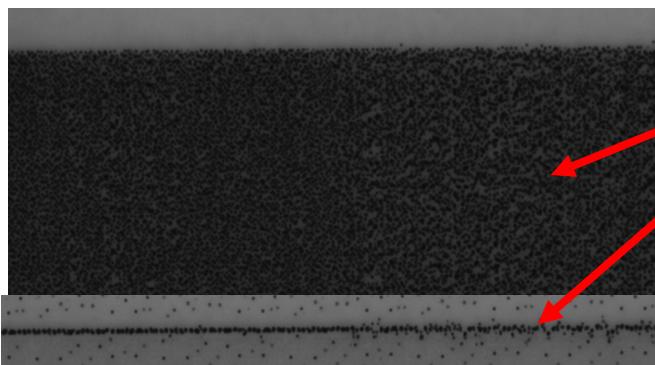
Figure 1: scan test print made on IJM113 coated paper.

Description: An area of half-tone prints with unexpected color variation. Horizontal thin lines with dot placement error (sometimes labelled “Exhaustion”).

Cause: Heat generated while printing the solid black area causes a sub-optimal ejection regime for the nozzles that later have to print the half-tone area.

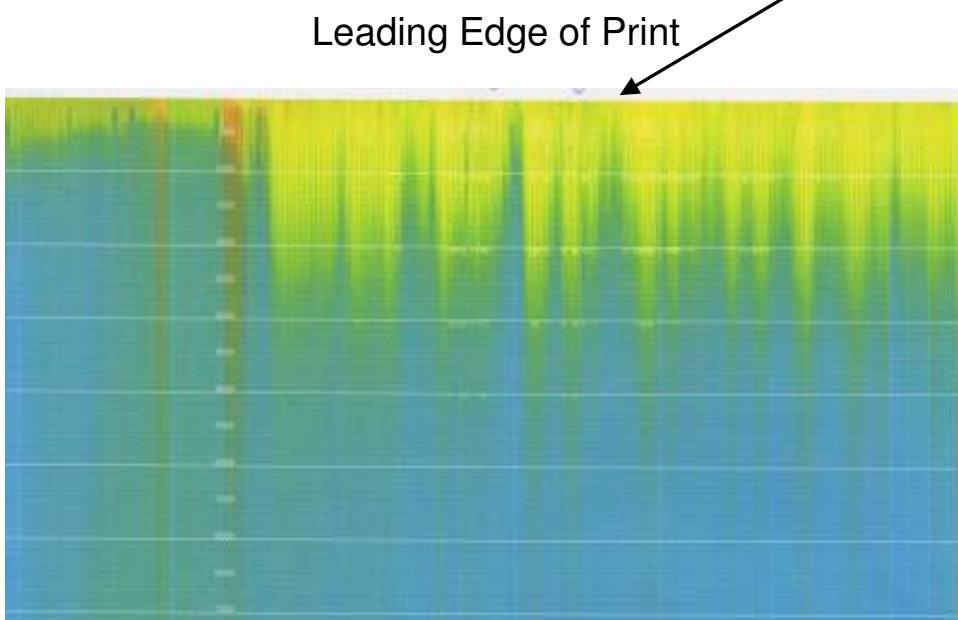
What to do:

Check PH power supply regulation and pulse width.



On photo paper you can see that dots fall on top of dots, and that fine lines have more dot placement error in sub-optimal pulse width area.

PQ ARTEFACT 6 – COLOR CONTAMINATION



Description: Prints that are supposed to be one color are coming out in a different color.

Cause:

- a) Nozzle flooding
- b) - Wiping with inadequate spitting
 - Wiping with wet wiper
- c) Excessive spitting

What to do:

- a) Check for any positive pressure pulses at inappropriate times such as:
 - Surge
 - Pump pulse
 - Incorrect acceleration/deceleration during flushing
 - Inadequate maintenance i.e. pressure prime recovery
- b) - Check maintenance algorithm
 - Check wiper ink load management OR adequate transfer operation
- c) Check wicking rate Vs spitting rate (for additional contamination).

PQ ARTEFACT 7 – REPEATED COLOR CONTAMINATION

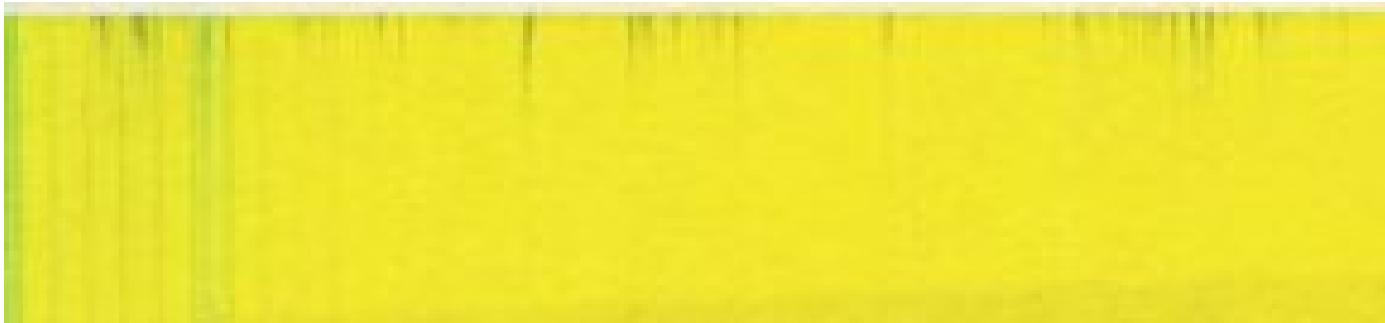
Description: Tiny amounts of color contamination appear on page after page or area after area.

Cause: The printhead is covered with ink somewhere and the ink keeps wicking back to the channels. Ink close to nozzles.

What to do:

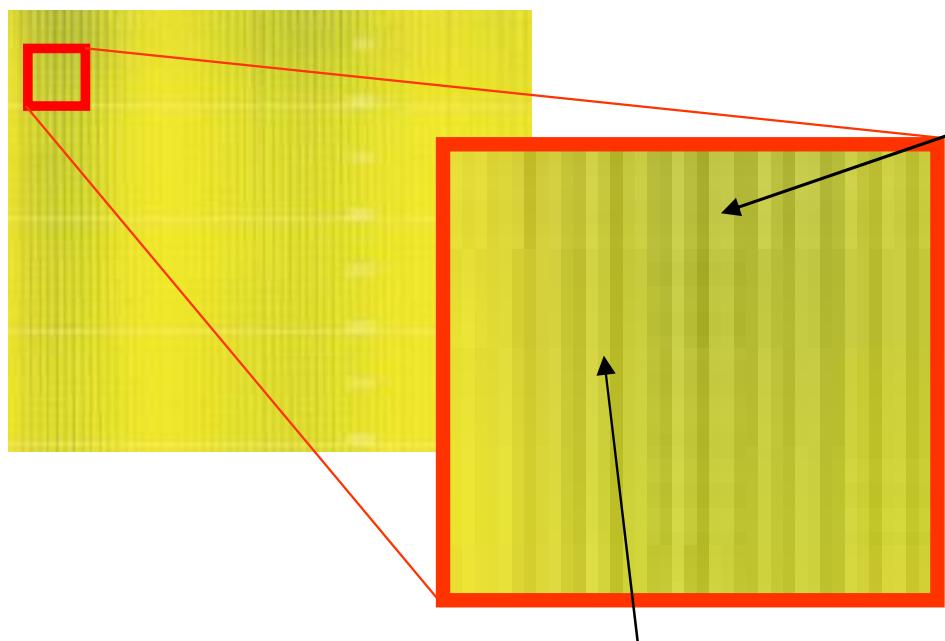
- a) Check performance of wiper in removing ink from PH surface
- b) Check for ink gathering on unwiped area of the PH surface
- c) Check air flow during printing
- d) Check performance of cap.

Leading Edge of Print



PQ ARTEFACT 8 – 1 MM INTERVAL COLOR CONTAMINATION

Leading Edge of Print



Fresh ink is feeding into the properly cleared areas, and the contaminated ink takes longer to clear in the eddies.

Description: Color contamination lines that continue at ~1 mm intervals after the majority of the color has cleared.

Cause: Ink mixing clears in this manner due to the location of the feed holes in the backchannel.

- a) Contaminants diffuse into the back channel.
- b) Artefacts such as those in PQ 6.

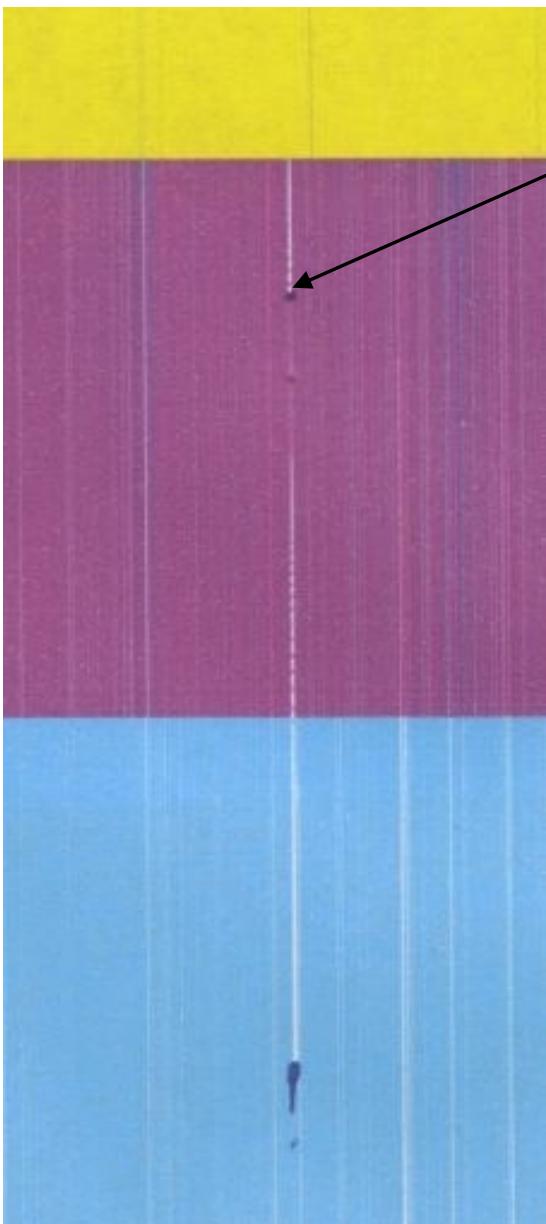
What to do:

- a) PH surface must be cleaned
- b) Spit sufficient ink during maintenance
- c) Others as for PQ 6.



PQ ARTEFACT 9 – DROOLING

Leading Edge of Print



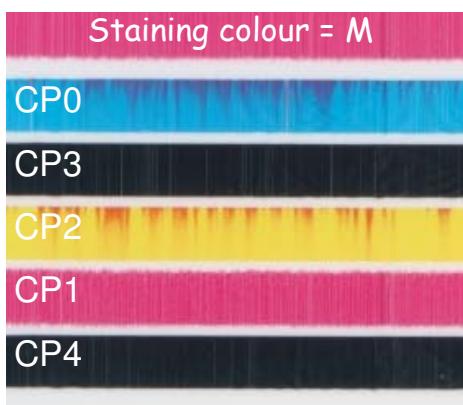
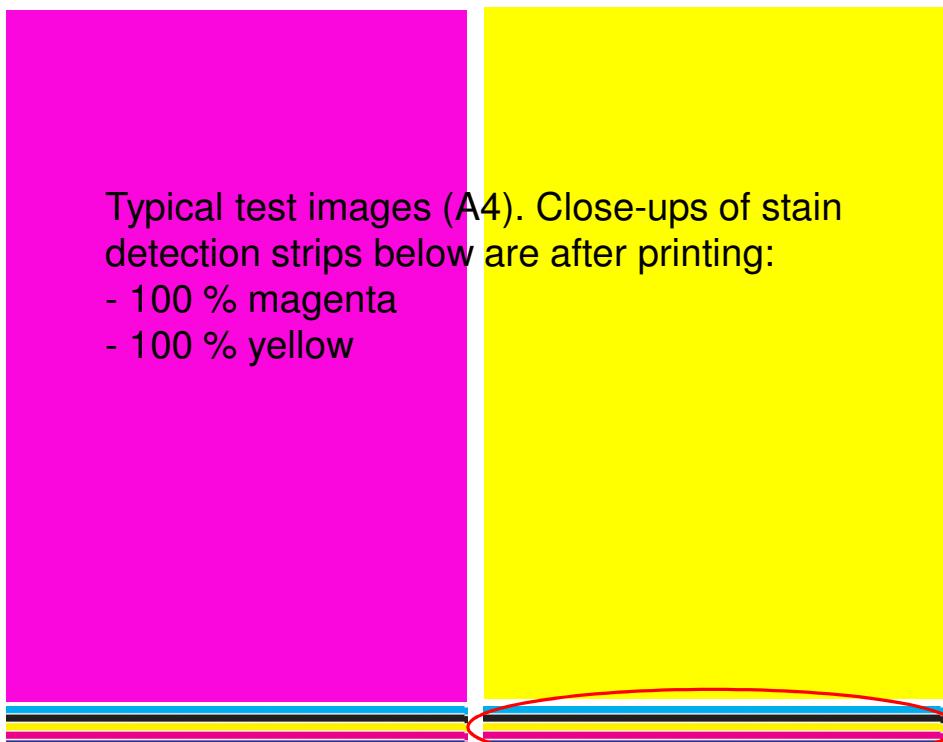
Description: Vertical white lines followed by a dark dot.

Cause: A puddle has formed in front of the nozzle (e.g. due to a particle or fibre on the printhead surface), and is capturing the drops that are fired. Eventually the puddle gets big enough to drop onto the page.

What to do: Check efficacy of wiper.

PQ ARTEFACT 10 – COLOR MIX AFTER HEAVY PRINTING

Leading Edge of Print



Stain detection strips (5 CPs)

Description: After printing long area fills with a primary (or secondary) color, adjacent color rows that were not ejecting are stained with the ink that was printing.

Cause: Ink migration across the MEMS surface from heavily printing nozzles into nearest odd or even nozzle row that was not printing.

What to do: Check color profiles ink limits.

PQ ARTEFACT 11A – FLUIDIC RESONANCE FLOODING VOID AREAS

Leading edge of print



Description: When printing horizontal bars of alternating dark and light color bands void areas show in lighter color bands. Worse at higher temperatures.

Cause:

- a) Repeating patterns excite resonance in the printhead (like an organ pipe) that eventually makes ink pressure go positive allowing ink to flood out onto PH surface. Nozzles are then not able to eject through flood until flood clears. Most obvious when firing reduced number of nozzles in light color areas.
- b) Ink in air boxes due to incorrect PH handling.

What to do:

Alter IDS to:

- a) Avoid resonance frequency OR add resonance damping elements to IDS or cartridge.

PQ ARTEFACT 11B – FLUIDIC RESONANCE FLOODING COLOR MIXING

Leading edge of print



Flooding color
bar

Description: When printing horizontal bars or alternating color and no-color, brief color mixing sometimes seen a short distance after trailing edge of flooding color plane's printed bar.
Worse at higher temperatures.

Cause:

- a) Repeating patterns excite resonance in the printhead (like an organ pipe) that eventually makes ink pressure go positive allowing ink to flood out onto PH surface. When the standing wave goes negative again, ink gets sucked back into the nozzles.
- b) Ink in air boxes due to incorrect PH handling.

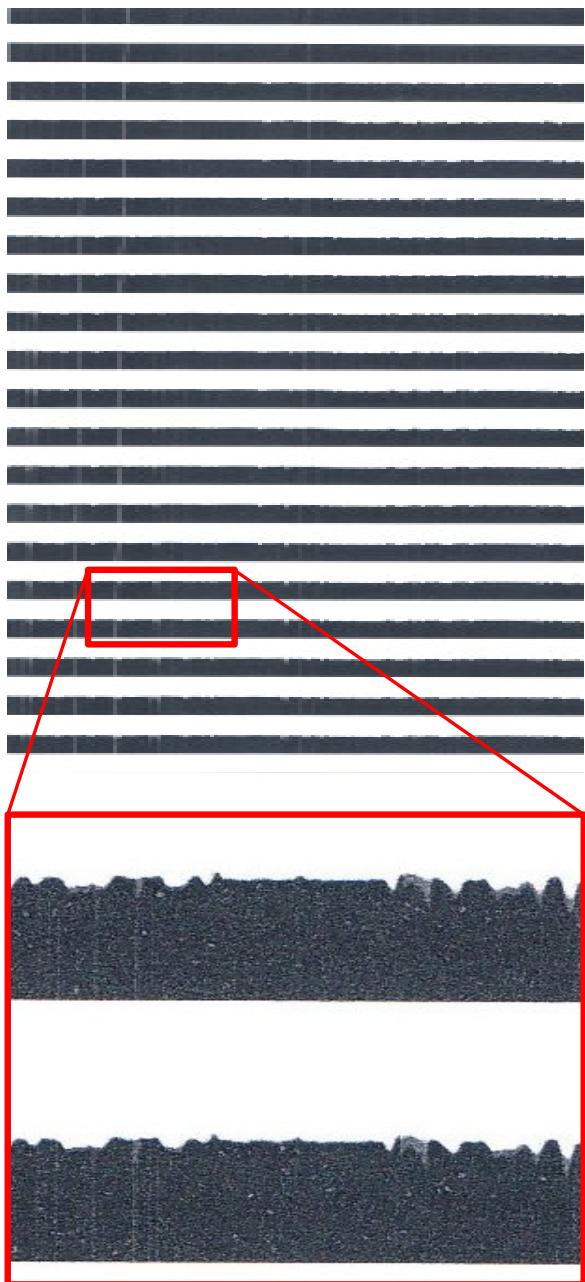
What to do:

Alter IDS to:

- a) Avoid resonance frequency OR add resonance damping elements to IDS or cartridge.

PQ ARTEFACT 11 – FLUIDIC RESONANCE FLOODING RAGGED EDGES

Leading edge of print



Description: When printing horizontal bars or alternating color and no-color, leading edges of the bars become ragged. Worse at higher temperatures.

Cause:

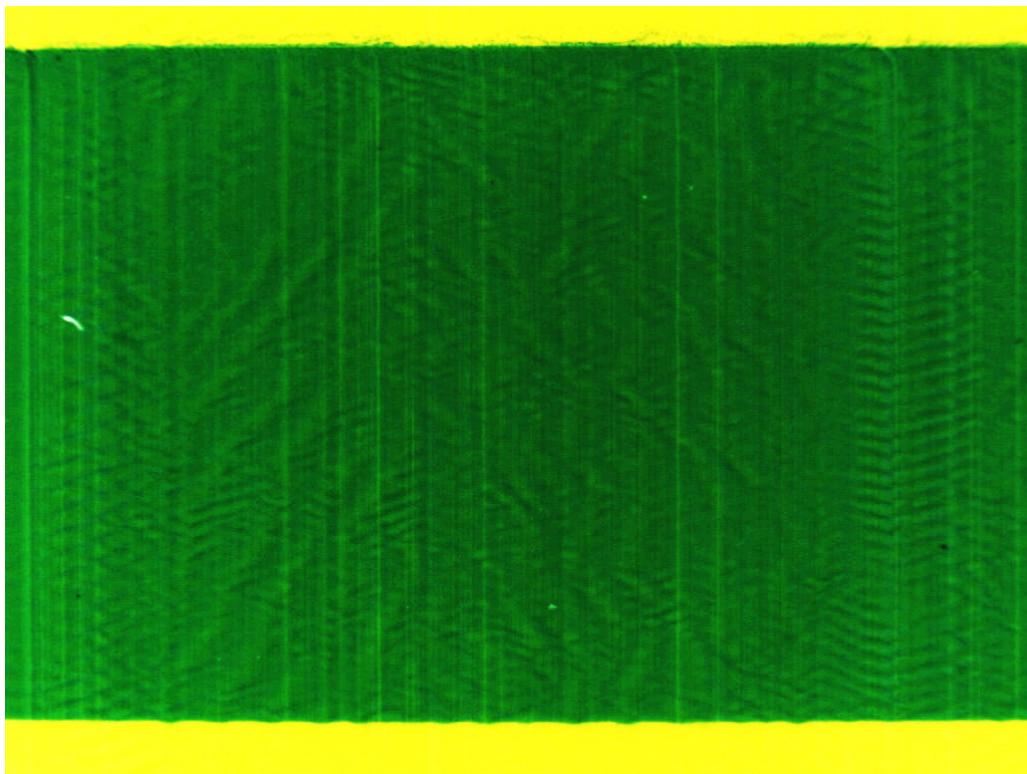
- a) Repeating patterns excite resonance in the printhead (like an organ pipe) that eventually makes ink pressure go positive allowing ink to flood out onto PH surface. Nozzles are then not able to eject through flood until flood clears.
- b) Ink in air boxes due to incorrect PH handling.

What to do:

Alter IDS to:

- a) Avoid resonance frequency OR add resonance damping elements to IDS or cartridge.

PQ ARTEFACT 12 – SAND DUNE EFFECT



Description: Patterns that look like “sand dunes”, “tiger stripes”, “ship wakes”, “aeroworms”, etc. The patterns are often determined by streaks or image edges. Can happen in any color area fill.

Cause:

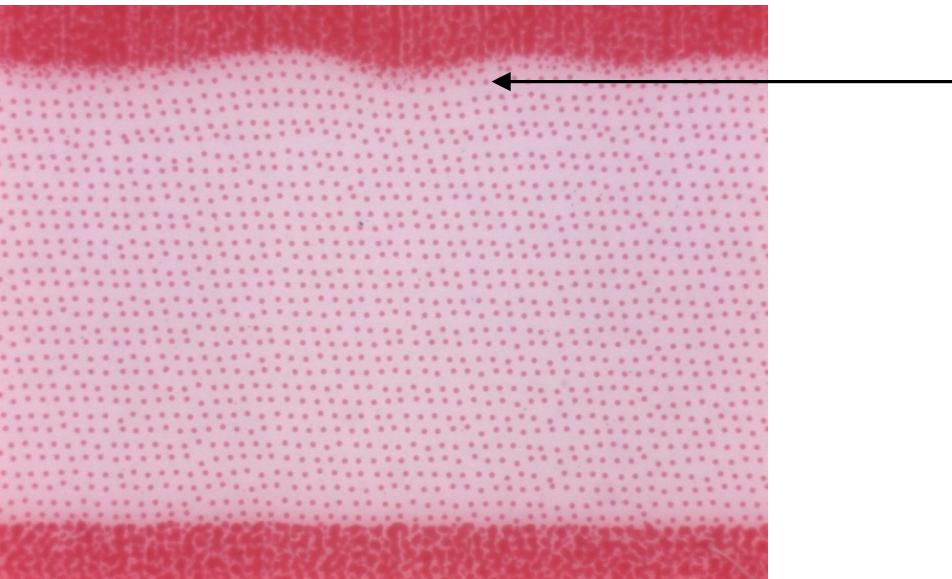
One of:

- (a) Ink mist that is exacerbated by excessive PPS
- (b) Excessive PPS

What to do: Move paper closer to nozzles.

PQ ARTEFACT 13 – WANDERING HORIZONTAL LINES/EDGES

PPS = 1.45 mm



Description: Grainy patterns in area fills, wandering horizontal lines or horizontal edges.

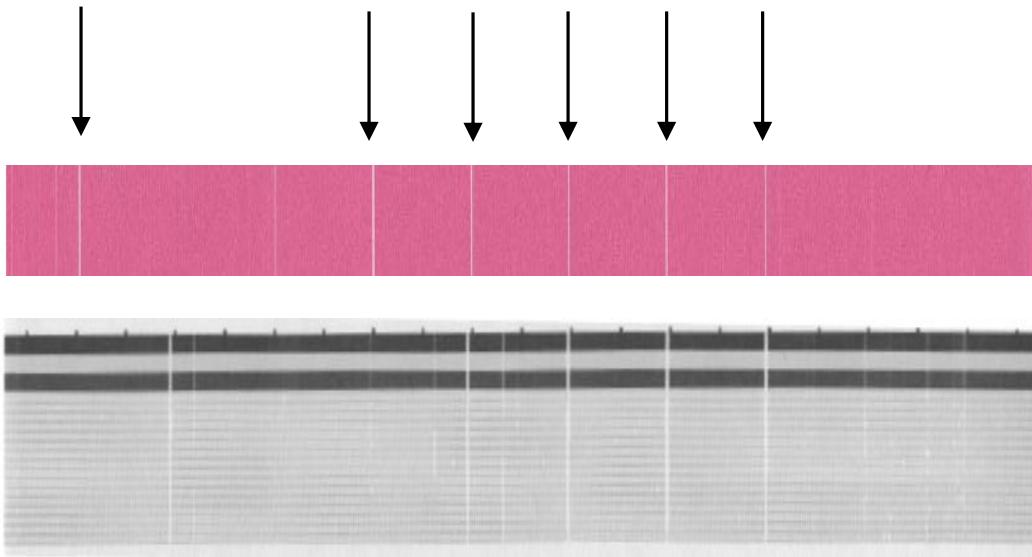
Cause: Excessive pen-to-paper distance.

What to do: Move paper closer to nozzles.

Same printhead with PPS = 0.80 mm



PQ ARTEFACT 14 – FINE STREAKS



Description: Regularly spaced white streaks where nozzles are not printing.

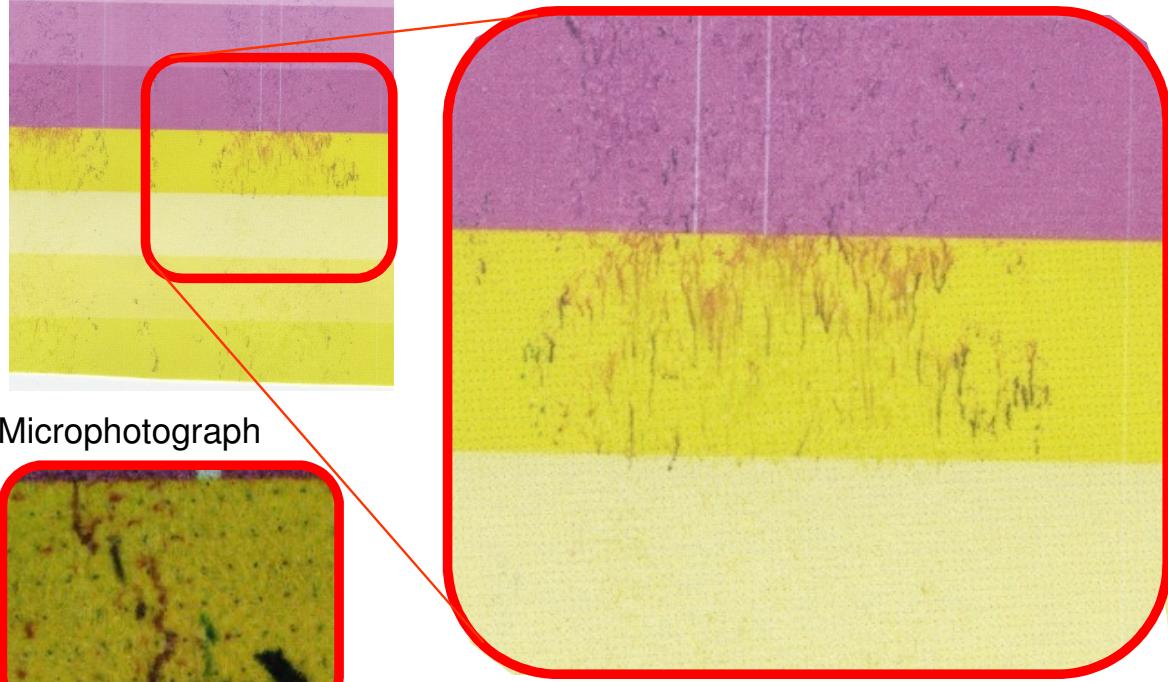
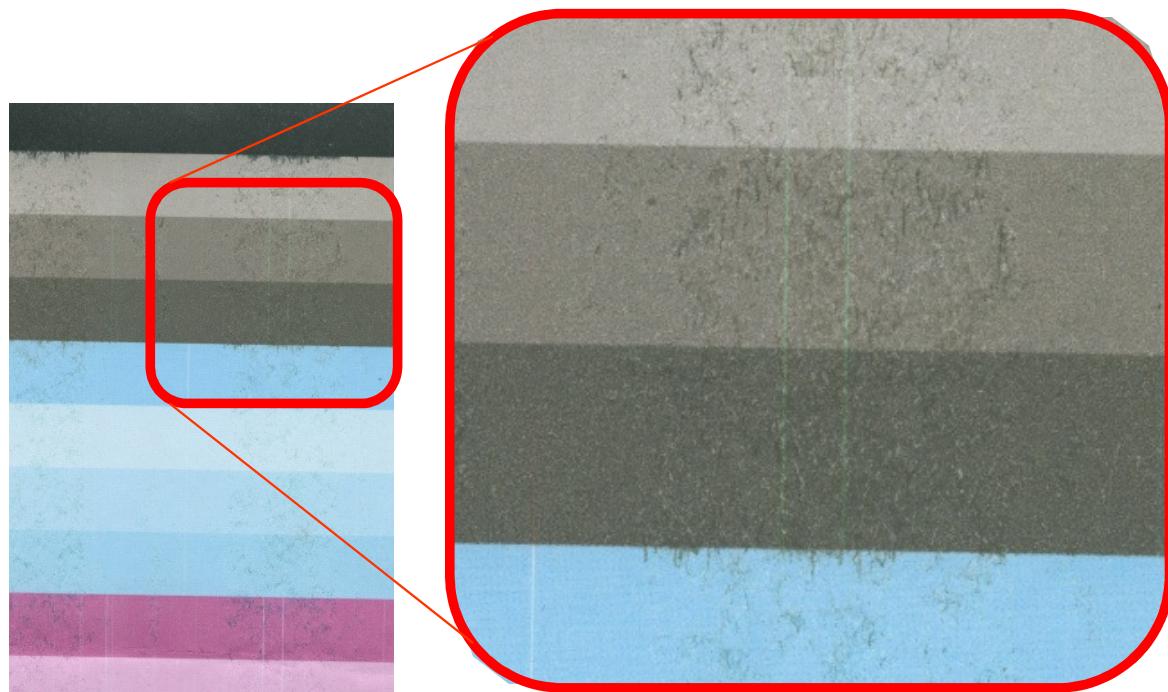
Cause: Blocked nozzles due to:

- a) Air bubbles (see PQ 1)
- b) Particles from contaminated ink
- c) Particles from PH surface

What to do:

- a) See PQ 1
- b) Check:
 - IDS materials for shedding
 - Check filter and/or wiping frequency compared to particle arrival rate.
- c) Check wiper.

PQ ARTEFACT 15 – LINTY LOOKING PRINTS



Microphotograph



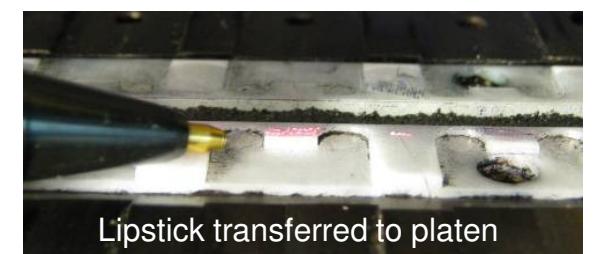
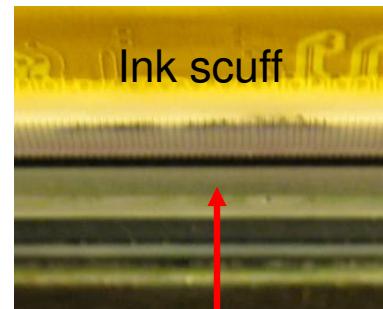
Description: Looks like there is lint spread out down the page.

Cause:

- a) Insufficient PPS or
- b) Wet curl of media under PH.

What to do: In each case:

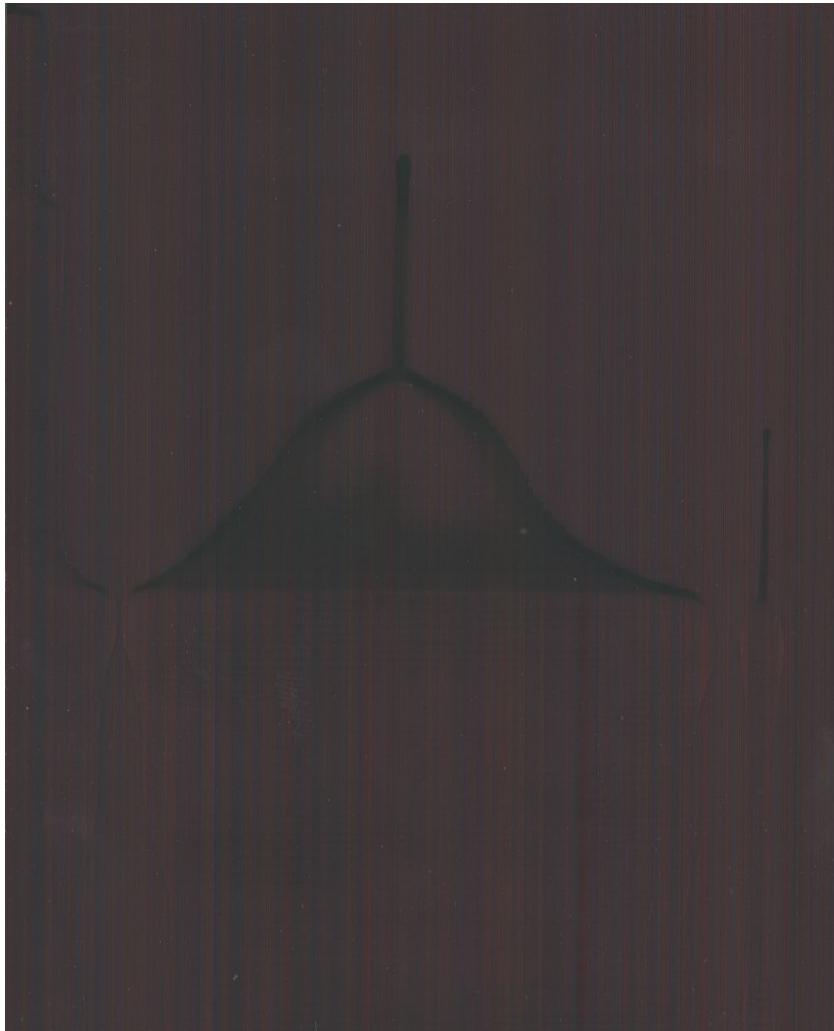
- (a) Check PPS
- (b) Check maintenance routines
- (c) Set color profile ink limits for the media.



PQ ARTEFACT 16 – INK SMUDGE



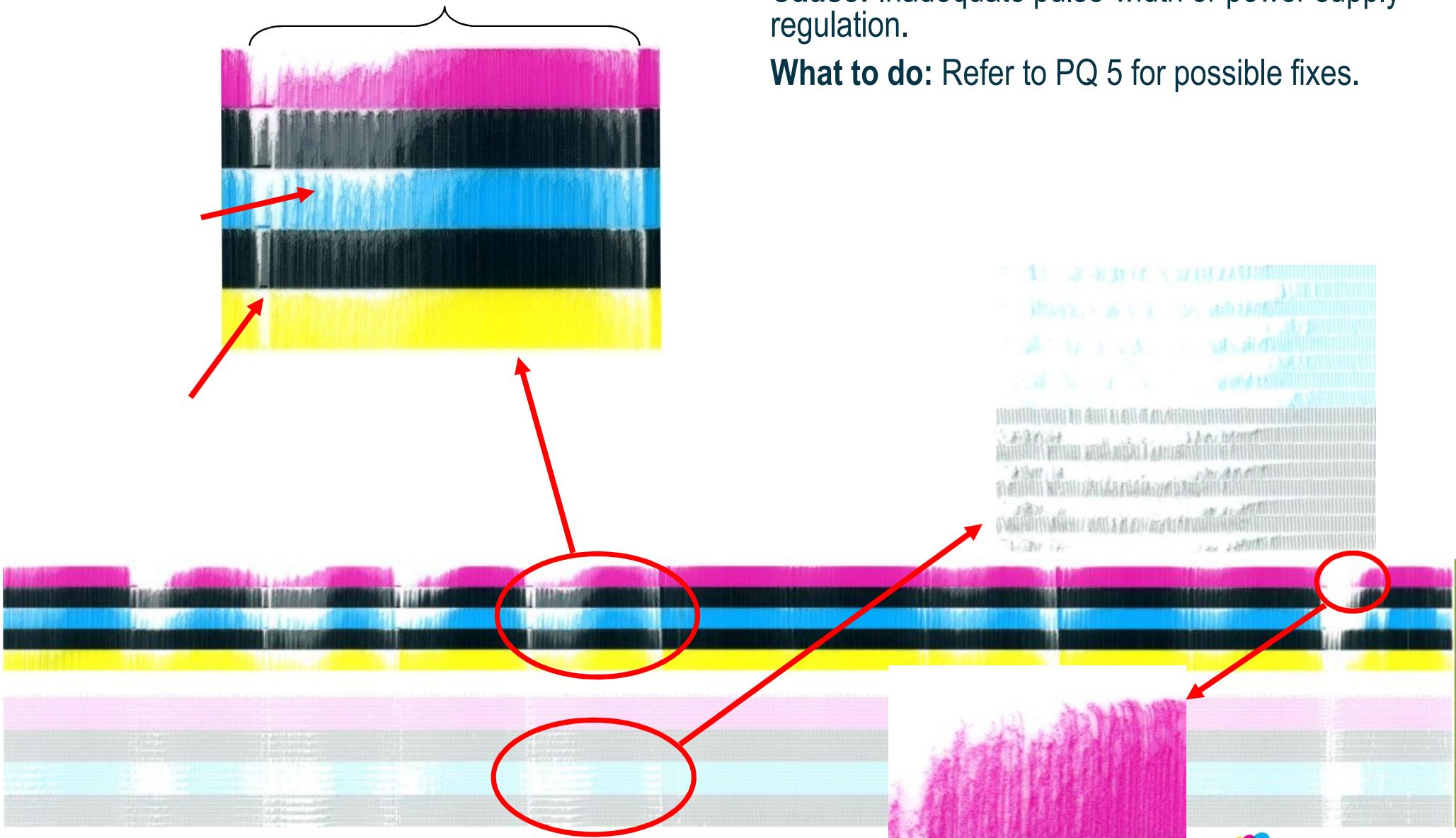
Direction
of paper
motion



Description: Smudge of ink (any color) on paper. This example is “bell shaped” but various shapes do occur. Width of smudge becomes narrower as paper moves past printhead.

Refer to PQ 15 for causes and possible fixes.

PQ ARTEFACT 17 – WEAK PRINTING

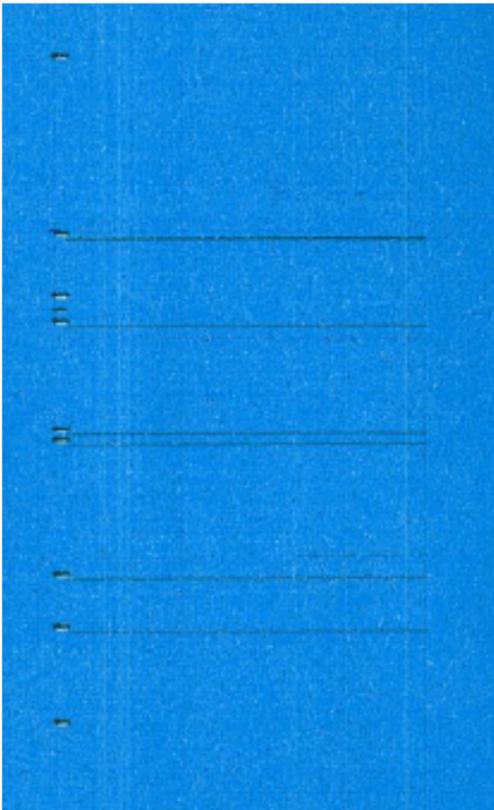


Description: Poor and inconsistent droplet ejection and directionality.

Cause: Inadequate pulse-width or power supply regulation.

What to do: Refer to PQ 5 for possible fixes.

PQ ARTEFACT 18 – SPURIOUS NOZZLE FIRING



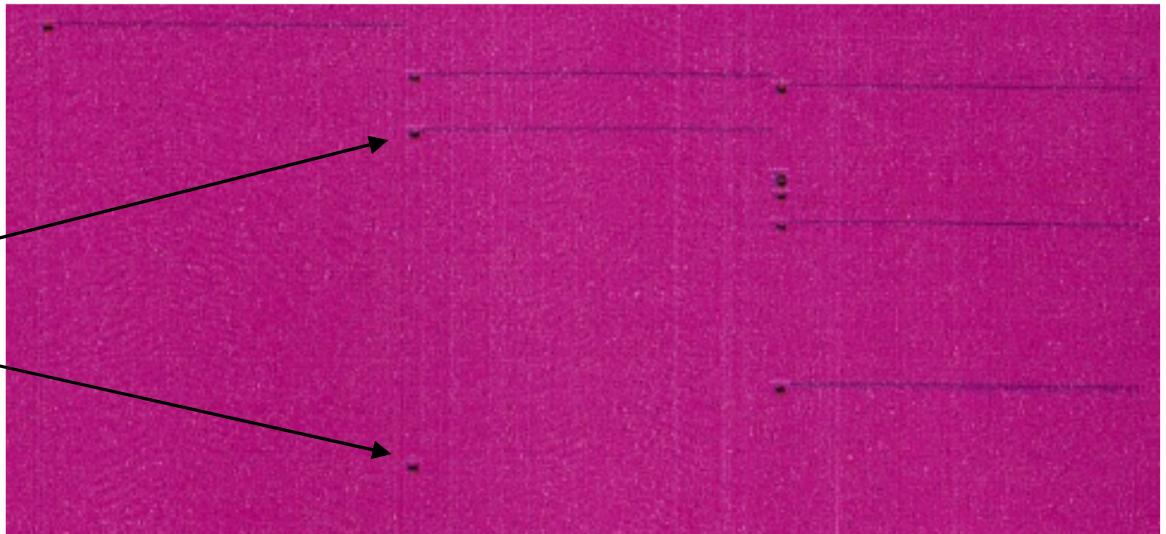
PHIC-wide or just “drop down triangle” width line of dots that should not be there! These examples show black dots on cyan and magenta but can be any color. May only affect some of the PHICs

Description: PHIC-wide or just “drop down triangle” width line of dots that should not be there. These examples show black dots on cyan and magenta but can be any color. May only affect some of the PHICs.

Cause: Internal PHIC logic errors caused by excessive noise on internal logic signals (“ground bounce” due to:

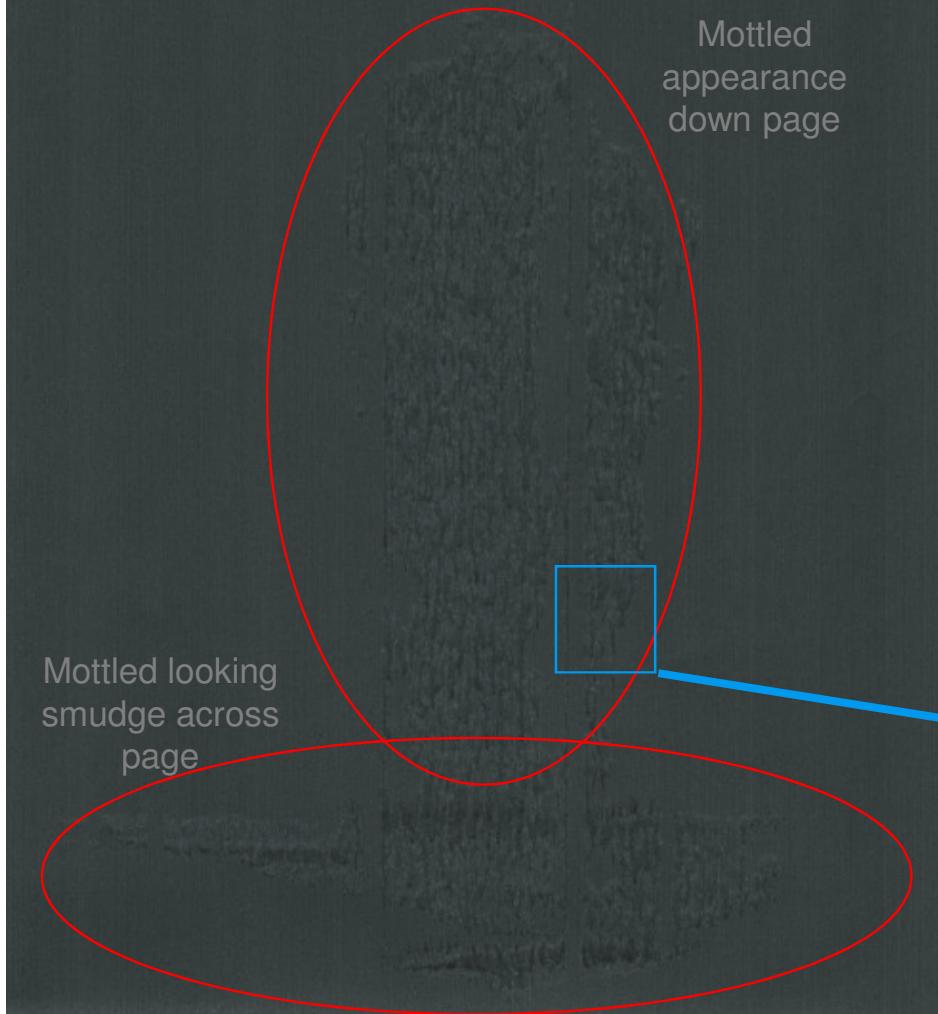
- (a) extremely high nozzle firing currents (I_{pos}) and/or
- (b) poor printhead ground contact.

What to do: Check grounding, excessive GND voltage “lift” during nozzle firing, excessive V_{dd} or V_{pos} droop during nozzle firing, nozzle firing parameters (span, pulse width, etc).



PQ ARTEFACT 19 – CONDENSATION ON PRINthead

Top of printed page (image scale = whole A4 Page)



Description: Mottled appearance on high density prints. Can happen while printing a single page with 100% ink coverage. Black and magenta seem to be worse.

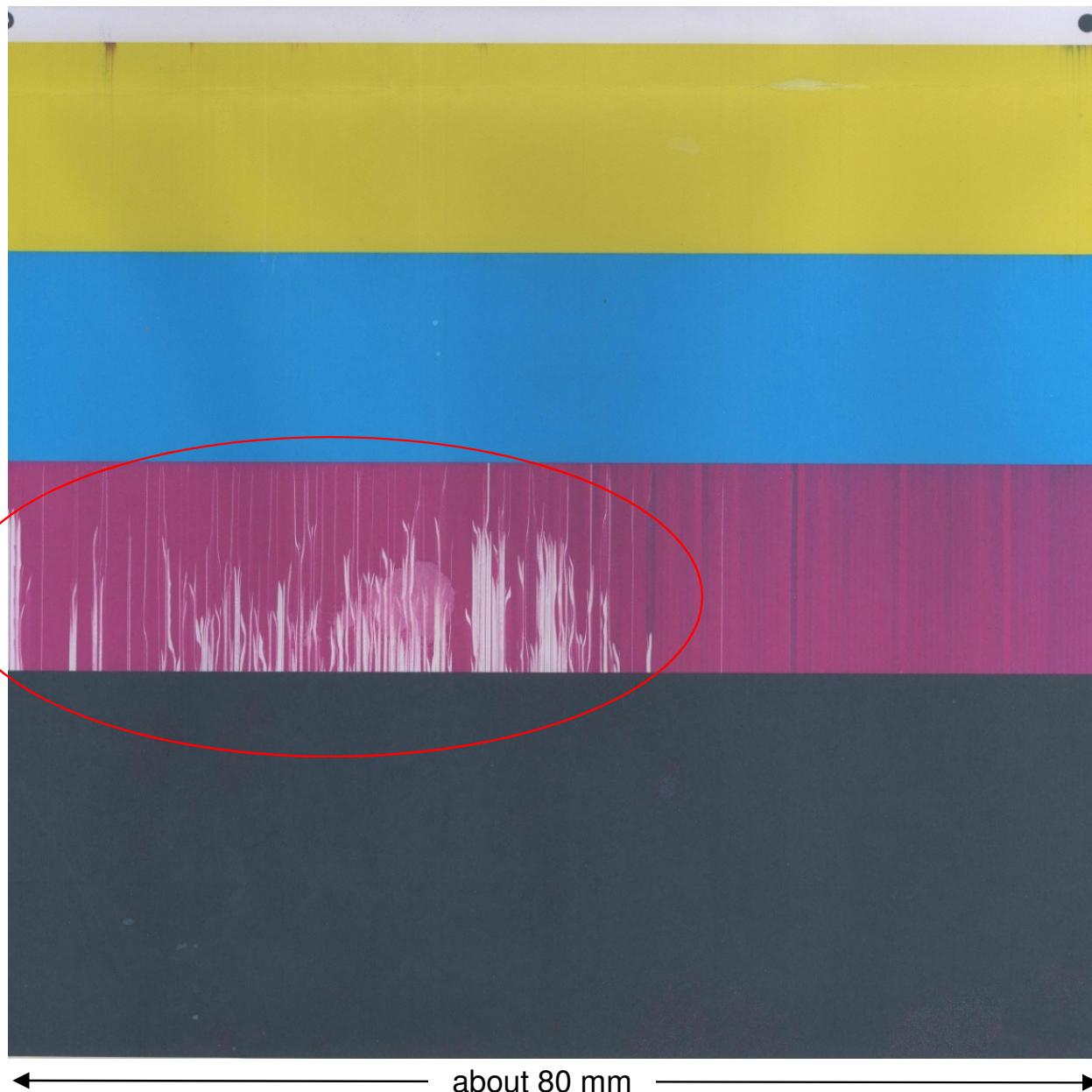
Cause: Water vapour from the thermal inkjet droplet ejection process condenses on prnthead forming into beads of water as printing proceeds. These beads eventually grow large enough to touch the paper and smudge the print.

What to do:

- a) Check color profiles
- b) Check maintenance routines.



PQ ARTEFACT 20 – DEPRIME DUE TO INK STARVATION



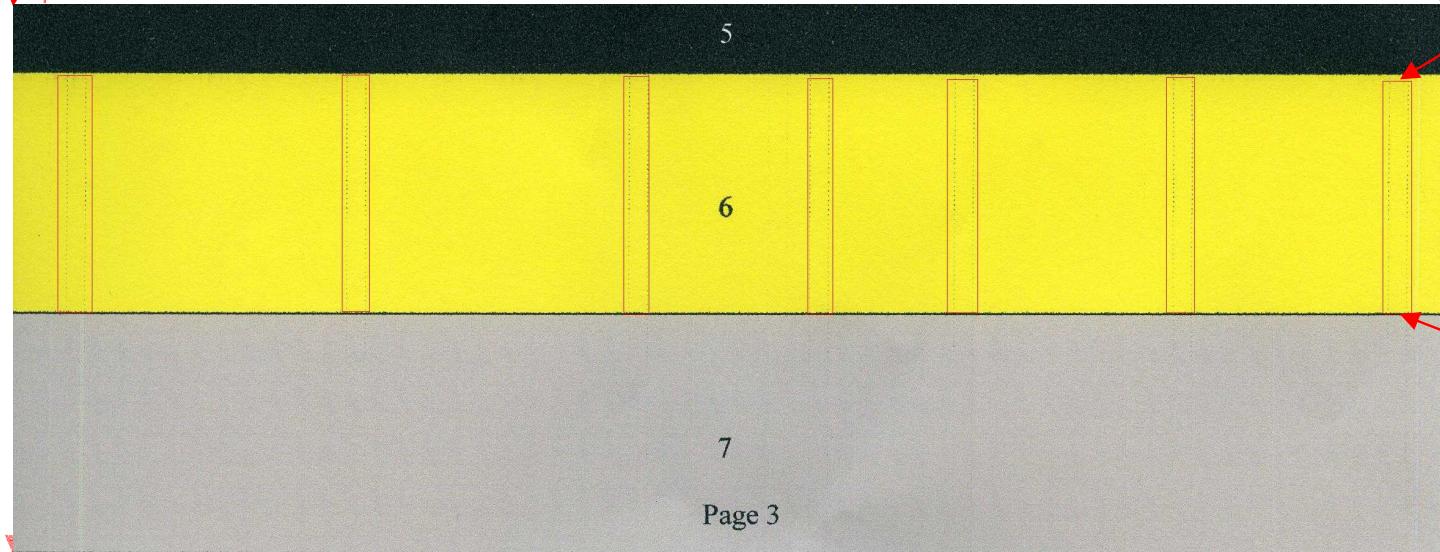
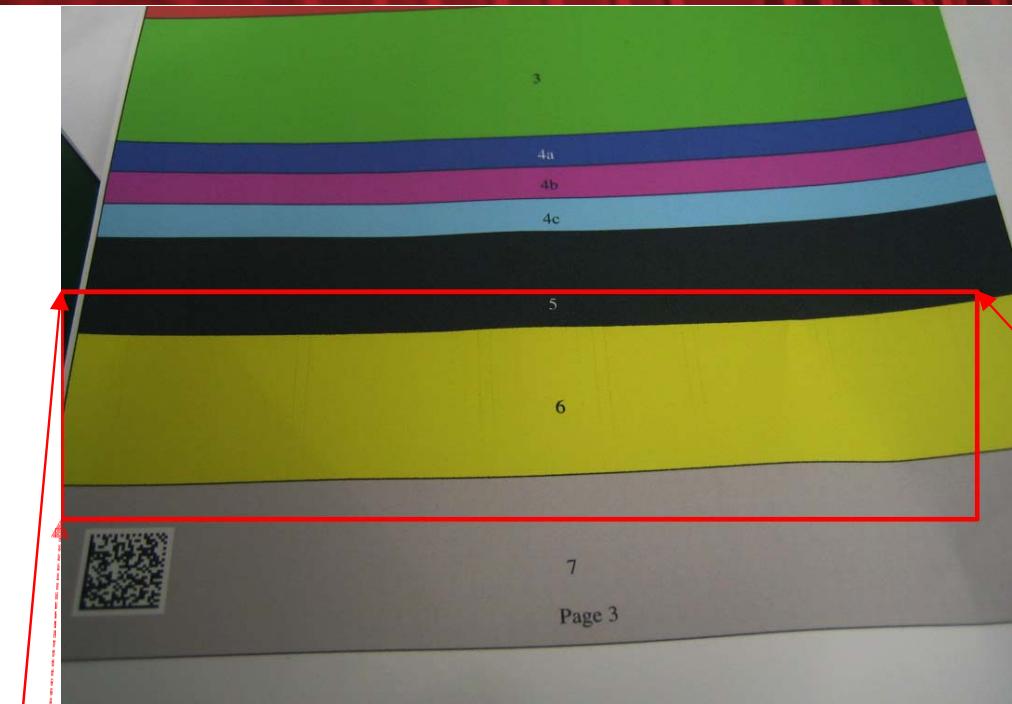
Description: Multiple streaks appear while printing. (Note: The color mixing we see in this example is not part of the problem being discussed here)

Cause: In this case the magenta ink tank ran out of ink. Air bubbles are being pulled along the LCP main ink channel, into the MEMS back-etch channels, and then into the nozzles. Permanent damage to the MEMS actuators may occur if you attempt to keep printing without ink in the nozzles.

What to do:

- a) Check Ink Out logic (software)
- b) Check any sensors involved in ink level detection
- c) Check tubing for kinks.

PQ ARTEFACT 21 – STAR WHEEL MARKS

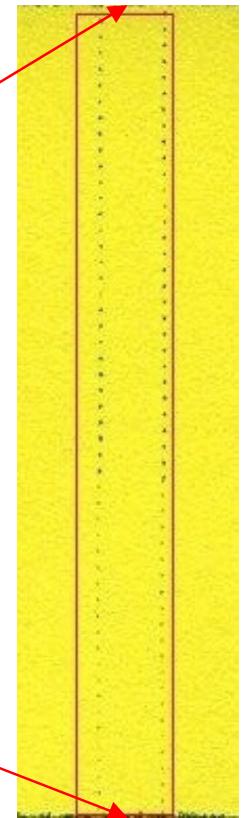


Description: Black dots after printing high density black areas may appear if Star Wheels are used post-printing.

Cause: Ink Media interaction effect. Ink has not dried before Star Wheels touch wet media and subsequently deposit wet ink down the page. Star Wheel marks are generally observed when black ink does not dry in time.

What to do:

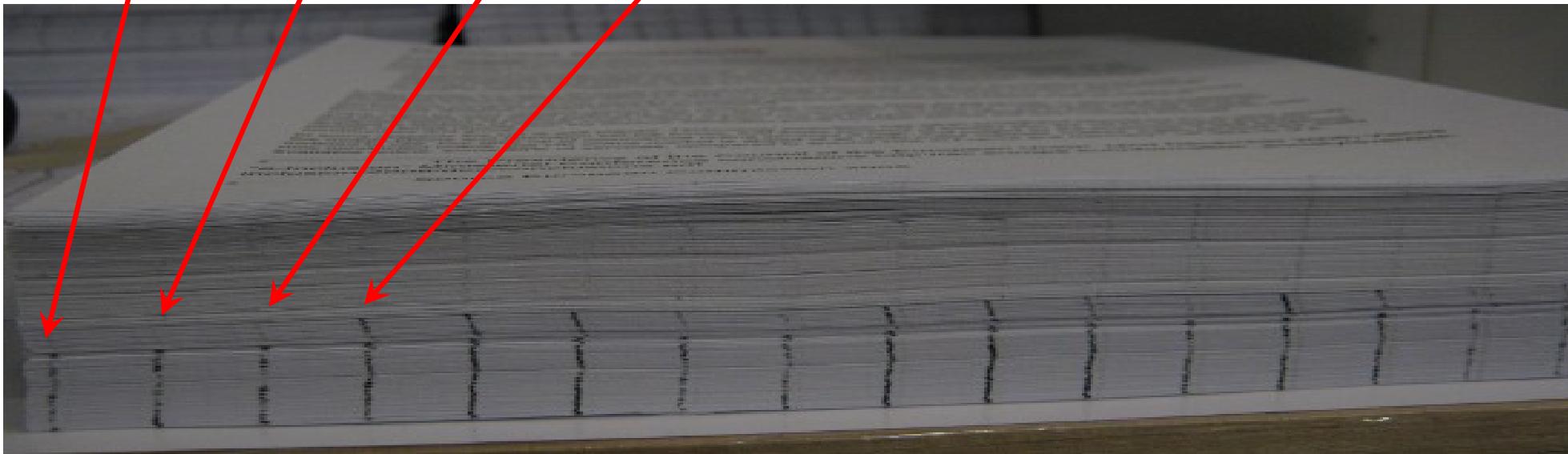
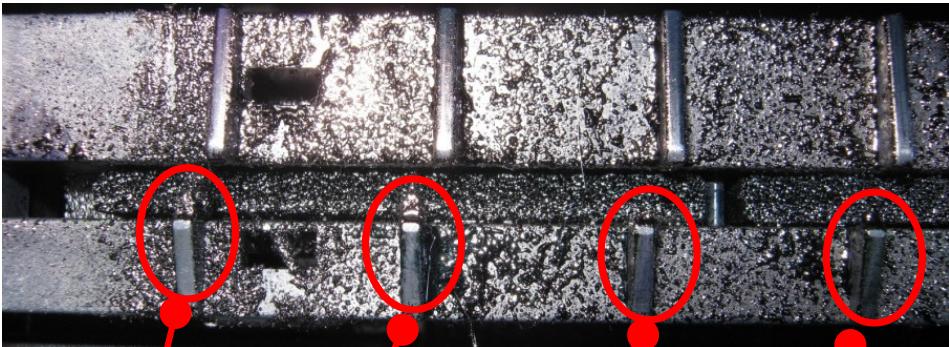
- a) Use higher PST media
- b) Try best mode (30ppm)
- c) Check Color profile.



PQ ARTEFACT 22 – LEADING AND TRAILING EDGE MARKS

Print direction

Plan view showing part of printing platen (printhead removed)



End view of stack of printed pages (~500 sheets)

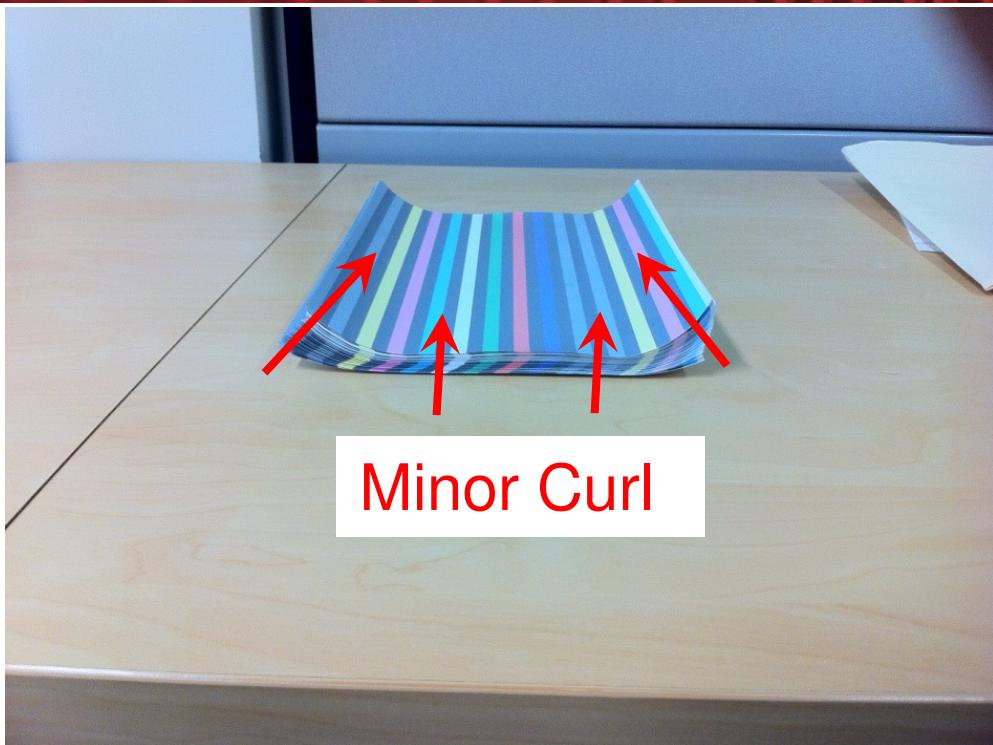
Description: When viewed end-on, a stack of pages show lines on the edges of the paper. These can disappear for a number of adjacently stacked pages but re-appear in the same vertical location. These can occur on both leading and trailing paper edges but more frequently occur on the trailing edges.

Cause: Paper dust can build up on the platen ribs creating stalactites which then subsequently transfer from print platen ribs onto the paper. The transient disappearance of the marks is due to the stalactites breaking off.

What to do:

- a) Review design of platen
- b) Check PPS
- c) Check air flow in area.

PQ ARTEFACT 23 – PAPER CURL

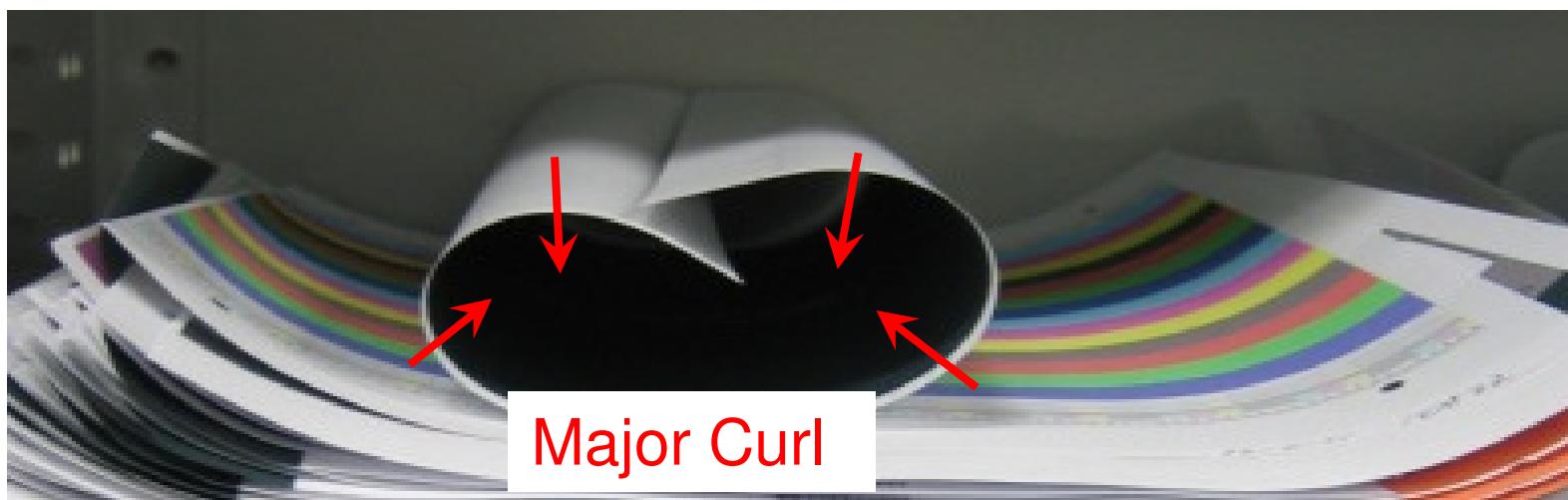


Description: Paper curls when left to dry unrestrained.

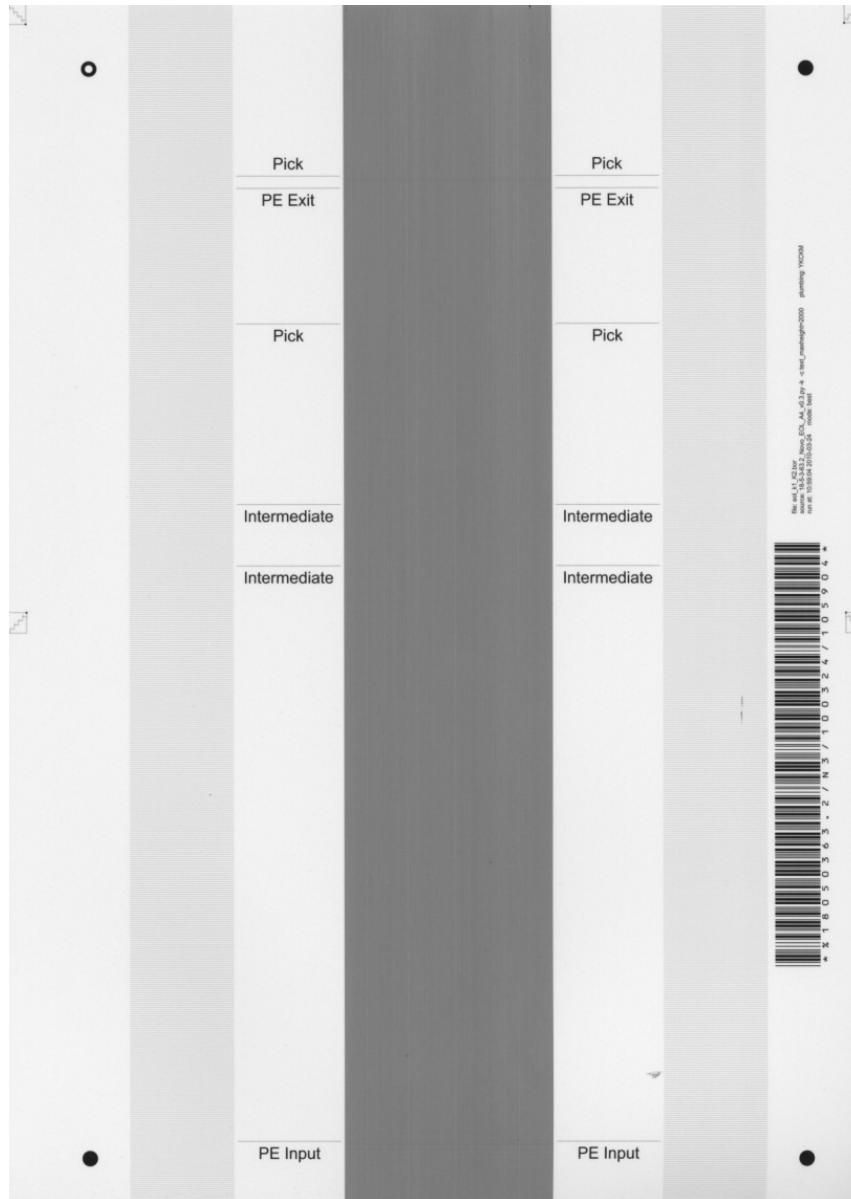
Cause: This is an ink media interaction effect, where too much ink is being printed for the paper. Most plain paper absorbs moisture very rapidly and swells. The swelling causes the printed surface to increase in size and with the unprinted side remaining the same initially the curl is toward the unprinted side. However, when the printed surface sheet dries, it shrinks to a size smaller than its original unprinted dimensions. The end result is paper curls towards the printed side.

What to do:

- a) Check color profile for the media
- b) Suggest different media.



PQ ARTEFACT 24 – HORIZONTAL LINES VARYING IN OD - MECHANICAL INSTABILITIES IN PAPER SPEED



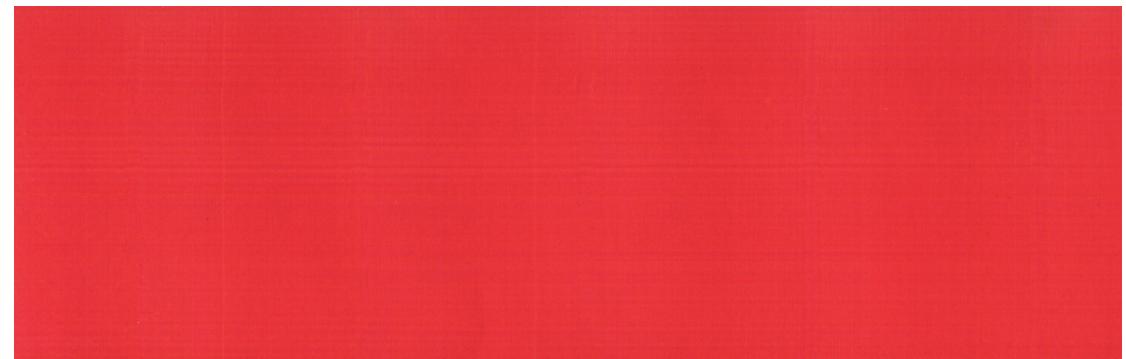
Test chart

Description: Horizontal lines with varying OD lines appear across the page in bands of a few mm (~3mm-10mm). These are most noticeable in uniform colors.

Cause: Mechanical instabilities in the paper feeding resulting in OD variation across the whole page. The location of the lines can be caused by a number of mechanical imperfections such as paper picking and feed rollers.

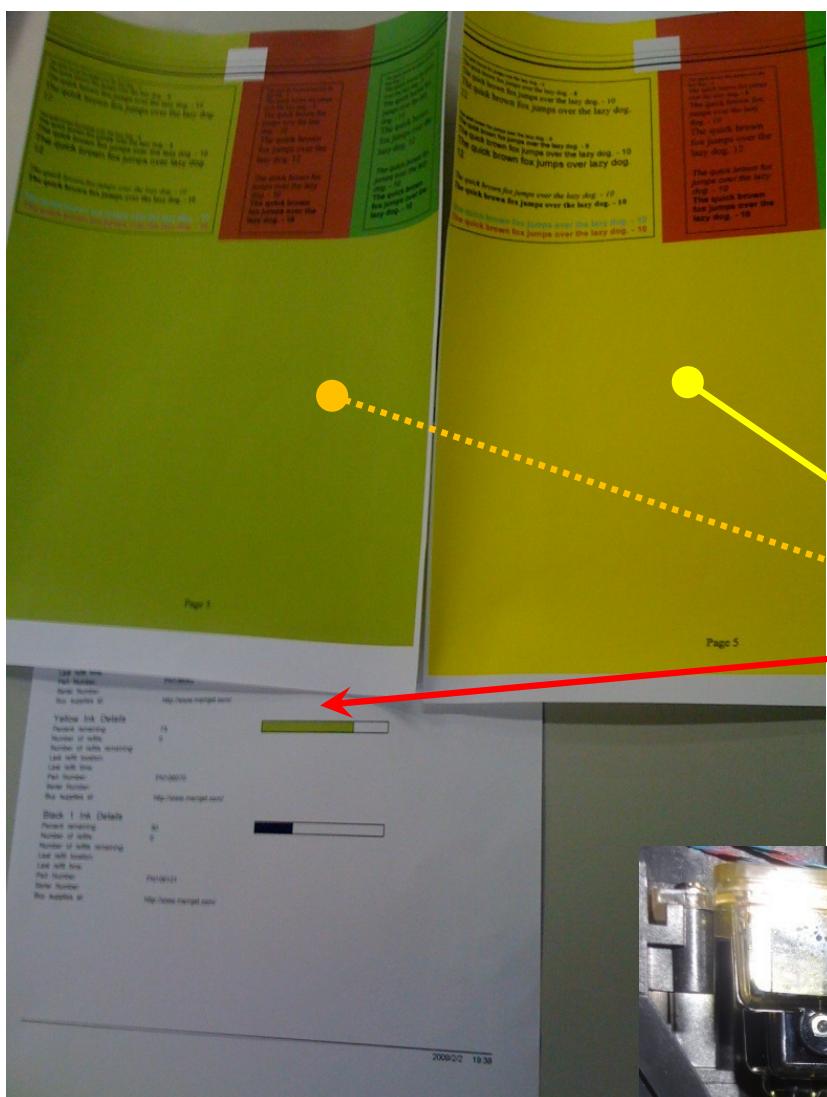
What to do: A test chart can be designed to establish if any of the known mechanical issues (mentioned above) correlate with the print Artefacts.

The picture on the left shows one such chart, used for K2 tests.



Horizontal OD variations in uniform color

PQ ARTEFACT 25 – WRONG COLOR PRINTED



Description: The wrong color is printed

Cause: Either:

- a) The wrong color profile has been selected or
- b) A severe uniform color mixing failure has occurred.

What to do:

- a) Check color profile
- b) Address cause of color mixing
- c) Check color management settings in OS / App.

Same image/profile printed on two different printers. The left one has severe uniform color mixing, as shown when compared with the internally generated document beneath.



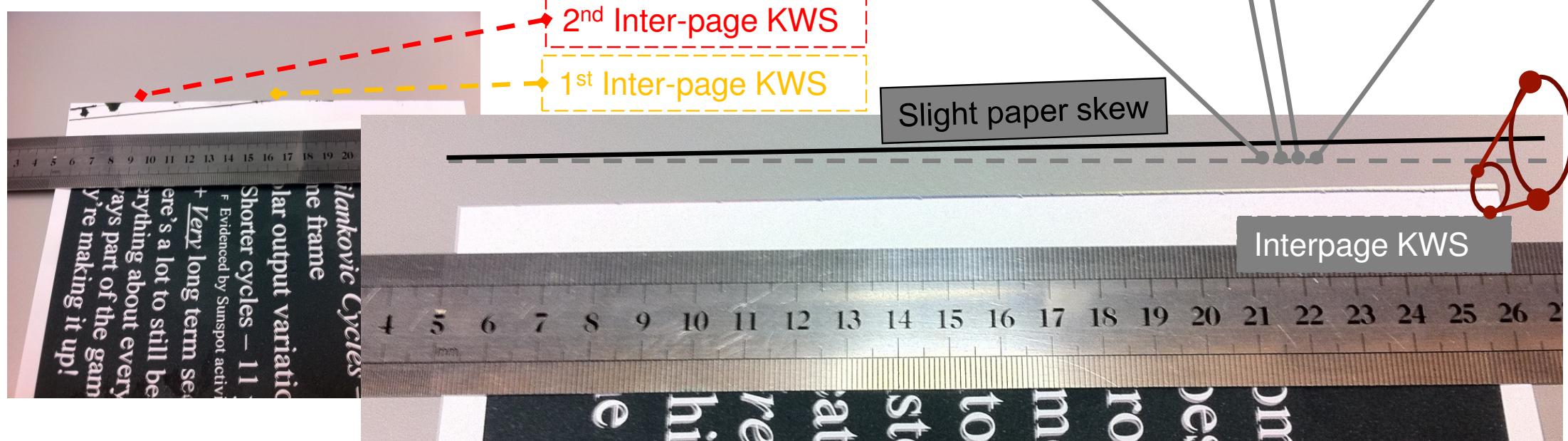
Accumulator with tubes showing different colors: One tube is coming from the ink tank, the other is connected to the IDS and some color mixing has occurred.

PQ ARTEFACT 26 – SOLID MULTI-COLORED HORIZONTAL LINE APPEARS AT TOP OF PAGE – INTER-PAGE SPIT APPEARS ON THE PAGE

Description: Horizontal line occurs at the top of the printed page and has the same footprint and plumbing order as the printhead ICs, i.e. showing drop down triangle (examples shown are YKCKM plumbing). In extreme cases multiple KWS overlap and result in a thick blurred black(ish) line.

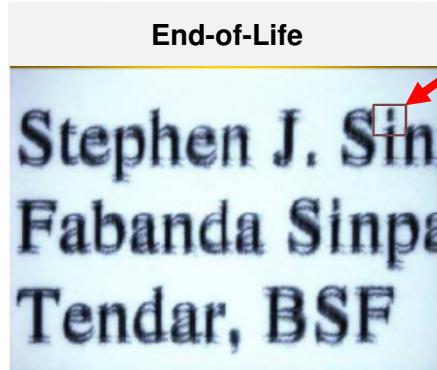
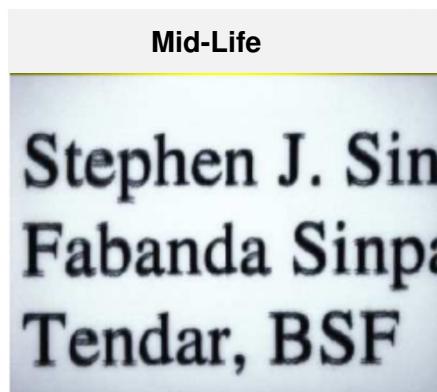
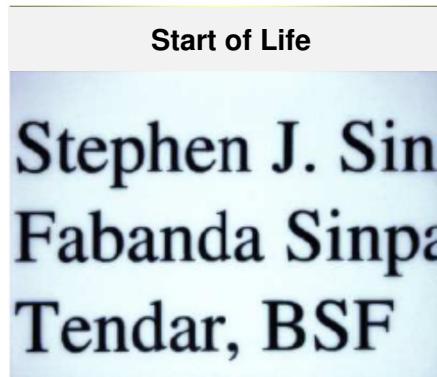
Cause: The inter-page spit has been printed on the page rather than between the pages. This could be due to incorrect timing and/or if the page is skewed such that if the paper sensor correctly detects one side of the page is clear, but the other side may still be in the print zone. Multiple inter-page spit may be observed (an example is shown below)

What to do: Address skew and/or timing issues.



Field Use

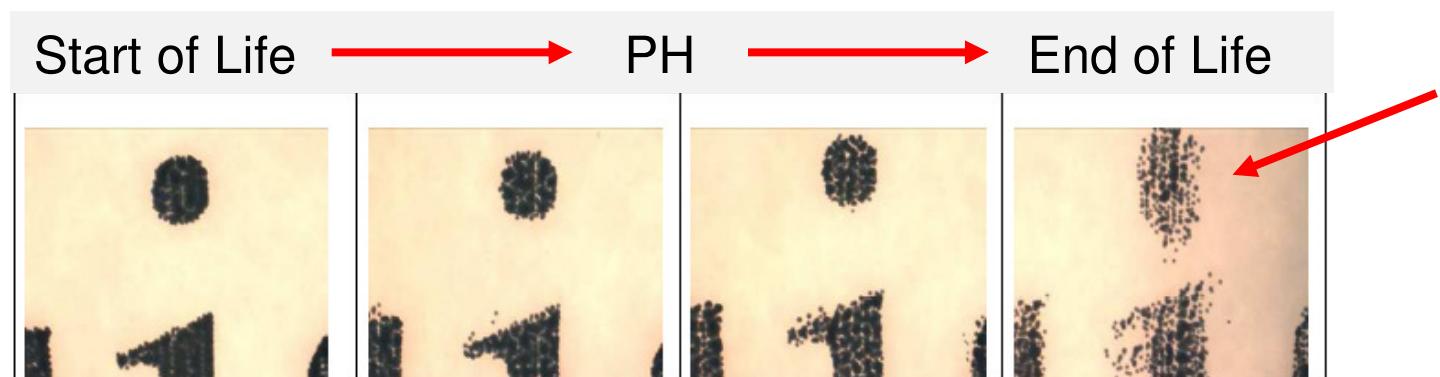
PQ ARTEFACT 27 – FUZZY TEXT



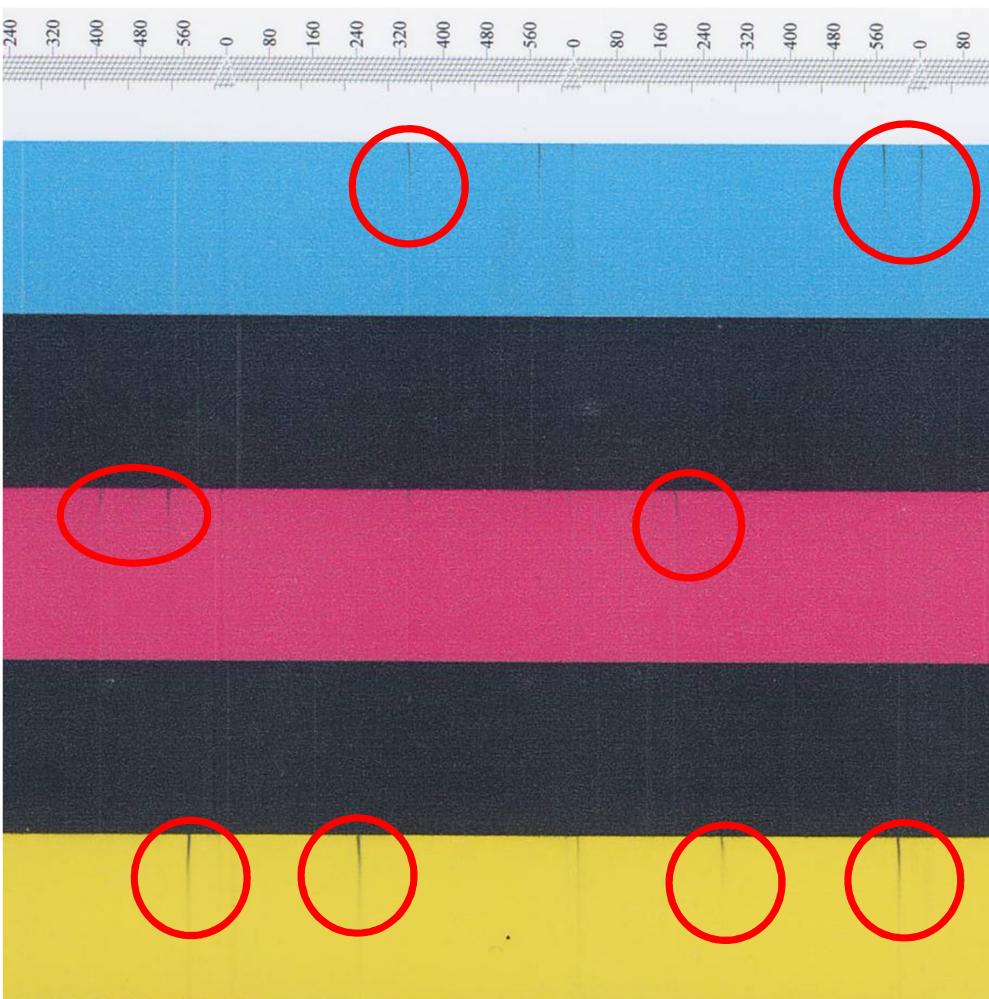
Description: Text becomes fuzzy or “unfocussed” after printing many thousands of pages.

Cause: Wear of the MEMS heaters as they age. PH has reached **end of life** (EOL)

What to do: Replace printhead with a newer one.



PQ ARTEFACT 28 – RAT TAILS



Rat tails in cyan, magenta and yellow

Description: Prints after a pause of a few ten's of seconds without keep wet have fine trails of mixed ink. Get longer and wider with more time idle & capped and with increasing differential pressure between ink colors. May be the same as Artefact #7.

Cause:

- a) Surface fibre causes fluidic bridge between color
- b) Dehydrated nozzles not ejecting properly cause micro-flood on MEMS surface

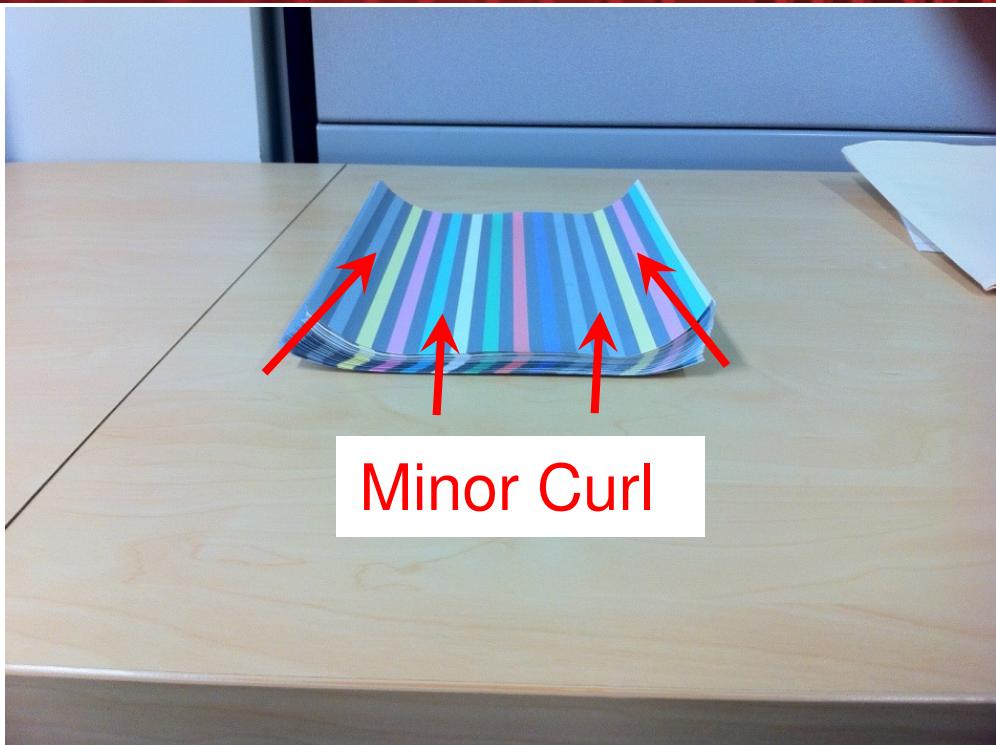
What to do:

- a) Repeat print
- b) Use Fixme button.

Magnified view showing trails of discolored dots



PQ ARTEFACT 29 – PAPER CURL

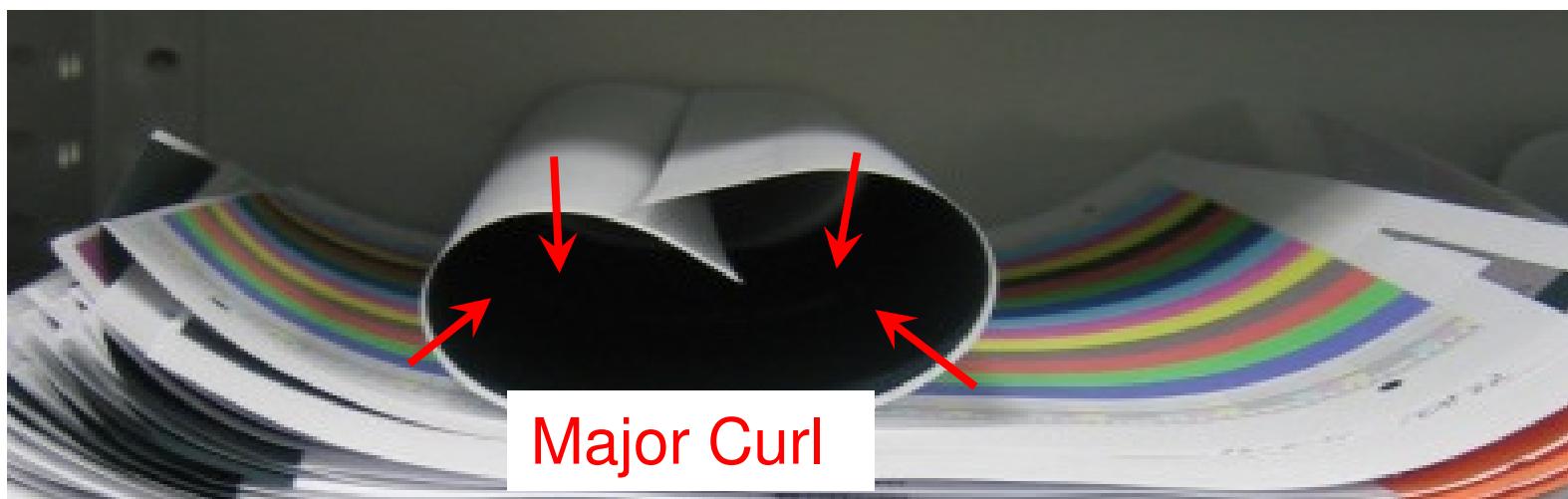


Description: Paper curls when left to dry unrestrained.

Cause: This is an ink media interaction effect, where too much ink is being printed for the paper. Most plain paper absorbs moisture very rapidly and swells. The swelling causes the printed surface to increase in size and with the unprinted side remaining the same initially the curl is toward the unprinted side. However, when the printed surface sheet dries, it shrinks to a size smaller than its original unprinted dimensions. The end result is paper curls towards the printed side.

What to do:

- a) Use different media.



PQ ARTEFACT 30 – VOIDS AND BLEMISHES

Top of printed page (image scale = whole A4 Page)

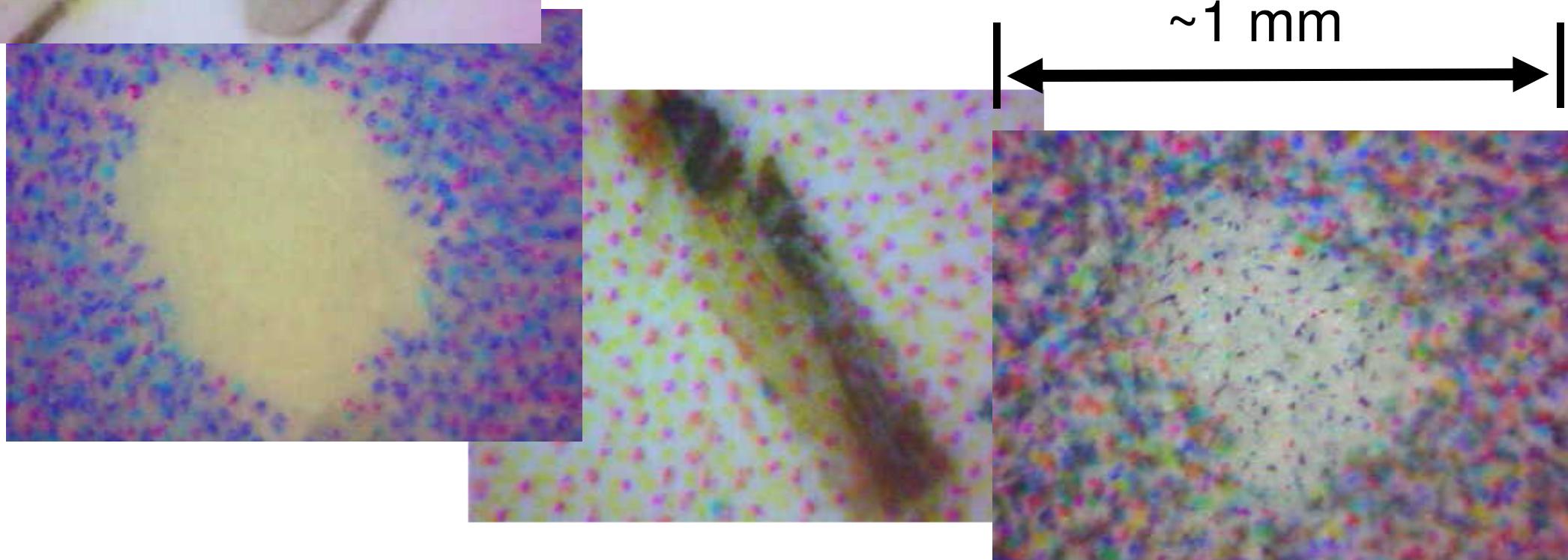


Description: Small light or dark patches appear in the middle of printed areas. These are typically <1mm in diameter.

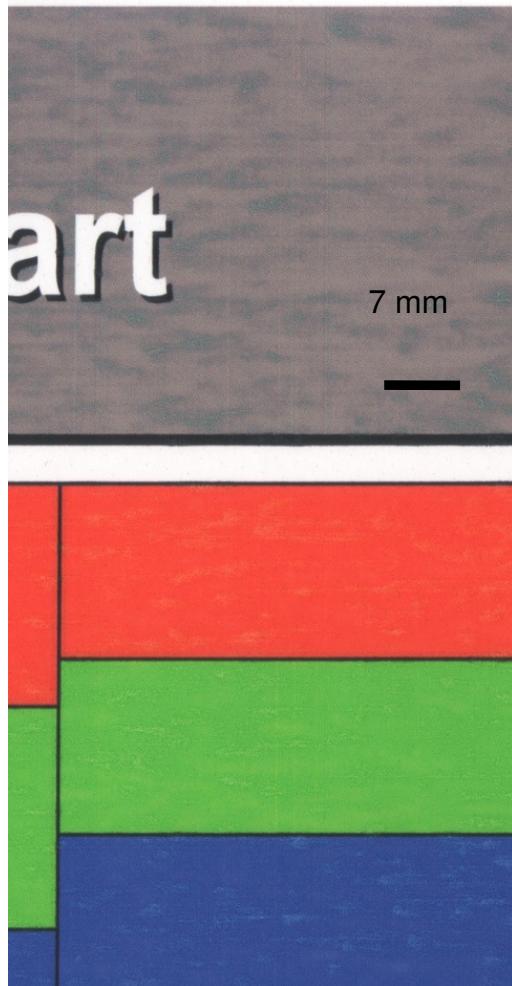
Cause: Media defect.

Hydrophobic particles embedded in the media prohibit ink being properly absorbed into the body of the paper. Instead the ink either migrates to the edges of the particles where the print appears slightly darker or produces very low dot gain drops.

What to do: If objectionable, then re-print only affected pages, since these are typically isolated artefacts.



PQ ARTEFACT 31 – LARGE SCALE MOTTLING – POOR PAPER COATING MANUFACTURE

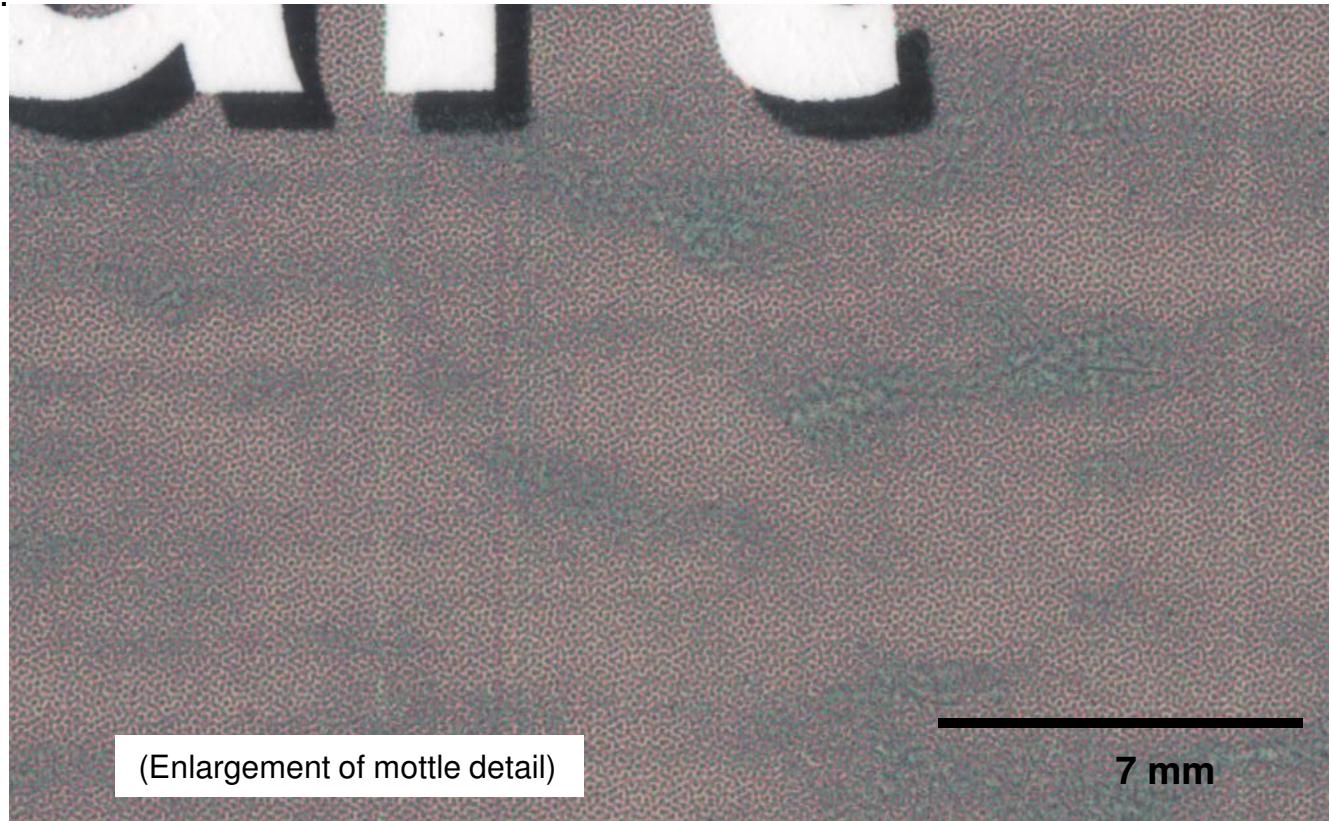


Printing direction perpendicular to long dimension of the cut sheet here.

Description: Coated paper products only. Image has large scale mottle, most noticeable in solid printed areas. Obvious disruption to the dither pattern. Light and dark mottled appearance in regions where uniform density is expected.

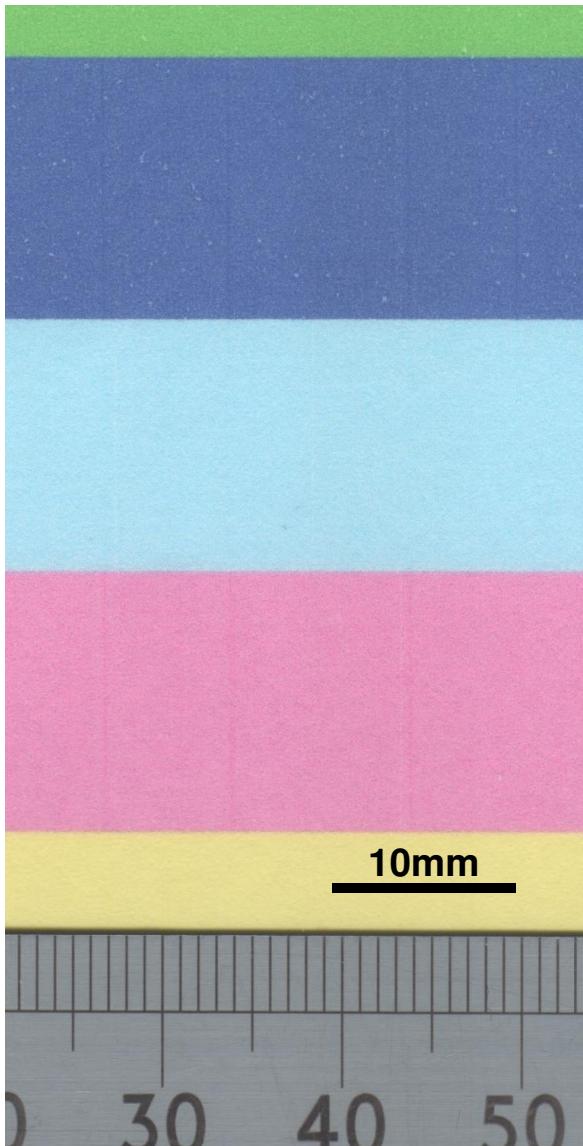
Cause: Media defect. Non-uniform application of microporous coating during paper manufacture causing dots to be smeared instead of discrete where coating is thin or missing.

What to do: Confirm non-uniformity of coating application in unprinted areas by viewing the paper under UV light. Try a new ream of paper, or try a different paper product.



(Enlargement of mottle detail)

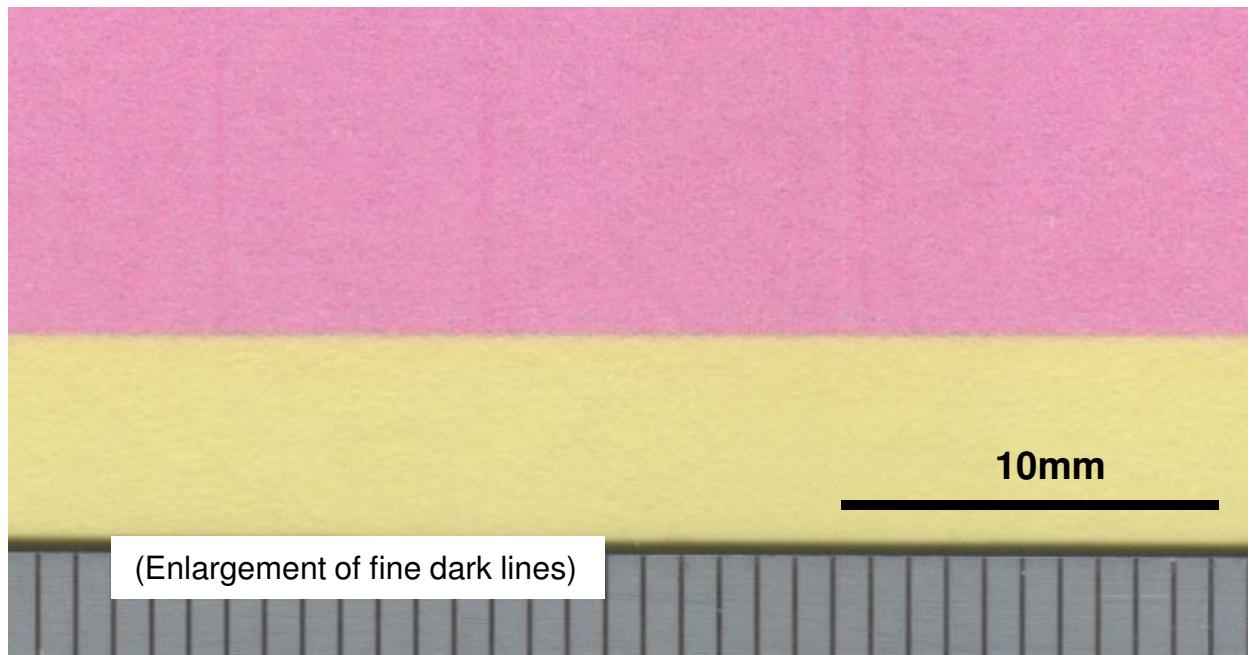
PQ ARTEFACT 32 – DARK VERTICAL LINES ON PRINTED AREAS – PAPER MANUFACTURING FLAW



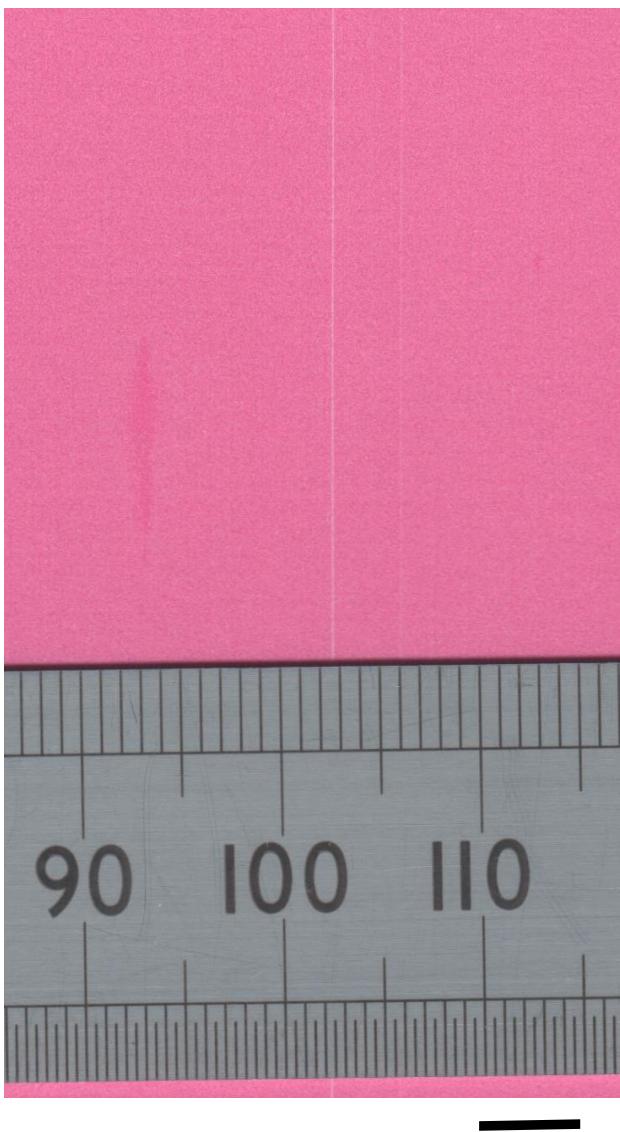
Description: Plain paper products only. Image has fine dark lines in the paper machine direction of manufacture (MD). Fine lines exhibit different levels of visibility for different colors printed. Lines extend for full length of page.

Cause: Non-uniform application of surface chemical treatment during paper manufacture. Possibly coating blade induced size press streaks devoid of optical brightener.

What to do: Confirm non-uniformity of paper in unprinted areas by viewing the paper under UV light. Fine lines will appear dark under UV light in unprinted areas. Try a new ream of paper, or try a different paper product.



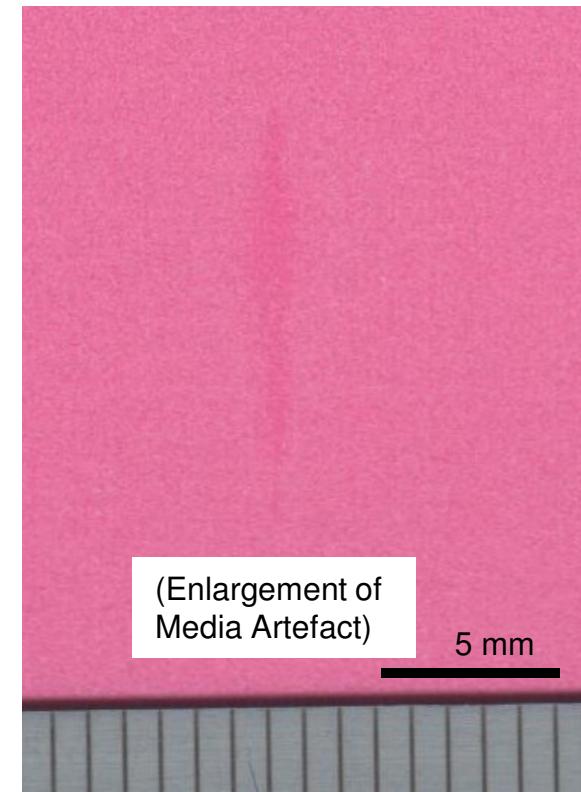
PQ ARTEFACT 33 – ELONGATED BLOTTCHES – PAPER MANUFACTURE FLAW



Description: Plain paper products only. Image has elongated dark blotches in printed solid color areas in the paper machine direction of manufacture. Dark blotches exhibit different levels of visibility for different colors printed.

Cause: Non-uniform application of surface chemical treatment during paper manufacture, or intrusion by unwanted stray liquid drops.

What to do: Confirm non-uniformity of chemically treated surface in unprinted areas by viewing the paper under UV light. The sites of similar dark blotches will appear dark under UV light in unprinted areas. Try a new ream of paper, or try a different paper product.



(Enlargement of
Media Artefact)

GLOSSARY

CMY	Cyan, Magenta and Yellow colors/inks
CP	Color plane – there are five color planes on a Remora printhead
DAF	Die Attach Film – a double sided adhesive tape that is used to attach the PHICs to the printhead, and also seals the tiny ink channels that run across the surface of the PH's LCP channel molding.
Dead Nozzle	A nozzle that is not ejecting or not ejecting well enough to be useful for printing. (AKA: Nozzle Out)
Die	See PHIC
DP	Dot Pitch (1/1600 inch, 15.875 µm)
FW	Firmware
Gulping	Drawing in air via nozzles
IDS	Ink Delivery System
K	Black color/ink
LCP	Liquid Crystal Polymer – the name of the type of off-white colored plastic that is used for the ink distributing parts of the printhead
MEMS	Micro Electro Mechanical System – the name given to the technology used to fabricate the printhead ICs
Microflood	A tiny pool of ink at a nozzle rim that affects droplet ejection (e.g., causing misdirection)
Nozzle Out	A nozzle that is not ejecting or not ejecting well enough to be useful for printing. (AKA: Dead Nozzle)
OD	Optical Density
PEO	Polyethylene Oxide
PH	Printhead
PHIC	Printhead Integrated Circuit – the trapezoid-shaped IC that contain the nozzles and associated logic circuits
PPS	Pen to Paper Spacing - the distance from the nozzles to the paper
PQ	Print Quality
PST	Penetrating Surface Tension . The surface tension at which a droplet of fluid exhibits a sudden penetration rate change (from slow to fast) into the target media.
PTD	Printhead Technology Department in Sydney
PW	Pulse width
Row	Each color plane has two nozzle rows. One row contains the even numbered nozzles and the other contains the odd numbered nozzles.
Vpos	MEMS heater actuator supply voltage
X axis/direction	The axis running across a printed page. X direction is left to right when viewing paper Y direction.
Y axis/direction	The axis running down a printed page. Y direction is the direction of paper movement.



THE END

The background of the slide is a dark red color with a subtle, organic texture. It appears to be composed of many thin, wavy, vertical lines that create a sense of depth and movement, resembling a microscopic view of a biological structure like a brain or a network of vessels.



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