SECTION I R100 SERIES REJECT CODES
(For Conventional CRT)

INTRODUCTION

This section is on the CRT screen and elements effecting the performance of the screen. The screen is the section in the CRT which converts an electrical signal into a visual display. The screen consists of several elements, which include the faceplate, graticule, phosphor, aluminium, wall bands, and, in some cases, a helix. Some storage CRT's have elements which are suspended behind the screen. This total assembly is called the target. The Conventional CRT uses only the screen as the target.

McLaw 9-16-82

SECTION I

FUNCTION OF ELEMENTS

FACEPLATE

It is the flat glass at the very front of the CRT. It has several functions. As part of the total bulb, it holds out the air. The faceplate supports all the other elements of the screen. In high voltage tubes, the faceplate is formulated to reduce the x-ray radiation.

GRATICULE

This is the first element on the faceplate. Its purpose is to assist an observer in making direct measurements of displayed waveforms. Because of the variety of user applications, a wide variety of graticules is available or can be requested.

PHOSPHOR

This is the material which converts the electrical signal into a visible image. The electron beam hitting the phosphor particles excites the phosphor to give off visible light. There is a variety of phosphors, each with its own characteristics. Phosphors are selected for combinations of color, brightness, sensitivity, persistance, and/or burn resistance.

ALUMINUM

This is the last element in the screen. It is part of the Post Deflection Accelerator (PDA) system which speeds-up the electron as it approaches the screen. This speed-up causes the phosphor to be brighter. The aluminum also acts as a reflector to make the trace brighter.

WALL BAND

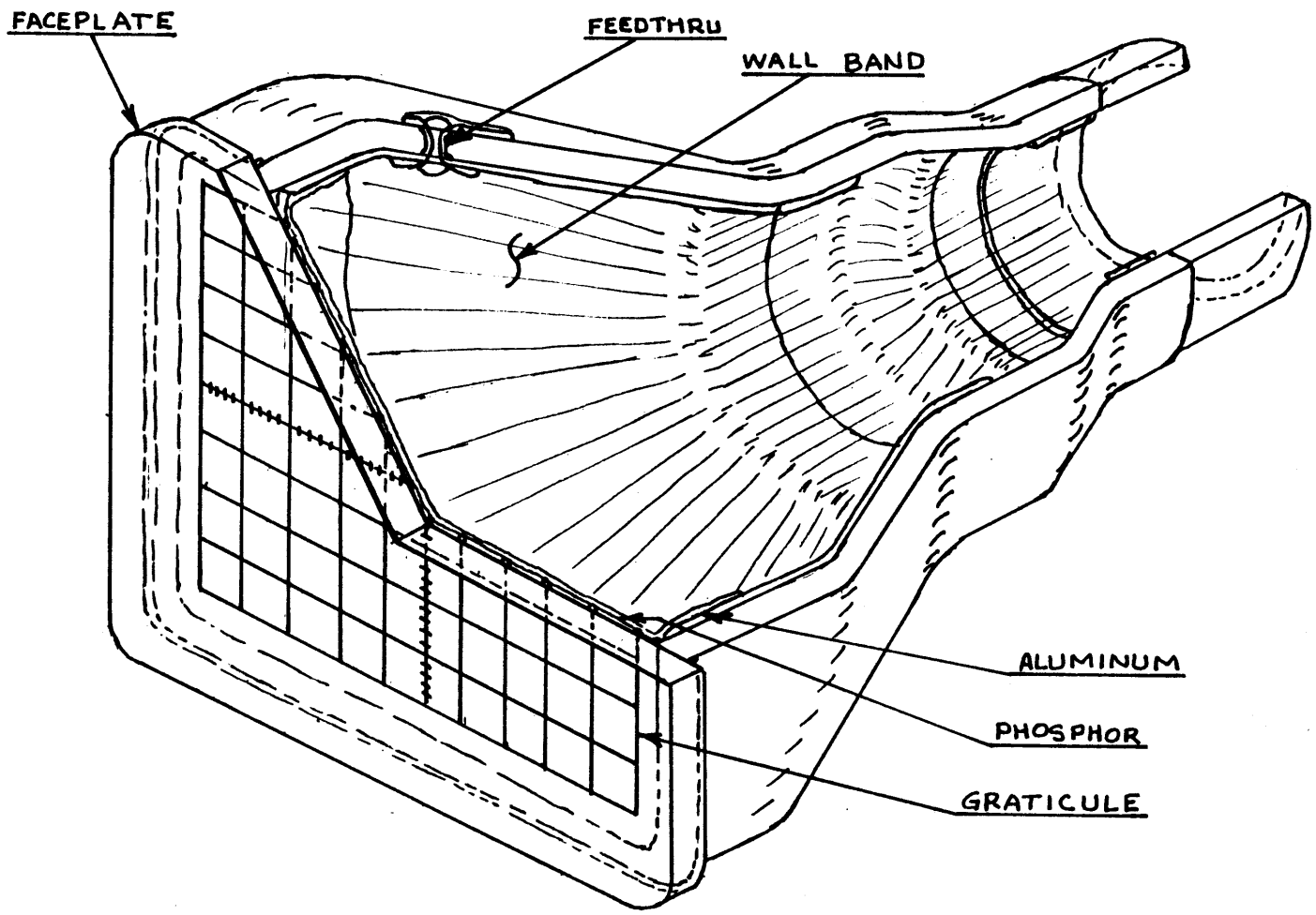
In Conventional tubes this is a single conductive coating on the inside wall of the bulb. It is also part of the PDA system. In tubes with mesh scan expansion the conductive coating is part of the scan expansion lense. In early tubes the walls were part of the monoaccelerator system.

HELIX

In some older tube designs the inside wall was painted with a stripe of resistive coating applied in a helix. The helix was a lense for better control of accelerated electrons.

MHR 9-16-82

R100 SERIES - CRT SCREEN



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SECTION I R100 SERIES REJECT CODES

THE REJECT CODES

R102 EXTERNAL FACEPLATE DEFECTS

The faceplate is expected to hold out the air. The air presses with a force of 16½ pounds (lbs) per square inch. For a 4 inch faceplate, this force is approximately 300 lbs and for 6 inch plate, it is 450 lbs. The glass thickness limits the loading the glass can have. Some glass is required to restrict x ray radiation. Again thickness is a function of the amount of protection provided. A working lower limit for glass thickness has been set at 0.200 inches.

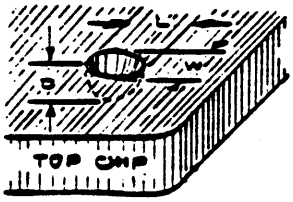
The type of defects requiring buffing include scratches, chips, digs, stains, and flakes. These are typically caused by poor handling. Before buffing starts, these defects must exceed the limits found in Table I of each individual CRT specification. Include in this package is a typical Table I. If buffing can not remove the defect before the faceplate gets too thin, then the tube is rejected for R102.

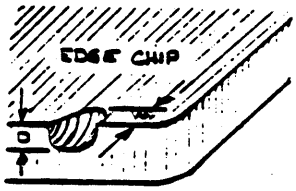
M Glass 9-16-82

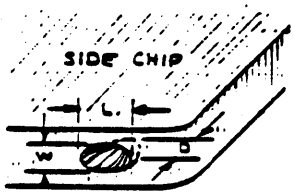
FACEPLATE QUALITY
TABLE I

I. CHIPS A depression or irregularity on a glass surface caused by unintentional removal of glass.

SPECIFICATIONS	L + W + D	NUMBER ALLOWED
L = 10mm (.400") Max	12mm to 17mm (.451" to .675")	1
W = 5mm (.200") Max	8mm to 12mm (.301" to .450")	3
D = 2mm (.075") Max	.1mm to 8mm (.005" to .300")	5

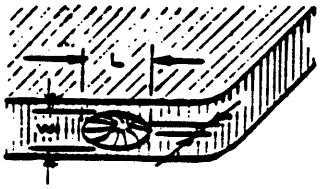






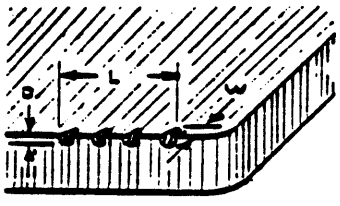
II. FLAKE A shallow depression in the side of the glass.

SPECIFICATIONS	L + W + D	NUMBER ALLOWED
L = 10 mm (.400") Max W = 5mm (.200") Max D = .8mm (.030") Max	13mm (.500") Max	1



III. CHAMFER CHIP A series of small chips.

SPECIFICATIONS	L + W + D	NUMBER ALLOWED
L = 38mm (1.500") Max W = 1.5mm (.050") Max D = 1.5mm (.050") Max	2mm (.075") Max	1



NOTE: If any chip on the fritted side of the faceplate extends more than one-half way through the seal, the tube is a reject.

SURFACE SPECIFICATION FOR EDGE-LIT TUBES

To be checked in edge light fixture, darkened area, with light from each of 2 edges, checking only those defects seen at 50cm from the faceplate.

QUALITY AREA: Center of faceplate to halfway through the border (frit seal on non-bordered tubes).

OUTSIDE AREA: The outside edge that is everything except the quality area.

IV. SCRATCHES	QUALITY AREA	OUTSIDE AREA
Scratch Width	Maximum Cumulative Length	Maximum Cumulative Length
Over .08mm	None	None
.06mm to .08mm or .05mm to .06mm or .04mm to .05mm	None	25mm or 30mm or 38mm
Total Allowed	None	See Note
Over .03mm	None	No Limit
.02mm to .03mm or .005mm to .02mm	25mm or 40mm	No Limit
Total Allowed	See Note	No Limit
Separation	13mm	

Note: The sum of lengths for any combination of scratches shall not exceed 32mm.

V. DIGS			
	$\frac{L + W}{2}$	.8mm Maximum	.8mm Maximum
	Separation	13mm Minimum	

Scratches shorter than 1mm will be treated as digs.

Frit spots will be treated as digs.

IV. STAINS			
	$\frac{L + W}{2}$	.5mm Maximum	1.6mm Maximum
		13mm Minimum	

SECTION I R 100 SERIES REJECT CODES

THE REJECT CODES

R 101 GLASS DEFECTS

During the manufacturing of the glass faceplate, gas or air gets trapped in the glass. This produces small air bubbles or seeds. When light hits a seed, a bright spot is produced. This is easily seen by a viewer or when taking a picture. Handling can cause chips, scratches, or cracks which also produce bright efects. These handling defects only apply to the inside surface of the glass. The amount of bright defect allowed is controlled by parts of Table II in each of the individual CRT specifications.

Occasionally in the manufacturing of the glass, an opague spot or contamination will get into the glass. This type of defect will produce a dark spot or break the trace. These defects are also controlled by parts of Table II.

This reject code includes a statement that any defect, crack or chip, which might render the bulb a safety hazard shall be scrapped. There is no specific limit on the size of cracks. A crack once started will grow until it causes a failure.

Mike 9-16-82

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TABLE II. SCREEN QUALITY

A. QUALITY AREA

Zone A is the center 4X6 graticule squares.
Zone B is the remainder of the graticule squares.
Zone C For tubes with border: is the area between graticule and border. For tubes without border: Is the area from outer graticule lines to 3mm from internal funnel face arris but not narrower than 1.5mm from graticule line and/or silkscreen characters.
Zone D is the area outside the C Zone to the edge of the glass which has no limit on the number of defects.

B. DEFINITION

1. Irregular shapes greater than .13mm (½") size = $\frac{\text{Length + Width}}{2}$
2. Defects on the screen side or in the glass are included in this table.

C. QUALITY LIMITS

DEFECT	SIZE	MAXIMUM NUMBER ALLOWED A Zone	MAXIMUM NUMBER ALLOWED B Zone	MAXIMUM NUMBER ALLOWED C Zone	MINIMUM SEPARATION A Zone	MINIMUM SEPARATION B Zone	MINIMUM SEPARATION C Zone
1. DARK SPOTS	Over .6mm (.025")	0					
	.5mm (.020") to 6mm (.025")	3		6	13mm (½")		
	.25mm (.010") to .5mm (.020")	6		10	7mm (¼")		
(1)	Total over .25mm (.010")	6		10	7mm (¼")		
	.2mm (.007") to .25mm (.010")	8		15/cm²	7mm (¼")		
	Under .2mm (.007")	Not to be considered as cause for rejection					
2. DARK LINES	.13mm (.005") wide	Apply Dark Spot Criteria					
	.1mm (.004") to .1mm (.005") wide						
	2mm (.070") to 4mm (.150") long	0		4	13mm (½")		
	.75mm (.030") to 2mm (.070") long	3		6	13mm (½")		
	.08mm (.003") to .10mm (.004") wide						
	4mm (.150") to 5mm (.200") long	0		2	13mm (½")		
	1mm (.040") to 4mm (.150") long	2		4	13mm (½")		
	.05mm (.002") to .08mm (.003") wide						
	4mm (.150") to 5mm (.200") long	2		4	13mm (½")		
	4mm (.150") long	3		6	13mm (½")		
(2)	Total allowed	3		6	13mm (½")		
	Less than .05mm (.002") wide	Not Cause For Rejection					
3. GRAY SPOTS	> .6mm (.025")	0					
	≤ .6mm (.025")	Note 1	8		13mm (½")		
4. BRIGHT SPOTS	.5mm (.020") to .6mm (.025")	0		3	13mm (½")		
	.4mm (.015") to .5mm (.020")	4			13mm (½")		
	.25mm (.010") to .4mm (.015")	8			13mm (½")		
(3)	Total allowed	8			13mm (½")		
	Under .25mm (.010")	Not Cause For Rejection					
5. BRIGHT LINES	Use Dark Line Criteria	Include these defects with the total Dark Line limits.					
6. SEED CLOUD	Seeds < .2mm (.007")	0		6	13mm (½")		
	2.5mm (.100") to 5mm (.200")	2		6	13mm (½")		
	.5mm (.020") to 2.5mm (.100")	Individually distinguishable without magnification Not Cause For Rejection					
7. COMBINED TOTAL of (1), (2), and (3)		8		12	7mm (¼")		

Note 1: Use Dark Spot size and limits. Gray spots count as a defect toward the total Dark Spots allowed.

Note 2: Aluminum penetration up to 3mm (1/8") in from the internal funnel face arris is allowed and may extend into the graticule area.

Note 3: The frit cannot extend inside the border by more than 0.13mm (½")

SECTION I R100 SERIES REJECT CODES

THE REJECT CODES

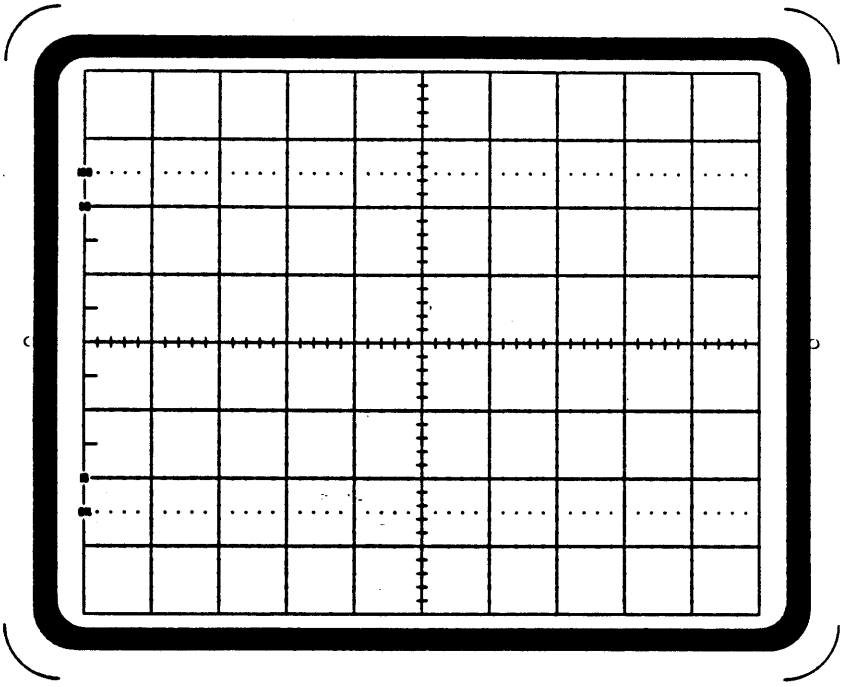
R 117 GRATICULE DEFECT

Most of the graticules used at TEK are silkscreened onto the inside of the faceplate before it is assembled into a bulb. A colored frit paste is used. The silkscreen process allows higher quality graticules. But there are process problems. Blockages in the silkscreen will cause breaks in the lines. Slack tension of the screen will cause crooked lines. Wrong viscosity of the paste will cause variations in line widths. Improper firing will allow wash-off or fading of the graticule. The allowable limits for each of the above defects is controlled by Table III in each of the individual CRT specifications.

Earlier designed CRTs with all glass tubes used a photo processed graticule. It had its own set of process problems which produced the same effects as above, breaks, crooked lines, and width variation. It should be noted that Table III for this graticule is different and looser than for a silkscreen graticule.

WCK 9-16-82

TABLE III. GRATICULE REQUIREMENTS



PARAMETER	SPECIFICATIONS
(Silkscreen Graticule)	
1. LINE WIDTH	.23mm (.009) ± .05mm (.002")
2. LINE VARIATION	.08mm (.003") maximum
3. LINE STRAIGHTNESS	1/3 actual line width
4. DOT DIAMETER	.4mm (.015") to .5mm (.020")
5. TICK MARK: Length	.4mm (.016") to .6mm (.024")
Width	.28mm (.011") maximum
Position	25% of line width minimum on each side of line.
6. NUMBERS	Must not join major line.
7. PERCENT MARK	Dots to be closed. May not join line. Dot size .4mm (.015") to .6mm (.025") with .13mm (.005") maximum difference.

TABLE III. GRATICULE REQUIREMENTS (cont.)

I. LINE BREAK

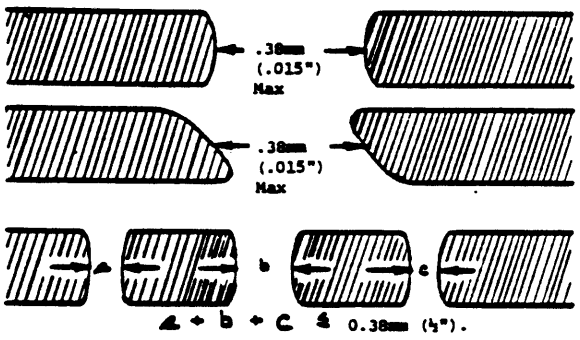
The sum of breaks not to exceed 0,~~38~~13mm (½").

Examples

A.

B.

C.



II. LINE VARIATION

Maximum number allowed, 4, at 13mm minimum separation.

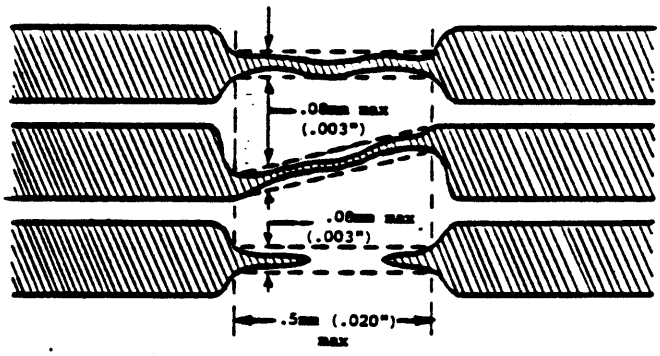
Examples

1. THIN LINES

A.

B.

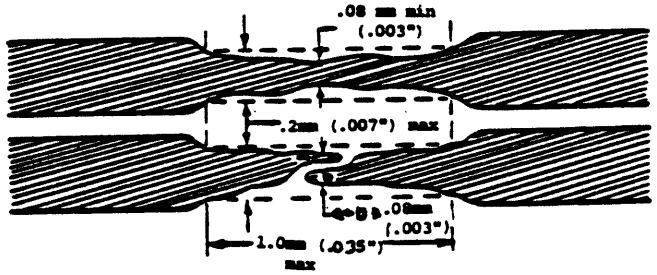
C.



2. NARROW LINES

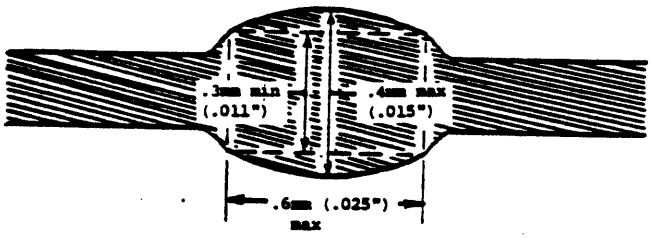
A.

B.



3. THICK LINES

A.



SECTION I R100 SERIES REJECT CODES

THE REJECT CODES

R 100 SCREEN DEFECT

This reject code number primary applies to the phosphor. Most of the screens are settled phosphor. Other methods of applying phosphor include PVA or photo processed and a silkscreen application. The first two are wet processes which have their own set of problems. The major contributor is contamination. Lint or particles displace the phosphor during the settling. After processing, the contaminate is mostly baked out, leaving a hole or void in the phosphor. These voids then produce dark spots or lines when the screen is fully flooded. During the draining off of the liquid, the phosphor can shift or slide. The will produce lines and or patterns. The silkscreen process spreads a uniform paste of phosphor over the screen. It has the same problem with contaminates which produce the same effect.

The old specs contained terms which no longer effect the performance. Other terms were vague and hard to understand. These terms tried to describe the cause of the failure. The terms of the specs have been changed to describe what is actually seen that caused the CRT to be a reject. They include Terms like Dark Spots, Bright Lines, or Gray Spots. The size of allowable defects is controlled by Table II in the individual CRT specifications.

WCLee 9-16-82

SECTION I R100 SERIES REJECT CODES

THE REJECT CODES

R 120 GLOWING SPOTS

A special condition or problem for phosphor is the effect called Glowing Spot. This can be caused by either contamination which causes the phosphor to charge or a mix of phosphor from an old batch mixed into a new batch of different phosphor. The effect is a spot of different colored phosphor. The specs do not do a good job as to how much is allowed. It is hard to see with a telescope the edge of the defective area. Most glowing spots blend into the surrounding phosphor and have no defined edge.

Mike 9-16-82

SECTION I R 100 SERIES REJECT CODES

THE REJECT CODES

R 121 ALUMINUM DEFECTS

The application of aluminum is a multi step operation. Each operation can contribute problems. The basic process steps are Wetting, Lacquering, Aluminizing, Lacquer Bake, Inspection, and Babb Wash. The basic functions are the water wets the phosphor and keeps the lacquer from penitrating. Next the lacquer is put on to keep the aluminum from penitrating the phosphor. The nitrocellulose is then bake out from under the aluminum. A desiccant bag is added at inspection to protect the aluminum from moisture damage. The Freon bulb wash removes any loose and potentially contaminating particles.

Here are some of the problem encountered during process. If the aluminum film is too smooth, it will not allow the material under the aluminum to out gas through the aluminum. This is typicalby caused by too thick a coating of lacquer. If the aluminum appear dark or dull and is spread of larger than normal area, the aluminum was evaporated at poor vacuum pressure. It may or may not function properly.

Most of the limit specifications for aluminum defects is contained in Table II of the individual CRT spec. This discussion will identify the effect and then suggest some cause.

1. Dark Spot and Dark lines:
   Shows when the screen is full flooded. For aluminum defect it is typically some form of contamination stuck to the aluminum.
2. Gray Spot:
   Shows when the screen is full flooded. May also show in room light. It is typically caused by moisture which causes the aluminum to flake. When the aluminum is flaking, it may produce a flash when the beam hits it.
3. Defocused area:
   Shows when a focused trace passes through the effected area. The cause is a blister of aluminum. It is produced when thick aluminum is cleaned at Freon wash and the smooth aluminum will not allow to Freon to easily pass through the film. See the illustration as to how a blister produces defocus. The upper limit for defocus is the upper limit of the trace width spec in each CRT spec.

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THE REJECT CODES

R121 ALUMINUM DEFECT (CONT)

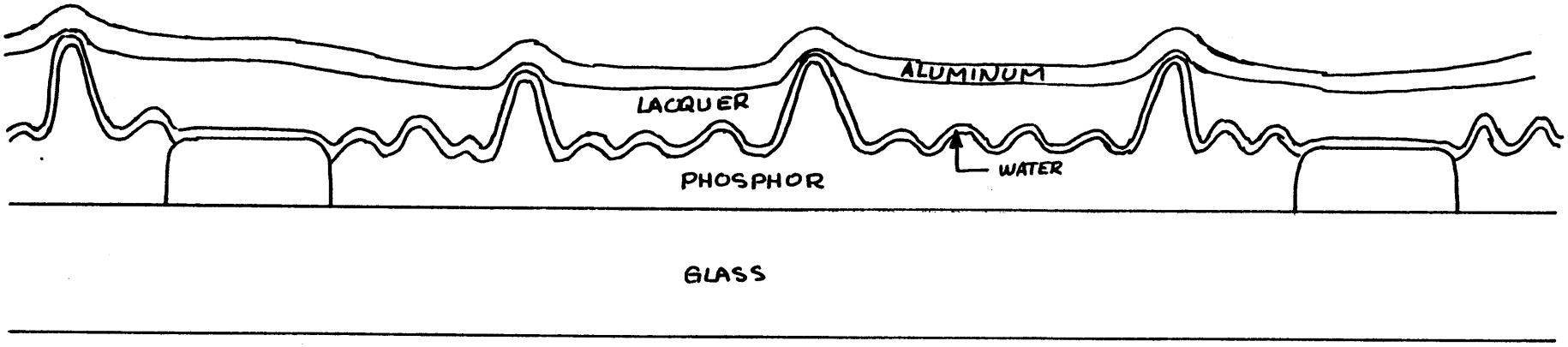
4. Dark Patterns :
These patterns typically show when the screen is fully flooded. The individual CRT specs do not do a good job at specifying limits. For this purpose limit samples are maintained. The following are specific patterns and their causes.
DARK CORNER : caused by thin aluminum or aluminum which has disappeared into the phosphor. The dark corners of aluminum penetration will also show in room light.
DARK CENTER : caused by thick aluminum which reduces the energy of the electron. This is typically caused by improper evaporation source distance.
GRAY PATTERNS : caused by areas of thin aluminum which when baked disappears. For good thickness, recommended thickness is 1800 Å.

MCL 9-16-82

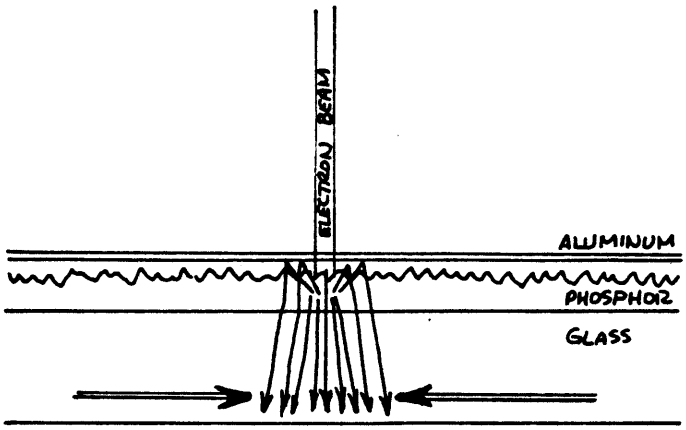
SECTION I R100 SERIES REJECT CODE

SCREEN STRUCTURE

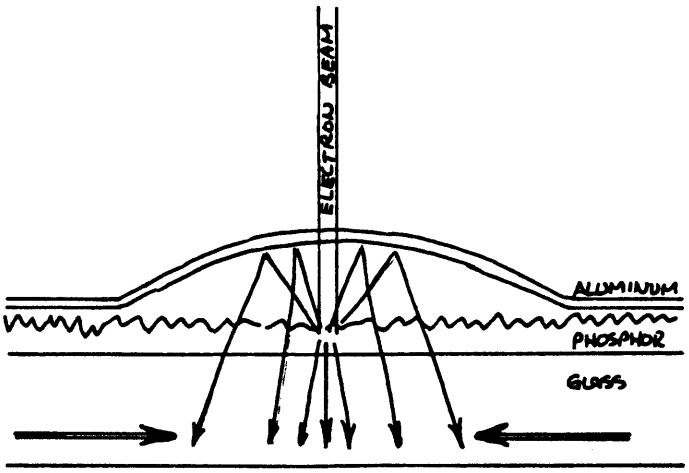
mcRae
9-8-72



SECTION I - R100 SERIES REJECT CODES

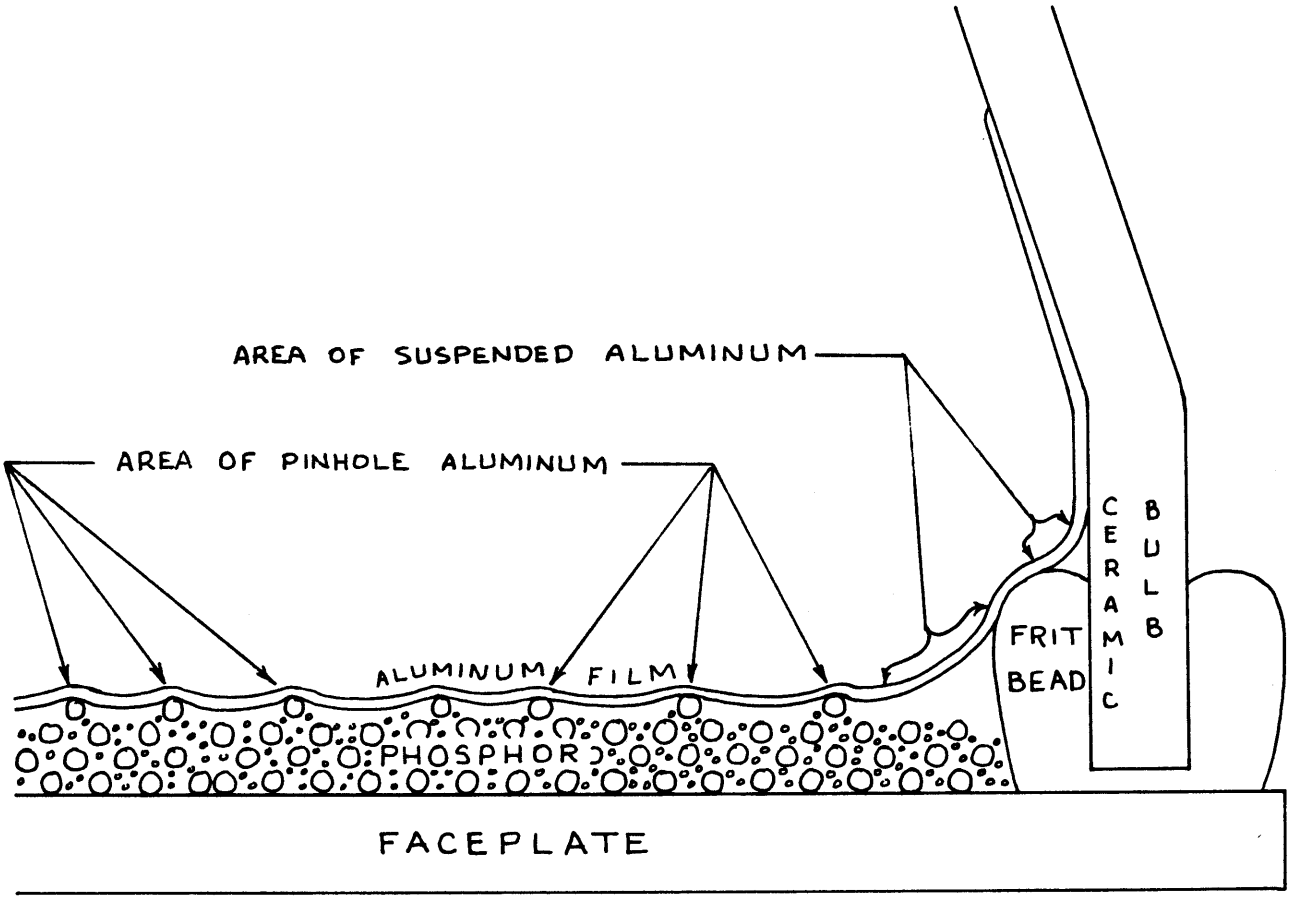


NORMAL



EFFECT OF BLISTER

FLAKING ALUMINUM



mcka 5-19-83

SECTION I R100 SERIES REJECT CODES

THE REJECT CODES

R 122 CONDUCTIVE COATING

Defects in the conductive coating can not be seen through the screen. Each type of defect will produce a different effect. Failure analysis has equipment which can separate the different types of causes. The best way is to look at the causes and describe the effects.

Gold to Silver interface at feedthru: It is caused by a process problem in ceramic where the gold is so thin at the silver pad that high current spikes cause it to fail. When the area is failing, a flash will be seen on the screen in the corner opposite the feedthru. In some tubes a trace pattern will shrink when the beam current is increased.

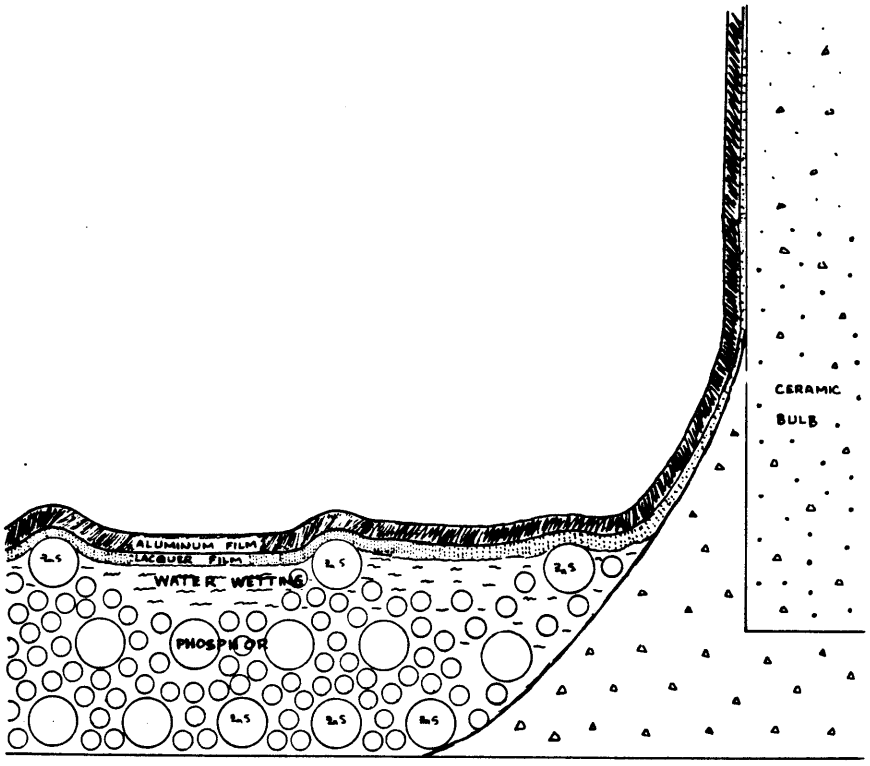
The second cause is poor aluminum at the frit bead. Again current causes the aluminum to open. When failure is occurring, flashing will show in the screen near the edge. Flashing will also identify a problem when the wall band (gold) makes contact with a painted dag coating.

Another cause which is not too common is charging areas on the ceramic walls. This occurs when the gold is too thick and the drying process produces an effect called "Mud Flats". This is where islands of unconnected gold charge creating gross geometry problems.

McRae 9-16-82

JURAN STUDY PROJECT

IDEAL SCREEN STRUCTURE



SECTION I R100 SERIES REJECT CODES

THE REJECT CODES

R123 PHOSPHOR UNIFORMITY

This is a new code which is a measure of luminance uniformity. The new family of Monitor tubes includes a luminance uniformity limit in their specific CRT specifications. The most common cause of non-uniformity is phosphor. New processes are being developed to better spread the phosphor. A second cause is non-uniformity in the aluminum film.

R212 LUMINANCE

This is another code related to new family of Monitor tubes. It is included in the R100 series because it is a screen caused defect. Variations in the thickness of the aluminum will change the brightness of the trace. Variations in the phosphor also will change the brightness of the trace. The individual CRT specifications describe the minimum brightness required and the test conditions at that measurement.

MWL 9-16-62

SECTION I R100 SERIES REJECT CODES

THE REJECT CODES

R 104 HELIX FLARE

Only some of the old type of CRT have helix in them. The helix helps form the trace on the screen. If the helix is open, it will cause the sensitivity to be out of spec. If the helix coating is not uniform, it will distort the pattern of the trace. The individual specs do not completely define usable limits. If it is not obvious the helix is at fault, I suggest using a reject code of performance which the CRT did not meet to scrap the tube.

OTHERS

There are other codes which are not used very often at test. I am therefore not going to include them in this discussion.

Mda 9-16-82

SECTION I R100 SERIES REJECT CODES

SUMMARY

R102 EXTERNAL FACEPLATE DEFECT

EFFECTS : WILL PRODUCE BRIGHT LINES OR SPOTS.
CAUSES : SCRATCHES, CHIPS, FLAKES FROM HANDLING.
SPEC : SEE TABLE I

R101 GLASS DEFECTS

EFFECTS : WILL PRODUCE BRIGHT LINES OR SPOTS.
CAUSES : SEEDS, OPAQUE SPOTS, SCRATCHES, CRACKS, FROM PROCESSING.
SPEC : SEE TABLE II

R117 GRATICULE DEFECT

EFFECTS : BROKEN LINES, LINE WIDTH, LINE STRAIGHTNESS.
CAUSES : FROM VARIATIONS IN SILKSCREEN PROCESSING.
SPEC : SEE TABLE III

R100 SCREEN DEFECT

EFFECTS : WILL PRODUCE DARK LINES OR SPOTS.
CAUSES : HOLES, LINT VOIDS, FOREIGN PARTICLE IN PHOSPHOR
SPEC : SEE TABLE II

R120 GLOWING SPOTS

EFFECTS : A SPOT OF DIFFERENT COLOR PRODUCING PHOSPHOR.
CAUSES : FROM CONTAMINATION IN PHOSPHOR.
SPEC : NONE

R121 ALUMINUM DEFECT

EFFECTS : WILL PRODUCE BRIGHT OR GRAY SPOTS, OR DEFOCUS.
CAUSES : INCLUDES FLAKING, BREAKS, AL. PENITRATION, BLISTERING
SPEC : SEE TABLE II

R123 PHOSPHOR UNIFORMITY

EFFECTS : APPEARS AS DARK AND BRIGHT AREAS ON SCREEN.
CAUSES : EITHER VARIATIONS IN AL. THICKNESS OR IN PHOSPHOR.
SPEC : INDIVIDUAL CRT SPEC OR A REFERENCE TUBE.

R212 LUMINANCE

EFFECT : APPEARS DARK
CAUSES : VARIATION IN AL. THICKNESS OR PHOSPHOR
SPEC : INDIVIDUAL CRT SPEC.

R122 CONDUCTIVE COATING

EFFECT : PRODUCES FLASHES ON SCREEN, ALSO CHANGES PATTERN
CAUSES : OPEN FEEDTHRU, OPEN ALUMINUM, MUDFLAT GOLD
SPEC : NONE ALLOWED

R104 HELIX FLARE

EFFECT : CHANGES GEOMETRY AND SENSITIVITY
CAUSES : OPEN OR NON-UNIFORM DAG STRIP
SPEC : NONE, USE PERFORMANCE PARAMETER

9-16-82