EXTERNAL VISUAL INSPECTION OF RESISTORS, HEATERS, FLEXIBLE

ESCC Basic Specification No. 2054009

Issue 5	January 2024

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DOCUMENTATION CHANGE NOTICE

(Refer to https://escies.org for ESCC DCR content)

DCR No.	CHANGE DESCRIPTION
1552	Specification upissued to incorporate changes per DCR.

TABLE OF CONTENTS

1 SCOPE

This specification, to be read in conjunction with ESCC Basic Specification No. 20500, External Visual Inspection, contains additional requirements for Flexible Heaters (Resistors).

They shall apply, where relevant, to each component inspected.

2 GENERAL REQUIREMENTS

2.1 APPLICABILITY

The following criteria may not be varied or modified after commencing any inspection stage. Any ambiguity or proposed minor deviation shall be referred to the ESCC Executive for resolution and approval.

2.2 PROCEDURE

All items shall be examined in such a manner that a minimum of handling and movement of the component is involved. During handling of components, lint free gloves/finger cots shall be used.

2.3 MAGNIFICATION

All items shall be examined with a binocular or stereoscopic microscope under a magnification of between 2X and 15X depending upon track width.

2.4 MOUNTING FIXTURES

Suitable fixtures may be used to assist in the inspection process provided they do not of themselves cause damage to the device.

2.5 ILLUMINATION

The samples are illuminated in such a manner that all aspect defects listed below will be revealed.

3 TERMS AND DEFINITIONS

Blister - Delamination in the form of a localised swelling and separation between the conductive track and the substrate/insulation layers/protective coating.

Bubble - A void fully enclosed within the substrate/insulation layers/protective coating due to entrapment of air or gas (that does not result in the any blistering or delamination).

Deformation - All conductive track defects such as dents, folds, bumps.

Delamination - A separation between the conductive track and the substrate/insulation layers/protective coating.

Flattened wire - A wire that has become flat during pressing operations.

Inclusions - Foreign particles, metallic or non-metallic, entrapped within the heater.

Metallic islet - A metallic area entrapped within the heater that reduces the separation between two conductive tracks.

Misregistration - Imperfect registration.

Nick - A cut or other damage to the edge of a conductive track.

Notch - A cut in the wire insulation.

Pad - The metallic extension where wire is welded.

Pinhole - An imperfection in the form of a small hole that penetrates into a conductive track or the substrate/insulation layers/protective coating.

Protrusion - A protuberance of the conductive track at the track edge.

Ragged edge - Edge of the substrate/insulation layers/protective coating with cuts, tears, impacts or other damage.

Scratch - A narrow furrow or groove in a surface.

Slip - Slipping of conductive tracks that occurred during substrate/insulation layers/protective coating lamination cycle.

Spot or Patch - A blot on a conductive track or the substrate/insulation layers/protective coating.

4 DETAILED REQUIREMENTS

4.1 GENERAL

A component shall be rejected if it exhibits one or more of the defects listed in any of the following paragraphs. Where applicable, drawings are included to provide additional explanatory material.

The external visual inspection includes the verification of:

- Dimensions.
- Marking.
- Materials.
- Mechanical defects.

4.2 DIMENSIONS AND MARKING

Dimensions and marking shall be inspected in accordance with the requirements of ESCC Basic Specification No. 20500.

All letters and numbers shall be clearly legible without the use of optical resources.

Dimensional tolerances shall be as specified in the relevant ESCC Detail Specification.

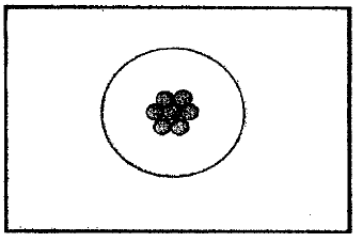
4.3 MATERIALS

The materials used shall be verified for conformance to the requirements of the applicable ESCC Detail Specification.

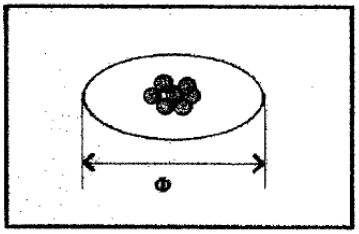
The production records shall be checked to ensure that the specified material requirements are met.

4.4 LEAD WIRES

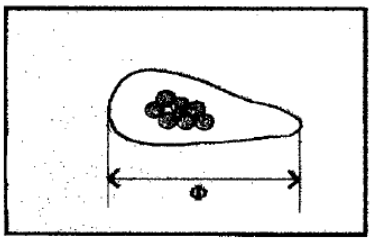
4.4.1 Flattened Wire



GOOD
Wire is intact.



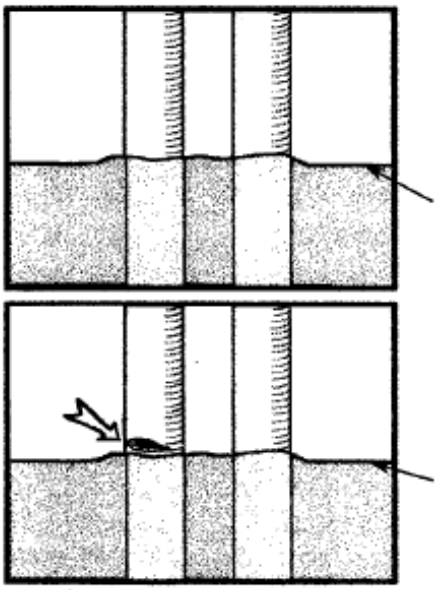
ACCEPTABLE
Wire is slightly flattened.
Rule: Ø ≤ 1.4 × Nominal diameter.



REJECTED
Wire is flattened.
Rule: Ø > 1.4 × Nominal diameter.

4.4.2 Integrity

Notches and scratches on wire insulation.



GOOD

Wire is intact.
No visible defect, without the use of optical resources.

Heater edge

REJECTED

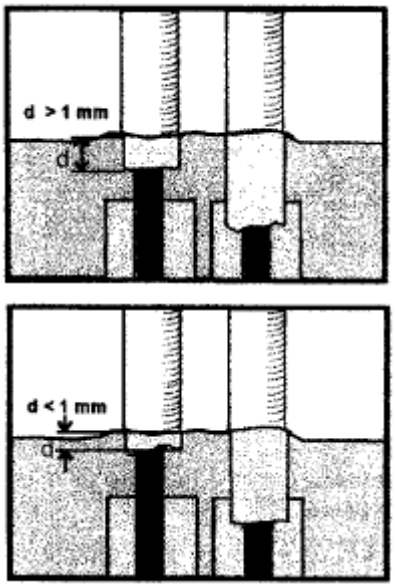
Visible defects on the wire insulation:
- Deep scratch or notch.
- Slight cut.

Heater edge

4.5 WELDED LEAD CONNECTIONS

4.5.1 Location of Lead Wire

(a) Position in relation to heater edge.



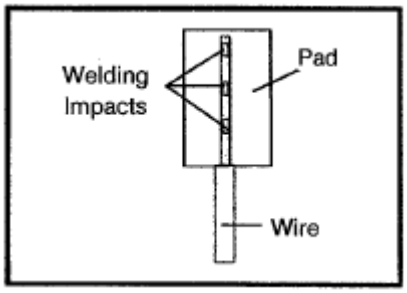
GOOD

The wire insulation penetration under the protective coating is d ≥ 1mm.

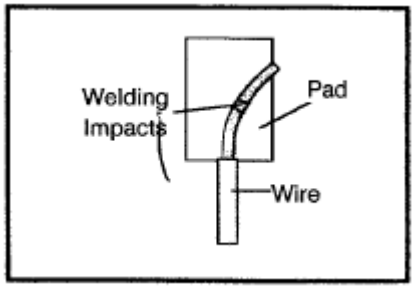
REJECTED

The wire insulation penetration under the protective coating is d < 1mm.

(b) Wire position on the connection pad.

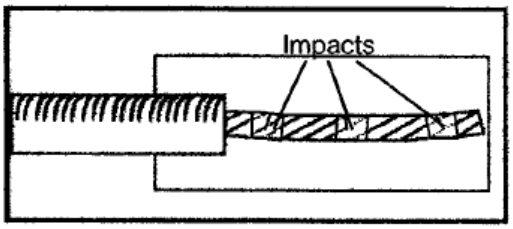


GOOD
The wire is centred.
Twist is regular, strands are well joined (see also Para. 4.4.1).

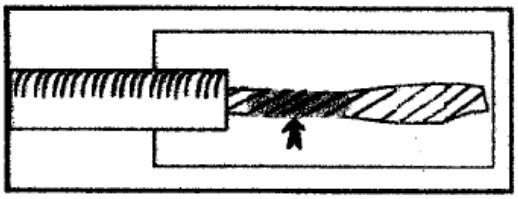


REJECTED
Wire outside pad.
Welding impacts are insufficient (< 2).

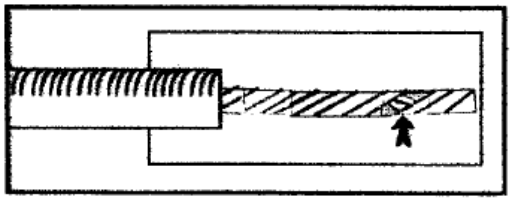
4.5.2 Visual Aspect



GOOD
No discoloration on the welding area.
No broken strands.
No free element (detached or projecting).



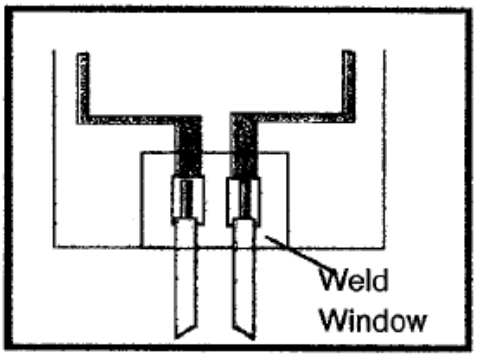
REJECTED
Discoloration within the welding area.



REJECTED
Broken strand.

4.5.3 Weld Window (if applicable)

(a) Examination of weld window itself and its environment.

+ 

GOOD

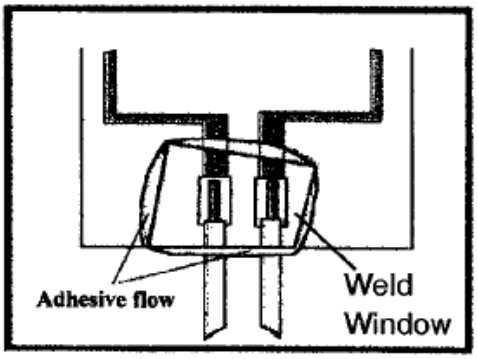
No unsticking.

No adhesive flow.

Good position. In particular the protective coating covering the welds shall also cover the opening of the upper insulation layer for double-sided heaters.

No bubbles in the adhesive.

Good wire encapsulation (no void at the end of the sheath next to bare areas).

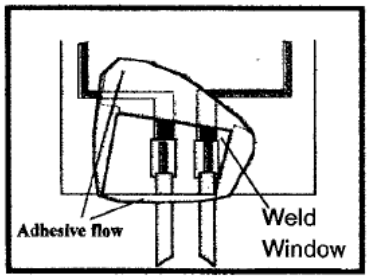


ACCEPTABLE

Adhesive flow next to wires < 2mm.
Crosswise position but wire encapsulation is correct.

N.B.

Removal of excess adhesive with scalpel is not allowed.



REJECTED

Excessive adhesive flow ≥ 2mm next to wires.

Bad wire encapsulation.

Local unsticking.

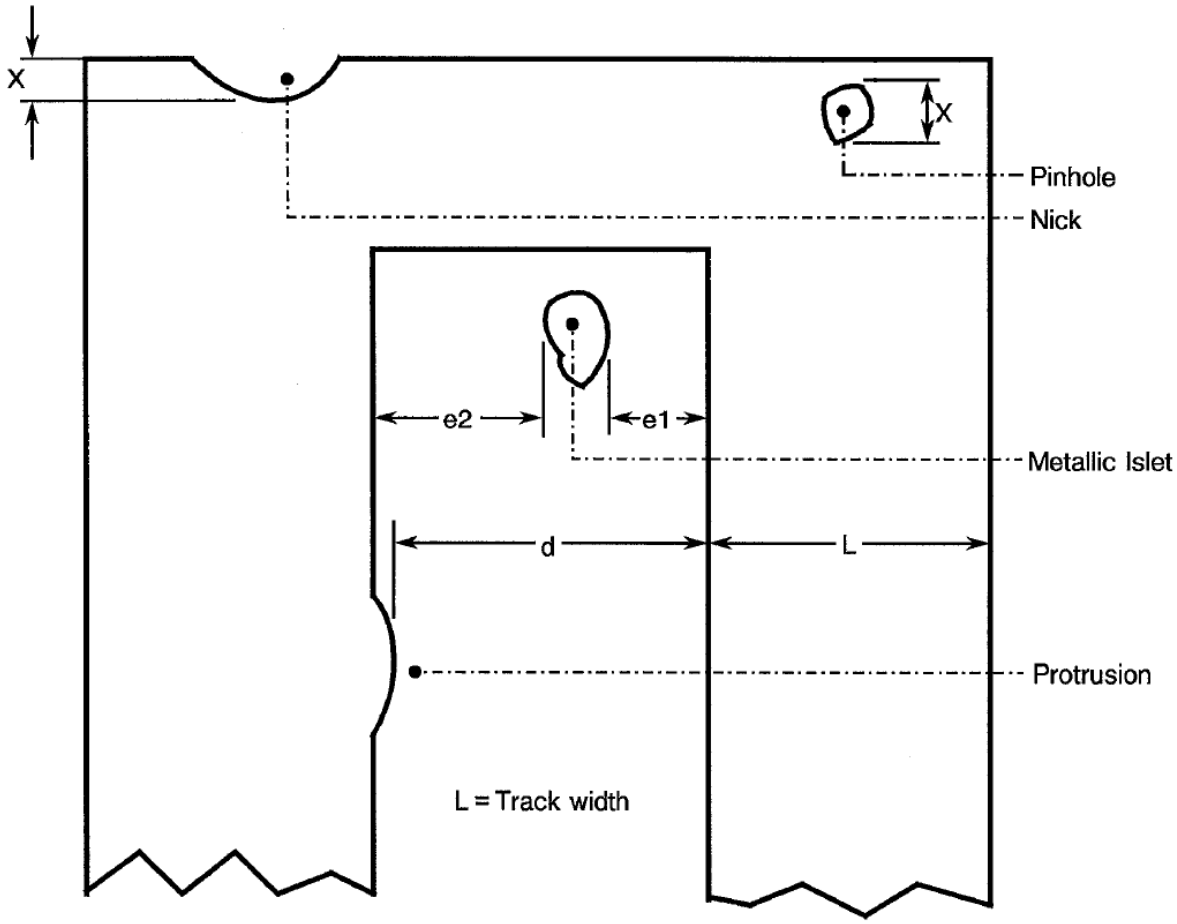
Bad coverage of the opening of the upper insulation layer for double-sided heaters.

N.B.

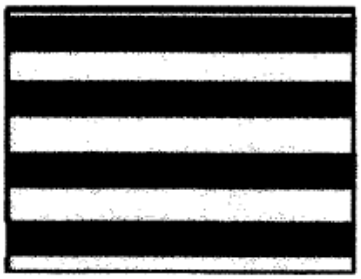
Removal of excess adhesive with scalpel is not allowed.

4.6 CONDUCTOR ETCHING

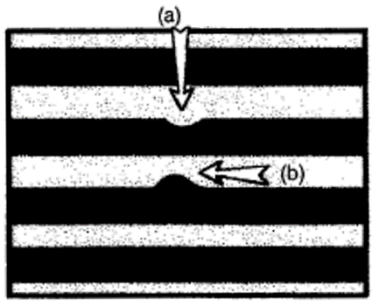
4.6.1 General



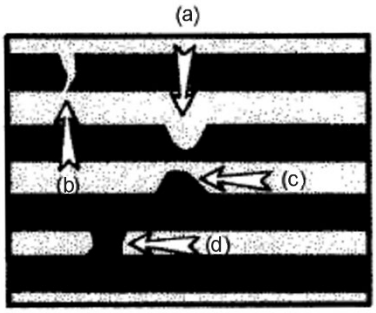
4.6.2 Nicks and Protrusions
Ref. Para. 4.6.1.



GOOD
No nicks or protrusions



ACCEPTABLE
(a) Track width reduction is: X ≤ 30% of the track width (L)
(b) Distance between tracks is: d ≥ 50µm

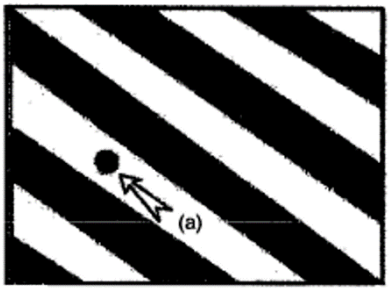


REJECTED
(a) Track width reduction is: X > 30% of the track width (L)
(b) Cut through track
(c) Distance between tracks is: d < 50µm
(d) Short circuit between tracks

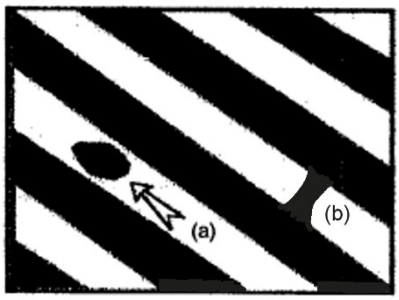
4.6.3 Metallic Islets and Inclusions
Ref. Para. 4.6.1.

Note: Metallic islets and inclusions are characterised by a bright appearance when using a bright-field light/magnification tool.

GOOD
No metallic islet/inclusion between tracks

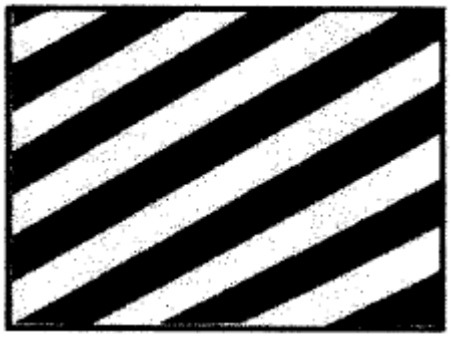


ACCEPTABLE
(a) The total spacing between the metallic islet/inclusion and the two tracks is: e1 + e2 ≥ 50µm
When adjacent tracks are from different resistors, the spacing to each track shall be: e1 = e2 ≥ 50µm

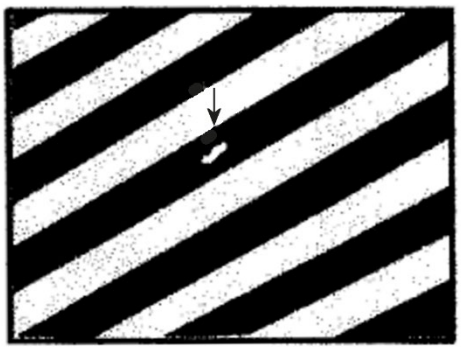


REJECTED
(a) Any metallic islet/inclusion not meeting the specified Acceptable criteria as given above.
(b) Any metallic islet/inclusion resulting in a short circuit between tracks

4.6.4 Lack of Metal
Ref. Para. 4.6.1.



GOOD
No pinholes, voids, nicks or other lack of metal on tracks



ACCEPTABLE
Track width reduction is: X ≤ 30% of the track width (L)

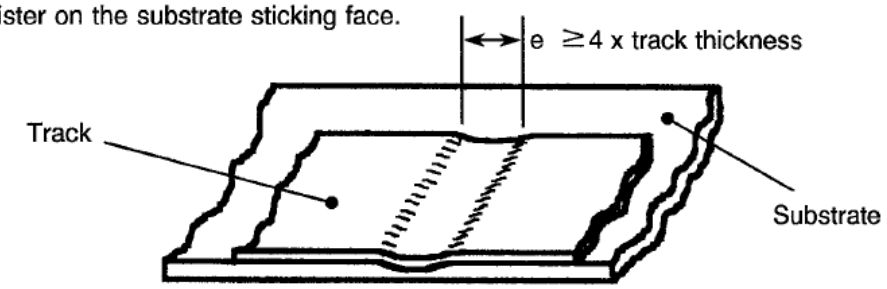
REJECTED
Track width reduction is: X > 30% of the track width (L)

4.7 DEFORMATION

4.7.1 Folds

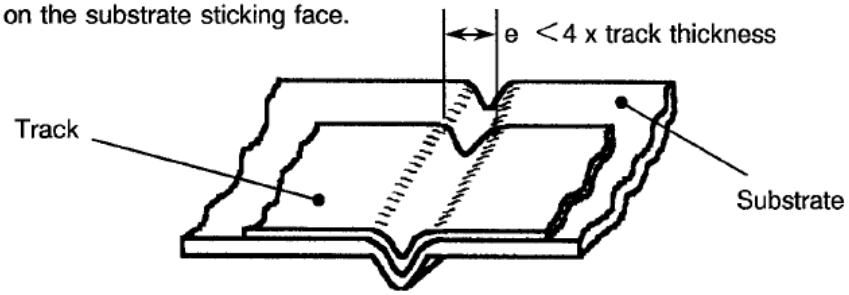
ACCEPTABLE

Gentle curve.
No blister on the substrate sticking face.



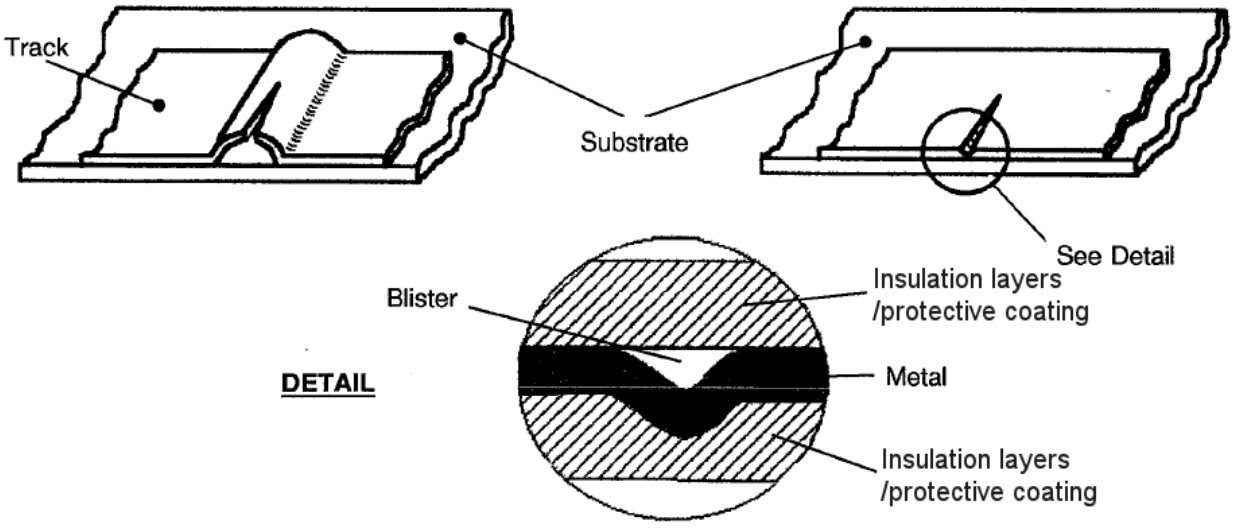
REJECTED

Sharp curve.
Rugged fold.
Blister on the substrate sticking face.

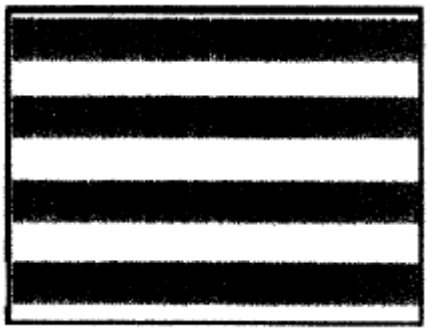


REJECTED

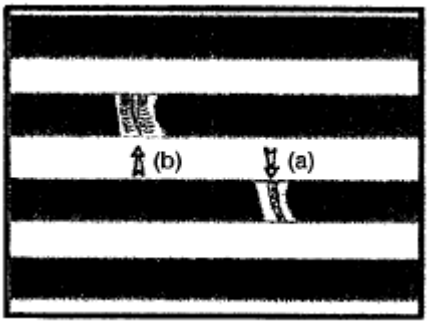
Void between track and substrate.
Torn track.



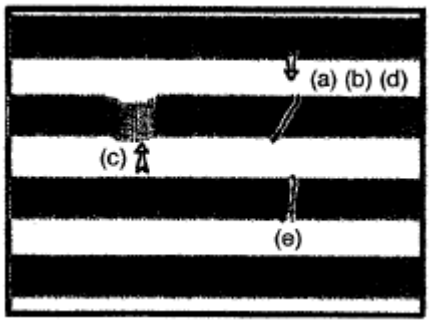
DETAIL



GOOD
No visual defects.
No visible fold.

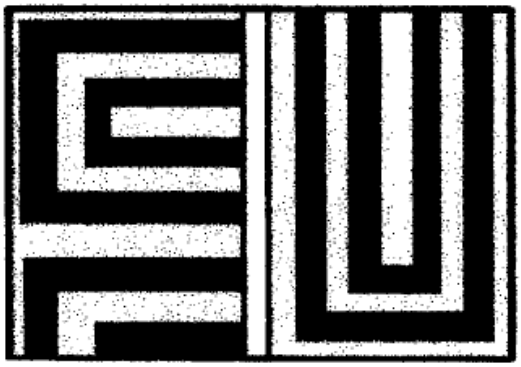


ACCEPTABLE
(a) Fold is not very pronounced.
(b) Fold width is ≥ 4 x track thickness.
(c) No obvious delamination.
(d) No bump on heater surface.
(e) Fold does not result in an over-thickness.

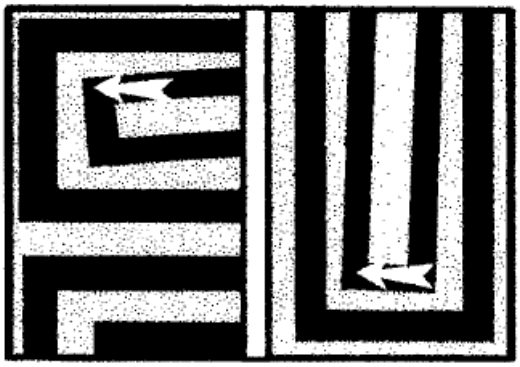


REJECTED
(a) Fold is very pronounced.
(b) Rugged fold.
(c) Fold results in delamination.
(d) Nail detectable over-thickness.
(e) Pronounced deformation and fold width < 4 x track thickness.

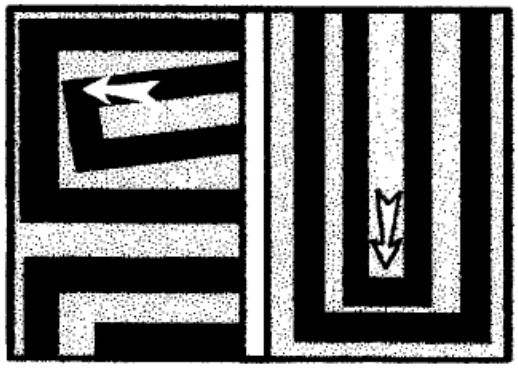
4.7.2 Slips



GOOD
No track slippage.



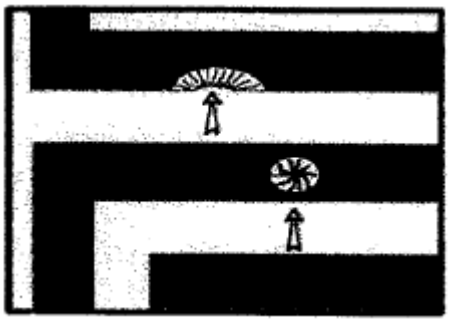
ACCEPTABLE
Track slipped but the spacing between tracks is:
≥ 50µm.



REJECTED
Track slipped and the spacing between tracks is:
< 50µm.

4.7.3 Local Deformation

GOOD
Tracks are smooth and without visible deformation.

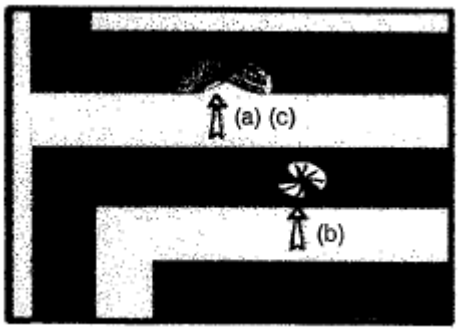


ACCEPTABLE
Deformation is well localized

Bump involves:

- Neither over-thickness.
- Nor delamination.

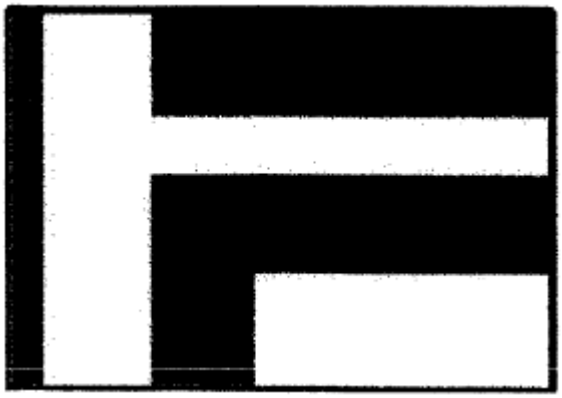
N.B. Acceptance criteria: No nail detectable deformation.



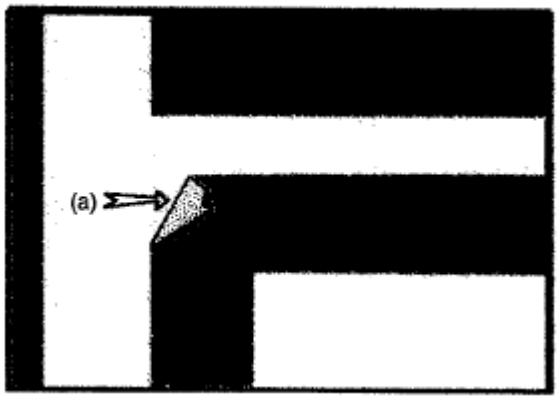
REJECTED
(a) Excessive and large deformation.
(b) Visible marks of cracking.
(c) Nail detectable over-thickness.

4.8 BLISTERING AND DELAMINATION

4.8.1 Track Unsticking



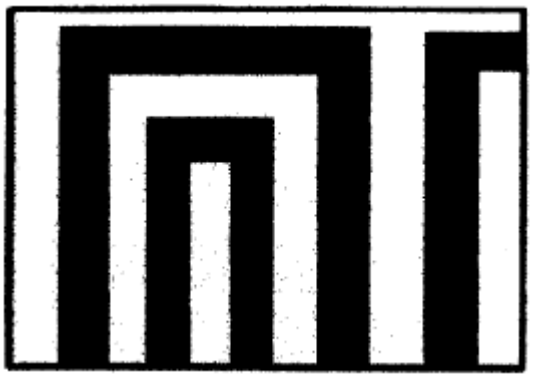
GOOD
No track area unstuck from the substrate.



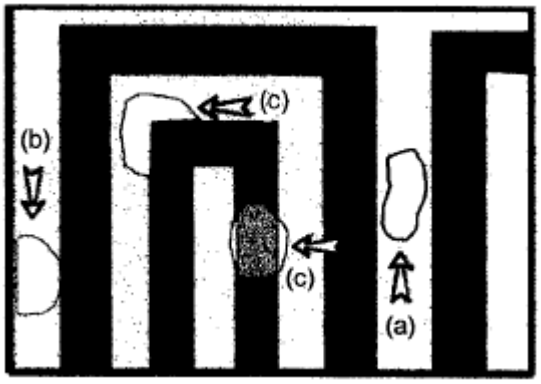
REJECTED
(a) Moved and/or folded track corner.
(a) Unstuck track corner.

Insulation layer/protective coating perforated during the pressing step.

4.8.2 Blistering/Delamination



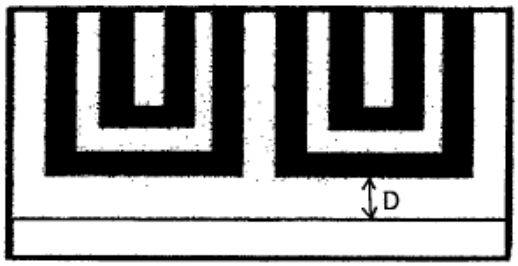
GOOD
No visible blistering or delamination.



REJECTED
Blisters that:
(a) result in delamination of the insulation layers/protective coating between the tracks.
(b) stretch from the track to heater edge.
(c) extend beyond the track edge.

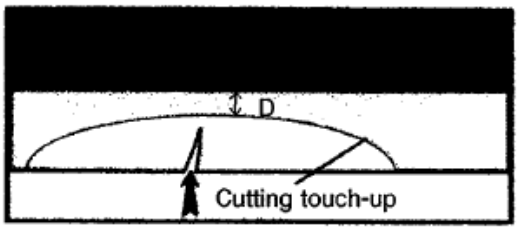
4.9 RAGGED EDGES

N.B. GENERAL RULE: Minimum distance between a track and the heater edge: D = 0.4mm.



GOOD

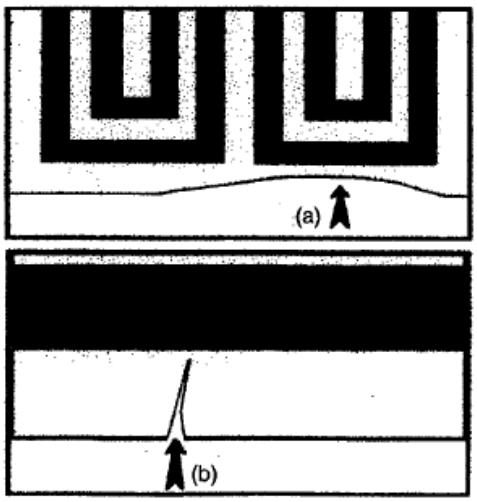
Minimum distance D is respected. Heater edge is without any cuts, tears, impacts or other damage.



ACCEPTABLE

The heater edge is damaged. This damage may be touched up (i.e. rounded off) subject to:

- The damage is not within 5mm of the lead wires, on both sides.
- The minimum distance D is respected.



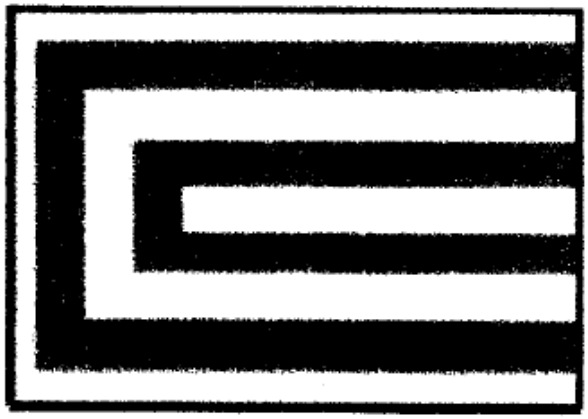
REJECTED

(a) The minimum distance D is not respected.

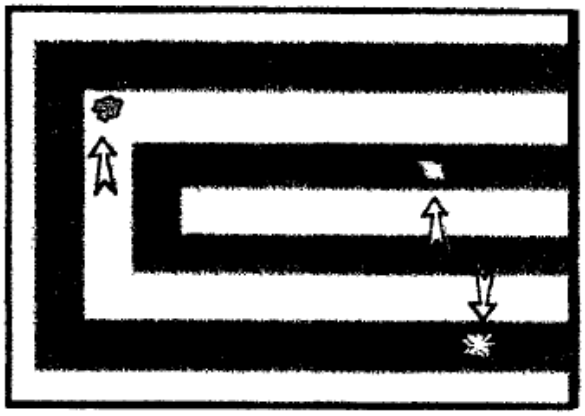
(b) The damage is too severe and cannot be rounded off with regard to the minimum distance D.

4.10 ASPECT DEFECTS

4.10.1 Spots and Patches



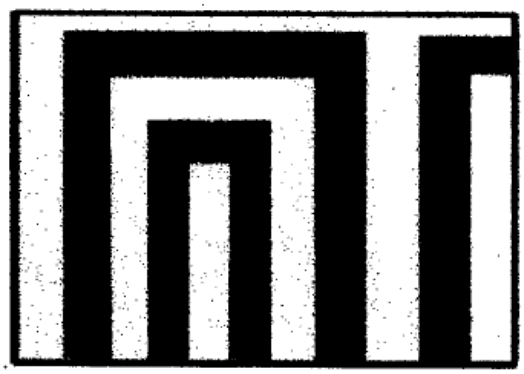
GOOD
No spot or patch visible on the heater



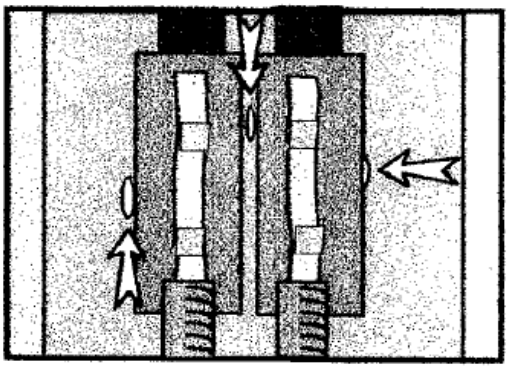
ACCEPTABLE
Spots/patches are present but without any delamination

REJECTED
Spots or patches showing delamination

4.10.2 Bubbles
See also Para. 4.8.2.

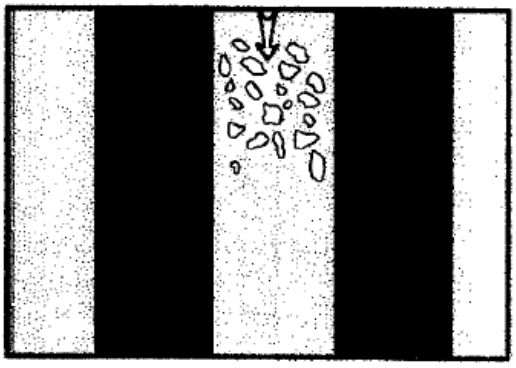


GOOD
No bubble visible within the heater.



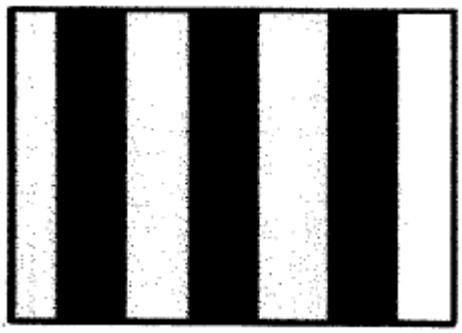
ACCEPTABLE
Bubbles coupled with the metallic pad with the following criteria:

- Bubble maximum length: 200µm
- Quantity: 5 maximum



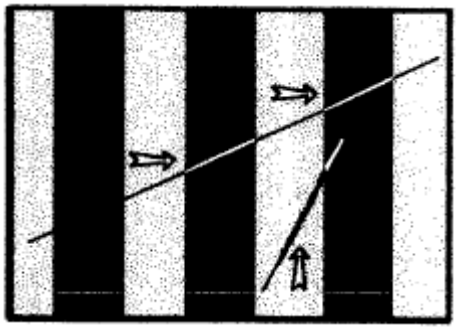
REJECTED
Bubbles that make groups of white spots.

4.10.3 Surface Defects



GOOD
No evidence of any scratch, abrasion, pinhole or other defect on the surface of the insulation layer/protective coating of the heater

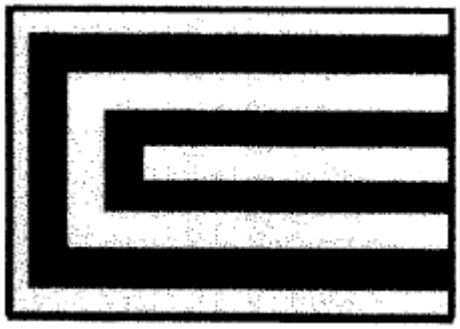
ACCEPTABLE
Scratches, abrasions, pinholes or other defect on the surface of the insulation layer/protective coating of the heater that do not expose the track metal.



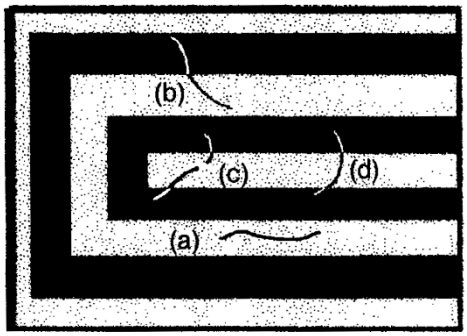
REJECTED
Scratches, abrasions, pinholes or other defect on the surface of the insulation layer/protective coating of the heater that do expose the track metal.

4.10.4 Non-Metallic Inclusions
Ref. Para. 4.6.1.

NOTE: See Para. 4.6.3 for criteria for metallic inclusions



GOOD
No evidence of any non-metallic inclusion on or between tracks.



ACCEPTABLE

(a) Any non-metallic inclusion respecting the total spacing between two tracks: e1 + e2 ≥ 50µm

When adjacent tracks are from different resistors, the spacing to each track shall be: e1 = e2 ≥ 50µm

(b) Any non-metallic inclusion that does not make a whole bridge between two tracks where the spacing to the unlinked track is ≥ 50µm

(c) Discontinuous non-metallic inclusions where the discontinuities between the tracks total ≥ 50µm

(d) Any non-metallic inclusion making a bridge between two tracks where:

i. The inclusion length* ≤ 2mm for a track width plus track spacing (L + d) ≤ 0.6mm

ii. The inclusion length* ≤ 4mm for a track width plus track spacing (L + d) > 0.6mm

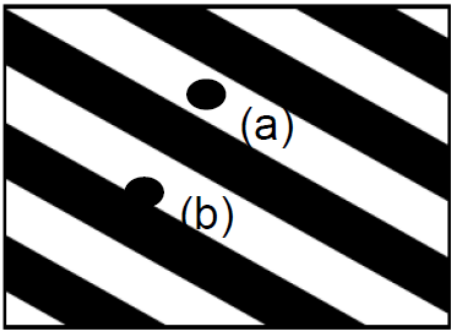
* The inclusion length shall be measured as the maximum distance (segment) between the 2 extreme points of the inclusion. Non-metallic inclusions may have any geometrical shape

(e) A maximum of 3 non-metallic inclusions are permitted in any area of $10cm^2$

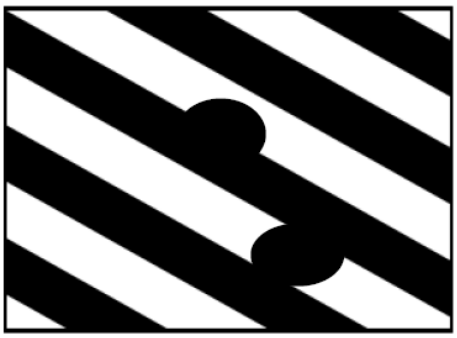
REJECTED
Any non-metallic inclusion not meeting the specified Acceptable criteria as given above.

4.10.5 Black Dots On/In the Insulation Layers/Protective Coating
Ref. Para. 4.6.1.

GOOD
No black dot on/in the insulation layers/protective coating

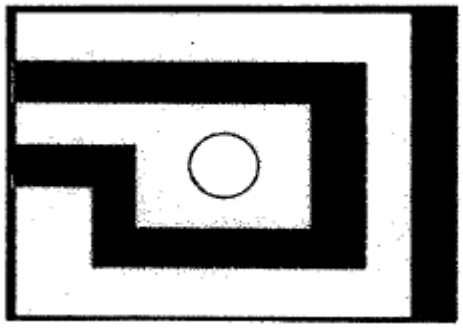


ACCEPTABLE
(a) Any black dot on/in the insulation layers/protective coating where the total spacing between the black dot and the two tracks is e1 + e2 ≥ 50µm
(b) Any black dot on/in the insulation layers/protective coating, partially or totally above a track and with a length ≤ 150µm, where the spacing to the next unlinked track is ≥ 50µm

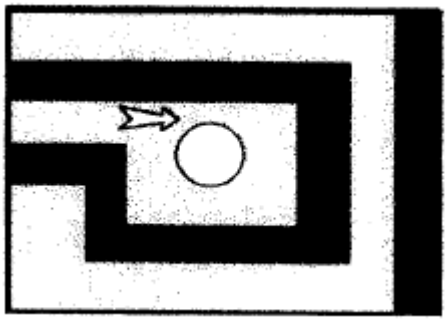


REJECTED
Any black dot on/in the insulation layers/protective coating not meeting the specified Acceptable criteria as given above.

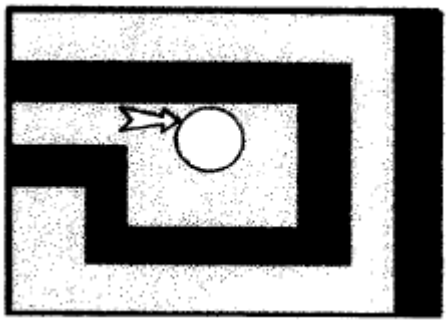
4.10.6 Misregistration



GOOD
Perforations are well centred in relation to tracks.



ACCEPTABLE
Perforations are misregistered in relation to tracks, but the spacing between the perforation edge and the track is: ≥ 0.4mm



REJECTED
Spacing between the perforation edge and the track is: < 0.4mm