EXTERNAL VISUAL INSPECTION OF

FLEXIBLE HEATERS

ESCC Basic Specification No. 2054009

ISSUE 1

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FLEXIBLE HEATERS

ESA/SCC Basic Specification No. 2054009

space components
coordination group

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		SCCG Chairman	ESA Director General or his Deputy
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DOCUMENTATION CHANGE NOTICE

Rev. Letter	Rev. Date	CHANGE Reference Item	Approved DCR No.

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1. SCOPE

This specification, to be read in conjunction with ESA/SCC Basic Specification No. 20500, External Visual Inspection, contains additional requirements for Flexible Heaters.

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 Qualifying Space Agency 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 base material and conductive foil or coverlay.

Bubble - An entrapment of air or gas in a protective coating.

Deformation - All metallic foil defects such as dents, folds, bumps and blisters.

Delamination - A separation between base material and conductive foil.

Flattened wire - A wire become flat during pressing operations.

Inclusions - Foreign particles, metallic or non-metallic, entrapped in an insulating material.

Metallic islet - An unetched little metallic area reducing insulation between two tracks.

Misregistration - Imperfect registration.

Nick - A cut in the edge of a track.

Notch - A cut in the wire insulation.

Pad - The metallic extension where wire is welded.

Paving-block - Insulating pavement making encapsulation of wires.

Pinhole - An imperfection in the form of a small hole that penetrates entirely through the layer of metal.

Protrusion - Metallic protuberance in the edge of a track.

Ragged edge - Edge with tears, impacts, notches or other damage.

Scratch - A narrow furrow or groove in a surface.

Slip - Slipping of tracks during coverlay lamination cycle.

Spot - A blot on a metallic surface or in an insulating material.

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 ESA/SCC Basic Specification No. 20500, Paras. 4.6 and 4.7.

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

Dimensional tolerances shall be as specified in the relevant ESA/SCC Detail Specification.

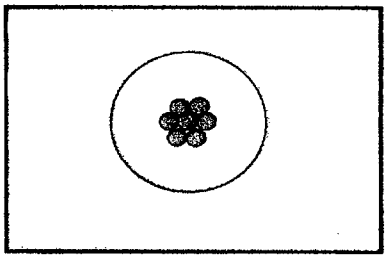
4.3 MATERIALS

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

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

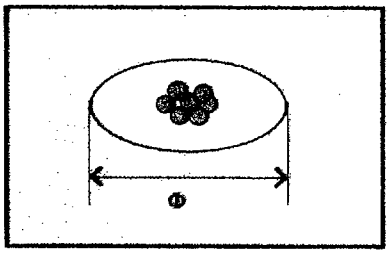
4.4 LEADWIRES

4.4.1 Flattened Wire



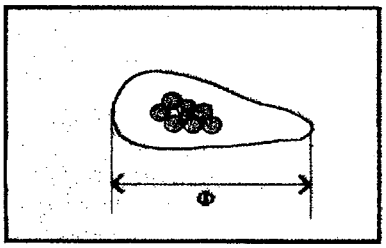
GOOD

Wire is intact.



ACCEPTABLE

Wire is slightly flattened.
Rule: $\varnothing \leq 1.4$ Nominal diameter.

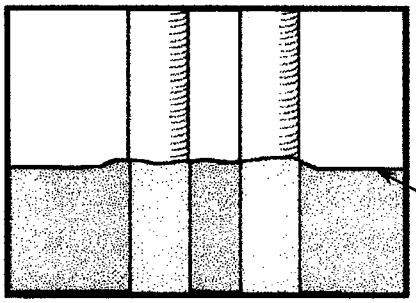


REJECTED

Wire is flattened.
Rule: $\varnothing \leq 1.4$ Nominal diameter.

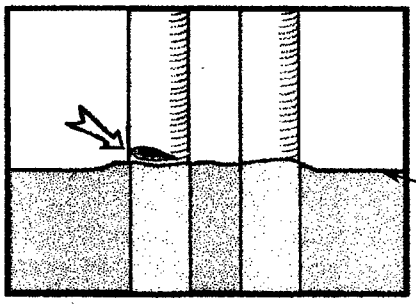
4.4.2 Integrity

Notches and scratches on wire insulation.



GOOD

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



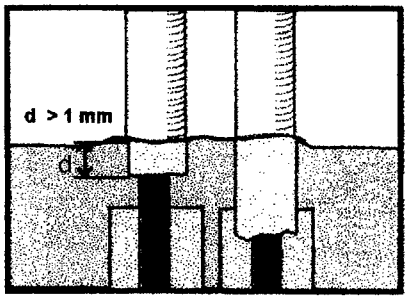
REJECTED

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

4.5 WELDED LEAD CONNECTIONS

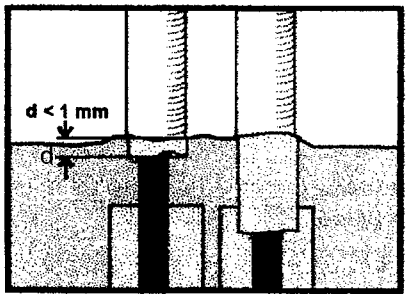
4.5.1 Location of Lead Wire

(a) Position in relation to heater edge.



GOOD

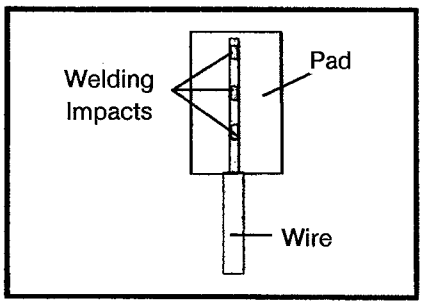
The wire insulation penetration under the Kapton is equal to or greater than 1.0mm.



REJECTED

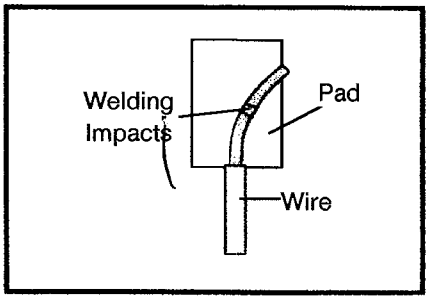
The wire insulation penetration under the Kapton is less than 1.0mm.

(b) Wire position on connection pad.



GOOD

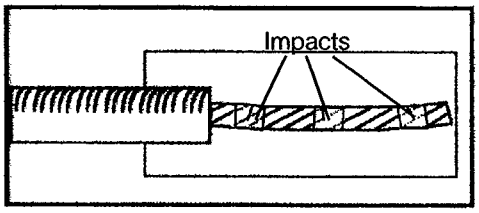
The wire is well centred.
The wire is right or slightly bowed.
Twist is regular, strands are well joined (see also Para. 4.4.1).



REJECTED

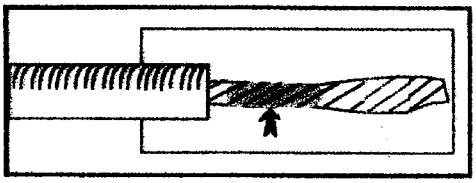
Wire outside pad.
Welding impacts are insufficient (<2).

4.5.2 Visual Aspect



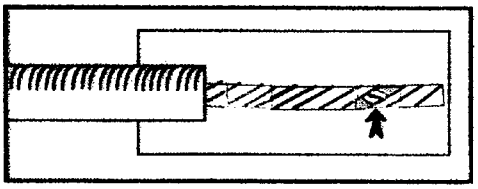
GOOD

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



REJECTED

Discoloration of the welding area.

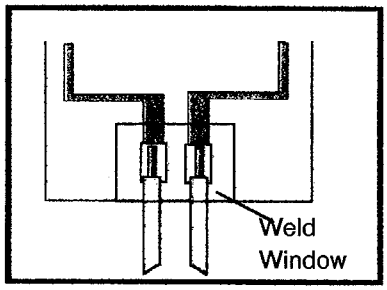


REJECTED

Broken strand.

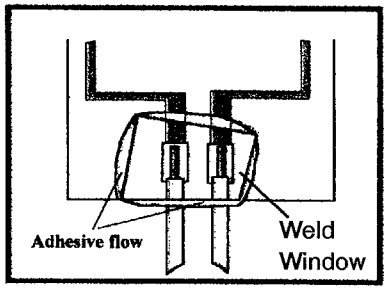
4.5.3 Weld Window (if applicable)

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



GOOD

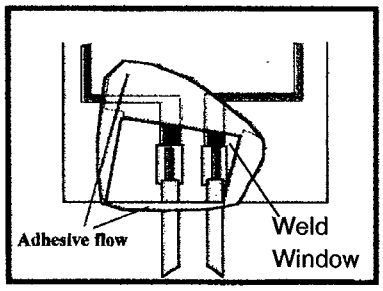
No unsticking.
No adhesive flow.
Good position. In particular the Kapton pad covers the opening of the upper coverlay for double-sided heaters.
No bubbles in the adhesive.
Good wire encapsulation (no void at the end of the sheath next to bare areas).



ACCEPTABLE

Adhesive flow next to wires ≥ 2.0mm.
Crosswise position but wire encapsulation is correct.

N.B.
Removal of excess adhesive with scalpel is not allowed.



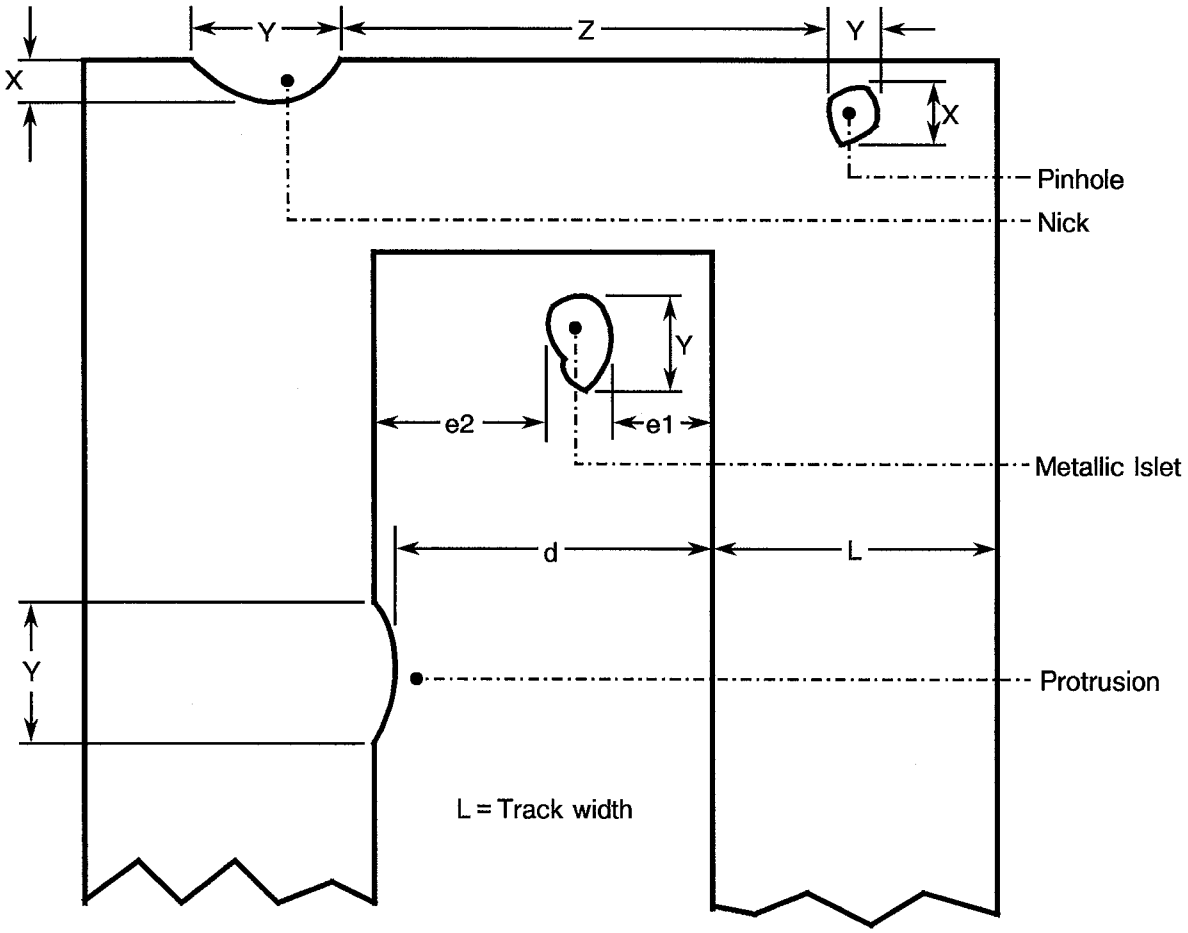
REJECTED

Excessive adhesive flow ≥ 2.0mm next to wires.
Bad wire encapsulation.
Local unsticking.
Bad coverage of the opening of the upper coverlay 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

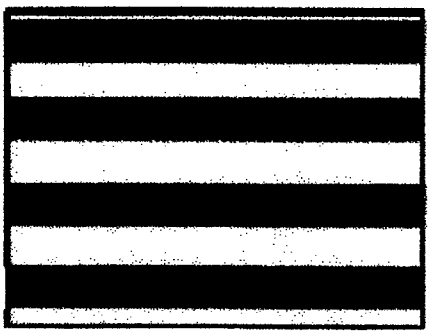
Distance between tracks ≤ 0.8mm.

(a) X ≤ 30% of L.
(b) Y ≤ 0.5mm.
(c) Z: Minimum space between two defects = 5.0mm.
(d) d ≥ 0.05mm.

Distance between tracks > 0.8mm.

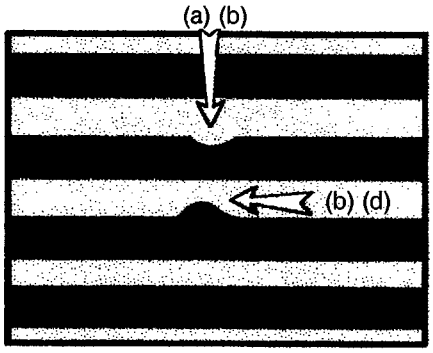
(a) X ≤ 25% of L.
(b) Y ≤ 1.0mm.
(c) Z: Minimum space between two defects = 1.5mm.
(d) d ≥ 0.05mm.

4.6.2 Nicks and Protrusions (Cont.)



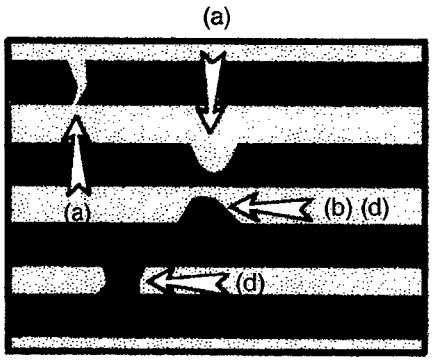
GOOD

No visual defects.



ACCEPTABLE

Track width reduction (a) and length of defect (b) are less than permitted limits.
Distance between tracks (d) is greater than 0.05mm and length of defect (b) is less than permitted limits.



REJECTED

Track width reduction (a) or length of defect is more than permitted limits.
Cut track (a).
Distance between tracks (d) is less than permitted limits or length defect (b) is more than permitted limits.
Short circuit between tracks (d).

4.6.3 Metallic Islets and Inclusions

Distance between tracks ≤ 0.8mm.

(a) Y ≤ 1.0mm.

(b) Z: Minimum space between two defects = 5.0mm.

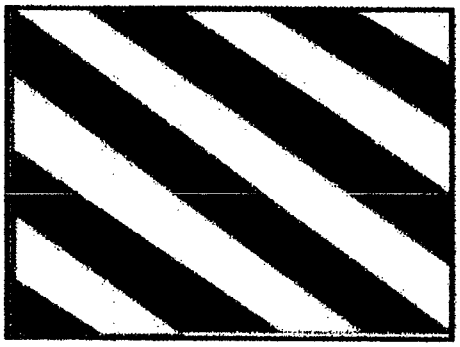
(c) e1 + e2 ≥ 50µm. When adjacent tracks are from different resistors, this requirement becomes e1 = e2 ≥ 50µm.

Distance between tracks > 0.8mm.

(a) Y ≤ 1.5mm.

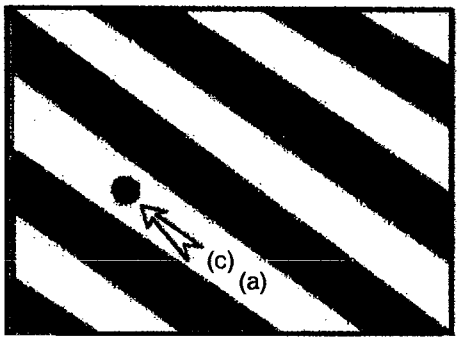
(b) Z: Minimum space between two defects = 1.5mm.

(c) e1 + e2 ≥ 50µm. When adjacent tracks are from different resistors, this requirement becomes e1 = e2 ≥ 50µm.



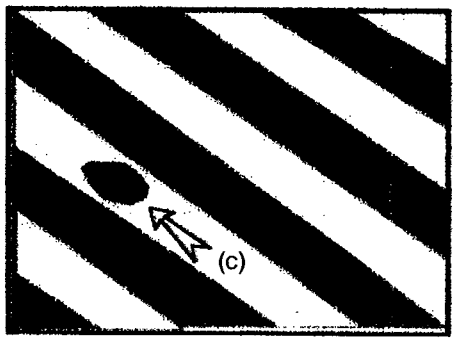
GOOD

No metallic islet between tracks.



ACCEPTABLE

Gap between inclusion and tracks (c) is more and length of inclusion (a) is less than permitted limits.



REJECTED

Gap between inclusion and tracks (c) is less than permitted limits.

4.6.4 Lack of Metal

Track width ≤0.8mm.

(a) X ≤30% of L.

(b) Y ≤0.5mm.

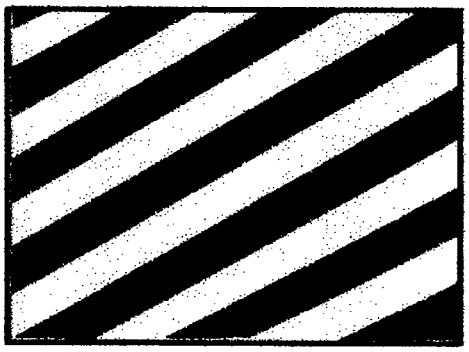
(c) Z: Minimum space between two defects = 5.0mm.

Track width >0.8mm.

(a) X ≤25% of L.

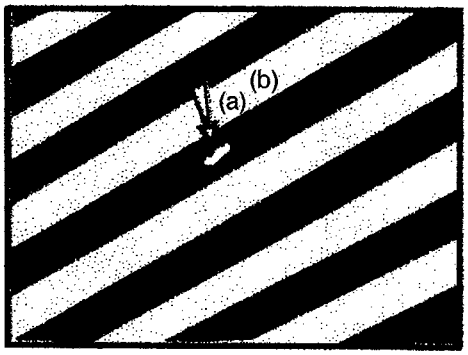
(b) Y ≤1.0mm.

(c) Z: Minimum space between two defects = 1.5mm.



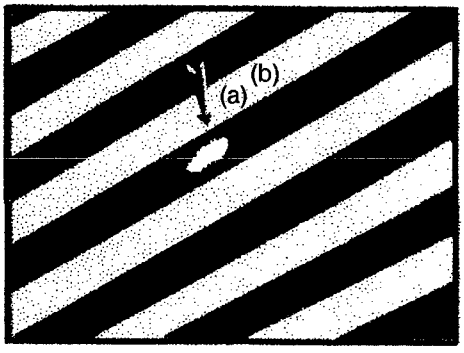
GOOD

No pinholes on tracks.



ACCEPTABLE

Track width reduction (a) and length of defect (b) are less than permitted limits.



REJECTED

Track width reduction (a) or length of defect (b) is more than permitted limits.

4.6.5 Other Random Defects

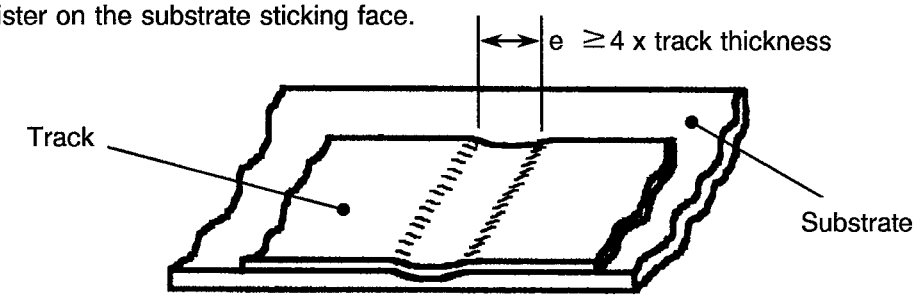
(a) Short-circuits and cuts are rejected in every case.
(b) Reduced insulation, reduced width, etc... (see Para. 3.6.1 for criteria).

4.7 DEFORMATION

4.7.1 Folds

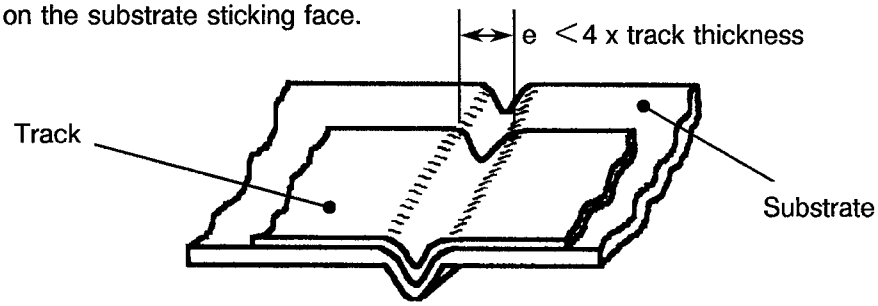
ACCEPTABLE

Gentle curve.
No blister on the substrate sticking face.



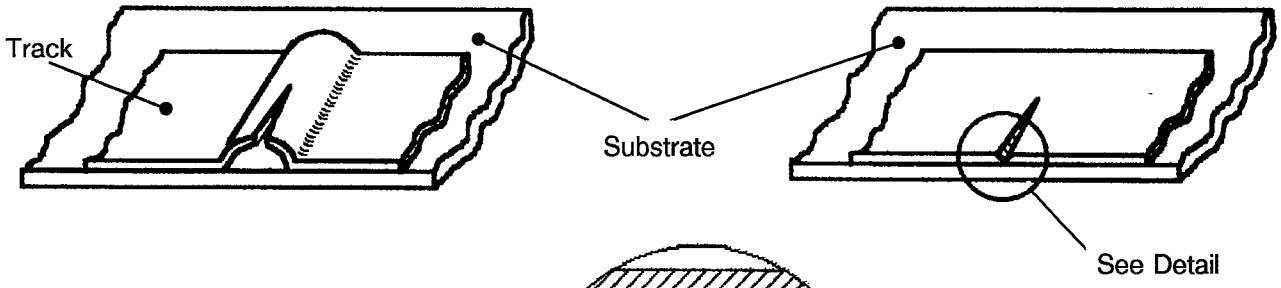
REJECTED

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

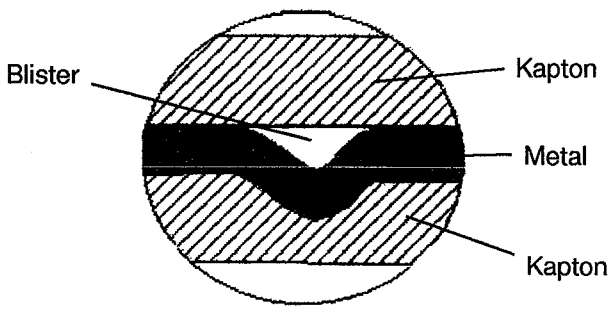


REJECTED

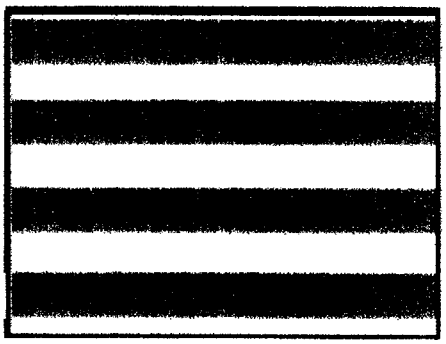
Void between track and substrate.
Torn track.



DETAIL

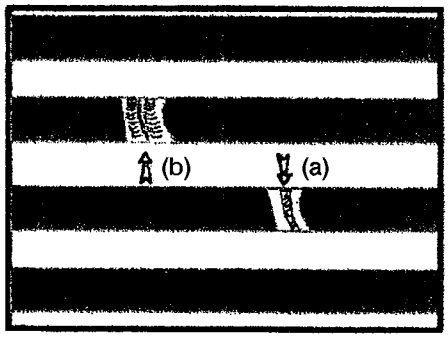


4.7.1 Folds (Cont.)



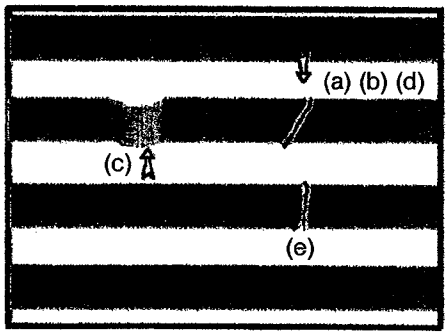
GOOD

No visual defects.
No visible fold.



ACCEPTABLE

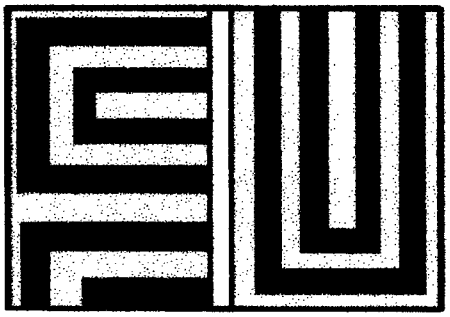
(a) Fold is not very pronounced.
(b) Fold width is ≥4 x track thickness.
(c) No obvious delamination.
(d) No bump on heater surface.
(e) Fold does not result in an overthickness.



REJECTED

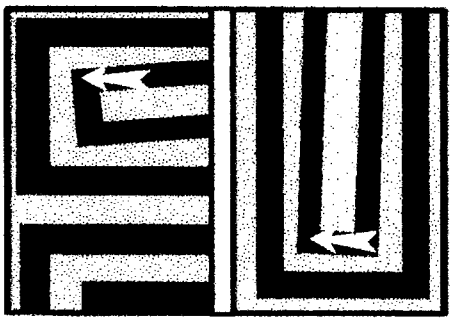
(a) Fold is very pronounced.
(b) Rugged fold.
(c) Fold results in delamination.
(d) Nail detectable overthickness.
(e) Pronounced deformation and width fold below 4 x track thickness.

4.7.2 Slips



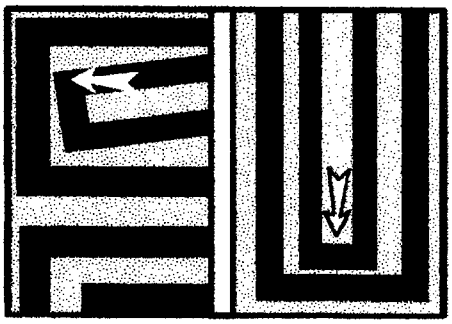
GOOD

No track slippage.



ACCEPTABLE

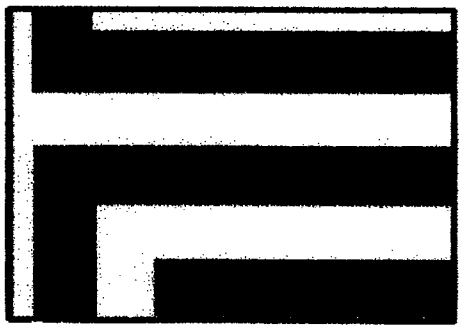
Track slipped but minimum spacing between tracks is >50μm.



REJECTED

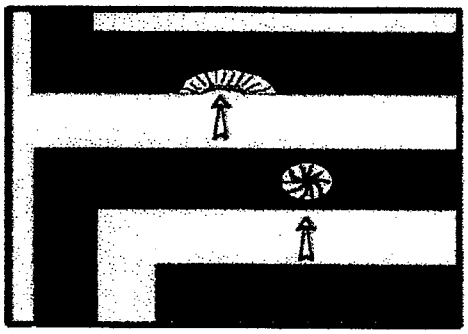
Track slipped: minimum spacing between tracks is <50μm.

4.7.3 Local Deformation



GOOD

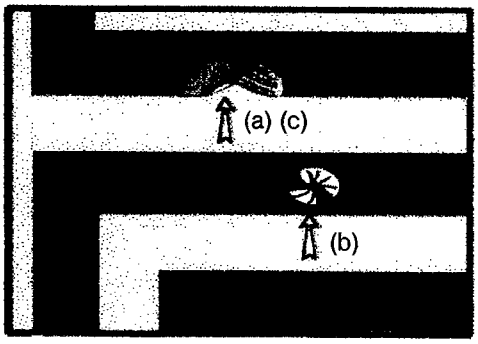
Tracks are smooth and without visible deformation.



ACCEPTABLE

Deformation is well localized
Bump involves:
- Neither overthickness.
- Nor delamination.

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

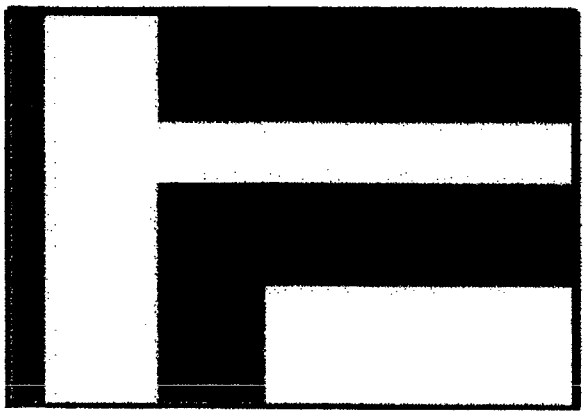


REJECTED

(a) Excessive and large deformation.
(b) Visible marks of cracking.
(c) Nail detectable overthickness.

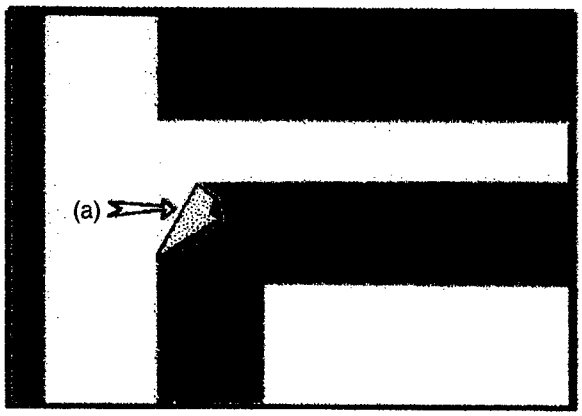
4.8 BLISTERING AND DELAMINATION

4.8.1 Track Unsticking



GOOD

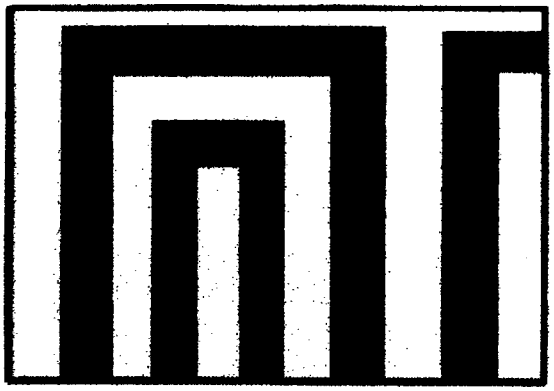
No track area unstuck from the substrate.



REJECTED

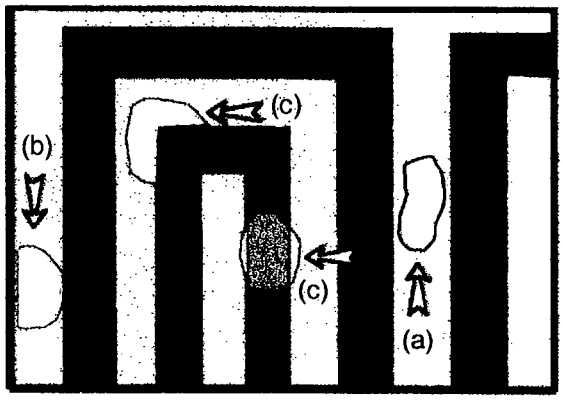
(a) Moved and/or folded track corner.
(b) Kapton coverlay perforated during the pressing step.
(c) Unstuck track corner.

4.8.2 Delamination



GOOD

No visible point of delamination.

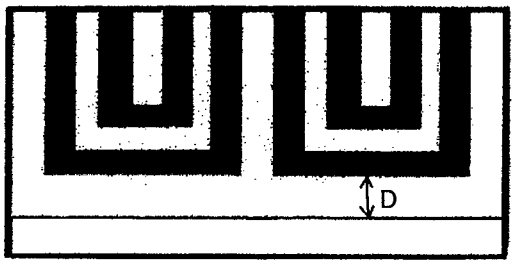


REJECTED

Bubbles:-
(a) Cause excessive delamination between tracks.
(b) Stretch from track to heater edge.
(c) Are between track and substrate.

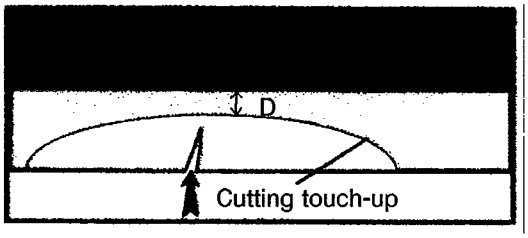
4.9 Ragged Edges

N.B. General Rule Minimum distance track/heater edge D = 0.4mm.



GOOD

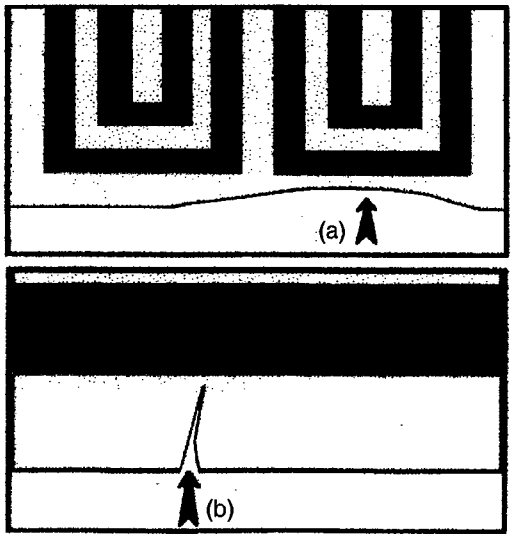
Minimum distance D is respected.
Heater edge is without notch.



ACCEPTABLE

The heater edge is notched. This notch will be touched up (rounded) if:

- The notch is not in an area around lead wires (5.0mm on both sides).
- The minimum distance D is respected.

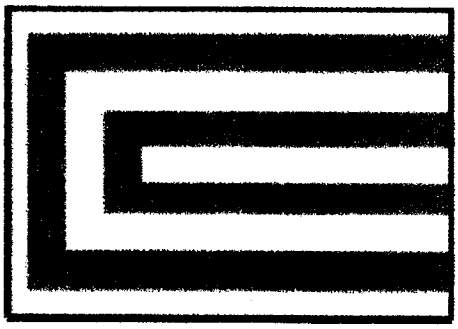


REJECTED

(a) The minimum distance D is not respected.
(b) The notch is too profound and cannot be rounded with regard to the minimum distance.

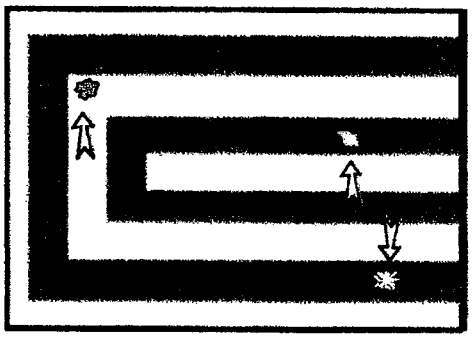
4.10 ASPECT DEFECTS

4.10.1 Spots



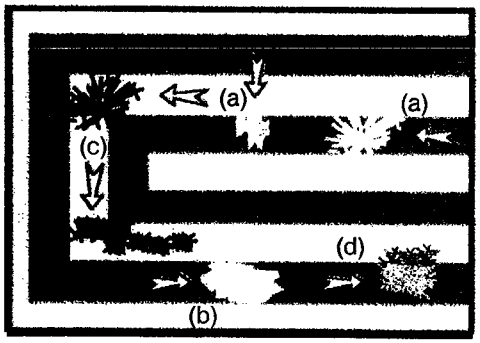
GOOD

No spot visible on the heater.



ACCEPTABLE

Isolated patch:
- Without presence of delamination.
- Gap between patch and tracks and length of patch less than permitted limits (see Para. 4.6.3).

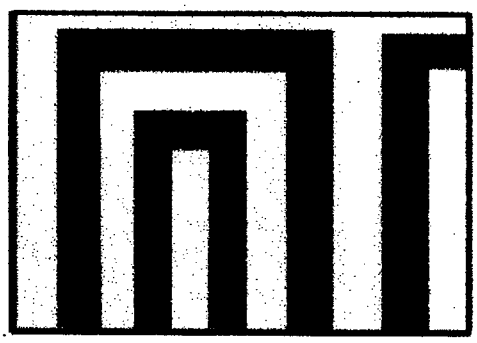


REJECTED

(a) Large patches on and between tracks.
(b) Patches showing delamination.
(c) Group of patches.
(d) Dark patches on the metallic surfaces.

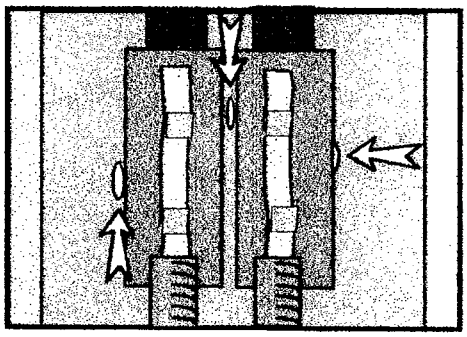
4.10.2 Bubbles

See also Para. 4.8.2, Delamination.



GOOD

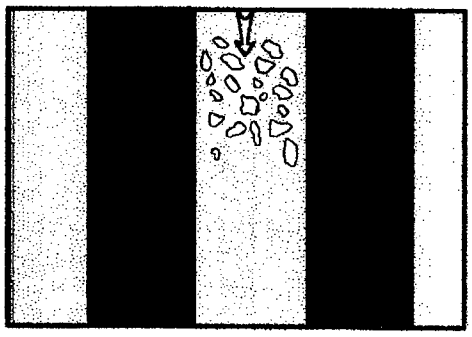
No bubble visible on the heater.



ACCEPTABLE

Bubbles coupled with metallic pad with regard to the following criteria:

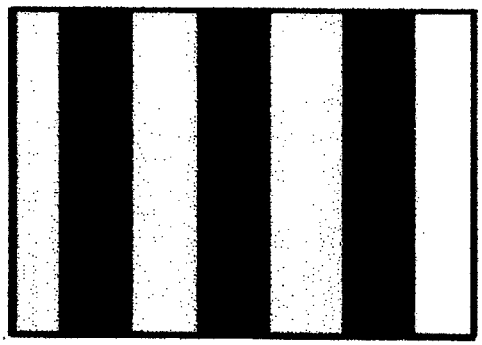
- Size: 0 up to 200µm.
- Number: 5 maximum.



REJECTED

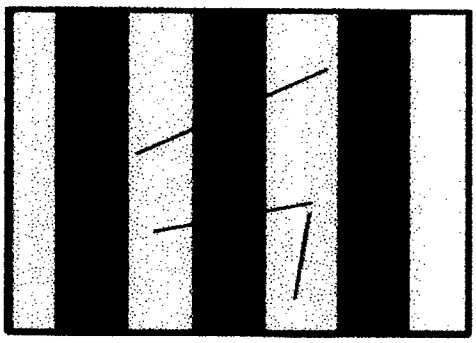
Bubbles make groups of white spots.

4.10.3 Surface Scratches



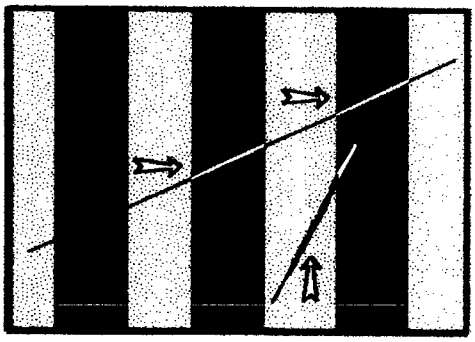
GOOD

No evidence of scratch.



ACCEPTABLE

Gentle scratches without Kapton removal or discontinuity.



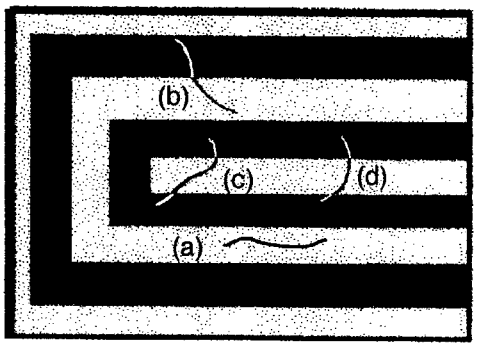
REJECTED

Deep scratches with Kapton removal.
Scratches exposing metal.

4.10.4 Non-Metallic Inclusions

GOOD

No evidence of inclusion on or between tracks.

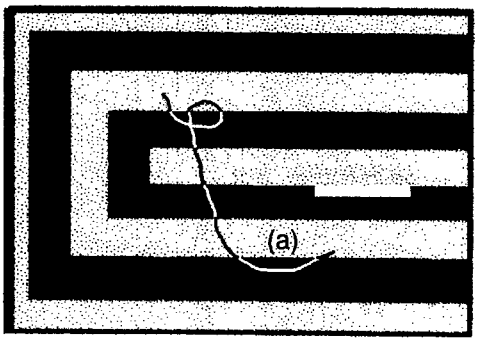


ACCEPTABLE

(a) Inclusion respecting minimum spacing.
(b) Inclusion does not make a whole bridge between two tracks (50µm respected).
(c) Discontinuous inclusions (50µm).
(d) Inclusion making a bridge between two tracks:
- Limited length (≤2mm).
- Limited number according to the heater surface.

0 up 20cm^2:
- 3 inclusions accepted by area of 10cm^2.
- 1 supplementary inclusion up 100cm^2.

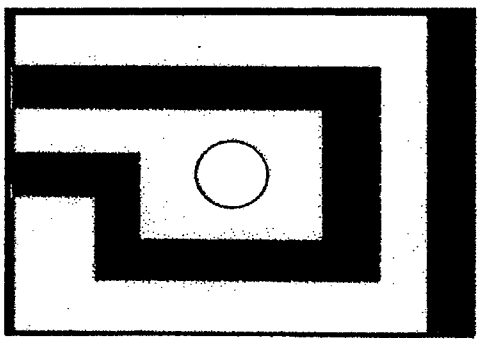
Beyond 100cm^2:
- 11 inclusions accepted.
- Proximity criterion: 3 inclusions maximum in a 2.0cm diameter circle.



REJECTED

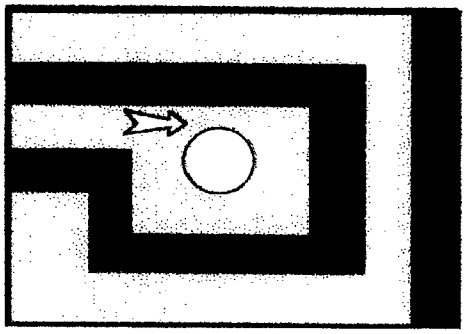
(a) Inclusion making a bridge between two tracks whose number and/or configuration are not covered by previous criteria (length >2.0mm).
(b) Bright inclusion or being reminiscent of metallic glare.
(c) Metallic inclusion.

4.11 Misregistration



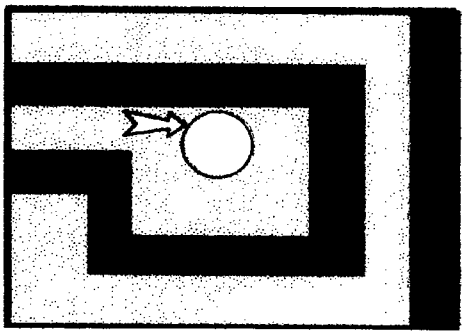
GOOD

Perforations are well centred in relation to tracks.



ACCEPTABLE

Perforations are misregistered in relation to tracks, but spacing between perforation edge/track edge is better than acceptable minimum (0.4mm).



REJECTED

Spacing between perforation edge/track edge is less than acceptable minimum (0.4mm).