

**Test Report No.:** 315G2348.001

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**Client:** Alien Technology Corporation  
845 Embedded Way  
San Jose, CA 95138 USA

**Test Item Description:** Material samples for analysis  
See material list

**Model Identification:** Higgs-Ec (ALC-380), Higgs 4 ALC-370 & Higgs 3 ALC-360 IC's  
ALN-98xx, ALN-97xx & ALN-96xx White Wet Inlays  
ALN-98xx, ALN-97xx & ALN-96xx Clear Dry Inlays

**Delivery Condition:** *apparent good*                      **Date of Receipt:** 8/4/2015

**Testing Location:** TÜV Rheinland of North America  
2709 SE Otis Corley Dr, Suite 11 Bentonville, AR 72712 USA

**Test Specification:** Directive **2011/65/EU** on the restriction of the use of certain hazardous substances in electrical and electronic equipment (**RoHS**)  
Following the guidelines for Analysis IEC 62321

**Test Result:** **The above described test object was tested and passed to the above-mentioned test specification.**

**Tested by:**

**Checked by:**



8/5/2015  
Date

Patrick Calcagni  
Laboratory Technician  
Name                      Signature

8/5/2015  
Date

Mark Smith  
Laboratory Manager  
Name                      Signature

**Other Aspects:**

Test Method: **IEC 62321:2008**

Components were evaluated using one or more of the following methods:

XOS XRF Screening, Wet chemical analysis, or Manufacturer RoHS compliance mark/documentation.

***This test report relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any safety mark on this or similar products.***

**1. Testing Date(s):**

8/5/2015 - 8/5/2015

**2. Test Results****Material List**

Material Number	Material Description
1	Higgs-Ec (ALC-380), Higgs 4 ALC-370 & Higgs 3 ALC-360 IC's
2-3	ALN-98xx, ALN-97xx & ALN-96xx White Wet Inlays
4-5	ALN-98xx, ALN-97xx & ALN-96xx Clear Dry Inlays

**XOS XRF Report matrix**

Material No.	ppm [mg/kg]				
	Cr <sup>^</sup>	Br <sup>^</sup>	Cd	Hg	Pb
1	ND	59.1	ND <5.1	ND <23.0	ND <6.4
2	ND	ND	ND <6.8	ND	ND
3	85.9	9.4	ND	ND	ND
4	ND	ND	ND <12.2	ND	ND
5	28.4	ND	ND <11.2	ND	ND

**Remark:**

- RED TEXT:** These items are inconclusive by XRF-Screening - see **Wet Chemistry Confirmation Results section**
- NT = Not Tested (Bromine in Alloys)
- ND = Not Detected (less than limits of detection)
- (WC) = See Wet Chemistry Results

	Cr	Br	Cd	Hg	Pb
<b>Limits of Detection (mg/kg)</b>	15	5	5	4	5

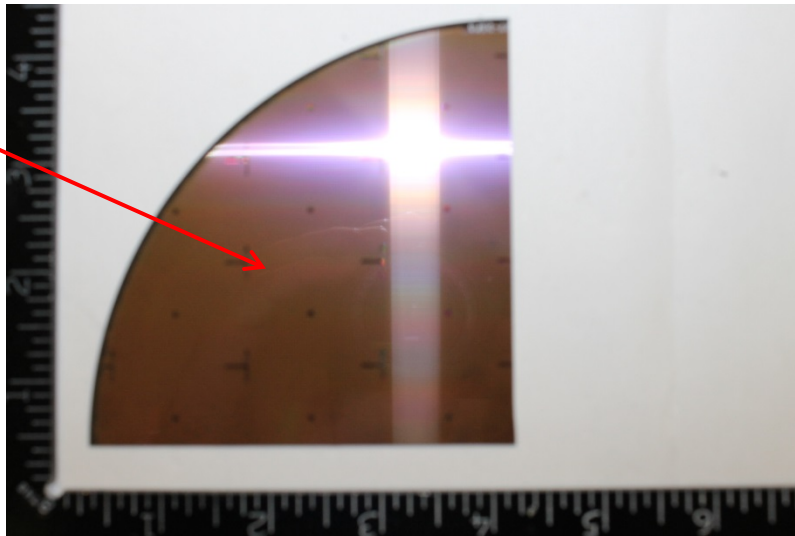
**XRF Screening limits for different matrices**

Materials	Unit(ppm)				
	Cr	Br	Cd	Hg	Pb
Metallic	P≤700<X	--	P ≤70<X≤130< F	P≤700<X≤1300<F	P≤700<X≤1300<F
Polymeric	P≤700<X	P≤300<X	P ≤70<X≤130< F	P≤700<X≤1300<F	P≤700<X≤1300<F
Electronic Components	P≤500<X	P≤250<X	P ≤40<X≤150< F	P≤500<X≤1500<F	P≤500<X≤1500<F

Instrument	Supplier/Vendor	Model / Type
X-ray Fluorescence Spectrometry	XOS	HD Prime

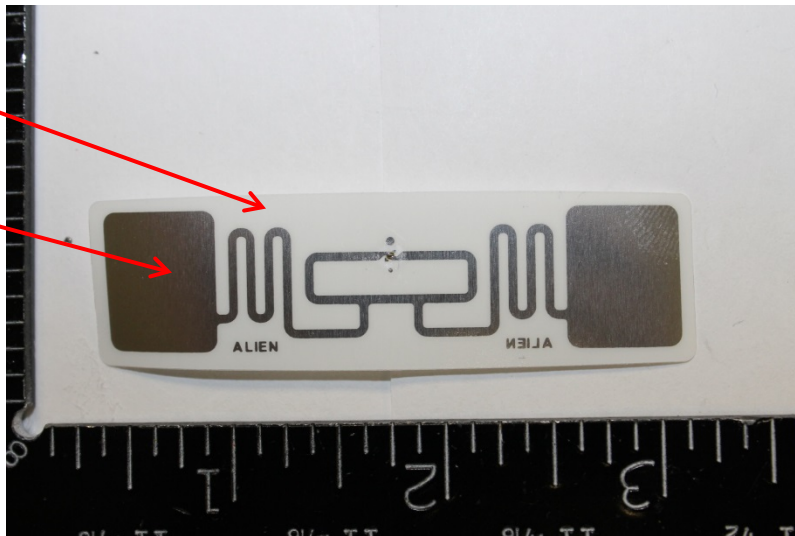
### 3. Sample Photos

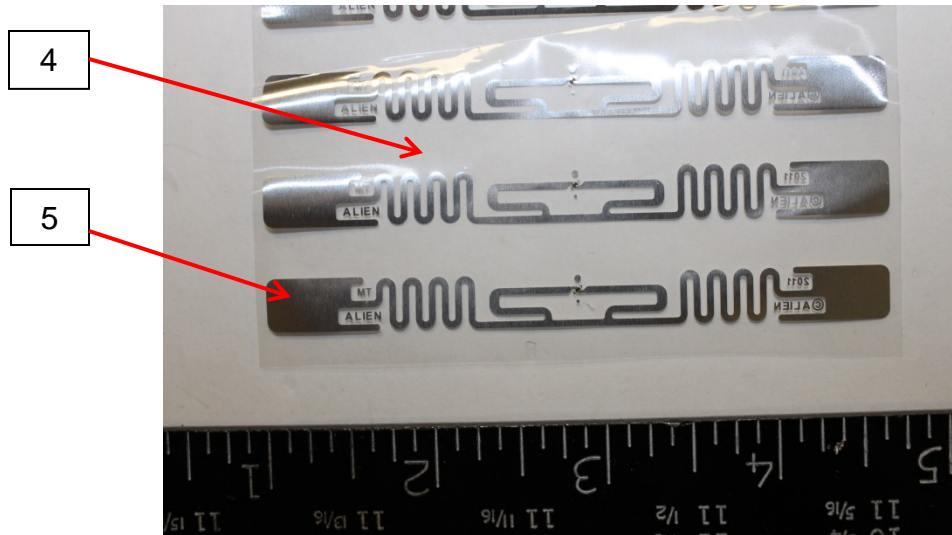
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## 4. Exemptions

### Annex III: Applications exempted from the restriction in Article 4(1)

1. Mercury in single capped (compact) fluorescent lamps not exceeding (per burner):
  - a) For general lighting purposes < 30 W: 5 mg  
Expires on 31 December 2011; 3,5 mg may be used per burner after 31 December 2011 until 31 December 2012; 2,5 mg shall be used per burner after 31 December 2012
  - b) For general lighting purposes  $\geq 30$  W and < 50 W: 5 mg  
Expires on 31 December 2011; 3,5 mg may be used per burner after 31 December 2011
  - c) For general lighting purposes  $\geq 50$  W and < 150 W: 5 mg
  - d) For general lighting purposes  $\geq 150$  W: 15 mg
  - e) For general lighting purposes with circular or square structural shape and tube diameter  $\leq 17$  mm  
No limitation of use until 31 December 2011; 7 mg may be used per burner after 31 December 2011
  - f) For special purposes: 5 mg
  - g) For general lighting purposes < 30 W with a lifetime equal or above 20 000 h: 3,5 mg  
Expires on 31 December 2017
2. Mercury in double-capped linear fluorescent lamps for general lighting purposes not exceeding (per lamp):
  - a) Tri-band phosphor lamps
    1. Tri-band phosphor with normal lifetime and a tube diameter < 9 mm (e.g. T2): 5 mg  
Expires on 31 December 2011; 4 mg may be used per lamp after 31 December 2011
    2. Tri-band phosphor with normal lifetime and a tube diameter  $\geq 9$  mm and  $\leq 17$  mm (e.g. T5): 5 mg  
Expires on 31 December 2011; 3 mg may be used per lamp after 31 December 2011
    3. Tri-band phosphor with normal lifetime and a tube diameter > 17 mm and  $\leq 28$  mm (e.g. T8): 5 mg  
Expires on 31 December 2011; 3,5 mg may be used per lamp after 31 December 2011
    4. Tri-band phosphor with normal lifetime and a tube diameter > 28 mm (e.g. T12): 5 mg  
Expires on 31 December 2012; 3,5 mg may be used per lamp after 31 December 2012
    5. Tri-band phosphor with long lifetime ( $\geq 25$  000 h): 8 mg  
Expires on 31 December 2011; 5 mg may be used per lamp after 31 December 2011
  - b) Mercury in other fluorescent lamps not exceeding (per lamp):
    1. Linear halophosphate lamps with tube > 28 mm (e.g. T10 and T12): 10 mg  
Expires on 13 April 2012
    2. Non-linear halophosphate lamps (all diameters): 15 mg  
Expires on 13 April 2016
    3. Non-linear tri-band phosphor lamps with tube diameter > 17 mm (e.g. T9)  
No limitation of use until 31 December 2011; 15 mg may be used per lamp after 31 December 2011
    4. Lamps for other general lighting and special purposes (e.g. induction lamps)

No limitation of use until 31 December 2011; 15 mg may be used per lamp after 31 December 2011

3. Mercury in cold cathode fluorescent lamps and external electrode fluorescent lamps (CCFL and EEFL) for special purposes not exceeding (per lamp):
  - a) Short length ( $\leq 500$  mm)  
No limitation of use until 31 December 2011; 3,5 mg may be used per lamp after 31 December 2011
  - b) Medium length ( $> 500$  mm and  $\leq 1500$  mm)  
No limitation of use until 31 December 2011; 5 mg may be used per lamp after 31 December 2011
  - c) Long length ( $> 1500$  mm)  
No limitation of use until 31 December 2011; 13 mg may be used per lamp after 31 December 2011
4.
  - a) Mercury in other low pressure discharge lamps (per lamp)  
No limitation of use until 31 December 2011; 15 mg may be used per lamp after 31 December 2011
  - b) Mercury in High Pressure Sodium (vapor) lamps for general lighting purposes not exceeding (per burner) in lamps with improved color rendering index  $R_a > 60$ :
    - I.  $P \leq 155$  W  
No limitation of use until 31 December 2011; 30 mg may be used per burner after 31 December 2011
    - II.  $155$  W  $< P \leq 405$  W  
No limitation of use until 31 December 2011; 40 mg may be used per burner after 31 December 2011
    - III.  $P > 405$  W  
No limitation of use until 31 December 2011; 40 mg may be used per burner after 31 December 2011
  - c) Mercury in other High Pressure Sodium (vapor) lamps for general lighting purposes not exceeding (per burner):
    - i.  $P \leq 155$  W  
No limitation of use until 31 December 2011; 25 mg may be used per burner after 31 December 2011
    - ii.  $155$  W  $< P \leq 405$  W  
No limitation of use until 31 December 2011; 30 mg may be used per burner after 31 December 2011
    - iii.  $P > 405$  W  
No limitation of use until 31 December 2011; 40 mg may be used per burner after 31 December 2011
  - d) Mercury in High Pressure Mercury (vapor) lamps (HPMV)  
Expires on 13 April 2015
  - e) Mercury in metal halide lamps (MH)
  - f) Mercury in other discharge lamps for special purposes not specifically mentioned in this Annex
  - g) Mercury in hand crafted luminous discharge tubes used for signs, decorative or architectural and specialist lighting and light-artwork, where the mercury content shall be limited as follows:
    - a) 20 mg per electrode pair + 0,3 mg per tube length in cm, but not more than 80 mg, for outdoor applications and indoor applications exposed to temperatures below 20 °C;
    - b) 15 mg per electrode pair + 0,24 mg per tube length in cm, but not more than 80 mg, for all other indoor applications.
5.
  - a) Lead in glass of cathode ray tubes
  - b) Lead in glass of fluorescent tubes not exceeding 0,2 % by weight
6.
  - a) Lead as an alloying element in steel for machining purposes and in galvanized steel containing up to 0,35 % lead by weight
  - b) Lead as an alloying element in aluminum containing up to 0,4 % lead by weight
  - c) Copper alloy containing up to 4 % lead by weight
7.
  - a) Lead in high melting temperature type solders (i.e. lead- based alloys containing 85 % by weight or more lead)
  - b) Lead in solders for servers, storage and storage array systems, network infrastructure equipment for switching, signaling, transmission, and network management for telecommunications
  - c)
    - I. Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectric devices, or in a glass or ceramic matrix compound
    - II. Lead in dielectric ceramic in capacitors for a rated voltage of 125 V AC or 250 V DC or higher
    - III. Lead in dielectric ceramic in capacitors for a rated voltage of less than 125 V AC or 250 V DC  
Expires on 1 January 2013 and after that date may be used in spare parts for EEE placed on the market before 1 January 2013
    - IV. Lead in PZT based dielectric ceramic materials for capacitors which are part of integrated circuits or discrete semiconductors

Expires on 21 July 2016

8.
  - a) Cadmium and its compounds in one shot pellet type thermal cut-offs  
Expires on 1 January 2012 and after that date may be used in spare parts for EEE placed on the market before 1 January 2012
  - b) Cadmium and its compounds in electrical contacts
9.
  - a) Hexavalent chromium as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0,75 % by weight in the cooling solution
  - b) Lead in bearing shells and bushes for refrigerant-containing compressors for heating, ventilation, air conditioning and refrigeration (HVACR) applications
11.
  - a) Lead used in C-press compliant pin connector systems  
May be used in spare parts for EEE placed on the market before 24 September 2010
  - b) Lead used in other than C-press compliant pin connector systems  
Expires on 1 January 2013 and after that date may be used in spare parts for EEE placed on the market before 1 January 2013
12. Lead as a coating material for the thermal conduction module C-ring  
May be used in spare parts for EEE placed on the market before 24 September 2010
13.
  - a) Lead in white glasses used for optical applications
  - b) Cadmium and lead in filter glasses and glasses used for reflectance standards
14. Lead in solders consisting of more than two elements for the connection between the pins and the package of microprocessors with a lead content of more than 80 % and less than 85 % by weight  
Expired on 1 January 2011 and after that date may be used in spare parts for EEE placed on the market before 1 January 2011
15. Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages
16. Lead in linear incandescent lamps with silicate coated tubes  
Expires on 1 September 2013
17. Lead halide as radiant agent in high intensity discharge (HID) lamps used for professional reprography applications
18.
  - a) Lead as activator in the fluorescent powder (1 % lead by weight or less) of discharge lamps when used as specialty lamps for diazoprinting reprography, lithography, insect traps, photochemical and curing processes containing phosphors such as SMS ((Sr,Ba) 2 MgSi 2 O 7 :Pb)  
Expired on 1 January 2011
  - b) Lead as activator in the fluorescent powder (1 % lead by weight or less) of discharge lamps when used as sun tanning lamps containing phosphors such as BSP (BaSi 2 O 5 :Pb)
19. Lead with PbBiSn-Hg and PbInSn-Hg in specific compositions as main amalgam and with PbSn-Hg as auxiliary amalgam in very compact energy saving lamps (ESL)  
Expires on 1 June 2011
20. Lead oxide in glass used for bonding front and rear substrates of flat fluorescent lamps used for Liquid Crystal Displays (LCDs)  
Expires on 1 June 2011
21. Lead and cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses
23. Lead in finishes of fine pitch components other than connectors with a pitch of 0,65 mm and less  
May be used in spare parts for EEE placed on the market before 24 September 2010
24. Lead in solders for the soldering to machine through hole discoidal and planar array ceramic multilayer capacitors
25. Lead oxide in surface conduction electron emitter displays (SED) used in structural elements, notably in the seal frit and frit ring
26. Lead oxide in the glass envelope of black light blue lamps  
Expires on 1 June 2011
27. Lead alloys as solder for transducers used in high-powered (designated to operate for several hours at acoustic power levels of 125 dB SPL and above) loudspeakers  
Expired on 24 September 2010
29. Lead bound in crystal glass as defined in Annex I (Categories 1, 2, 3 and 4) of Council Directive 69/493/EEC ( 1 )
30. Cadmium alloys as electrical/mechanical solder joints to electrical conductors located directly on the voice coil in transducers used in high-powered loudspeakers with sound pressure levels of 100 dB (A) and more
31. Lead in soldering materials in mercury free flat fluorescent lamps (which, e.g. are used for liquid crystal displays, design or industrial lighting)

32. Lead oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes
33. Lead in solders for the soldering of thin copper wires of 100 µm diameter and less in power transformers
34. Lead in cermet-based trimmer potentiometer elements
36. Mercury used as a cathode sputtering inhibitor in DC plasma displays with a content up to 30 mg per display  
Expired on 1 July 2010
37. Lead in the plating layer of high voltage diodes on the basis of a zinc borate glass body
38. Cadmium and cadmium oxide in thick film pastes used on aluminum bonded beryllium oxide
39. Cadmium in color converting II-VI LEDs (< 10 µg Cd per mm<sup>2</sup> of light-emitting area) for use in solid state illumination or display systems  
Expires on 1 July 2014
40. Cadmium in photoresistors for analogue optocouplers applied in professional audio equipment  
Expires on 31 December 2013

**Annex IV: restrictions specific to medical devices and monitoring and control instruments**

Equipment utilizing or detecting ionizing radiation

1. Lead, cadmium and mercury in detectors for ionizing radiation.
2. Lead bearings in X-ray tubes.
3. Lead in electromagnetic radiation amplification devices: micro-channel plate and capillary plate.
4. Lead in glass frit of X-ray tubes and image intensifiers and lead in glass frit binder for assembly of gas lasers and for vacuum tubes that convert electromagnetic radiation into electrons.
5. Lead in shielding for ionizing radiation.
6. Lead in X-ray test objects.
7. Lead stearate X-ray diffraction crystals.
8. Radioactive cadmium isotope source for portable X-ray fluorescence spectrometers.

Sensors, detectors and electrodes

- 1a. Lead and cadmium in ion selective electrodes including glass of pH electrodes.
- 1b. Lead anodes in electrochemical oxygen sensors.
- 1c. Lead, cadmium and mercury in infra-red light detectors.
- 1d. Mercury in reference electrodes: low chloride mercury chloride, mercury sulphate and mercury oxide.

Others

9. Cadmium in helium-cadmium lasers.
10. Lead and cadmium in atomic absorption spectroscopy lamps.
11. Lead in alloys as a superconductor and thermal conductor in MRI.
12. Lead and cadmium in metallic bonds creating superconducting magnetic circuits in MRI, SQUID, NMR (Nuclear Magnetic Resonance) or FTMS (Fourier Transform Mass Spectrometer) detectors. Expires on 30 June 2021.
13. Lead in counterweights.
14. Lead in single crystal piezoelectric materials for ultrasonic transducers.
15. Lead in solders for bonding to ultrasonic transducers.
16. Mercury in very high accuracy capacitance and loss measurement bridges and in high frequency RF switches and relays in monitoring and control instruments not exceeding 20 mg of mercury per switch or relay.
17. Lead in solders in portable emergency defibrillators.
18. Lead in solders of high performance infrared imaging modules to detect in the range 8-14 µm.
19. Lead in Liquid crystal on silicon (LCoS) displays.
20. Cadmium in X-ray measurement filters.
21. Cadmium in phosphor coatings in image intensifiers for X-ray images until 31 December 2019 and in spare parts for X-ray systems placed on the EU market before 1 January 2020.
22. Lead acetate marker for use in stereotactic head frames for use with CT and MRI and in positioning systems for gamma beam and particle therapy equipment. Expires on 30 June 2021.
23. Lead as an alloying element for bearings and wear surfaces in medical equipment exposed to ionizing radiation. Expires on 30 June 2021.
24. Lead enabling vacuum tight connections between aluminum and steel in X-ray image intensifiers. Expires on 31 December 2019.
25. Lead in the surface coatings of pin connector systems requiring nonmagnetic connectors which are used durably at a temperature below – 20 °C under normal operating and storage conditions. Expires on 30 June 2021.
26. Lead in
  - solders on printed circuit boards,

- termination coatings of electrical and electronic components and coatings of printed circuit boards,
  - solders for connecting wires and cables,
  - solders connecting transducers and sensors,
- that are used durably at a temperature below – 20 °C under normal operating and storage conditions.  
Expires on 30 June 2021.
27. Lead in
- solders,
  - termination coatings of electrical and electronic components and printed circuit boards,
  - connections of electrical wires, shields and enclosed connectors,
- which are used in
- a) magnetic fields within the sphere of 1 m radius around the isocentre of the magnet in medical magnetic resonance imaging equipment, including patient monitors designed to be used within this sphere, or
  - b) magnetic fields within 1 m distance from the external surfaces of cyclotron magnets, magnets for beam transport and beam direction control applied for particle therapy.
- Expires on 30 June 2020.
28. Lead in solders for mounting cadmium telluride and cadmium zinc telluride digital array detectors to printed circuit boards.  
Expires on 31 December 2017.
29. Lead in alloys, as a superconductor or thermal conductor, used in cryo-cooler cold heads and/or in cryo-cooled cold probes and/or in cryo-cooled equipotential bonding systems, in medical devices (category 8) and/or in industrial monitoring and control instruments. Expires on 30 June 2021.
30. Hexavalent chromium in alkali dispensers used to create photocathodes in X-ray image intensifiers until 31 December 2019 and in spare parts for X-ray systems placed on the EU market before 1 January 2020.
31. Lead, cadmium and hexavalent chromium in reused spare parts, recovered from medical devices placed on the market before 22 July 2014 and used in category 8 equipment placed on the market before 22 July 2021, provided that reuse takes place in auditable closed-loop business-to-business return systems, and that the reuse of parts is notified to the consumer. Expires on 21 July 2021.
32. Lead in solders on printed circuit boards of detectors and data acquisition units for Positron Emission Tomographs which are integrated into Magnetic Resonance Imaging equipment. Expires on 31 December 2019.
33. Lead in solders on populated printed circuit boards used in Directive 93/42/EEC class IIa and IIb mobile medical devices other than portable emergency defibrillators. Expires on 30 June 2016 for class IIa and on 31 December 2020 for class IIb.
34. Lead as an activator in the fluorescent powder of discharge lamps when used for extracorporeal photopheresis lamps containing BSP (BaSi 2 O 5 :Pb) phosphors. Expires on 22 July 2021.
35. Mercury in cold cathode fluorescent lamps for back-lighting liquid crystal displays, not exceeding 5 mg per lamp, used in industrial monitoring and control instruments placed on the market before 22 July 2017.  
Expires on 21 July 2024.
36. Lead used in other than C-press compliant pin connector systems for industrial monitoring and control instruments.  
Expires on 31 December 2020. May be used after that date in spare parts for industrial monitoring and control instruments placed on the market before 1 January 2021.
37. Lead in platinized platinum electrodes used for conductivity measurements where at least one of the following conditions applies:
- a) wide-range measurements with a conductivity range covering more than 1 order of magnitude (e.g. range between 0.1 mS/m and 5 mS/m) in laboratory applications for unknown concentrations;
  - b) measurements of solutions where an accuracy of +/- 1 % of the sample range and where high corrosion resistance of the electrode are required for any of the following:
    - i. solutions with an acidity < pH 1;
    - ii. solutions with an alkalinity > pH 13;
    - iii. corrosive solutions containing halogen gas;
  - c) measurements of conductivities above 100 mS/m that must be performed with portable instruments.
- Expires on 31 December 2018
38. Lead in solder in one interface of large area stacked die elements with more than 500 interconnects per interface which are used in X-ray detectors of computed tomography and X-ray systems.  
Expires on 31 December 2019. May be used after that date in spare parts for CT and X-ray systems placed on the market before 1 January 2020.'
39. Lead in micro-channel plates (MCPs) used in equipment where at least one of the following properties is present:
- a) a compact size of the detector for electrons or ions, where the space for the detector is limited to a maximum of 3 mm/MCP (detector thickness + space for installation of the MCP), a maximum of 6 mm in total, and an alternative design yielding more space for the detector is scientifically and technically impracticable;
  - b) a two-dimensional spatial resolution for detecting electrons or ions, where at least one of the following applies:



- i. a response time shorter than 25 ns;
  - ii. a sample detection area larger than 149 mm<sup>2</sup>;
  - iii. a multiplication factor larger than  $1,3 \times 10^3$ .
- c) a response time shorter than 5 ns for detecting electrons or ions;
- d) a sample detection area larger than 314 mm<sup>2</sup> for detecting electrons or ions;
- e) a multiplication factor larger than  $4,0 \times 10^7$ .
- The exemption expires on the following dates:
- (a) 21 July 2021 for medical devices and monitoring and control instruments;
  - (b) 21 July 2023 for in-vitro diagnostic medical devices;
  - (c) 21 July 2024 for industrial monitoring and control instruments.
40. Lead in dielectric ceramic in capacitors for a rated voltage of less than 125 V AC or 250 V DC for industrial monitoring and control instruments.  
Expires on 31 December 2020. May be used after that date in spare parts for industrial monitoring and control instruments placed on the market before 1 January 2021.
41. Lead in solders and termination finishes of electrical and electronic components and finishes of printed circuit boards used in ignition modules and other electrical and electronic engine control systems, which for technical reasons must be mounted directly on or in the crankcase or cylinder of hand-held combustion engines (classes SH:1, SH:2, SH:3 of Directive 97/68/EC of the European Parliament and of the Council  
Expires on 31 December 2018

**-End of Report-**