1.9 Attachment: Application Form

Exemption Request Form

Date of Submission: January 6, 2020

1. Name and contact details

1) Name and contact details of applicant:

Company: Bourns Inc. Telephone: 951-781-5008
Name: Cathy Godfrey email: cathy.godfrey@bourns.com
Function: Corporate EHS Manager Address: 1200 Columbia Ave., Riverside, CA USA

2) Name and contact details of responsible person for this application (if different from above):

Same as above

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2. Reason for application:

Please indicate where relevant:

○ Request for new exemption in:

○ Request for amendment of existing exemption in

● Request for extension of existing exemption:

○ Request for deletion of existing exemption in:

○ Provision of information referring to an existing specific exemption in:

● Annex III ○Annex IV

No. of exemption in Annex III or IV where applicable: 7a

Proposed or existing wording: __existing wording___

"Lead in high melting temperature type solders (i.e. lead-based alloys containing 85 % by weight or more lead)"

Duration where applicable: standard extension at minimum

○ Other:

3. Summary of the exemption request / revocation request

Bourns, Inc. respectively requests to extend the current exemption 7a, lead in high melting temperature (LHMP) type solders. Bourns continues to research and monitor potential alternatives to the lead-containing high melting temperature solders. With a multitude of applications and specific requirements/specifications of our customers, no single lead-free solution has been identified. Applications where simple substitutions were possible have already occurred. Any potential alternatives require material development, evaluation, internal process and product qualification and reliability testing to guarantee product reliability. Lead-containing solders have been used for over 50 years; the years of experience and data are well documented. More time is needed to understand lead-free solders or other alternatives and their reliability especially in critical safety applications. Many of our customers including aerospace, automotive and military mandate high temperature solders with melting points above 300C in components they use in their end products. Reliability is crucial. A recent Internet search for alternatives for high temperature solders does not show many new options from four years ago. Various solder suppliers' websites offer their potential solutions. Bourns continues to work with suppliers and their options but, in many cases, just a review of the properties and characteristics do not provide the attributes needed to work with our product's functional type and specifications.

Semiconductor products use high-lead solder as a die attach material and/or internal electrical interconnections within components including diodes, transistors, clip bonding of discrete devices and for surface mount and insertion components due to excellent wettability, reliability due to ductility and no re-melting during PCB reflow process. Many of these devices have essential safety purposes in many applications including the automotive industry. The unique properties such as the high melting point and thermal conductivity of the high-lead alloys are necessary for the level of reliability required. Potential substitute reliability issues include voiding/cracking/disruption after stress, growth of brittle intermetallics at high temperature and disruption during temperature cycling. Some alternative solders such as zinc, bismuth or tin/ antimony-based solder have limited experience on reliability.

Specific examples include:

- Electro-Static Discharge (ESD) Protection for appliances, computers, consumer electronics, general purpose ESD protection, high speed communication ports (such as USB 3.0, IEEE1394, HDMI, Gb Ethernet), fast communication ports (such as USB 1.1, 10/100b Ethernet ports); RS232, RS422 & RS485 type applications;
- Surge Protection for Central office POTS, access equipment POTS, fibre to the home, xDSL and integrated linecards, PABx protection, VOIP protection, xDLS modem protection, ISDN linecards and NT equipment, V.92 modems, cordless DECT and analog phones, set top boxes;

- LED shunt protectors for LED streetlights, avionics lighting, high-bay industrial lighting, intrinsically safe lighting, low maintenance lighting;
- SIP and DIP Resistor Networks used in access equipment, barcode scanners, cable boxes, computer peripherals, consumer electronics, data communications, fax equipment, modems, monitoring equipment, portable power generators, satellite systems, telecom switching devices and test equipment;
- Transient voltage suppressor (TVS) diodes used in appliances, portable electronics, desktop PCs & notebooks, digital cameras, base stations, port protection (USB1.0, 1.1, 2.0, 3.0, RS-485, Ethernet, RS-232, RS-422, etc).
- Power TVS - AC & DC power supplies used in telecom and other exposed applications often require protection against hostile events such as a power line surge and indirect lightning strikes. Avoiding damage to the power supply by limiting the peak surge voltage to an acceptable level without short-circuiting the line for an extended period of time is crucial to minimizing downtime of critical systems. Other applications include wireless base stations, photovoltaic systems, street lighting, process control equipment and surge protection devices (SPD).
- Overcurrent and overvoltage protection for automobile applications including window regulators, powerbus (mode protection), DC motor applications, car alarm systems, power steering motors, GPS shark fin antennae, cooling and HVAC systems, electronic control unit (ECU) input/output protection, load dump and other transient voltage protection, infotainment, telematics and navigation input/output protection.

A cost friendly and high-melting point solder for semiconductor components has not been identified at this time. We continue to work with suppliers for potential alternative materials or processes. With the numerous individual applications, it is difficult to find one suitable substitute.

Examples of supplier sources are included here for review:

Heraeus Products:
https://www.heraeus.com/media/media/het/doc_het/products_and_solutions_het_documents/adhesives_docs/FirstSpirit_1461048855943Brochure_Power_and_Discrete.pdf

Ametek Products:
https://www.ametek-ecp.com/resources/blog/2018/may/what-are-the-best-materials-for-high-temperature-soldering

4. Technical description of the exemption request/revocation request

(A) Description of the concerned application:

1. To which EEE is the exemption request/information relevant?

   Name of applications or products: Listed are electronic components used as subcomponents in various categories of EEE. Components include Transient Voltage Suppressor Diodes, Fast Response Rectifier Diodes, High Voltage Rectifier Diodes, Schottky Barrier Rectifier Diodes, Power TVS Diodes, Telecom CPTC Resettable Fuses, Thick Film Molded DIP/SIP, Thin Film Molded SIP, Thin Film Wide Body Gull Wing Resistor Network,

Thick Film Surface Mounted Body Wide Resistor Network, Thyristor Surge Protector (SMA and SMB packages), Telecom Ceramic PTC Resettable Fuse, Fast Acting Precision SMD fuse, Single Blow Fuse for Overcurrent Protection, High Inrush SMD Fuse, Telecom Protectors – High Surge, Time Lag & Low Power SMD fuse. These electronic components are typically used on circuit boards and other internal electronics of the various categories used by our customers.

a. List of relevant categories: possibly 1-11 depending on EEE manufacturer using electronic components as part of their assembly.

b. Please specify if application is in use in other categories to which the exemption request does not refer: N/A

c. Please specify for equipment of category 8 and 9.

   Bourns does not manufacture equipment; components may be used by manufacturers of categories 8 and 9.

2. Which of the six substances is in use in the application/product?

   ●Pb ○Cd ○Hg ○ Cr-VI ○PBB ○PBDE

3. Function of the substance: High temperature Pb-containing (>85%) solder

4. Content of substance in homogeneous material (% weight): 88 - 95.5%

5. Amount of substance entering the EU market annually through application for which the exemption is requested:

   Name of material/component: High temperature solders used in:

   Passive electronic components Transient Voltage Suppressor Diodes, Fast Response Rectifier Diodes, High Voltage Rectifier Diodes, Schottky Barrier Rectifier Diodes, Power TVS Diodes, Telecom CPTC Resettable Fuses, Thick Film Molded DIP/SIP, Thin Film Molded SIP, Thin Film Wide Body Gull Wing Resistor Network, Thick Film Surface Mounted Body Wide Resistor Network, Thyristor Surge Protector (SMA and SMB packages), Telecom Ceramic PTC Resettable Fuse, Fast Acting Precision SMD fuse, Single Blow Fuse for Overcurrent Protection, High Inrush SMD Fuse, Telecom Protectors – High Surge, Time Lag & Low Power SMD fuse.

   A majority of Bourns components are sold by distribution; it is not known exactly the amount of high temperature Pb solder entering the EU per total components sold. Approximately 117M components containing a high temperature solder were sold in 2014. The total lead content of these 117M parts collectively is approximately 77g. The average weight of the components is 0.37g. New products have been added to the catalog

some replacing prior models, some used in new applications as the product lines have expanded.

6. Environmental Assessment:

   LCA: Yes

   A search for recent LCA documentation regarding lead usage did not reveal new information. The LCA used for this review is the EPA document (EPA-744-S-05-001, August 2005) *Solders in Electronics: A Life-Cycle Assessment Summary*. This study evaluated both lead-based and lead-free solder alternatives. Although no high temperature solders were in the evaluation, Sn63Pb37, was included with alternatives SnCu, SnAgCu, BiSnAg and SnAgBiCu. Comparisons of lead-based and lead-free environmental and occupational/health impacts are evaluated. Various impact categories are used including non-renewable resource use, renewable resource use, energy use, global warming, ozone depletion, acidification, water quality, aquatic ecotoxicity, occupational health for both cancer and non-cancer and public human health for cancer and non-cancer. There is no real winner in the environmental or health category as each type of solder has its impacts.

   The complete document, executive summary and various sections can be found at the EPA's website: https://www.epa.gov/sites/production/files/2013-12/documents/lead_free_solder_lca_full.pdf

   The US Center for Disease Control includes worker exposure to lead as a health impact. Activities such a lead smelting and refining, foundry working, soldering, steel welding and cutting operations, battery manufacturing plants and lead compound manufacturing industries are some occupations that could result in workplace exposure typically by breathing lead particles. The International Agency for Research on Cancer (IARC) has determined that inorganic lead is probably carcinogenic to humans. The Agency for Toxic Substances & Disease Registry (ATSDR) recently published a ToxGuide for lead which mentions the use of solder as a potential exposure source.
   https://www.atsdr.cdc.gov/toxguides/toxguide-13.pdf

   Other substances including silver, copper and tin also have hazard characteristics. ATSDR's fact sheets have not been updated in recent years. Similar documents still agree with the information provided for silver, copper and tin. Current links follow each element.

   Silver inhalation can result in breathing issues, lung and throat irritation and digestive issues. Skin contact can cause allergic reactions such as rash, swelling and inflammation. Long term exposure can result in arygria, a blue-gray discoloration of skin and body tissues.
   https://www.atsdr.cdc.gov/phs/phs.asp?id=537&tid=97

High copper exposures can cause liver and kidney damage and even death. Other lesser exposures to copper dust can irritate the respiratory system, cause headaches, dizziness, nausea and diarrhea. Drinking water with high levels of copper may cause vomiting, diarrhea, stomach cramps, and nausea.
https://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=37

Large amounts of tin can cause digestive issues, anemia, and liver and kidney problems. Breathing or swallowing organotin compounds can cause breathing problems and eye irritation and can interfere with the way the brain and nervous system works. Rats and mice exposed to organotin compounds showed reproduction problems and development issues of young.
https://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=98

The current USGS Mineral Commodity Summaries 2019 report show the current world reserves. The report states reserve data are dynamic and considered working inventory. The reserves data does indicate there is no real shortage of the metals of discussion.

Metal	World Reserves (thousand metric tons) 2019
Antimony	1,500,000
Bismuth	Not available
Copper	830,000
Tin	4,700,000
Indium	Not available
Silver	560,000
Lead	83,000

http://prd-wret.s3-us-west-2.amazonaws.com/assets/palladium/production/atoms/files/mcs2019_all.pdf

To summarize, lead and alternatives all have their environmental/health impacts. Fortunately, worker exposure can be mitigated through safe work practices and engineering controls. Resources are not infinite. There are trade-offs with all choices.

(B) In which material and/or component is the RoHS-regulated substance used, for which you request the exemption or it revocation? What is the function of this material or component?

Lead as in exemption 7a is the regulated substance in question. High temperature solders are used in many applications and equipment. Electronic components for some applications require a solder that can perform well in harsh environments. Some applications, such as Automotive, may have safety concerns with failure.

(C) What are the characteristics and functions of the RoHS-regulated substance that require its use in this material or component?

High temperature solders (>85% Pb) are used in electronic components to maintain the integrity of the joints between the die and leadframe at the board level assembly. The softening temperature must be no lower than 260C; there must be good thermal fatigue resistance; good wettability and ductility. Other factors include the manufacturability, reliability factors in a harsh environment and cost effectiveness. For lead-containing solders, the historical data of over 50 years of usage provides proven reliability.

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5. Information on possible preparation for reuse or recycling of waste from EEE and on provisions for appropriate treatment of waste

1) Please indicate if a closed loop system exist for EEE waste of application exists and provide information of its characteristics (method of collection to ensure closed loop, method of treatment, etc.)

   Electronic components alone are not typically listed as EEE. These components are subassembly parts used to build the inner electronics workings of specific EEE. Electronic components at end of life are typically classified as electronic waste. In the US, the EPA classifies electronic waste as universal waste and requires specific handling. It is unknown the methods of handling/treatment globally.

2) Please indicate where relevant: All answers may be applicable for various EEE manufacturers.

   ● Article is collected and sent without dismantling for recycling (example: electronic waste) or

   ● Article is collected and completely refurbished for reuse (components as a part of the EEE article), or

   ● Article is collected and dismantled (components as a part of the EEE article), or:

      ○ The following parts are refurbished for use as spare parts: ___
      ○ The following parts are subsequently recycled: ____

   ● Article cannot be recycled and is therefore (components as a part of an EEE article that is not recyclable)

      ○Sent for energy return
      ○ Landfilled

3) Please provide information concerning the amount (weight) of RoHS substance present in EEE waste accumulates per annum:

○ In articles which are refurbished	unknown since Bourns is not the end user
○ In articles which are recycled	unknown since Bourns is not the end user
○ In articles which are send for energy return	unknown since Bourns is not the end user
○ In articles which are landfilled	unknown since Bourns is not the end user

6. Analysis of possible alternative substances

(A) Please provide information if possible alternative applications or alternatives for use of RoHS substances in application exist. Please elaborate analysis on a life-cycle basis, including where available information about independent research, peer-review studies development activities undertaken:

(B) Please provide information and data to establish reliability of possible substitutes of application and or RoHS materials in application

(A)+(B) discussion: High temperature solders are used in many components including aerospace, military and automotive applications. Components must be able to survive in harsh high temperature environments. The automotive engine compartments are more compact increasing the compartment temperature. Modules are now installed near the point of use requiring higher temperature solders. Components containing high lead solder are reflowed up to 260C without melting the inner component solder which will soften at about 300C. Semiconductor-type devices require these high temperature solders to maintain the integrity of the joint between the die and leadframe at board level assembly.

PTC fuses are also used in automotive, medical and industrial applications. These fuses may be used to protect battery packs whether in an electrical car or a cell phone from an overcurrent situation. The fuses are typically used in a harsh, extreme heat environment. The solders must have properties to protect the solder from melting thereby creating a failure situation.

Research papers and journal articles discussing this issue with many alternatives are available on the internet although not much current information. These alternatives are compared to lead-based high temperature solders based on reliability, manufacturability, cost and environmental factors. There is no drop-in solution or a one-size-fits-all solution. Any change will take research, testing, final qualification, process changes, etc. for each specific application. Potential substitutes in these articles do not yet meet all the positive characteristics of lead-based high temperature solders that are cost-effective. There may be one or more alternatives to address each individual application. It appears at this time, there may be solutions but, most likely, the solutions will not be identified, tested, qualified and adapted to the process in the early 2020-21 time frame.

Reviewed literature includes:

Review of High-Lead Solder and Lead-Glass RoHS Exemptions
http://rohs.exemptions.oeko.info/fileadmin/user_upload/Stakeholder_comments/Exemption-7a_5_Pecht_Uni_Maryland_25_March_2008.pdf

High Lead Solder (over 85%) Solder in the Electronics Industry; RoHS Exemptions and Alternatives
https://www.researchgate.net/publication/276534201_High_lead_solder_over_85_solder_in_the_electronics_industry_RoHS_exemptions_and_alternatives

High Melting Lead-Free Mixed BiAgX Solder Paste System
http://www.globalspec.com/Indium/ref/high_melting_leadfree_mixed_biagx_solder_paste_system_98747_r0.pdf

Additional Exemptions from the RoHS Directive needed by the Medical Industry
https://cocir.org/fileadmin/5.5_Policies_Environment/cobham_era_report_on_rohs_exemptions_for_medical_devices_sept_2009.pdf

7. Proposed actions to develop possible substitutes

(A) Please provide information if actions have been taken to develop further possible alternatives for the application or alternatives for the application or alternatives for RoHS substances in application.

The applications where SnPb solders can be converted to a non-leaded solder have already taken place. We are still researching and testing alternative solders or processes to eliminate the high temperature solder in some cases. We are currently working with a solder supplier testing a potential alternative. This information is proprietary at this time. This is for a specific product line and may not be a solution for our other product lines. Component manufacturers still need to supply their customers with parts that work for their applications. If automotive, aerospace, military and other manufacturers require specific materials for their applications, Bourns as a supplier, will find it necessary to continue to meet specifications and requirements. Some actions on the component level will depend on the higher level needs.

(B) Please elaborate what stages are necessary for establishment of possible substitute and respective timeframe needed for completion of such stages.

As a component manufacturer, research and internal testing will continue. We continue to work with our customers to meet their requirements. Some legacy products may be phased out over time as technological advances in components occur.

8. Justification according to Article 5(1)(a):

(A) Links to REACH: (substance + substitute)

1) Do any of the following provisions apply to the application described under (A) and (C)?

○ Authorisation

- ● SVHC (lead)
- ○ Candidate list
- ○ Proposal inclusion Annex XIV
- ○ Annex XIV

○ Restriction

- ○ Annex XVII
- ○ Registry of intrusions

○ Registration

2) Provide REACH-relevant information received through the supply chain.

Name of document:

REACH declaration: Kester Solder example
https://www.kester.com/DesktopModules/Bring2mind/DMX/Download.aspx?EntryId=6788&PortalId=0&DownloadMethod=attachment

(B) Elimination/substitution:

1. Can the substance named under 8(A)1 be eliminated?

○ Yes. Consequences? _____

● No. Justification: Still need to meet customer specifications for automotive, medical, and industrial applications used in harsh environments.

2. Can the substance named under 8(A)1 be substituted?

○ Yes.

- ○ Design changes:
- ○ Other materials:
- ○ Other substance:

● No: Justification: For components discussed earlier, no suitable substitute is available at this time.

3. Give details on the reliability of substitutes (technical date + information): _N/A___

4. Describe environmental assessment of substance from 8(A)1 and possible substitutes with regard to:
    1) Environmental impacts: _ discussed in Section 4(A)(6)
    2) Health impacts: discussed in Section 4(A)(6)_____
    3) Consumer safety impacts: discussed throughout regarding automotive, industrial, medical and overcurrent protection devices used in many devices.

→ Do impacts of substitution outweigh benefits thereof?
Please provide third-party verified assessment on this: ____

(C) Availability of substitutes: N/A
a) Describe supply sources for substitutes:
b) Have you encountered problems with the availability? Describe: ___
c) Do you consider the price of the substitute to be a problem for the availability?

In some cases, yes. Solders with high gold content are typically high priced. For example, if a gold material was a potential substitute, it may drive the cost of the finished component up where it is difficult to be competitive. Equipment and/or process changes may also be necessary which is unknown at this time. There are also some disadvantages such as low ductility and low melting point compared to LHMP solders.

● Yes ○ No

d) What conditions need to be fulfilled to ensure the availability? _____

(D) Socio-economic impact of substitution:

→ What kind of economic effects do you consider related to substitution:

○ Increase in direct production costs
○ Increase in fixed costs
○ Increase in overhead
○ Possible social impacts within the EU
○ Possible social impacts external to the EU
○ Other: unknown

→ Provide sufficient evidence (third-party verified) to support your statement: ___

9. Other relevant information

Please provide additional relevant information to further establish the necessity of your request:

Critical components used in automotive, medical and some industrial applications are used in harsh environments. To maintain reliability of these parts, to date, high temp solders are still required to meet customer requirements.

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10. Information that should be regarded as proprietary

Please state clearly whether any of the above information should be regarded to as proprietary information. If so, please provide verifiable justification: N/A