1.9 Attachment: Application Form

Exemption Request Form

Date of Submission: January 3, 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: 7c-I

Proposed or existing wording: Existing wording

Duration where applicable: Maximum validity period

○ Other:

3. Summary of the exemption request / revocation request

Bourns, Inc. respectively requests to extend the current exemption 7c-I, *Electrical and electronic components containing lead in a glass and/or ceramic other than dielectric ceramic in capacitors...* Bourns continues to research and monitor potential alternatives to lead-containing glass in thick film inks/glazes used in electronic components. Thick film is a resistive and conductive film greater than 0.0001" thick resulting from firing a paste or ink that has been deposited on a ceramic substrate. These thick film inks typically contain a glass material that may include lead. With a multitude of applications and specific requirements of our customers, no single lead-free solution has been identified for all resistance values of the components. Applications where simple substitutions were possible have already been implemented. Any potential alternatives require material development, evaluation, internal process and product qualification and reliability testing to guarantee product reliability. Research has continued since the last application in January 2015. New regulations including 2017/745 Medical Devices Regulation (MDR) creates additional considerations when researching alternatives to lead-containing glass in electronic components and potential end-user applications.

Lead-containing glass frits have several applications including barrier layers for stopping the migration of silver and a sealing material for hermetic packages. Glasses are typically part of a thick film formulation. Various oxides are melted together to form a glass matrix. It is also used as a sealant in hermetic ceramic and metal electronic (semiconductor and hybrid) component packages. The lead oxide is used to lower melting temperature and viscosity for processing below 550C and to raise dielectric strength. The lead oxide content of the glass can be adjusted controlling the coefficient of thermal expansion which is favorable for high sintering temperature operations. Bourns has been experimenting with various non-lead glass formulations. While success for low to mid-level resistance values have been implemented on some individual models, other potential alternatives are still in the design/test stage. It is not a one size fits all application. Bourns continues to experiment with potential alternatives but, to date, the current exemption 7c-I is still necessary to provide components with property requirements to meet industry needs. Therefore, Bourns is requesting the current exemption to be extended for the maximum validity period.

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 Chip Arrays, Chip Resistors, ESD protectors, Transient Voltage Suppressor Diodes, Encoders, Fuelcards, Ceramic PTC Resettable Fuses, Thick Film Molded DIPs, Panel Controls, Power Resistors, Trimming Potentiometers. These electronic components are typically used on circuit

boards and other internal electronics of the various categories 1-11 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: Bourns as a component manufacturer does not know all our customers' end use. We believe the end use may fall into all Categories 1-11.

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

Bourns does not manufacture equipment; Bourns components may be used by medical device or other monitoring/control instruments 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: The current exemption 7c-I states "Electrical and electronic components containing lead in glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound."

- Many of our parts fall into the lead in a glass matrix compound application including: Transient Voltage Suppressor Diodes, High Voltage Rectifier Diodes, Fast Response Rectifies Diodes, Bridge Rectifier Diodes, Schottky Barrier Rectifier Chip Diodes. These may contain lead in the glass passivation of semiconductor chips. Some magnetic components using ferrite cores (ceramic) may also contain lead in the glass portion of the core. Other application may include glass sealants.
- Lead-containing glass as part of thick film inks or encapsulating materials are used on ceramic substrates or organic substrates. There are many applications using the lead-containing glasses. Many of Bourns products fall into glass on ceramics category such as Bourns': PTC Resettable fuses and Thick film technology (Bourns Chip arrays, Chip Resistors, TF Molded DIPS, TF Molded SIPS, TF Surface Mount Wide Body (SOL), TF Surface Mount Medium Body (SOM), TF Conformal SIP, Power Resistors, Encoders, Panel Controls, Precision Potentiometers, Trimming Potentiometers, ESC Protector Arrays, Fuel Cards.
- These examples represent the majority of lead-containing glasses used for Bourns but there are other minor applications that fall under 'lead in glass or ceramic matrix.'

It is impossible for Bourns to know all the potential applications used by our customers. Lead continues to be used due to the favorable specific properties and characteristics in electronic components.

4. Content of substance in homogeneous material (% weight): The homogeneous material is the glass included in the thick film ink or encapsulation (homogeneous material) which is then fired on a substrate. The lead content will vary and can range from 1-75% of the glass only as a homogeneous material. The total ink/encapsulation including the glass is generally <1% of the finished part.

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

   Name of material/component: components using a thick film ink or encapsulation glaze that includes a lead-containing glass matrix.

   Passive electronic components Chip Arrays, Chip Resistors, ESD protectors, Transient Voltage Suppressor Diodes, Encoders, Fuel cards, Ceramic PTC Resettable Fuses, Thick Film Molded DIPs, Panel Controls, Power Resistors, Trimming Potentiometers, Fuel Cards.

   With the wide use of applications for electronic components, subassemblies containing electronic components and finished products containing electronic components, it is not possible for Bourns to determine the total amount of lead in glass for all products entering the EU market. Bourns' usage of lead in glass is for specific electronic components as mentioned in question 3. Once our parts are sold either directly or through distribution, we do not have information on how all parts are used. Bourns' parts are not finished parts but used in the assembly of other goods such as cell phones, computers and even automobiles. Bourns cannot determine where all global parts that claim exemption 7c-I are used and the final destination of that finished product. Further, the end products that use these parts may not be under the RoHS scope. There may be other applications using this exemption that are out of the scope of the Bourns' customer base. There are just too many unknowns to provide a good estimate.

6. Environmental Assessment:

   Life Cycle Analysis (LCA): Not specifically for lead-containing glass.

   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. There is not enough test data for organic lead sources to identify as a probably carcinogen to humans.
   http://www.atsdr.cdc.gov/sites/toxzine/docs/lead_toxzine.pdf
   Fortunately, worker exposure can be mitigated through safe work practices and engineering controls.

Other agencies such as California's Proposition lists lead as a substance known to the State of California to cause cancer. This regulation requires a warning and notice to consumers.

Another published LCA is discussed in Section 6A.

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

Lead in exemption 7c-I is the regulated substance in question. Glass frit is a substance in thick film inks used for electronic circuitry. The glass portion is comprised of vitrified oxides forming a glass matrix. The functions of the glass include a barrier to prevent the migration of silver; a sealing material for hermetic ceramic and metal component packages (semiconductors and hybrids); control for coefficient of thermal expansion used for high sintering operations; resistance to corrosion; wettability traits with ceramics and metals which improves adhesion. The number of applications using lead in glass is too numerous to list given the numerous end users and their individual applications.

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

Lead oxide as part of a glass matrix is used to lower melting temperatures and viscosity for processing below 550C and to raise dielectric strength. Lead in glaze is used for passivation of thick film resistors for some legacy products that are targeted for phase out in the next 5 years. Glass is used as a sealant in hermetic ceramic and metal electronic (semiconductor and hybrid) component packages. Adjusting the amount of lead oxide in the glass allows control of the coefficient of thermal expansion. Other properties discussed in (B) in lead-containing glass make a more durable product in humidity, electrical and chemical stability function, protection in adverse environments.

Aside from electronic component usage, lead oxide is also used in solar cells; it acts as catalyst for contact formation between silver and silicon. The link below from March 2008 still holds true. Literature states that there is no commonly available and cost-effective substitute with the positive attributes of lead-containing glass materials.

http://rohs.exemptions.oeko.info/fileadmin/user_upload/Stakeholder_comments/Exemption-7a_5_Pecht_Uni_Maryland_25_March_2008.pdf

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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 a subassembly part used to build the inner electronic workings of specific EEE within a countless variety of end-use applications. 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. Regulatory requirements in the EU include Directive 2019/19/EU on Waste Electrical & Electronic Equipment (WEEE) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0019&from=EN.

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

   Typically, electronic components (with and without lead-glasses) are within electronic equipment. The equipment is subject to recycling, dismantling, landfilled, etc.

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

   ○ In articles which are refurbished unknown

   ○ In articles which are recycled unknown

   ○ In articles which are send for energy return unknown

   ○ In articles which are landfilled unknown

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:

For a few Bourns applications, lead-free glasses have been developed internally. These glass formulations are proprietary. These limited solutions do not solve the lead-glass issue in all applications. Obviously, any successful substitution will be used to eliminate lead in glass when possible. The majority of potential alternatives are still in the research stage. Research requires studying published information and reviewing potential substances new to our product line for possible trial. Many times, these trials are not productive. It is a lengthy process to identify potential solutions, testing on a small-scale basis, testing on a larger scale, qualification with reliability checks. The test phase is trial and error taking an unspecified amount of time. To date, our internal analysis as well as published information states more time is needed to find suitable substitutes. Unfortunately, the successes to date may solve an issue for one or two specific models only. The typical successes do not necessarily transfer to other applications. Many of our parts that currently use exemption 7c-I are not trimming potentiometers, therefore, do not qualify for exemption 34 use.

Within our Trimming Potentiometer product line, our research team has developed lead-free thick film inks for low to mid-range resistance values for some applications. Some of these applications fall under cermet-based element category, but not all. The challenge is the higher end resistance values which we continue to find a suitable solution with suitable properties. Since some inks are developed specifically for one model; there is not a typical upper limit with the lead-free inks. These ink systems are used on the Trimming Potentiometer products only. Within this family, there are still some models where a solution is yet to be qualified for all resistance values. These inks do not solve the lead in glass issue for all Bourns' parts. Bourns has many trimmers of various sizes and electrical/environmental characteristics. Their application depends on the end user's need and the form, fit and function of their end products. We are working on these one by one but will take time for development, testing, notification when and if we find something that works, qualification and implementation. It varies based on application of the part. Some termination inks still use lead-containing glass.

Bourns has other product lines that also use thick film inks containing lead-glass materials with different applications. Each product line using these lead-based thick film inks is unique, so a one-size-fits-all application does not apply. Bourns continues to work with our suppliers, explore possible solutions, experiment with possible alternatives. It is slow process with research, experimentation, testing, scale-up, qualification and reliability testing. If there is a failure along the way, the process starts over.

A recent Life Cycle Analysis (LCA) on lead-free piezoelectrics published by T. Ibn-Mohammed et al. from the University of Sheffield discusses various potential alternatives to lead. The LCA

included indicators such as: greenhouse emissions/climate change, material use and processes, toxicity and pollution. The abstract summary basically states that comparisons of several potential alternatives may not be so straight forward. Processing differences creating pollution and waste products may not indicate lead as the worst culprit. The conclusion demonstrates the need for a holistic approach to the development of sustainable functional materials. It is not as simple as just a substitution. There are other factors to consider.

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

(A)+(B) discussion: Research papers and journal articles discussing this issue regarding potential alternatives for leaded glass in thick film inks/glazes are available on the internet. 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 glasses that are also cost-effective. There may be one or more alternatives to address each individual application. It appears at this time, there may be some solutions but, most likely, the solutions will not be identified, tested, qualified and adapted to the process within this next exemption review time.

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

REACH Dossier: Exemption from registration for glass under REACH regulation n. 1907/2006/EC.
https://www.glassallianceeurope.eu/images/cont/dossier-glass-alliance-europe-on-glass-exemption-under-reach_file.pdf

Position paper concerning the status of the raw materials for the production of glass, as intermediates, under the EU REACH regulation
https://www.glassallianceeurope.eu/images/cont/gae-revised-position-paper-on-intermediates-february-2018_file.pdf

Life cycle assessment and environmental profile evaluation of lead-free piezoelectrics in comparison with lead zirconate titanate, T. Ibn-Mohammed et al., Journal of the European Ceramic Society, Volume 38, Issue 15, December 2018, pages 4922-4938.
https://www.sciencedirect.com/science/article/pii/S0955221918304163

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.

We are still researching and testing alternative glasses used in thick film ink or glazes. Component manufacturers still need to supply their customers with parts that work for their applications and varying environmental conditions. Many components required hermetically sealed packaging. To date, there is no solution for all applications. More time is needed for continued research.

(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. Bourns continues to work with our customers to meet their requirements with consideration for regulatory efforts, environmental conditions, safety and performance. Some legacy products may be phased out in time as technological advances in certain 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 is currently listed as a SVHC)
- ○ 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: links to documents that discusses lead in glasses:

REACH Dossier: Exemption from registration for glass under REACH regulation n. 1907/2006/EC. https://www.glassallianceeurope.eu/images/cont/dossier-glass-alliance-europe-on-glass-exemption-under-reach_file.pdf

Position paper concerning the status of the raw materials for the production of glass, as intermediates, under the EU REACH regulation
https://www.glassallianceeurope.eu/images/cont/gae-revised-position-paper-on-intermediates-february-2018_file.pdf

(B) Elimination/substitution:

1. Can the substance named under 4(A)2 be eliminated:

○ Yes. Consequences? _____

● No. Justification: Not at this time. While there may be substitutes for numerous applications yet to be determined, it will take time to make those determinations and to implement into production.

2. Can the substance named under 4(A)2 be substituted?

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

● No: Justification: Not at this time. While there may be substitutes for numerous applications yet to be determined, it will take time to make those determinations and to implement into production. To date, substitutes that have been used are for specific model and not a fit for all types of components.

3. Give details on the reliability of substitutes (technical date + information): see 6A

4. Describe environmental assessment of substance from 4(A)2 and possible substitutes with regard to: See 6A-B for 1-3.
   1) Environmental impacts: _____
   2) Health impacts: _____
   3) Consumer safety impacts: _____

→ Do impacts of substitution outweigh benefits thereof?
Please provide third-party verified assessment on this: Not determined

(C) Availability of substitutes: Substitutes not determined

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

○ Yes ● No Not at this time

d) What conditions need to be fulfilled to ensure the availability? _____ see 6A

(D) Socio-economic impact of substitution: not determined

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

- ○ 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: _____

→ 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:

We believe this exemption may be eventually phased out as legacy parts/products phase out and as substitute glasses or other substitute materials emerge. But in the meantime, this exemption needs to be extended for at least another review period.

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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:

None of the information provided in this document is proprietary. Some information regarding successful substitute glasses developed by Bourns is excluded due to proprietary information.