

# Clean Electronics Production Network

## Second Round Priority Chemical Selection

June 2023

# 1. Introduction

This document summarizes Clean Electronics Production Network's (CEPN) process and research conducted for selection of the 2<sup>nd</sup> Round of Priority Chemicals – process chemicals to be prioritized for elimination and/or substitution in electronics manufacturing.

CEPN's 1<sup>st</sup> Round Priority Chemical list was published in 2019 and was incorporated into the Toward Zero Exposure program. Information on the selection and research conducted for the 1<sup>st</sup> Round of Priority Chemicals can be found in the [Summary of Priority Chemical Selection Report, December 2019](#). This 2<sup>nd</sup> Round of Priority Chemicals will also be incorporated into the Toward Zero Exposure requirements.

In addition, some of the electronics industry's most influential organizations adopted CEPN's 1<sup>st</sup> Round Priority Chemicals:

- Responsible Business Alliance (RBA) included CEPN's 1<sup>st</sup> Round Priority Chemicals in its [Industry Focus Process Chemicals List \(IFPCL\) Policy](#), which requires higher levels of control, like engineered isolation or elimination, for these chemicals
- Nine of the sixteen chemicals featured in Electronics Watch's [Guidance for Public Buyers](#) are CEPN 1<sup>st</sup> Round Priority Chemicals
- CEPN's 1<sup>st</sup> Round Priority Chemicals are also included as a restricted substance list in Healthy Building Network's [Pharos database](#), offering broad access to this information on toxic solvents used in manufacturing

The selection process involved CEPN members, as well as CEPN's Technical Review Board (TRB) – an advisory body to CEPN, comprised of technical experts, NGOs, industry, certifiers and chemical suppliers. In addition, feedback was collected from Responsible Business Alliance members and CEPN's NGO Advisors.

An overview of the eight steps in the process is provided in Figure 1 below, and detailed information provided in the subsequent sections.

Figure 1 – Selection Process Steps



Table 1 – 2<sup>nd</sup> Round Priority Chemicals

CAS Number	Chemical Name
98-82-8	Cumene
107-06-2	1,2-Dichloroethane
111-96-6	Diethylene glycol dimethyl ether
68-12-2	Dimethylformamide
110-80-5	2-Ethoxyethanol (ethylene glycol monoethyl ether)
111-15-9	2-Ethoxyethyl acetate (ethylene glycol monoethyl ether acetate)
100-41-4	Ethylbenzene
109-86-4	2-Methoxyethanol (ethylene glycol monomethyl ether)
108-10-1	Methyl isobutyl ketone
75-52-5	Nitromethane
76-01-7	Pentachloroethane
630-20-6	1,1,1,2- Tetrachloroethane
79-34-5	1,1,2,2- Tetrachloroethane
97-99-4	Tetrahydrofurfuryl alcohol
67-66-3	Trichloromethane (Chloroform)
1330-20-7	Xylenes

## 2. Selection of 2<sup>nd</sup> Round Priority Chemicals

### Step 1: Chemical Nomination

This first step in the selection process – chemical nomination – includes four elements:

1. CEPN members determine the focus area(s) of the priority chemical round.
2. CEPN staff compile available information for chemicals, including Manufacturing Restricted Substance Lists (MRSs), aggregated and anonymized data from the PCDC Tool and other available information.
3. Chemicals for consideration are screened against CEPN’s High Hazard Criteria and the focus area. Those chemicals meeting the criteria (are high hazard and within the focus area) are nominated for further evaluation.

4. CEPN staff solicit other chemical nominations within the selected focus area(s), from CEPN members, NGO Advisors and Technical Review Board members.

### 1. Focus Area of the Round

CEPN members determined that the focus of the 2<sup>nd</sup> Round would be solvents, and for the Toward Zero Exposure program, would be limited to solvents in manufacturing cleaning products consistent with the scope of 1<sup>st</sup> Round of Priority Chemicals.

### 2. Compilation of Available Information

CEPN staff compiled available information for chemicals from company MRSLs and aggregated and anonymized data from the PCDC Tool.

MRSLs from 14 electronics companies (8 CEPN members and 6 non-CEPN members) as well as 3 non-industry organizations (IPC 1402 (draft), GreenScreen, Electronics Watch) were compiled and reviewed with 154 total chemicals on at least one company MRSL or NGO list.

PCDC Tool submittals from 4 CEPN companies, including 59 distinct templates from 106 individual facilities in 6 countries were aggregated and anonymized. Over 700 unique chemicals were identified in the consolidated data set.

### 3. Screening Using CEPN’s High Hazard Criteria and Focus Area

Chemicals for consideration were screened against CEPN’s High Hazard Criteria (see Table 2 below) and the focus area (solvents), and those chemicals meeting the criteria (are high hazard and potentially used as solvents in electronics manufacturing) were nominated for further evaluation.

Table 2 – CEPN’s High Hazard Criteria

CEPN’s High Hazard Criteria	
California Proposition 65	
Greenscreen LT1	
GHS Health Hazard End Point	GHS Category
Acute toxicity (oral, dermal, gases, vapours, dust and mist)	1, 2 or 3
Respiratory or skin sensitization	1A
Germ cell mutagenicity	1A or 1B
Carcinogenicity	1A or 1B
Reproductive Toxicity	1A or 1B
Specific target organ toxicity (STOT) single dose	1
Specific target organ toxicity (STOT) repeated dose	1

The 154 chemicals generated from the combined MRSLs were screened for 1st Round Priority Chemicals (excluded), CEPN High Hazard Criteria and potential use as a solvent in electronics manufacturing, resulted in nominated 14 chemicals.

The more than 700 chemicals identified from the aggregated PCDC Tool data set were also screened for the same elements and resulted in 24 chemicals. Of these 24 chemicals, 5 were also on the combined MRSL.

**MRSL & PCDC Tool Screened Chemicals Combined**

- 34 nominated chemicals
- 5 chemicals on both lists
- 9 similar petroleum distillates
- 7 chlorinated solvents
- 4 glycol ethers

The MRSL & PCDC Tool screened chemicals combined resulted in 34 nominated chemicals.

**Table 3 – Nominated Chemicals**

CAS	Chemical Name	MRSL Screened Chemicals	PCDC Tool Filtered Chemicals
74-96-4	Bromoethane (ethyl bromide)	X	
107-06-2	1,2-Dichloroethane	X	
75-35-4	1,1-Dichloroethylene	X	
110-80-5	2-Ethoxyethanol (ethylene glycol monoethyl ether)	X	
111-15-9	2-Ethoxyethyl acetate (ethylene glycol monoethyl ether acetate)	X	
110-49-6	2-Methoxyethyl acetate (ethylene glycol monomethyl ether acetate)	X	
76-01-7	Pentachloroethane	X	
630-20-6	1,1,1,2- Tetrachloroethane	X	
79-34-5	1,1,2,2- Tetrachloroethane	X	
71-55-6	1,1,1-Trichloroethane (TCA) (Methyl chloroform)	X	
67-66-3	Trichloromethane (Chloroform)	X	
100-41-4	Ethylbenzene	X	X
109-86-4	2-Methoxyethanol	X	X
111-96-6	Diethylene glycol dimethyl ether	X	X
68-12-2	Dimethylformamide	X	X
1330-20-7	Xylene	X	X
106-88-7	1-Butene oxide		X
108-10-1	Methyl isobutyl ketone		X
143-24-8	Tetraglyme		X
64742-48-9	C9-11 alkane/cycloalkane		X
64742-49-0	Hydrotreated light straight run (petroleum)		X

64742-52-5	Distillates (petroleum), hydrotreated (mild) heavy naphthenic (9Cl)		X
64742-53-6	Distillates (petroleum), hydrotreated (mild) light naphthenic (9Cl)		X
64742-65-0	Solvent-dewaxed heavy paraffinic petroleum distillates		X
64742-94-5	(Polyethyl)benzenes		X
64742-95-6	Aromatic naphtha, type 1		X
75-52-5	Nitromethane		X
75-56-9	1,2-Propylene oxide		X
8052-41-3	Stoddard solvent		X
91-20-3	Naphthalene		X
92045-53-9	Naphtha (petroleum), hydrodesulfurized light, dearomatized		X
97-99-4	Tetrahydrofurfuryl alcohol		X
98-82-8	Cumene		X

#### 4. Solicitation of Other Chemical Nominations

Following the identification of the 34 nominated chemicals through the process described above, CEPN staff solicited other chemical nominations from CEPN members, NGO Advisors and Technical Review Board members. Eight chemical nominations were received and evaluated as outlined in the table below.

Table 4 – Chemical Nominations from Stakeholders

CAS	Chemical Name	Evaluation				Added to Candidate List for Evaluation
		CEPN High Hazard Criteria	Potential Use as a Solvent	1 <sup>st</sup> Round Priority Chemical	Already 2 <sup>nd</sup> Round Candidate	
67-63-0	Isopropyl Alcohol	No	Yes			No – Does not meet high hazard criteria
163702-08-7	Hydrofluoroether	No	Yes			No – Does not meet high hazard criteria
106-89-8	1-chloro-2,3-epoxypropane (Epichlorohydrin)	Yes	No			No – Does not appear to be used as a solvent in the electronics industry
1589-47-5	2-methoxy-1-propanol	Yes	No			No - An isomer synthesized during the manufacturing process of 1-methoxy-2-propanol (not used as solvent)

79-01-6	Trichloroethylene	Yes	Yes	X		No – One of the 1 <sup>st</sup> Round Priority Chemicals
108-88-3	Toluene	Yes	Yes	X		No – One of the 1 <sup>st</sup> Round Priority Chemicals
108-10-1	Methyl Isobutyl Ketone	Yes	Yes		X	Already on the 2 <sup>nd</sup> Round nominated list
68-12-2	Dimethylformamide	Yes	Yes		X	Already on the 2 <sup>nd</sup> Round nominated list

## Step 2: Evaluation of Nominated Chemicals

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Detailed information on each of the 34 nominated chemicals, including evidence of use in the electronics industry (direct or indirect evidence and relative order of magnitude reported use volume), toxicity profiles, regulatory restrictions and standards, industry use, criticality and applications, as well as a high-level literature review of potentially viable alternatives was collected from CEPN members, CEPN NGO Advisors, Technical Review Board members and publicly available information.

It is important to note that the potentially viable safer alternatives listed in this document were not screened for performance, cost, specific application or global availability at market scale. A full Alternatives Assessment would need to be conducted to assess specific applicability.

Key information is summarized in Appendix A, and additional information available upon request for each chemical.

## Step 3: Technical Review Board Evaluation and Categorization

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CEPN's Technical Review Board met several times to review, evaluate and categorize the 34 nominated chemicals. The board developed and used the following categorization decision process for this round.

- Recommended for Current Round – Category #1
  - Some use identified (either directly and/or via literature; current or historic)
  - Some indication of potential alternatives with or without relevant use case
- Recommended for Future Round (Watch List) – Category #2
  - Some use identified (either directly and/or via literature)
  - Potential alternatives do not appear to be available currently or near future OR meets Category #1 criteria, but lower priority due to lower exposure potential
  - Nine petroleum distillates - very widely used (ubiquitous in the world); unlikely to be able to move the market currently

- Not Under Consideration – Category #3
  - No use identified (current or historic) or appears to be taken out of commerce
  - Solid at room temperature
- Further Discussion Needed – Category #4

Exposure potential was also considered by reviewing:

- Vapor Pressure (at 20 - 25 degrees C)(mm Hg)
- Exposure Limits (Source: <https://www.osha.gov/annotated-pels/table-z-1>)
- Concern for Skin Absorption (Dermal)
  - ACGIH Flag (Source: TLVs and BEIs based on the Documentation of the TLV for chemical substances)
  - DFG Flag (Source: Deutsche Forschungsgemeinschaft (DFG) List of MAK and BAT Values 2020)
- GHS Health Hazard Classification (GreenScreen & California Proposition 65)

Based on this information and evaluation, the Technical Review Board recommended the following 16 chemicals for the 2<sup>nd</sup> Round Priority Chemical list.

**Table 5 – Technical Review Board Recommended Priority Chemicals (Category #1)**

CAS#	Chemical Name
98-82-8	Cumene
107-06-2	1,2-Dichloroethane
111-96-6	Diethylene glycol dimethyl ether
68-12-2	Dimethylformamide
110-80-5	2-Ethoxyethanol (ethylene glycol monoethyl ether)
111-15-9	2-Ethoxyethyl acetate (ethylene glycol monoethyl ether acetate)
100-41-4	Ethylbenzene
109-86-4	2-Methoxyethanol (ethylene glycol monomethyl ether)
108-10-1	Methyl isobutyl ketone
75-52-5	Nitromethane
76-01-7	Pentachloroethane
630-20-6	1,1,1,2- Tetrachloroethane
79-34-5	1,1,2,2- Tetrachloroethane



97-99-4	Tetrahydrofurfuryl alcohol
67-66-3	Trichloromethane (Chloroform)
1330-20-7	Xylenes

Note: For the Toward Zero Exposure program, concentrations in mixtures must be below GHS cutoff reporting values according to Table 1.5.1 of the [Globally Harmonized System of Classification and Labelling of Chemicals \(GHS\), Ninth revised edition \(2021\)](#). For all 2<sup>nd</sup> Round Priority Chemicals this is <0.1%, except 1,1,2,2-tetrachloroethane which is <1%.

The following nominated chemicals in Table 6 were:

- Recommended for a future round (Category #2), although the Technical Review Board noted that a closer review of the practicality of including petroleum distillates should be conducted
- Not under consideration (Category #3)

**Table 6 – Technical Review Board Recommended for Category #2 & Category #3**

CAS#	Chemical Name	Notes
<b>Category #2 – Recommended for a Future Round</b>		
143-24-8	Tetraglyme	Meets Category #1 criteria, but lower priority due to lower exposure potential (vapor pressure = 0.0018 mm Hg (at 20 – 25 degrees C)
64742-49-0	Hydrotreated light straight run (petroleum)	Petroleum distillate
8052-41-3	Stoddard solvent	Petroleum distillate
64742-95-6	Aromatic naphtha, type 1	Petroleum distillate
64742-94-5	(Polyethyl)benzenes, Solvent naphtha (petroleum)	Petroleum distillate
64742-48-9	C9-11 alkane/cycloalkane	Petroleum distillate
64742-65-0	Solvent-dewaxed heavy paraffinic petroleum distillates	Petroleum distillate
64742-53-6	Distillates (petroleum), hydrotreated (mild) light naphthenic (9Cl)	Petroleum distillate
64742-52-5	Distillates (petroleum), hydrotreated (mild) heavy naphthenic (9Cl)	Petroleum distillate
92045-53-9	Naphtha (petroleum), hydrodesulfurized light, dearomatized	Petroleum distillate
<b>Category #3 – Not Under Consideration</b>		
75-56-9	1,2-Propylene oxide	Use as solvent in the electronics industry not identified

75-35-4	1,1-Dichloroethylene	Use as solvent in the electronics industry not identified, nor potential alternatives
74-96-4	Bromoethane (ethyl bromide)	Use as solvent in the electronics industry not identified, nor potential alternatives
106-88-7	1-Butene oxide	Use as solvent in the electronics industry not identified, nor potential alternatives
71-55-6	1,1,1-Trichloroethane (TCA) (Methyl chloroform)	Use as solvent in the electronics industry not identified; Montreal Protocol banned substance
110-49-6	2-Methoxyethyl acetate (ethylene glycol monomethyl ether acetate)	Use as solvent in the electronics industry not identified
91-20-3	Naphthalene	Use as solvent in the electronics industry not identified, and solid at room temperature
106-89-8	1-chloro-2,3-epoxypropane (Epichlorohydrin)	Use as solvent in the electronics industry not identified
1589-47-5	2-methoxy-1-propanol	Use as solvent in the electronics industry not identified

## Steps 4, 5, 6, 7 & 8: Broader Consultation, CEPN Review and Approval

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Progress updates were regularly shared with CEPN members and the Design Team during the process. In the fall of 2022, the Technical Review Board provided the list of 16 recommended 2<sup>nd</sup> Round Priority Chemicals. Input was then sought from CEPN members and a broader consultation was launched with CEPN's NGO Advisors as well as RBA's Chemical Workgroup.

The process was completed with final affirmation from CEPN membership and final approval from the Design Team.

# Appendix A

CAS#	Chemical Name	Found on Reviewed MRSLs	Evidence of Use in the Electronics Industry			Exposure Potential			
			Reported on PCDC Tool or Other Direct Evidence of Use	Indirect Evidence of Use (via research & TRB/CEPN member/RBA member input)	Highest Reported Volume (by individual company) (High: >~10,000 lbs/1,200 gallons)	Vapor Pressure (at 20 - 25 degrees C) (mm Hg)	Exposure Limits***	Concern for Skin Absorption (Dermal) (ACGIH* or DFG** Flag)	GHS Health Hazard Classification
67-66-3	Trichloromethane (Chloroform)	Yes (7)	No	Used as a cleaning agent and solvent for rubber, waxes and resins to help other substances dissolve.		197	ACGIH TLV 10 ppm 8-hr TWA	Yes	Carcinogen - Cat 2 Reproductive Toxicity - Cat 2 Acute Toxicity - Cat 3 STOT - Cat 3
107-06-2	1,2-Dichloroethane	Yes (4)	No	Used in the production of vinyl chloride to make plastics; used as solvent to remove grease, resins, glue and dirt.		60	ACGIH TLV 1 ppm 8-hr TWA. 2 ppm STEL. 200 ppm Ceiling	Yes	Carcinogen - Cat 1B Acute Toxicity - Cat 3 STOT - Cat 3
75-52-5	Nitromethane	No	Yes	Used as an intermediate in chemical syntheses, and as a solvent for coatings and inks. Also used as a fuel additive.		35	ACGIH TLV 20 ppm 8-hr TWA. CA OSHA PEL 2 ppm 8-hr TWA	Yes	Carcinogen - Cat 2 Reproductive Toxicity - Cat 2 Acute Toxicity - Cat 4
108-10-1	Methyl isobutyl ketone	No	Yes	Widely used as a solvent in the electronics industry especially for coating, ink, primer, adhesives. Used in semiconductor industry.	Very High	16	ACGIH TLV 20 ppm 8-hr TWA. 75 ppm STEL	Yes	Carcinogen - Cat 2 Acute Toxicity - Cat 4 STOT - Cat 3
79-34-5	1,1,2,2- Tetrachloroethane	Yes (6)	No	Was historically used as a solvent in cleaning and degreasing metals, in paint removers and others. No longer used in US. Restricted in EU REACH.		14	ACGIH TLV 1 ppm 8-hr TWA	Yes	Acute Toxicity - Cat 1 & 2
630-20-6	1,1,1,2- Tetrachloroethane	Yes (5)	No	Used as cosolvent for degreasing. Restricted in EU REACH.		10	No published exposure limit	Not Flagged	Carcinogen - Cat 2 Acute Toxicity - Cat 4
1330-20-7	Xylenes	Yes (4)	Yes	Widely used as a solvent in the electronics industry especially for coating, ink, primer, adhesives. Used to develop the pattern in photoresists in semiconductor manufacturing. Used as a cleaning agent for steel and silicon wafers. Restricted in China's VOC regulations.	Very High	8.29	ACGIH TLV 100 ppm 8-hr TWA 150 ppm STEL	Yes	Carcinogen - Cat 2 Acute Toxicity - Cat 4 STOT - Cat 2, 3
100-41-4	Ethylbenzene	Yes (3)	Yes	Found as solvent for lacquers, coatings, adhesive, inks or thinner, and unspecific cleaning processes. Ingredient for adhesion; Used in the manufacture of styrene. Restricted in China's VOC regulations.	Very High	7	ACGIH TLV 25 ppm 8-hr TWA	Yes	Carcinogen - Cat 2 Acute Toxicity - Cat 4 STOT - Cat 2
109-86-4	2-Methoxyethanol	Yes (3)	Yes	Used as solvent for cellulose acetate, resins (particularly in the electronics industry), dyes and quick drying varnishes.	High	6	ACGIH TLV 0.1 ppm 8-hr TWA	Yes	Reproductive Toxicity - Cat 1B Acute Toxicity - Cat 4 STOT - Cat 1 & 3
98-82-8	Cumene	No	Yes	Found as solvent for lacquers, coatings, adhesive, inks or thinner, and unspecific cleaning processes.	High	4.5	ACGIH TLV 50 ppm 8-hr TWA	Yes	Carcinogen - Cat 2 Germ Cell - Cat 3
110-80-5	2-Ethoxyethanol (ethylene glycol monoethyl ether)	Yes (4)	No	Industrial solvent for printing inks, dyes, coatings.	High	3.8	ACGIH TLV 5 ppm 8-hr TWA	Yes	Reproductive Toxicity - Cat 1B Acute Toxicity - Cat 3
76-01-7	Pentachloroethane	Yes (6)	No	Vapor degreasing of metals; ultrasonic cold cleaning. Restricted in China VOC regulations.		3.5	No published exposure limit	Yes	Carcinogen - Cat 2 Acute Toxicity - Cat 4 STOT - Cat 1
68-12-2	Dimethylformamide	Yes (2)	Yes	Solvent in production of electronic components and used as solvent for epoxy resin catalysts used during the lamination of circuit boards.	High	3	ACGIH TLV 5.0 ppm 8-hr TWA	Yes	Carcinogen - Cat 1B Reproductive Toxicity - Cat 1B
111-96-6	Diethylene glycol dimethyl ether	Yes (3)	Yes	Used in the coating industry & in photolithography to make semiconductor chips; also used in adhesives and sealants	High	2.96	CA OSHA PEL 1.0 ppm 8-hr TWA	Yes	Carcinogen - Cat 1B Reproductive Toxicity - Cat 1B Acute Toxicity - Cat 4
111-15-9	2-Ethoxyethyl acetate (ethylene glycol monoethyl ether acetate)	Yes (4)	No	Metal degreasing, semiconductor manufacturing. Solvent for cellulose, resins, and coating applications.	High	1.2	ACGIH TLV 5 ppm 8-hr TWA	Yes	Reproductive Toxicity - Cat 1B Acute Toxicity - Cat 4
97-99-4	Tetrahydrofurfuryl alcohol	No	Yes	Used as a solvent (fats, waxes, and resins) and in organic synthesis; Used as a cleaner, paint stripper, and solvent.	High	0.8	No published exposure limit	Not Flagged	Reproductive Toxicity - Cat 1B

\*Source: TLVs and BEIs based on the Documentation of the TLV for chemical substances and physical agents and biological exposure indices <https://www.acgih.org/data-hub-2022/#T>

\*\* Source: Deutsche Forschungsgemeinschaft (DFG) List of MAK and BAT Values 2020

\*\*\*Source: <https://www.osha.gov/annotated-pels/table-z-1>