



GREEN AMERICA  
**CLEAN ELECTRONICS  
PRODUCTION NETWORK**  
A project of the Center for Sustainability Solutions

## Clean Electronics Production Network

# Summary of Priority Chemical Selection

## First Round

December 2019

# 1. Introduction

This document summarizes the process and research conducted for selection of the first round of Clean Electronics Production Network (CEPN) Priority Chemicals.

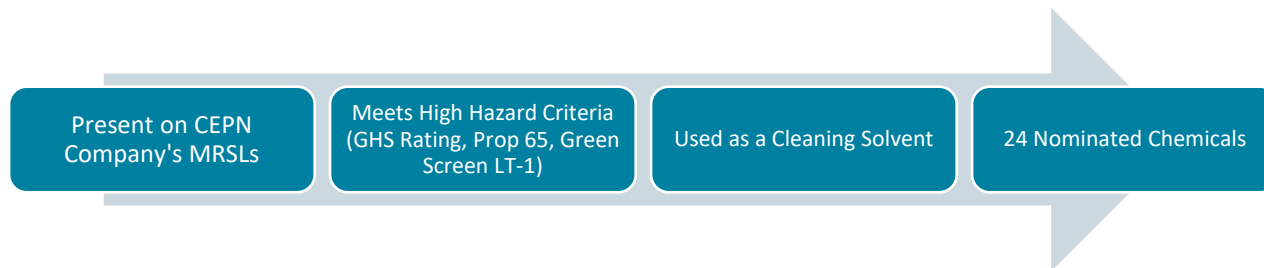
An Initiative Group (IG3) of CEPN developed the list of nominated process chemicals, and the Technical Review Board (TRB), with the support of a technical researcher, evaluated these nominated process chemicals, generating a recommended first round list of Priority Chemicals. The CEPN Design Team and full membership then reviewed and approved the selected Priority Chemicals.

## Summary of Priority Chemicals

Priority Chemicals*	Program-Wide Exempted Conditional Use Case
1-Bromopropane (CAS #106-94-5)	N-Methyl-Pyrrolidone (NMP) (CAS #872-50-4) for photoresist stripping
Benzene (CAS #71-43-2)	
Dichloromethane (Methylene Chloride) (CAS #75-09-2)	
Methanol (CAS #67-56-1)	
n-Hexane (CAS #110-54-3)	
N-Methyl-Pyrrolidone (NMP) (CAS #872-50-4) – Exempted Conditional Use for photoresist stripping	
Tetrachloroethylene (CAS #127-18-4)	
Toluene (CAS #108-88-3)	
Trichloroethylene (CAS #79-01-6)	
<i>*Concentrations in mixtures must be below GHS cutoff reporting values (which is &lt;0.1% (1000 ppm) - the lowest cutoff value globally for these chemicals for this round)</i>	

# 2. Priority Chemical Nomination Process

The Initiative Group nominated 24 chemicals for the first round of Priority Chemicals using the following screening process:



For this first round of Priority Chemicals, the review began with chemicals present on CEPN member company's MRSLs. Future rounds will incorporate data that is collected through the Process Chemicals Data Collection (PCDC) Tool.

The chemicals were then screened against the **CEPN High Hazard Criteria**:

- California Proposition 65
- Greenscreen LT1
- GHS Rating per the table below:

<b>GHS Health Hazard End Point</b>	<b>Harmonized GHS Category</b>
▪ 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

Additionally, the decision was made for the first round of Priority Chemicals to be focused on solvents used in cleaning products, and therefore chemicals that were not used as cleaning solvents were removed (e.g. brominated flame retardants, metals, etc.). For the purpose of this work, cleaning products are defined as chemicals and chemical mixtures used to remove contaminants, unwanted materials and/or manufacturing processing residues (e.g. lubricants, adhesives, solder flux residues, plastic residue, mold releases, etc.) from:

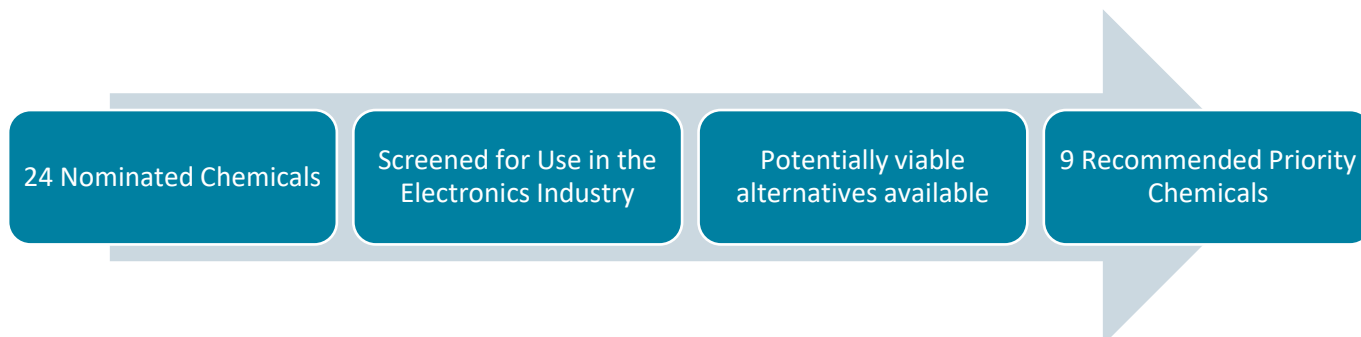
- Individual parts, subcomponents, assemblies, process substrates and/or final assembled products; and/or
- Manufacturing equipment to manufacture individual components or final products

Examples of chemical products used for cleaning include solvents, aqueous detergent solutions, stencil/ink removers, adhesive removers, solvent vapor degreaser solutions, ultrasonic parts cleaner solutions, photo-resist strippers, solder defluxing solutions, etc. Fluxes are not considered in-scope.

Detailed information on each of the 24 chemicals, including toxicity profiles, regulatory restrictions and standards, industry use and applications, as well as a review of potentially viable alternatives, was collected from CEPN members, from publicly available information, and from interviews with Technical Review Board members. This information is available upon request for each chemical.

### 3. Priority Chemical Research and Evaluation Process

The CEPN Technical Review Board researched and evaluated the nominated process chemicals, generating a recommended first round list of Priority Chemicals using the following screening process:



Each chemical's use within the electronics industry and the availability of potential safer alternatives was researched using publicly available information and input from Technical Review Board members. The potential alternatives were screened against use as a process cleaning product in a manufacturing setting, as well as the High Hazard Listing Criteria. Any alternatives meeting the High Hazard Criteria or not for use as a cleaner were not included. 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.

After the research was completed, the Technical Review Board provided its recommendations to the CEPN Design Team for review. This was an iterative process until the final recommendations were agreed upon. This process involved reviewing the data presented, assessing the scope of the chemical's use as a solvent in cleaning products, evaluating if conditional uses were applicable, and if so, determining what occupational exposure limits are acceptable for use.

The review process indicated that 9 of the 24 nominated chemicals (potentially used as cleaning solvents and meeting the CEPN High Hazard Criteria) are potentially used within the electronics industry. Of the 9 chemicals identified, one has an allowed specific conditional use (for photoresist stripping) that will be phased out in the future as it did not have a current viable potential alternative. Of the remaining nominated chemicals, one was identified as needing further research and assessment, while the other 14 chemicals were identified as high hazard chemicals with no indication of current use within the electronics industry. The following section details each of these categories and chemicals selected.

### 4. Summary of Nominated Chemical Designations

The nominated Priority Chemicals were sorted into the following four categories:

1. **PRIORITY CHEMICALS** - Chemicals selected for the current round of the Priority Chemical List.
  - a. Meets CEPN High Hazard Criteria

- b. Used as a solvent in cleaning products
  - c. Some indication of use within the electronics industry
  - d. Potentially viable safer alternatives available
2. **FUTURE PHASE OUT, SPECIFIC CONDITIONAL USE ALLOWED** - Chemicals identified for future phase-out, with an allowed specific conditional use until phase-out is possible. Note that a chemical can be both a Priority Chemical for some uses and have a conditional use for other specific uses.
- a. Meets CEPN High Hazard Criteria
  - b. Used as a solvent in cleaning products
  - c. Some indication of use within the electronics industry
  - d. Potential viable safer alternatives not available
  - e. More research needed on use and/or safer alternatives
3. **FURTHER RESEARCH/ASSESSMENT** - Further research and assessment is needed to assess for consideration in a future round of Priority Chemicals.
4. **HIGH HAZARD CHEMICALS WITH NO INDICATION OF CURRENT USE** - Chemical nominated but not currently under consideration for the Priority Chemical List as there is no indication of current use in the electronics industry. These chemicals are nonetheless high hazard, using the CEPN High Hazard Criteria, and as such they would not qualify as safer alternatives.
- a. Meets CEPN High Hazard Criteria
  - b. Potentially used as a solvent in cleaning products
  - c. No indication of use within the electronics industry

A more detailed description of the chemicals identified in each category is provided below. The table below provides a summary of the designation of each of the 24 nominated chemicals.

## PRORITY CHEMICALS

Nine chemicals met all of the criteria for selection for the first round of Priority Chemicals: 1-Bromopropane (CAS #106-94-5), Benzene (CAS #71-43-2), Dichloromethane (Methylene Chloride) (CAS #75-09-2), Methanol (CAS #67-56-1), n-Hexane (CAS #110-54-3), N-Methyl-Pyrrolidone (NMP) (CAS #872-50-4)(Exempted Conditional Use for photo-resist stripping), Tetrachloroethylene (CAS #127-18-4), Toluene (CAS #108-88-3) and Trichloroethylene (CAS #79-01-6).

## FUTURE PHASE OUT, SPECIFIC CONDITIONAL USE ALLOWED

One chemical, N-Methyl-Pyrrolidone (NMP), was designated as both a Priority Chemical and a Future Phase Out chemical with Specific Conditional Use Allowed list. NMP meets all the criteria for selection as a Priority Chemical yet does not have a viable large-market scale alternative for photoresist stripping applications. Therefore, it is a Priority Chemical for any application besides photoresist stripping. It is recommended that NMP be considered for a future phase-out, and research on alternatives is continued by industry.

For conditional use of NMP for photoresist stripping, CEPN has adopted an Occupation Exposure Limit (OEL) from the lowest published regulatory limits for NMP - California OSHA/Japan 8-hr Time Weighted Average (TWA) OEL of 1.0 ppm and the EU 15-minute Short-Term-Exposure-Limit (STEL) of 20.0 ppm. See Appendix A for detailed information.

## FURTHER RESEARCH/ASSESSMENT

It is recommended that more research be conducted on Ethylbenzene (CAS #100-41-4) to assess whether it was used as a cleaning solvent in the electronics industry as the information collected is not definitive.

## HIGH HAZARD CHEMICALS WITH NO INDICATION OF CURRENT USE

The research on the remaining 14 chemicals did not uncover information indicating their current use in the electronics industry and are consequently not be included as Priority Chemicals. However, these chemicals are considered high hazard using the CEPN High Hazard Criteria, and as such they do not qualify as safer alternatives.

Two of these 14 chemicals - 1,1-Dichloroethane and 1,1,1-Trichloroethane – may have been used in the past, although no information was found indicating current use in the electronics industry. The Technical Review Board indicated that these two chemicals remain priorities and should not be reintroduced into the electronics supply chain. If they are found in use in the future, they will be considered for a future round of Priority Chemicals.

## SUMMARY OF NOMINATED PRIORITY CHEMICAL DESIGNATIONS

Priority Chemicals*	Future Phase-Out Specific Conditional Use Allowed	Further Research/ Assessment	High Hazard Chemicals with No Indication of Current Use**
<b>1-Bromopropane</b> (106-94-5)	N-Methyl-Pyrrolidone (NMP) (872-50-4) for photo-resist stripping	Ethylbenzene (100-41-4)	1,2-Dichloroethane (107-06-2)
<b>Benzene</b> (71-43-2)			1,1-Dichloroethylene (75-35-4)
<b>Dichloromethane (Methylene Chloride)</b> (75-09-2)			Carbon Tetrachloride (56-23-5)
<b>Methanol</b> (67-56-1)			Chloroethane (75-00-3)
<b>n-Hexane</b> (110-54-3)			Chloroform (67-66-3)
<b>N-Methyl-Pyrrolidone (NMP)</b> (872-50-4) – Exempted Conditional Use for photo-resist stripping			Hexachloroethane (67-72-1)
<b>Tetrachloroethylene</b> (127-18-4)			Methyl chloride (74-87-3)

<b>Toluene</b> (108-88-3)			Pentachloroethane (76-01-7)
<b>Trichloroethylene</b> (79-01-6)			Pentachlorophenol (87-86-5)
			1,1,2,2-Tetrachloroethane (79-34-5)
			1,1,1,2-Tetrachloroethane (630-20-6)
			Vinyl trichloride (79-00-5)
			1,1-Dichloroethane (75-34-3)***
			1,1,1-Trichloroethane (71-55-6)***

**9 Chemicals**

**1 Chemical**

**1 Chemical**

**14 Chemicals**

*\*Concentrations must be <0.1% (1000 ppm) (Based on GHS cutoff values)*

*\*\*No indication of current use in the electronics industry; high hazard chemicals*

*\*\*\*May have been historically used in the electronics industry; not to be re-introduced*

Detailed information on the 9 Priority Chemicals and the one chemical recommended for further research/assessment is provided in the following sections.

## 5. Priority Chemicals & Conditional Use Chemicals

### 1-Bromopropane

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**Name:** 1-Bromopropane

**CAS:** 106-94-5

Detailed information for 1-Bromopropane is available upon request.

#### CHEMICAL TOXICITY PROFILE

- GHS classifications:
  - Carcinogenicity- Category 2
  - Reproductive Toxicity- Category 1B
  - Specific Target Organ Toxicity- STOT- Single Exposure- Category 3
  - Specific Target Organ Toxicity- STOT- Repeated Exposure- Category 2
- Green Screen benchmarks:
  - LT-1
- Prop 65:
  - Cancer
  - Developmental Toxicity: Female & Male Reproductive Toxicity

#### INDUSTRY USE AND APPLICATIONS

- Electronics Industry Use/ Application in Cleaning
  - Used as a solvent cleaner in vapor and immersion degreasing operations to clean optics, electronics and metals
- Other Industry Use/ Application
  - Used as a solvent in spray adhesives and dry cleaning.

### Benzene

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**Name:** Benzene

**CAS:** 71-43-2

Detailed information for Benzene is available upon request.

#### CHEMICAL TOXICITY PROFILE

- GHS classifications:
  - Germ Cell Mutagenicity- Category 1B
  - Carcinogenicity- Category 1A
  - Specific Target Organ Toxicity- STOT- Repeated Exposure- Category 1
- Green Screen benchmarks:



- LT-1
- Prop 65:
  - Cancer
  - Developmental Toxicity: Female & Male Reproductive Toxicity

## INDUSTRY USE AND APPLICATIONS

- Electronics Industry Use/ Application in Cleaning
  - Used as a degreaser in final assembly process. Used for cleaning electronics and as an industrial cleaner.
- Other Industry Use/ Application
  - Solvent for adhesives, sealants, paints, coatings, inks, rubber, cement and asphalt formulations. Used as an industrial solvent. Used as a starting material in the production of other chemicals.

## Dichloromethane (Methylene Chloride)

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**Name:** Dichloromethane (Methylene Chloride)

**CAS:** 75-09-2

Detailed information for Dichloromethane is available upon request.

## CHEMICAL TOXICITY PROFILE

- GHS classifications:
  - Carcinogenicity- Category 2
  - Specific Target Organ Toxicity- STOT- Single Exposure- Category 3
- Green Screen benchmarks:
  - LT-1
- Prop 65:
  - Cancer

## INDUSTRY USE AND APPLICATIONS

- Electronics Industry Use/ Application in Cleaning
  - Used as a metal cleaning and finishing solvent. Used to degrease the surface of the substrate before photoresist layer is added.
- Other Industry Use/ Application
  - Used for paint stripping, adhesives, pharmaceutical manufacturing, aerosol solvents, chemical processing, flexible polyurethane foam manufacturing.

## Methanol

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**Name:** Methanol

**CAS:** 67-56-1

Detailed information for Methanol is available upon request.

### CHEMICAL TOXICITY PROFILE

- GHS classifications:
  - Acute toxicity- Category 3
  - Specific Target Organ Toxicity- STOT- Single Exposure- Category 1
- Green Screen benchmarks:
  - LT-1
- Prop 65:
  - Developmental Toxicity

### INDUSTRY USE AND APPLICATIONS

- Electronics Industry Use/ Application in Cleaning
  - Used for product cleaning and machine cleaning. Used in cold cleaning. Used in analytical labs for extraction and cleaning. May be used to degrease silicon ingots and ribbons. It may be used in the purification of surfactant
- Other Industry Use/ Application
  - Used to produce formaldehyde & other chemicals, used for fuel cells and for water treatment.

## n-Hexane

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**Name:** n-Hexane

**CAS:** 110-54-3

Detailed information for n-Hexane is available upon request.

### CHEMICAL TOXICITY PROFILE

- GHS classifications:
  - Reproductive Toxicity - Category 2
  - Specific Target Organ Toxicity (STOT) - Single Exposure Category 3
  - Specific Target Organ Toxicity (STOT) - Repeat Exposure Category 2
- Green Screen benchmarks:
  - LT-1
- Prop 65:
  - Male Reproductive Toxicity

## INDUSTRY USE AND APPLICATIONS

- Electronics Industry Use/ Application in Cleaning
  - Used for machine cleaning and to clean phone screens. Removes flux residues after soldering. Used to clean printed circuit boards.
- Other Industry Use/ Application
  - Used as a degreaser in the printing industry. Used as solvent for glues, varnishes and inks. Used as a cleaning solvent in assembly line and molding of plastics.

## N-Methyl-2-Pyrrolidone

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**Name:** N-Methyl-2-Pyrrolidone

**CAS:** 872-50-4

Detailed information for N-Methyl-2-Pyrrolidone is available upon request.

## CHEMICAL TOXICITY PROFILE

- GHS classifications:
  - Skin Irritation- Category 2
  - Eye Irritation- Category 2A
  - Reproductive Toxicity- Category 1B
  - Specific Target Organ Toxicity- STOT- Single Exposure- Category 3
- Green Screen benchmarks:
  - LT-1
- Prop 65:
  - Reproductive Toxicity; Developmental Toxicity

## INDUSTRY USE AND APPLICATIONS

- Electronics Industry Use/ Application in Cleaning
  - Used as a solvent in electronic cleaning and for printed circuit board manufacturing, semiconductor parts cleaning, semiconductor photo-resist thinner, color filter photo-resist thinner
- Other Industry Use/ Application
  - Industrial and household cleaning: NMP is used for paint stripping, in graffiti removers, oven cleaners, in automotive and industrial cleaner formulations.
  - Pharmaceuticals: NMP can be used as solvent, extraction medium.
  - Agrochemicals: NMP can be used as solvent during synthesis or as a formulation agent.
  - Petrochemical processing: lube oil processing, natural and synthetic gas purification.
  - Coatings: High temperature coating, urethane dispersions, acrylic and styrene latexes.

## SPECIFIC CONDITIONAL USE ALLOWED

Allowed for current use in photo-resist stripping.

## Tetrachloroethylene

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**Name:** Tetrachloroethylene

**CAS:** 127-18-4

Detailed information for Tetrachloroethylene is available upon request.

### CHEMICAL TOXICITY PROFILE

- GHS classifications:
  - Respiratory Sensitization- Category 1
  - Carcinogenicity- Category 2
  - Specific Target Organ Toxicity- STOT- Single Exposure- Category 3
- Green Screen benchmarks
  - LT-1
- Prop 65:
  - Cancer

### INDUSTRY USE AND APPLICATIONS

- Electronics Industry Use/ Application in Cleaning
  - Used for metal surface preparation and cleaning & cold cleaning (in electric and electronic equipment and other industries).
- Other Industry Use/ Application
  - To produce PFCs, solvent in dry cleaning & vapor degreasing. Used in cleaning products, lubricants and greases, adhesives and sealants and paint coatings.

## Toluene

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**Name:** Toluene

**CAS:** 108-88-3

Detailed information for Toluene is available upon request.

### CHEMICAL TOXICITY PROFILE

- GHS classifications:
  - Reproductive Toxicity- Category 2
  - Specific Target Organ Toxicity- STOT- Single Exposure- Category 3
  - Specific Target Organ Toxicity- STOT- Repeated Exposure- Category 2
- Green Screen benchmarks
  - LT-1
- Prop 65:
  - Developmental Toxicity

## INDUSTRY USE AND APPLICATIONS

- Electronics Industry Use/ Application in Cleaning
  - Used as a cleaning solvent in surface coating, printing and leather industry.
- Other Industry Use/ Application
  - Common ingredient in solvents for adhesives, paints, coatings, inks.

## Trichloroethylene

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**Name:** Trichloroethylene

**CAS:** 79-01-6

Detailed information for Trichloroethylene is available upon request.

## CHEMICAL TOXICITY PROFILE

- GHS classifications:
  - Germ Cell Mutagenicity
  - Carcinogenicity
  - Specific Target Organ Toxicity- Single Exposure- Category 3
- Green Screen benchmarks
  - LT-1
- Prop 65:
  - Cancer
  - Developmental Toxicity
  - Male Reproductive Toxicity

## INDUSTRY USE AND APPLICATIONS

- Electronics Industry Use/ Application in Cleaning
  - Used for vapor degreasing; semiconductor wafer (before, during and after fabrication)
- Other Industry Use/ Application
  - Used in cleanrooms to remove contaminants. Used to clean ingot and wafer material. Primarily used as an intermediate in the production of HFCs and as a spotting agent for dry-cleaning.

## 6. Further Research/ Assessment Needed

### Ethylbenzene

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**Name:** Ethylbenzene

**CAS:** 100-41-4

Detailed information for Benzene is available upon request.

#### CHEMICAL TOXICITY PROFILE

- GHS classifications:
  - Carcinogenicity- Category 2
  - Specific Target Organ Toxicity- STOT- Single Exposure- Category 2
  - Acute Toxicity- Category 4
- Green Screen benchmarks:
  - LT-1
- Prop 65:
  - Cancer

#### INDUSTRY USE AND APPLICATIONS

- Electronics Industry Use/ Application in Cleaning
  - Possibly used in very low volumes for QA/QC in analytical labs (not used in the manufacturing process).
  - Possibly used in low volumes as an ingredient for adhesion.
- Other Industry Use/ Application
  - Mainly used in the production of styrene (98-99%).
  - Used as a solvent (remaining 2%).

## 7. High Hazard Chemicals with No Indication of Current Use

The research on the following remaining 14 nominated chemicals did not uncover information indicating their current use in the electronics industry and are consequently not be included as Priority Chemicals. However, these chemicals are considered high hazard using the CEPN High Hazard Criteria, and as such they would not qualify as safer alternatives.

For two of these 14 chemicals - 1,1-Dichloroethane and 1,1,1-Trichloroethane - while no information was found indicating current use in the electronics industry, they may have been used in the past and the Technical Review Board indicated that these two chemicals remain priorities and they should not to be reintroduced into the electronics supply chain. If they are found in use in the future, they will be considered for a future round of Priority Chemicals.

- 1,2-Dichloroethane (CAS #107-06-2)
- 1,1-Dichloroethylene (CAS #75-35-4)
- Carbon Tetrachloride (CAS #56-23-5)
- Chloroethane (CAS #75-00-3)
- Chloroform (CAS #67-66-3)
- Hexachloroethane (CAS #67-72-1)
- Methyl chloride (CAS #74-87-3)
- Pentachloroethane (CAS #76-01-7)
- Pentachlorophenol (CAS #87-86-5)
- 1,1,2,2-Tetrachloroethane (CAS #79-34-5)
- 1,1,1,2-Tetrachloroethane (CAS #630-20-6)
- Vinyl trichloride (CAS #79-00-5)
- 1,1-Dichloroethane (CAS #75-34-3)\*\*\*
- 1,1,1-Trichloroethane (CAS #71-55-6)\*\*\*

## Appendix A - Adoption of an OEL for Conditional Use of NMP

### OCCUPATIONAL EXPOSURE LIMITS

Occupational exposures to NMP used for photoresist stripping shall be controlled to prevent inhalation exposures above:

- An 8-hr Time-Weighted-Average (TWA) Occupational Exposure Limit of **1.0 ppm**; and
- A 15 minute Short-Term-Exposure-Limit (STEL) of **20.0 ppm**

Exposure controls shall also include protective measures to prevent all potential skin contact with NMP or mixtures containing NMP.

### RATIONALE

The adoption of an 8-hr TWA of 1.0 ppm and a 15-minute STEL of 20.0 ppm Occupational Exposure Limits (OEL) for conditional use of NMP is based on selection of the lowest published regulatory occupational exposure limits for NMP.

The recommended Occupational Exposure Limit of 1.0 ppm (8-hr TWA) is based on selection of the lowest published regulatory occupational exposure limits for NMP. Currently, California OSHA ([CA OSHA Permissible Exposure Limits](#)) and Japan ([International Regulatory Exposure Limits](#)) have the lowest published 8-hr TWA limit for NMP (1.0 ppm). California OSHA issued a PEL of 1 ppm (8-hour TWA), along with a "Skin" notation, to prevent adverse effects on the developing fetus based on the No Observable Affect Exposure Level (NOAEL) value of 50 ppm and a cumulative uncertainty factor of 60 consistent with California's Office of Environmental Health Hazard Assessment's (OEHHA) current noncancer risk assessment guidelines ([California OSHA NMP PEL Rational](#)). Neither California OSHA nor Japan list a STEL for NMP.

In addition to an 8-hr TWA limit of 10 ppm, the European Union and other countries also recommend a 15 minute Short Term Exposure Limit of 20.0 ppm ([EU Occupational Exposure Limit for NMP Rational](#)). The EU Scientific Committee on Occupational Exposure Limits report on NMP (SCOEL/REC/119 N-Methyl-2-Pyrrolidone) indicated 8-hr TWA limit of 10 ppm and a STEL of 20.0 ppm would be protective of workers for both worker irritation and reproductive toxicity endpoints. The EU OEL for NMP also lists a "Skin" or "Dermal" notation indicating a potential exposure route to NMP through direct skin or eye contact with the chemical.

Based on this, CEPN has selected the lowest published regulatory limits for NMP for the California OSHA/Japan 8-hr TWA concentration of 1.0 ppm and the EU 15-minute STEL of 20.0 ppm.

### SOURCES

California OSHA Permissible Exposure Limits ([https://www.dir.ca.gov/title8/5155table\\_ac1.html#\\_blank](https://www.dir.ca.gov/title8/5155table_ac1.html#_blank))

California OSHA NMP PEL rational ([https://www.dir.ca.gov/oshsb/Airborne\\_contaminants\\_N\\_-\\_Methylpyrrolidone\\_ISOR.pdf](https://www.dir.ca.gov/oshsb/Airborne_contaminants_N_-_Methylpyrrolidone_ISOR.pdf))



ECHA Committee for Risk Assessment (RAC) and Scientific Committee on Occupational Exposure Limits (SCOEL) EU Occupational Exposure Limit for NMP Rational, 2016.

[https://echa.europa.eu/documents/10162/13579/rac\\_joint\\_nmp\\_opinion\\_en.pdf/e4b4f43b-a3bd-a7c0-08be-16c3886593e7](https://echa.europa.eu/documents/10162/13579/rac_joint_nmp_opinion_en.pdf/e4b4f43b-a3bd-a7c0-08be-16c3886593e7)

International Regulatory Exposure Limits (<https://limitvalue.ifa.dguv.de>)

SCOEL REC 119 N-Methyl-2-Pyrrolidone (<https://op.europa.eu/en/publication-detail/-/publication/c0dbb7a4-0c3a-11e6-ba9a-01aa75ed71a1/language-en>)

US EPA Risk Assessment on NMP, 2017. ([https://www.epa.gov/sites/production/files/2017-06/documents/nmp\\_scope\\_6-22-17\\_0.pdf](https://www.epa.gov/sites/production/files/2017-06/documents/nmp_scope_6-22-17_0.pdf))