The Chemical Universe: Scheduled and Unscheduled

Science for Diplomats at EC-88
The Hague, 10 July 2018

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Explore the Chemical Universe

Scan with your phone,

Press , insert your phone and enjoy!
Science for Diplomats at EC-88
The Chemical Universe: Scheduled and Unscheduled

Tuesday, 10 July 2018
Ooms Room, OPCW
13:30 - 14:45
Light lunch served at 13:00
Join us at EC-88 for #ScienceforDiplomats, a journey across the chemical universe & a look at the @OPCW Scientific Advisory Board #CWCRC4 recommendations on schedules.

Science for Diplomats at EC-88
The Chemical Universe: Scheduled and Unscheduled

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Scientific Advisory Board’s Recommendations to the Fourth Review Conference of the Chemical Weapons Convention

A quick reference guide to the executive summary recommendations of the OPCW Scientific Advisory Board’s report on developments in science and technology to the Fourth Review Conference (RC-4/DG.1, dated 30 April 2018).

Download RC-4/DG.1

REPORT OF THE SCIENTIFIC ADVISORY BOARD ON DEVELOPMENTS IN SCIENCE AND TECHNOLOGY FOR THE FOURTH SPECIAL SESSION OF THE CONFERENCE OF THE STATES PARTIES TO REVIEW THE OPERATION OF THE CHEMICAL WEAPONS CONVENTION

Introduction

1. The Scientific Advisory Board (SAB) was established by the Director-General in accordance with subparagraph 21(b) and paragraph 4 of Article VIII of the Chemical Weapons Convention (hereinafter “the Convention”), so that he could render to the Conference of the States Parties (hereinafter “the Conference”) and the Executive Council (hereinafter “the Council”) specialised advice in areas of science and technology relevant to the Convention. In keeping with this mandate, and as its contribution to the Fourth Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention (hereinafter “the Fourth Review Conference”), to be held from 21 to 30 November 2018, the SAB has prepared this report, which analyses relevant developments in science and technology over the past five years and presents recommendations and observations that the SAB considers to be important for the review of the operation of the Convention and its future implementation.

2. This report contains an executive summary and recommendations addressing issues that may impact the implementation of the Convention and the work of the Technical Secretariat (hereinafter “the Secretariat”). The analysis of developments in science and technology that informed the recommendations, as well as additional, more detailed recommendations, are provided in Annex 1.

3. This is the fourth report for a Review Conference by the SAB on developments in science and technology relevant to the Convention. The three earlier reports were presented to the First Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention (hereinafter “the First Review Conference”), the Second Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention (hereinafter “the Second Review Conference”), and the Third Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention (hereinafter “the Third Review Conference”).
Many thanks to delegations that joined us for today's discussion of the @OPCW Scientific Advisory Board's #CWCRC4 recommendations. #ScienceforDiplomats. Quick reference guide can be found here ow.ly/2Brl30kmSYc
Scheduled Chemicals under the Chemical Weapons Convention (CWC)

### Schedule 1
Guidelines for Schedule 1
The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 1:
(a) It has been developed, produced, stockpiled or used as a chemical weapon as defined in Article II;
(b) It poses otherwise a risk to the object and purpose of this Convention by virtue of its high potential for use in activities prohibited under this Convention because one or more of the following conditions are met:
(i) It possesses a chemical structure closely related to that of other toxic chemicals listed in Schedule 1, and has, or can be expected to have, comparable properties;
(ii) It possesses such lethal or incapacitating toxicity as well as other properties that would enable it to be used as a chemical weapon;
(iii) It may be used as a precursor in the final single technological stage of production of a toxic chemical listed in Schedule 1, regardless of whether this stage takes place in facilities, in munitions or elsewhere;
(c) It has little or no use for purposes not prohibited under this Convention.

### Schedule 2
Guidelines for Schedule 2
The following criteria shall be taken into account in considering whether a toxic chemical not listed in Schedule 1 or a precursor to a chemical listed in Schedule 2, part A, should be included in Schedule 2:
(a) It poses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;
(b) It may be used as a precursor in one of the chemical reactions at the final stage of formation of a chemical listed in Schedule 1 or Schedule 2, part A;
(c) It poses a significant risk to the object and purpose of this Convention by virtue of its importance in the production of a chemical listed in Schedule 1 or Schedule 2, part A;
(d) It is not produced in large commercial quantities for purposes not prohibited under this Convention.

### Schedule 3
Guidelines for Schedule 3
The following criteria shall be taken into account in considering whether a toxic chemical or precursor, not listed in other Schedules, should be included in Schedule 3:
(a) It has been produced, stockpiled or used as a chemical weapon;
(b) It poses otherwise a risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that might enable it to be used as a chemical weapon;
(c) It poses a risk to the object and purpose of this Convention by virtue of its importance in the production of one or more chemicals listed in Schedule 1 or Schedule 2, part B;
(d) It may be produced in large commercial quantities for purposes not prohibited under this Convention.

### Schedule 2 Part A. Toxic Chemicals

![Cyanide](image1)

### Schedule 2 Part B. Precursors

![Thiodiglycol](image2)

### Schedule 3 Part A. Toxic Chemicals

![Cyanide](image3)

### Schedule 3 Part B. Precursors

![Thiodiglycol](image4)
“Given the substantial changes in chemistry and chemical industry since the schedules were finalised a quarter century ago, a review of the schedules should be considered to assess whether: (a) the chemicals currently listed are in the appropriate Schedule, and (b) any toxic chemicals or specific precursors should be added to or removed from the Schedules.”
Where should we start?

Review the Schedules?
Let's Start with a Quiz!
How Well Do You Know Your Schedules?

Download at: https://www.opcw.org/special-sections/science-technology/science-for-diplomats/
How Well Do You Know Your Schedules?

Instructions

“Test your schedule knowledge”
Place the molecule on the correct schedule

Single bond: 3.5 cm
Double bond: 3 cm
Triple bond: 2.5 cm
Bond to H: 2 cm

You can check the answers by scanning QR codes with the Augment app. Download here:

For molecular models:

\[
\begin{array}{c|c|c|c|c}
\text{C}\text{*:} & \text{H}: & \text{S}: & \text{N}: & \text{P}\text{*:} \\
\text{Cl}: & \text{F}: & \text{O}: & \text{As}\text{*}: & \text{C}: & \text{P}: & \text{As}: \\
\end{array}
\]

* in Augment app:

Match the molecules to the Schedule
Prizes for whomever gets the most correct!
Scheduled Chemicals under the Chemical Weapons Convention (CWC)

Schedule 1

Guidelines for Schedule 1
The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 1:
(a) It has been developed, produced, stockpiled or used as a chemical weapon as defined in Article I.
(b) It poses otherwise a high risk to the object and purpose of this Convention by virtue of its high potential for use in activities prohibited under this Convention because one or more of the following conditions are met:
(i) It possesses a chemical structure closely related to that of other toxic chemicals listed in Schedule 1, and has, or can be expected to have, comparable properties;
(ii) It possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;
(iii) It may be used as a precursor in the final single technological stage of production of a toxic chemical listed in Schedule 1, regardless of whether this stage takes place in facilities, in munitions or elsewhere;
(c) It has little or no use for purposes not prohibited under this Convention.

Schedule 2

Guidelines for Schedule 2
The following criteria shall be taken into account in considering whether a toxic chemical not listed in Schedule 1 or a precursor to a Schedule 1 chemical or to a chemical listed in Schedule 2, part A, should be included in Schedule 2:
(a) It poses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;
(b) It may be used as a precursor in one of the chemical reactions at the final stage of formation of a chemical listed in Schedule 1 or Schedule 2, part A;
(c) It poses a significant risk to the object and purpose of this Convention by virtue of its importance in the production of a chemical listed in Schedule 1 or Schedule 2, part A;
(d) It is not produced in large commercial quantities for purposes not prohibited under this Convention.

Schedule 3

Guidelines for Schedule 3
The following criteria shall be taken into account in considering whether a toxic chemical or precursor, not listed in other Schedules, should be included in Schedule 3:
(a) It has been produced, stockpiled or used as a chemical weapon;
(b) It poses otherwise a risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that might enable it to be used as a chemical weapon;
(c) It poses a risk to the object and purpose of this Convention by virtue of its importance in the production of more chemicals listed in Schedule 1 or Schedule 2;
(d) It is not produced in large commercial quantities for purposes not prohibited under this Convention.

What are on the Schedules?
Text us your answers!
Answers from the Audience

What Do the Schedules Contain?

- chemical agents
- precursors
- toxic chemicals
- nerve agents
- blood agents
- chemical weapons
- mustard gas
- blister agents
- organophosphates
- chlorine
- carbon
- prlb
- cl
- ricin
- sarin
- toxic chemicals
- there are three plus doc dangerous chemicals
Schedule 1

Guidelines for Schedule 1
The following criteria shall be taken into account in considering whether a chemical or precursor should be included in Schedule 1:

(a) It has been developed, produced, stockpiled or used as a chemical weapon (as defined in Article VI);
(b) It poses otherwise a high risk to the object and purpose of the Convention because of its high potential for use in activities prohibited under the Convention because one or more of the following conditions are met:
   (i) It possesses a chemical structure closely related to that of a chemical listed in Schedule 1, and has, or can be expected to have, comparable properties;
   (ii) It possesses such lethal or incapacitating toxicity as well as other properties that would enable it to be used as a chemical weapon;
   (iii) It may be used as a precursor in the final stage of the production of a toxic chemical listed in Schedule 1, and has, or has been expected to have, such properties that would enable it to be used as a chemical weapon;
(c) It has little or no use for purposes not prohibited under this Convention.

Schedule 1 Part A, Toxic Chemicals

Schedule 1 Part B, Precursors
Schedule 2

Schedule 2 Part A, Toxic Chemicals

Schedule 2 Part B, Precursors

Exemption Formulae

Arsenic Trichloride

2,3-Diethyl-1-hydroxyxymethyl acetic acid

(+)(--)-3-Quinuclidinol

(--)-3-Quinuclidinol

Thiodiglycol: Bis(2-hydroxyethyl)sulfide

(+)-(++)-Pinacolyl alcohol

(--)-(--)Pinacolyl alcohol
Schedule 2

Organophosphorus pesticides

PREV and

Fire Retardants
Schedule 3

Schedule 3 Part A, Toxic Chemicals

- Phosgene: Carbonyl dichloride 3A(1)
- Cyanogen chloride 3A(2)
- Hydrogen cyanide 3A(3)
- Chloropicrin: Trichloronitromethane 3A(4)

Schedule 3 Part B, Precursors

- Phosphorus oxychloride 3B(5)
- Phosphorus trichloride 3B(6)
- Phosphorus pentachloride 3B(7)
- Trimethyl phosphate 3B(8)
- Triethyl phosphate 3B(9)
- Dimethyl phosphate 3B(10)
- Diethyl phosphate 3B(11)
- Sulfur monochloride 3B(12)
- Sulfur dichloride 3B(13)
- Thionyl chloride 3B(14)

Ethyl diethanolamine 3B(15)
Methyl diethanolamine 3B(16)
Triethanolamine 3B(17)
Schedule 3

Schedule 3 Part A, Toxic Chemicals

- Phosgene: Carbonyl dichloride
  3A(1)
- Cyanogen chloride
  3A(2)
- Sulfur mustard
  3A(3)
- Chloropicrin: Trichloronitromethane
  3A(4)

Schedule 3 Part B, Precursors

- Phosphorus oxychloride
  3B(5)
- Phosphorus trichloride
  3B(6)
- Phosphorus pentachloride
  3B(7)
- Trimethyl phosphate
  3B(8)
- Triethyl phosphate
  3B(9)
- Dimethyl phosphate
  3B(10)
- Dime thyl phosphite
  3B(11)
- Sulfur dichloride
  3B(13)
- Thionyl chloride
  3B(14)
- Ethyldiethanolamine
  3B(15)
- Methyl diethanolamine
  3B(16)
- Triethanolamine
  3B(17)
Schedule 3

Schedule 3 Part A, Toxic Chemicals

- Hydrogen cyanide
  - 3A(3)
- Chloropicrin: Trichloronitromethane
  - 3A(4)
- Dimethyl phosphate
  - 3B(8)
- Triethyl phosphate
  - 3B(9)
- Sulfur dichloride
  - 3B(13)
- Thionyl chloride
  - 3B(14)
- Triethanolamine
  - 3B(17)

In use: Materials

OPCW
“Given the substantial changes in chemistry and chemical industry since the schedules were finalised a quarter century ago, a review of the schedules should be considered to assess whether: (a) the chemicals currently listed are in the appropriate Schedule, and (b) any toxic chemicals or specific precursors should be added to or removed from the Schedules. In this connection, it should be considered whether it is technically feasible to accurately monitor Schedule 3 chemicals that are produced in very large quantities (e.g. over 100,000 tons/year).”
Schedule 3

Schedule 3 Part A, Toxic Chemicals
(isocyanates derived from phosgene)

- Phosgene: Carbonyl dichloride
  3A(1)
- Cyanogen chloride
  3A(2)
- Hydrogen cyanide
  3A(3)
- Chloropicrin: Trichloronitromethane
  3A(4)

Schedule 3 Part B, Precursors

- Phosphorus oxychloride
  3B(5)
- Phosphorus trichloride
  3B(6)
- Phosphorus pentachloride
  3B(7)
- Trimethyl phosphite
  3B(8)
- Triethyl phosphite
  3B(9)
- Dimethyl phosphite
  3B(10)
- Diethyl phosphite
  3B(11)
- Thionyl chloride
  3B(14)
- Ethyldiethanolamine
  3B(15)
- Methyl diethanolamine
  3B(16)
- Triethanolamine
  3B(17)

Some of these chemicals *might* qualify for the > 100,000 club?
What are on the Schedules?
The Scheduled chemicals explicitly specified in the Convention for monitoring purposes, include chemical warfare agents and their key precursors.

Scheduled chemicals are associated with historical chemical warfare programmes – this does not mean they are chemical weapons...

A Chemical Weapon:

Toxic chemicals and their precursors, except where intended for purposes not prohibited under this Convention as long as the types and quantities are consistent with such purposes (Article II).
The Scheduled chemicals explicitly specified in the Convention for monitoring purposes, include chemical warfare agents and their key precursors. Scheduled chemicals include toxic chemicals and their precursors, except where intended for purposes not prohibited under this Convention as long as the types and quantities are consistent with such purposes.
Precursors?
Chemical Warfare Agents and Precursors

Schedule 3

“Chemical weapon” (historical or potential)
Key precursor to S1 or S2(A)
Produced in large commercial quantities

Schedule 2

Potential chemical weapon;
Final stage or key precursor to S1 or S2(A)
Not produced in large commercial quantities

Schedule 1

“Chemical weapon” (historical or potential)
Closely related chemical structure to S1(A)
Comparable properties to S1(A)
Final stage precursor to S1(A)
No (or limited) non-prohibited uses

Sarin (1A.01)
chemical warfare agent
Chemical Warfare Agents and Precursors

Schedule 3

3B.06

\[ \text{PCI}_3 + \text{MeOH} \rightarrow \text{MeO} + \text{Cl} \]

phosphorus trichloride

“Chemical weapon” (historical or potential)
Key precursor to S1 or S2(A)
Produced in large commercial quantities

Schedule 2

2B.04

\[ \text{CH}_3\text{P} + \text{PCl}_3 \rightarrow \text{CH}_3\text{P} + \text{Cl}_2 \]

Potential chemical weapon;
Final stage or key precursor to S1 or S2(A)
Not produced in large commercial quantities

Schedule 1

1B.09

\[ \text{CH}_3\text{P} + \text{i-PrOH} \rightarrow \text{MeF} + \text{Cl}_2 \]

“Chemical weapon” (historical or potential)
Closely related chemical structure to S1(A)
Comparable properties to S1(A)
Final stage precursor to S1(A)
No (or limited) non-prohibited uses

“Chemical weapon” (historical or potential)
Closely related chemical structure to S1(A)
Comparable properties to S1(A)
Final stage precursor to S1(A)
No (or limited) non-prohibited uses
Chemical Warfare Agents and Precursors

**Schedule 3**

3B.06

\[ \text{PCI}_3 \xrightarrow{\text{MeOH}} (\text{MeO})_3\text{P} \]

Phosphorus trichloride → Trimethyl phosphite (heat)

“Chemical weapon” (historical or potential)
Key precursor to S1 or S2(A)
Produced in large commercial quantities

3B.08

\[ \text{Sarin (1A.01)} \]

Chemical warfare agent
Schedule 2

2B.04

Potential chemical weapon;
Final stage or key precursor to S1 or S2(A)
Not produced in large commercial quantities

3B.06

Closely related chemical structure to S1(A)
Comparable properties to S1(A)
Final stage precursor to S1(A)
No (or limited) non-prohibited uses

3B.08

“Chemical weapon” (historical or potential)
Key precursor to S1 or S2(A)
Produced in large commercial quantities

Sarin

If making sarin for prohibited uses, under Article II, these would be:

“Unscheduled Chemical Weapons”

MeOH, i-PrOH, HF, NaF Unscheduled “Precursors”
(these are not considered “key” precursors)

Potential chemical weapon
Final stage or key precursor to S1 or S2(A)
Not produced in large commercial quantities

Sarin

99% Isopropyl Alcohol

OPCW
How Many Chemicals are Contained within the Schedules?

### Schedule 1

#### A. Toxic chemicals:

2. Phosphorus pentachloride (75-05-8)
3. Hydrogen cyanide (74-90-8)
4. Chlorosulfonic acid (76-02-7)
5. Phosphorus trichloride (7799-12-2)
6. Phosphorus pentoxide (10025-87-3)
7. Phosphorus oxychloride (10026-11-8)
8. Tin(II) oxide (12145-40-8)
9. Tin(II) chloride (23252-51-9)
10. Dibutyl phthalate (886-85-9)
11. Dibutyl phthalate (762-90-4)
12. Silica (12003-10-7)
13. Dibutyl phthalate (10545-99-0)
14. Tin(IV) chloride (7778-06-7)
15. Ethylbenzene (100-42-5)
16. Methylchloroform (105-59-9)
17. Tribromonitromethane (102-71-6)

#### B. Preparations:

- Ammonium phosphomolybdate
- Amidine phosphoramide
- Alkaline earth metal phosphates
- Aromatic or aliphatic hydrocarbons
- Ethylene glycol
- Formic acid
- Formamide
- Hydrogen sulfide
- Phosphorus pentoxide
- Phosphorus pentoxide
- Phosphorus oxychloride
- Tin(II) oxide
- Tin(II) chloride
- Methylchloroform
- Tribromonitromethane

### Schedule 2

#### A. Toxic chemicals:

2. Phosphorus pentachloride (75-05-8)
3. Hydrogen cyanide (74-90-8)
4. Chlorosulfonic acid (76-02-7)
5. Phosphorus trichloride (7799-12-2)
6. Phosphorus pentoxide (10025-87-3)
7. Phosphorus oxychloride (10026-11-8)
8. Tin(II) oxide (12145-40-8)
9. Tin(II) chloride (23252-51-9)
10. Dibutyl phthalate (886-85-9)
11. Dibutyl phthalate (762-90-4)
12. Silica (12003-10-7)
13. Dibutyl phthalate (10545-99-0)
14. Tin(IV) chloride (7778-06-7)
15. Ethylbenzene (100-42-5)
16. Methylchloroform (105-59-9)
17. Tribromonitromethane (102-71-6)

#### B. Preparations:

- Ammonium phosphomolybdate
- Amidine phosphoramide
- Alkaline earth metal phosphates
- Aromatic or aliphatic hydrocarbons
- Ethylene glycol
- Formic acid
- Formamide
- Hydrogen sulfide
- Phosphorus pentoxide
- Phosphorus pentoxide
- Phosphorus oxychloride
- Tin(II) oxide
- Tin(II) chloride
- Methylchloroform
- Tribromonitromethane
How many chemicals are contained within the Schedules?

- 35
- Failed
- Chemistry
- Endless
- 300
- 2400
- 1000000
- Lots
- Tens of thousands
- Infinity
- Numbers
- Too many
- Millions
- 100000
- 250
- 150
- 40000

<table>
<thead>
<tr>
<th>Schedule of Chemicals</th>
<th>Schedule of Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>17</td>
</tr>
</tbody>
</table>

[Exemptions and corresponding permitted salts]

- Nitric ether/nitromethane and corresponding permitted salts
- Hydrazine/nitrosomethylhydrazine and corresponding permitted salts

- Acids: H2O, Et, s-Py or s-Pt, nitrocellulose, 2-thiols
- Thiolcarbonyls: Bi-ethylcyclohexylthiothiol (111-49-5)
- Fluoroethyl alcohol: 1,2-Dimethylform-2-ul (941-07-2)
How Many Chemicals are Contained within the Schedules?

53 specific chemicals are listed by chemical name, CAS number and/or uniquely defined chemical formula (3 are exemptions to the Schedule they would otherwise fall under).

Chemical Abstracts Service (CAS) Registry Numbers
A Matter of Atoms and Molecules
Scheduled Chemicals under the Chemical Weapons Convention (CWC)

**Schedule 1**

Guidelines for Schedule 1:
The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 1:

(a) It has been developed, produced, stockpiled or used as a chemical weapon as defined in Article I.

(b) It possesses such lethal or incapacitating properties that could enable it to be used as a chemical weapon.

(c) It may be used as a precursor in one of the technological stages of production of a toxic chemical listed in Schedule 2, regardless of whether this stage takes place in facilities, munitions or elsewhere.

(d) It has little or no use for purposes not prohibited under this Convention.

3 Groups of compounds (15 compounds in total)

**Schedule 2**

Guidelines for Schedule 2:
The following criteria shall be taken into account in considering whether a chemical not listed in Schedule 1 or a precursor to a Schedule 2 chemical should be included in Schedule 2:

(a) It poses a significant risk to the object and purpose of this Convention by virtue of its importance in the production of the associated Schedule 1 or Schedule 2 part A chemical.

(b) It possesses such lethal or incapacitating properties that could enable it to be used as a chemical weapon.

(c) It is not produced in large commercial quantities for purposes not prohibited under this Convention.

26 Single chemical substances

**Schedule 3**

Guidelines for Schedule 3:
The following criteria shall be taken into account in considering whether a chemical not listed in any other Schedule, should be included in Schedule 3:

(a) It has been developed, produced, stockpiled or used as a chemical weapon as defined in Article I.

(b) It possesses such lethal or incapacitating properties that could enable it to be used as a chemical weapon.

(c) It may be used as a precursor in one of the technological stages of production of a toxic chemical listed in Schedule 1 or Schedule 2 part A.

(d) It poses a significant risk to the object and purpose of this Convention by virtue of its importance in the production of the associated Schedule 2 part A chemical.

3 Single chemical substances

Shown here as stereoisomers
Scheduled Chemicals under the Chemical Weapons Convention (CWC)

**Schedule 1**
- **Guidelines for Schedule 1**
  - The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 1:
    1. It has been developed, produced, stockpiled or used as a chemical weapon as defined in Article II.
    2. It possesses such lethal or incapacitating properties that could enable it to be used as a chemical weapon.
    3. It may be used as a precursor in the final single technological stage of production of a toxic chemical listed in Schedule 3, regardless of whether this stage takes place in facilities, in munitions or elsewhere;
    4. It has little or no use for purposes not prohibited under this Convention.

**Schedule 2**
- **Guidelines for Schedule 2**
  - The following criteria shall be taken into account in considering whether a precursor to a Schedule 1 chemical or a chemical listed in Schedule 2, part A, should be included in Schedule 2:
    1. It has an intermediate or final stage of formation of a Schedule 2 chemical.
    2. It poses a significant risk to the object and purpose of this Convention by virtue of its properties or method of production.

**Schedule 3**
- **Guidelines for Schedule 3**
  - The following criteria shall be taken into account in considering whether a precursor to a Schedule 1 chemical or a chemical listed in Schedule 2, part A, should be included in Schedule 3:
    1. It has an intermediate or final stage of formation of a Schedule 3 chemical.
    2. It poses a significant risk to the object and purpose of this Convention by virtue of its properties or method of production.

---

3 Groups of compounds
(15 compounds in total)
26 Single chemical substances
Shown here as stereoisomers
3 Single chemical substances
And 11 structural “families”
Families of Chemicals?

- **1B.09**: Four members
  
  - \[ R_1 \] has four possible structures
  
  - **What about \[ R_2 \]?**
    
    - \[ R_2 = C_1 (-CH_3) \], 1 structure \( \times 4 = 4 \) 1A.01 chemicals
    
    - \[ R_2 = C_2 (-CH_2CH_3) \], 1 structure \( \times 4 = 4 \) 1A.01 chemicals
    
    - \[ R_2 = C_3 (-CH_2CH_2CH_3 \text{ or } -\text{CH(CH}_3)_2 \text{ or } \bigtriangleup ) \], 3 structures \( \times 4 = 12 \) 1A.01 chemicals

- **1A.01**
  
  - \[ R_1 \] has four possible structures

  - **What about \[ R_2 \]?**
    
    - \[ R_2 = C_6 \]

  21 structures

  83 ways of attachment

  332 1A.01 chemicals

*Includes sarin, soman, cyclosarin*

With one variable R group from C1 to C10 for 1A.01, 1A.02 and 1A.03: > 1.3 million possible chemicals in these three Schedules
Families of Chemicals?

- **1B.09: Four members**

  - $R_1$ has four possible structures
  - What about $R_2$?
    - $R_2 = C_1(-CH_3)$, 1 structure x 4 = 4 chemicals
    - $R_2 = C_2(-CH_2CH_3)$, 1 structure x 4 = 4 chemicals
    - $R_2 = C_3(-CH_2CH_2CH_3)$ or $-CH(CH_3)_2$, 3 structures x 4 = 12 chemicals

Includes sarin 21 structures 83 ways of attachment 332 chemicals
Includes soman, cyclosarin

Exemption: Fonofos
2B.04 is the Largest Family on the Schedules
(unlimited possibilities with one exemption)
Is that all a bit too Complicated?
Is that all a bit too Complicated?
Is that all a bit too Complicated?

Why stop at $C_{10}$?
Is that all a bit too Complicated?

Nerve agent adduct

Sarin: Why stop at C10?
A Matter of Size

$R_2 = C_3$ (sarin)

$R_2 = C_6$

$R_2 = C_{10}$
Families also help to mitigate issues of “designer” compounds being exempt from monitoring and control.
Are Individual Chemicals any Less Complicated?

\[
i-\text{PrO}\quad P\quad O
\]
\[
H_3C\quad F
\]
Sarin
CAS 107-44-8
Schedule 1.A.01

\[
i-\text{PrO}\quad P\quad O
\]
\[
H_3C\quad F
\]
(R)-(−)-Sarin
CAS 6171-94-4

\[
i-\text{PrO}\quad P\quad O
\]
\[
H_3C\quad F
\]
(S)-(+)−Sarin
CAS 6171-93-3
Are Individual Chemicals any Less Complicated?

$i$-PrO\(\overset{\text{H}}{\overset{\text{P}}{\overset{\text{O}}{\overset{\text{F}}{\overset{\text{H}_3}{\text{C}}}}}}\)

Sarin

CAS 107-44-8

Schedule 1.A.01

For the other enantiomer, switch the positions of the fluoride and the methyl (\(\text{CH}_3\)) that is connected to the phosphorous.

Can you superimpose these two enantiomers onto one another? No? That’s because they are mirror images. Similarly, can you superimpose your own hands? Your hands are also mirror images of one another.

Stereoisomers should still fall under the Schedule of the parent compound (SAB Recommendation)
16 protons + 16, 17, 18 or 19 neutrons = 4 isotopes ($^{32}$S, $^{33}$S, $^{34}$S, $^{35}$S)
Isotopically labeled chemicals should still fall under the Schedule of the parent compound (SAB Recommendation)

- \( \text{Cl} - ^{32}\text{S} - \text{Cl} \) 94.99 %
- \( \text{Cl} - ^{33}\text{S} - \text{Cl} \) 0.75 %
- \( \text{Cl} - ^{34}\text{S} - \text{Cl} \) 4.25 %
- \( \text{Cl} - ^{35}\text{S} - \text{Cl} \) 0.01 %
- \( \text{Cl} - ^{35}\text{S} - \text{Cl} \) this isotopically labelled form has CAS 6755-76-6

sulfur mustard: bis(2-chloroethyl)sulfide as listed within Schedule 1.A.04 under CAS 505-60-2
Isotopes

Just to complicate things more:
Hydrogen isotopes are written in chemical structures as: H (\(^1\)H), D (\(^2\)H) or T (\(^3\)H)

\[
\text{i-PrO}_2\text{PO} \quad \text{H}_3\text{C} \quad \text{F} \\
\text{sarin}
\]

Schedule 1.A.01
CAS 107-44-8

\[
i\text{-PrO}_2\text{PO} \quad \text{D}_3\text{C} \quad \text{F} \\
\text{sarin-}d_3
\]

CAS 104801-08-3
Salts?
Why Does This Matter?

Are salts of 1A.04 and 1A.07 chemicals scheduled?

Should salts of scheduled chemicals not specified on the schedules be scheduled?
The Number of Scheduled Chemicals is Limitless...
Keeping Track of Chemicals Known to Science: CAS Registry Numbers are assigned when new substances are "published" in scientific and patent literature. ~32,000 CAS numbers assigned to Scheduled Chemicals.
The Number of Scheduled Chemicals is Limitless…

Keeping Track of Chemicals Known to Science:

CAS Registry Numbers are assigned when new substances are “published” in scientific and patent literature.

~32,000 CAS numbers assigned to Scheduled Chemicals

Handbook on Chemicals 2017 Revised version 1

www.opcw.org/our-work/non-proliferation/declarations-adviser/handbook-on-chemicals/

Not all Scheduled Chemicals that have been declared have CAS Numbers
What About Chemicals Not on Schedules?

How many chemicals are there?
More Possible Chemicals than Atoms in the Universe!
More Possible Chemicals than Atoms in the Universe!

CAS Registry Numbers
(chemical substances and sequences)

1993
CWC Opened for Signature

~196,000,000 CAS Numbers at beginning of 2017

> 209 Million CAS Numbers as of July 2018..
> 142 Million are organic/inorganic chemical substances
> 13 million new CAS numbers in past 18 months...
Which unscheduled chemicals matter?
Which unscheduled chemicals matter?
**What About Chemicals Not on Schedules?**

### The Definition of a Toxic Chemical

Any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals. *This includes all such chemicals, regardless of their origin or of their method of production*, and regardless of whether they are produced in facilities, in munitions or elsewhere.

---

**Chemical Weapons Convention Article II, Paragraph 2**
## Riot Control Agents

**Fauzia Nurul Izzati, Jonathan E. Forman and Christopher M. Timperley**

### What is the definition of a Riot Control Agent (RCA)?

From paragraph 7, Article II of the Chemical Weapons Convention:

> "Any chemical not listed in a Schedule, which can produce rapidly in humans sensory irritation or disabling physical effects which disappear within a short time following termination of exposure."

### How do Riot Control Agents work?

RCAs produce irritation through binding to TRP (Transient Receptor Potential) receptors. This activates some of the same biochemical pathways that are triggered by eating horseradish or hot peppers.

### What are Riot Control Agents?

Chemicals that meet the criteria of an RCA include the following:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Structure</th>
<th>Physical State</th>
<th>Solubility</th>
<th>Reactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td><img src="image" alt="CS Structure" /></td>
<td>Yellow solid powder</td>
<td>Soluble in water and acetone</td>
<td>Low reactivity</td>
</tr>
<tr>
<td>Capsaicin</td>
<td><img src="image" alt="Capsaicin Structure" /></td>
<td>White solid</td>
<td>Soluble in ethanol and acetone</td>
<td>High reactivity</td>
</tr>
</tbody>
</table>

### What are TRP Receptors?

TRP receptors are a family of ion channel receptors mainly located on cell membranes of multicellular organisms. TRP receptors are classified into seven subfamilies: TRPC (canonical or classical), TRPV (vanilloid), TRPM (melastatin), TRPA (ANKTM1 homologues), TRPP (polycystin), TRPML (mucolipin), and TRPN (NOMPC homologues).

TRP receptor functions are diverse; the receptors serve as versatile sensors that allow individual cells and entire organisms to detect changes in their environment. This includes experiencing changes in temperature, touch, taste and other stimuli (including pain).

**TRPA1**

CS and isothiocyanate compounds bind to the TRPA1 receptor. Allyl isothiocyanate is the main pungent ingredient in wasabi, horseradish, and mustard oils - this chemical also binds to the TRPA1 receptor.

**TRPV1**

Capsaicin, homocapsaicin, and other related compounds bind to the TRPV1 receptor. These chemicals are naturally found in hot chili peppers.
Degradation and Environmental Fate of Sulfur Mustard

Darcy van Eerten

Environmental fate in:
- Cement & Soil
- Sea Water
- Synthesis Routes
- Toxicology
- Reported Impurities
- Decontamination

Scheduled Chemical

Unscheduled precursors, degradation products and contaminants

Metabolic pathway for TDG utilization by bacteria isolated from the Baltic Sea

DNA adducts to nucleobases can result in cross-linked strands which can lead to cancer and/or cell death.

Epsilochlorotrimethyloladisulfide to Cytosine-34 in human serum. Albumin in the blood.
# Toxic Industrial Chemicals

<table>
<thead>
<tr>
<th>High</th>
<th>Medium</th>
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<tbody>
<tr>
<td>Ammonia (CAS# 7664-41-7)</td>
<td>Acetone cyanohydrin (CAS# 75-86-5)</td>
<td>Allyl isothiocyanate (CAS# 57-06-7)</td>
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<tr>
<td>Arsine (CAS# 7784-42-1)</td>
<td>Acrolein (CAS# 107-02-8)</td>
<td>Arsenic trichloride (CAS# 7784-34-1)</td>
</tr>
<tr>
<td>Boron trichloride (CAS#10294-34-5)</td>
<td>Acrylonitrile (CAS# 107-13-1)</td>
<td>Bromine (CAS# 7726-96-6)</td>
</tr>
<tr>
<td>Boron trifluoride (CAS#7637-07-2)</td>
<td>Allyl alcohol (CAS# 107-18-6)</td>
<td>Bromine chloride (CAS# 13863-41-7)</td>
</tr>
<tr>
<td>Carbon disulfide (CAS# 75-15-0)</td>
<td>Allylamine (CAS# 107-11-9)</td>
<td>Bromine pentafluoride (CAS# 7789-30-2)</td>
</tr>
<tr>
<td>Chlorine (CAS# 7782-50-5)</td>
<td>Allyl chlorocarbonate (CAS# 2937-50-0)</td>
<td>Bromine trifluoride (CAS# 7787-71-5)</td>
</tr>
<tr>
<td>Diborane (CAS# 19287-46-7)</td>
<td>Boron tribromide (CAS# 10294-33-4)</td>
<td>Carbonyl fluoride (CAS# 353-50-4)</td>
</tr>
<tr>
<td>Ethylene oxide (CAS# 75-21-8)</td>
<td>Carbon monoxide (CAS# 630-08-0)</td>
<td>Chlorine pentafluoride (CAS# 13637-63-3)</td>
</tr>
<tr>
<td>Fluorine (CAS# 7782-41-4)</td>
<td>Carbonyl sulfide (CAS# 483-58-1)</td>
<td>Chlorine trifluoride (CAS# 7790-91-2)</td>
</tr>
<tr>
<td>Formaldehyde (CAS# 50-00-0)</td>
<td>Chloroacetone (CAS# 78-95-5)</td>
<td>Chloroacetaldehyde (CAS# 107-20-0)</td>
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<tr>
<td>Hydrogen bromide (CAS# 10035-10-8)</td>
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<td>Chloroacetyl chloride (CAS# 79-04-9)</td>
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<tr>
<td>Hydrogen chloride (CAS# 7647-01-0)</td>
<td>Chlorosulfonic acid (CAS# 7790-94-5)</td>
<td>Crotonaldehyde (CAS# 123-73-9)</td>
</tr>
<tr>
<td>Hydrogen cyanide (CAS# 74-00-8)</td>
<td>Diketene (CAS# 674-82-8)</td>
<td>Cyanogen chloride (CAS# 508-77-4)</td>
</tr>
<tr>
<td>Hydrogen fluoride (CAS# 7664-39-3)</td>
<td>1,2-Dimethylhydrazine (CAS# 540-73-8)</td>
<td>Dimethyl sulfate (CAS# 77-78-1)</td>
</tr>
<tr>
<td>Hydrogen sulfide (CAS# 7783-0604)</td>
<td>Ethylene dibromide (CAS# 106-93-4)</td>
<td>Diphenylmethane-4,4’-disocyanate (CAS# 101-68-8)</td>
</tr>
<tr>
<td>Nitric acid, fuming (CAS# 7697-37-2)</td>
<td>Hydrogen selenide (CAS# 7783-07-5)</td>
<td>Ethyl chloroformate (CAS# 541-41-3)</td>
</tr>
<tr>
<td>Phosgene (CAS# 75-44-5)</td>
<td>Methanesulfonyl chloride (CAS# 124-63-0)</td>
<td>Ethyl chlorothioformate (CAS# 2941-04-2)</td>
</tr>
</tbody>
</table>

Some are scheduled

[https://www.osha.gov/SLTC/emergencypreparedness/guides/chemical.html](https://www.osha.gov/SLTC/emergencypreparedness/guides/chemical.html)
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Central Nervous System Acting Chemicals
Central Nervous System Acting Chemicals
Central Nervous System Acting Chemicals

Stage 1
Drug discovery
10,000 compounds

Stage 2
Pre-clinical development
250 compounds

Stage 3
Clinical development
5 compounds

Phases
0  Effect on body
1  Safety in humans
2  Effectiveness at treating diseases
3  Larger scale safety and effectiveness
4  Long term safety

Regulatory approval
1 compound
Relative Toxicity?

- Can be lower than other CW
- Can also be very high!

*e.g.* Carfentanil

**Median Lethal Dose, LD₅₀ in mg/kg (Skin Exposure)**

**Blood Agent**
- Hydrogen Cyanide
  - LD₅₀: 100 mg/kg
  - LCT₅₀: 5000 mg·min/m³

**Choking Agents**
- Chlorine
  - LD₅₀: 800 mg/kg
  - LCT₅₀: 6000 mg·min/m³

**Nerve Agents**
- Tabun
  - LD₅₀: 0.071 mg/kg
  - LCT₅₀: 15 mg·min/m³
- VX Nerve Agent
  - LD₅₀: 0.071 mg/kg
  - LCT₅₀: 35 mg·min/m³
- Sarin
  - LD₅₀: 24.28 mg/kg
  - LCT₅₀: 35 mg·min/m³
- Soman
  - LD₅₀: 71 mg/kg
  - LCT₅₀: 70 mg·min/m³
- Cyclosarin
  - LD₅₀: 0.42 mg/kg
  - LCT₅₀: 35 mg·min/m³

**Blister Agents**
- Nitrogen Mustard HN-2
  - LD₅₀: 10 mg/kg
  - LCT₅₀: 1500 mg·min/m³
- Nitrogen Mustard HN-3
  - LD₅₀: 10 mg/kg
  - LCT₅₀: 1500 mg·min/m³

**Perfluorosbutene**
- LD₅₀: 100 mg/kg
- LCT₅₀: 870 mg·min/m³

**Skin exposure LD₅₀ is not available or not applicable**
Scheduled Chemicals under the Chemical Weapons Convention (CWC)

Schedule 1

Guidelines for Schedule 1

The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 1:

(a) It has been developed, produced, stockpiled or used as a chemical weapon as defined in Article II;
(b) It poses otherwise a high risk to the object and purpose of this Convention by virtue of its high potential for use in activities prohibited under this Convention, because one or more of the following conditions are met:
   (i) It possesses a chemical structure closely related to that of other toxic chemicals listed in Schedule 2, and has, or can be expected to have, comparable properties;
   (ii) It possesses such lethal or incapacitating toxicity as well as other properties that would enable it to be used as a chemical weapon;
   (iii) It may be used as a precursor in the final single technological stage of production of a toxic chemical listed in Schedule 2, regardless of whether this stage takes place in facilities, in munitions or elsewhere;
(c) It has little or no use for purposes not prohibited under this Convention.

Schedule 2

Guidelines for Schedule 2

The following criteria shall be taken into account in considering whether a toxic chemical not listed in Schedule 1 or a precursor to a chemical listed in Schedule 2, part A, should be included in Schedule 2:

(a) It possesses a significant risk to the object and purpose of this Convention because it has or may be used as a precursor to a chemical in Schedule 2, part A;
(b) It is not produced in large commercial quantities for purposes not prohibited under this Convention.

Schedule 3

Guidelines for Schedule 3

The following criteria shall be taken into account in considering whether a toxic chemical or precursor, not listed in other Schedules, should be included in Schedule 3:

(a) It has been developed, produced, stockpiled or used as a chemical weapon;
(b) It poses otherwise a high risk to the object and purpose of this Convention because it has or may be used as a precursor to a chemical in Schedule 2, part A;
(c) It possesses a chemical structure closely related to that of other toxic chemicals listed in Schedule 2, and has, or can be expected to have, comparable properties;
(d) It possesses such lethal or incapacitating toxicity as well as other properties that would enable it to be used as a chemical weapon;
(e) It may be used as a precursor in the final single technological stage of production of a toxic chemical listed in Schedule 2, regardless of whether this stage takes place in facilities, in munitions or elsewhere;
(f) It has little or no use for purposes not prohibited under this Convention.

A scheduled CNS-Acting Chemical and its precursors

These precursors are not as widely used for pharmaceuticals as in the past. Thanks to new and improved chemistry!
# Chemical – Biological Threat Spectrum

<table>
<thead>
<tr>
<th>Classical CW</th>
<th>Industrial Chemicals</th>
<th>Bioregulators Peptides</th>
<th>Toxins</th>
<th>Genetically Modified BW</th>
<th>Traditional BW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mustard Nerve Agents</td>
<td>Toxic Industrial, Pharmaceutical and Agricultural Chemicals</td>
<td>Substance P Neurokinin A</td>
<td>Botulinum Saxitoxin Ricin</td>
<td>Modified/tailored Bacteria and Viruses</td>
<td>Bacteria Viruses Rikettsia</td>
</tr>
<tr>
<td>Hydrogen Cyanide</td>
<td>Emerging CW Aerosols</td>
<td>Neurokinin A</td>
<td></td>
<td></td>
<td>Anthrax Plague Tularemia</td>
</tr>
<tr>
<td>Phosgene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

“Chemicals”

Poisons

Chemical Weapons Convention (Article II)

Biological and Toxin Weapons Convention (Article I)

Adopted from Graham S Pearson, ASA Newsletter, 90-1, February 1990 and Robert Mathews at TWG on Convergence.1st Meeting 2011
Toxins

What are Toxins?
Toxins are toxic substances produced by animals, plants or microbes. They are classified by their source and mechanism of action (neurotoxic or cytotoxic). Neurotoxins affect neurons and are further classified based on the mechanism by which they create their toxic effect; the subclasses are presynaptic neurotoxins, postsynaptic neurotoxins, ion channel-binding toxins and ionophores. Cytotoxins affect all cell types in the body, causing cellular destruction or interfering with metabolic processes such as cell respiration and protein synthesis.

Schedule 1

Examples of toxins from plants

Examples of toxins from insects & animals

Examples of toxins from cyanobacteria

Examples of other bacterial toxins

Comparative Toxicity (Median Lethal Dose, LD₅₀, in ng/kg) of Selected Toxins And Chemical Agents In Laboratory Mice

Decreasing toxicity

OPCW
Toxins

What are Toxins?
Toxins are toxic substances produced by animals, plants or microbes. They are classified by their source and mechanism of action (neurotoxic or cytotoxic). Neurotoxins affect neurons and are further classified based on the mechanism by which they create their toxic effect; the subclasses are presynaptic neurotoxins, postsynaptic neurotoxins, ion channel-binding toxins and ionophores. Cytotoxins affect all cell types in the body, causing cellular destruction or interfering with metabolic processes such as cell respiration and protein synthesis.

Schedule 1

Higher toxicity than Ricin or saxitoxin!

Many more toxins exist!

Comparative Toxicity (Median Lethal Dose, LD₅₀, in ng/kg) of Selected Toxins And Chemical Agents In Laboratory Mice

Decreasing toxicity
Bioregulators

- Endogenous molecules that regulate life processes...

Substance P (pain modulation)
Bioregulators

- Endogenous molecules that regulate life processes
  - Substance P (pain modulation)

SAB does not view advances in research on bioregulators as posing a risk at present
Unscheduled Chemicals that Pose a Risk to the Convention?
Recent Advice from the Scientific Advisory Board

Annex

DIRECTOR-GENERAL’S REQUEST TO THE SCIENTIFIC ADVISORY BOARD TO PROVIDE ADVICE ON NEW TYPES OF NERVE AGENTS

1. Recent events involving the use of nerve agents against individuals in Malaysia and Great Britain and Northern Ireland have drawn considerable public attention, including in the scientific community. While the Malaysia incident involved a previously unknown V-series nerve agent, the incident in the United Kingdom involved a well-known nerve agent with a structure that has appeared in previous reports. To date, the United Kingdom incident, no information has been released to the scientific community.

2. Types of nerve agents have been developed as weapons, and there have been many years among experts outside the OPCW. The development of organophosphorus compounds that would fall outside of the Convention’s Annex on Chemicals, as well as related agents that would not belong to any of the current schedules, has been included in the scientific literature. Now new types of toxic chemicals to the Convention and the re-emergence of chemical weapons, a clear factual and future discussions. Information is necessary as background for Parties of possible measures to address the potential threat scenarios.

3. Submissions to the Director-General’s request for information from States Parties on new types of nerve agents were made available by the end of May 2018, any information that could assist the SAB in its work. The Director-General requested States Parties to provide information on new types of nerve agents.

4. Submissions to the Director-General’s request for new types of nerve agents have also been made available.

5. Submissions to the Director-General’s request for new types of nerve agents have also been made available.

NOTE BY THE DIRECTOR-GENERAL

REQUEST FOR INFORMATION FROM STATES PARTIES ON NEW TYPES OF NERVE AGENTS

1. In view of the findings of the March 2018 technical assistance visit requested by the United Kingdom of Great Britain and Northern Ireland (TA/2018/17), the OPCW has tasked the Scientific Advisory Board (SAB) with providing advice on toxic chemicals that have been identified as, or are suspected of being, new types of nerve agents. The SAB is currently working on this request and intends to issue a report and brief States Parties before the Eighty-Eighth Session of the Executive Council. The full text of the request is contained in the Annex to this Note.

2. The Director-General requests States Parties to provide information on new types of nerve agents.

3. States Parties possessing relevant information that can be provided to the SAB are requested to contact the SAB Secretariat (sab@opcw.org).
Scheduled Chemicals under the Chemical Weapons Convention (CWC)

Schedule 1

Guidelines for Schedule 1
The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 1:
(a) It has been developed, produced, stockpiled or used as a chemical weapon as defined in Article III;
(b) It proves otherwise a high risk to the object and purpose of this Convention by virtue of its high potential for use in activities prohibited under this Convention because one or more of the following conditions are met:
(i) It possesses a chemical structure closely related to that of other toxic chemicals listed in Schedule 1, and has, or can be expected to have, comparable properties;
(ii) It possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;
(iii) It may be used as a precursor in the final single technological stage of production of a toxic chemical listed in Schedule 1, regardless of whether this stage takes place in facilities, in munitions or elsewhere;
(c) It has little or no use for purposes not prohibited under this Convention.

Schedule 2

Guidelines for Schedule 2
The following criteria shall be taken into account in considering whether a toxic chemical not listed in Schedule 1 or a precursor to a Schedule 1 chemical or to a chemical listed in Schedule 2, part A, should be included in Schedule 2:
(a) It possesses a significant risk to the object and purpose of this Convention because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;
(b) It may be used as a precursor in any of the chemical reactions at the final stage of formation of a chemical listed in Schedule 1 or Schedule 2, part A;
(c) It possesses a significant risk to the object and purpose of this Convention by virtue of its importance in the production of a toxic chemical listed in Schedule 1 or Schedule 2, part A;
(d) It possesses a significant risk to the object and purpose of this Convention.

Schedule 3

Guidelines for Schedule 3
The following criteria shall be taken into account in considering whether a toxic chemical or precursor should be included in Schedule 3:
(a) It possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon;
(b) It possesses such properties that could enable it to be used as a chemical weapon;
(c) It possesses such properties that could enable it to be used as a chemical weapon;
(d) It possesses such properties that could enable it to be used as a chemical weapon;
(e) It possesses such properties that could enable it to be used as a chemical weapon;
(f) It possesses such properties that could enable it to be used as a chemical weapon.

SAB Recommendations on Unscheduled Chemicals: Detection! OCAD!
Proposals to Change Schedules?
Must Come From States Parties (Article XV)

ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS
Working Together for a World Free of Chemical Weapons

Relationship between Schedules, illustrated with sulfur mustard.
Given the substantial changes in chemistry and chemical industry since the schedules were finalised a quarter century ago, a review of the schedules should be considered to assess whether: (a) the chemicals currently listed are in the appropriate Schedule, and (b) any toxic chemicals or specific precursors should be added to or removed from the Schedules.
Scheduled Chemicals under the Chemical Weapons Convention (CWC)

One Last Question...

What have you learned today?
What did you learn today?

- Complicated
- Chemicals
- Jonathon
- Everything
- Ricin
- Its coming home
- 2 CW on schedule 3
- Isomers and isotopes
- Infinite minus three
- CW in schedule 1 and 3
- Infinity minus three
- Lots to know about
- Very complicated
- Stereoisomer CW
- Yes
- Thanks
- Number
- Different cas
- Salt
Scientific Advisory Board from January to July 2018
A Preview of Science for Diplomats at EC-89 (October)
The Inspectorate will join us for an interactive session of Personal Protective Equipment and Fine Motor Skills
OPCW

منظمة حظر الأسلحة الكيميائية

禁止化学武器组织

Organisation for the Prohibition of Chemical Weapons

Organisation pour l’Interdiction des Armes Chimiques

Организация по запрещению химического оружия

Organización para la Prohibición de las Armas Químicas