

nation and that it is acting in breach of the obligations deriving from the treaty or (b) a request for inspection is filed by any other State party;

(3) any State party which is notified by the international verification organization of its planned inspection would have to give strong reasons for not complying with the notification.

**Canadian Working Paper Submitted to the Conference of the Committee on Disarmament: Problem of Defining Chemical Substances in Treaty Prohibiting the Development, Production, and Stockpiling of Chemical Weapons, August 21, 1973**<sup>1</sup>

*The Problem*

The purpose of this paper is to address the question of defining as simply and unambiguously as possible the substances that might be banned or controlled as chemical weapons agents if a comprehensive agreement on chemical weapons could be negotiated.

2. As the effects of chemical substances on living organisms are both varied and complex, it has proven difficult to formulate simple definitions to separate those chemicals that are relatively harmless from those that have military utility and which are also in production for civil purposes.

3. A widely expressed view in the CCD has been that a treaty could set out the scope of a comprehensive ban by way of a general description of the chemical agents to be affected by a general purpose criterion, while more detailed technical provisions could be elaborated in an annex to the treaty which could be subject to periodic review and revision by an international body established for that purpose by the treaty. There has also been a view that to the extent possible the scope of a treaty should encompass the chemical agents found in civil use which have been or could be put to military use.

4. This paper examines the basis on which a general purpose criterion in a comprehensive treaty could be supplemented by a more detailed technical scheme of definition of chemical warfare agents based on levels of toxicity of chemicals. It also examines how such a scheme of definition could be used, together with other definitions, to assist in establishing the scope of prohibition under a treaty.

5. It is useful at this point to draw attention to the meaning of some of the terms used in this paper :

*toxic* means poisonous in the sense of causing physiological in-

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<sup>1</sup> CCD/414, Aug. 21, 1973.

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jury to a human; this effect includes blistering, blindness, and death;

*supertoxic* means highly poisonous; that is, only very small quantities are needed to produce physiological harm; in practice, for the modern nerve agents, this means death;

*binary agents* or precursors are agents employed in weapons in which the components necessary to produce a super-toxic agent are kept separated until mixed during the process of delivery. The main advantage of such a weapon is the ease of handling.

*Approaches to Defining CW Agents*

6. From a number of working papers presented to the CCD, it is apparent that three general approaches to defining chemical weapons agents can be employed.

- (a) a definition based on purpose or intent;
- (b) a strict technical definition of chemicals based on generalized formulae, supplemented where necessary by the specific identification of chemicals; and
- (c) a definition based on chemical agent effects, as in the Geneva Protocol.

7. *A definition based on purpose or intent.* This approach would be exemplified by a general criterion derived from the Biological Weapons Convention, requiring the prohibition of "agents . . . of types and in quantities that have no justification for . . . peaceful purposes" and "weapons equipment or means of delivery designed to use such agents for hostile purposes or in armed conflict".<sup>2</sup>

8. A general prohibition based on purpose or intended use, given the difficulty of objectively identifying intent, might not take sufficient account of technical considerations to allow a meaningful CW prohibition. The filling of munitions with toxic chemicals and the production or stockpiling of single purpose agents are the only self evident measures. However, it would be possible to use toxic CW in war without employing either single purpose agents or special munitions. Hence the need has been seen to supplement a general purpose criterion with technical definitions.

9. *A definition of chemical substances based on generalized formulae.* This approach is based on the idea that it may be possible to derive a generalized formula or series of such formulae which would encompass all agents, present and future, that could have military utility. To be valid, however, this approach would require a direct correlation between formula and desired military effectiveness. Unfortunately, it has not proven generally possible to determine the lethality of a chemical from an examination of its molecular structure or its formula, nor to predict lethality from the formula of an untested compound.

<sup>2</sup> *Documents on Disarmament, 1972, p. 134.*



10. While this correlation cannot be established generally, there has been some success in relating the formulae of organophosphorous compounds to toxicity [CCD/320 (Netherlands),<sup>3</sup> CCD/365 (USA),<sup>4</sup> CCD/374 (Japan)] and it may be possible to extend this concept to the mustards and arsines. On the other hand, for carbamates and some of the older dual purpose agents, even a limited general formula approach has not proven to be practical and it becomes necessary to list specific compounds.

11. A definition based on chemical agent effects, such as in the Geneva Protocol, which prohibits "the use in war of asphyxiating, poisonous or other gases, and of all analogous liquid materials or devices".

12. Agents having lethal effects or producing serious and permanent injury can be described by toxicity. Discussion of toxicity and the methods of its measurement have been features of a number of presentations to the CCD [e.g., Canada (CCD/387), Japan (CCD/301,<sup>5</sup> 374) and Sweden (CCD/372)<sup>6</sup>]. There has been no discussion of other agent effects.

13. A scheme of definitions based on toxicity has the strength of focusing on the effects which are of military importance: death or permanent injury. By establishing lines of demarcation or thresholds, based on the dosages required to produce such effects, it is possible to define chemicals as agents of war and, supplemented by agreement on whether a chemical agent has civil uses, to establish for different chemicals, the scope of activities which should be prohibited.

14. A general purpose criterion may be essential to a treaty to describe its broad intent and to encompass certain CW agents and weapons; of the technical means of supplementing such a general purpose definition, the third of the approaches to definition holds the most promise.

#### *Toxicity Thresholds*

15. The question arises whether by considering a range of toxicity, a toxicity threshold can be established above which compounds can be considered as potential weapons and below which, for all practical purposes, no such potential exists.

16. A number of CCD papers have discussed the concept of a threshold by considering the determination of a line of demarcation (CCD/372) or a target point (CCD/374) to separate the single purpose supertoxic agents from all other chemicals of lower toxicity, including some which have military application. This threshold of effective median dosage is used as the upper or first threshold in this paper and could be used to separate modern

<sup>3</sup> *Ibid.*, 1971, pp. 99-101.

<sup>4</sup> *Ibid.*, 1972, pp. 331-342.

<sup>5</sup> *Ibid.*, 1970, pp. 379-382.

<sup>6</sup> *Ibid.*, 1972, pp. 417-422.

established generally, there are the formulae of organophosphorus (320 (Netherlands),<sup>3</sup> CCD/320) it may be possible to extend lines. On the other hand, for dual purpose agents, even a is not proven to be practical compounds.

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single purpose "nerve" agents from those of lower yet significant lethality.

17. To assist in the problem of defining those chemical agents of lower toxicity but potential military usefulness from the rest, it is proposed to introduce the concept of a second threshold to separate militarily useful agents from those chemicals that have no practical potential as CW agents. This lower threshold would serve to define the scale of toxicity so that any militarily useful chemical would be above this boundary, while those below would be classed as non-military.

18. For the purposes of this paper an upper threshold is set by naming tabun, the least toxic of the single purpose supertoxic agents, as a boundary agent. Other supertoxic agents would fall above tabun. Mustard would be just below this threshold. Chlorine, which is not a highly lethal agent, could be used to set the lower threshold or level of the least militarily significant lethal agent.

19. This classification of toxic chemical agents is shown in Table I.

20. While no numerical values of these thresholds for toxic agents are included in the table, the following values are suggested:

Upper threshold	Lct50 = 500 mg.min/m <sup>3</sup>
Lower threshold	Lct50 = 20,000 mg.min/m <sup>3</sup>

(Lct50 = Dosage vapour concentration multiplied by time of exposure lethal to 50 per cent of exposed personnel. (The toxicity units chosen depend on inhalation. Equivalent values for dosages associated with other methods of exposure, for example, through the skin or the eyes, could be derived. Uncertainties in the dosage value of a particular agent are within the range defined by the threshold valued.))

21. The upper threshold is suggested because of the major difference of toxicity between tabun and mustard, and should be the subject of both international discussion and agreement. This value has no significance in the definition of a chemical as an agent of war. It is relevant, however, to the scope of activities which might be prohibited, for once we drop below this toxicity level, we begin to encounter toxic chemicals in industrial use.

22. The lower value was also chosen somewhat arbitrarily. Chlorine, although used in World War One, is not now considered as an effective agent and has been relegated by some countries to training purposes. It might be regarded as the least toxic agent to have military utility, at least against an unprotected force.

23. From this, it now seems possible to suggest a general definition of toxic chemical substances that might be agents of war subject to control and/or prohibition: a chemical compound or element can be considered as an agent of war if its toxicity has a



median lethal dosage less than 20,000 mg.min/<sup>3</sup> or a practical equivalent of this dosage.

*Use of Agent Definition in Establishing Scope of Prohibition*

24. Having now suggested a system for identifying chemical substances as being potential agents of war, it remains to consider how these definitions might be applied in determining the scope of prohibition of a comprehensive chemical weapons ban.

25. Thresholds have been suggested which separate those chemical substances which have military potential based on their lethality, from those that do not have such a potential. (Some of the chemical substances thus defined as being potential agents of war also have recognized peaceful uses.)

26. A threshold of toxicity has been suggested which defines the supertoxic compounds for which there are no recognized peaceful uses (other than for small quantities required for defensive research and medical purposes). From this, it is possible to suggest that the development, production and stockpiling of these chemicals could be prohibited if a chemical weapons prohibition could be negotiated.

27. Of those toxic chemical substances identified by the lower threshold as being potential agents of war, but which fall below the upper threshold, some have recognized civil uses, i.e., the

TABLE I

Classification of some chemical compounds and elements based on toxicity including sub-groupings based on purpose

	Lct50 <sup>7</sup>	mg.min/m <sup>3</sup>
Lethal Agents	VX	10-50
	Sarin	100
	Soman	50-100
	Tabun	400
UPPER THRESHOLD		
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	Mustard 1500	
	Lewisite 1500	
Toxic	Arsine 5000	3200 Phosgene Toxic 5000 HCN
SINGLE PURPOSE		
(Adamsite 15000)		11000 Cyanogen Chloride
DUAL PURPOSE <sup>8</sup>		
		19000 Chlorine
LOWER THRESHOLD		
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All other chemicals that have no significant military value		

<sup>7</sup> Dosage vapour concentration multiplied by time of exposure lethal to 50 per cent of exposed personnel.

<sup>8</sup> Chemicals having both military and civil uses.

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ds and elements based on toxicity

Lct50 <sup>7</sup>	mg.min/m <sup>3</sup>
VX	10-50
Sarin	100
Soman	50-100
Tabun	400

SHOLD

d 1500  
e 1500

POSE

3200 Phosgene Toxic  
5000 HCN

POSE<sup>8</sup>

11000 Cyanogen Chloride  
19000 Chlorine

SHOLD

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“dual-purpose” toxic agents having peaceful industrial uses. It would, therefore, not be possible to ban the development, production and stockpiling of these chemicals solely on the basis of their place on the scale of toxicity. It is suggested that an international committee of experts could identify those chemicals having such civil uses for which development, production and stockpiling could be permitted. However, the filling of military ordnance with toxic dual purpose industrial chemicals could be prohibited. The development, production and stockpiling of other chemicals above the lower threshold and not identified as having recognized civil uses could be prohibited. The toxic chemicals in this latter sub-class could be identified by specific formula in some cases and possibly by family of formulae for others (both the mustards and arsines may be accommodated by the “family approach”).<sup>9</sup>

28. Binary weapons are designed to create a supertoxic compound only on discharge; it is likely that in any binary system at least one of the components would have a toxicity falling above the lower threshold. If this component were identified as having a civil purpose, it could be treated in the same way as the other dual-purpose agents; that is, its production and stockpiling for peaceful purposes might be permitted, but the filling of munitions with such binary weapons components could be prohibited.

29. For illustrative purposes the application of the types of definition to the scope of prohibition is shown in condensed form in Table II.

TABLE II  
Application of types of definitions to the scope of prohibition:  
ILLUSTRATIVE ONLY

	<i>Super-Toxic</i>	<i>Single Purpose Toxic</i>	<i>Dual Purpose Toxic</i>	<i>Binaries</i>
Development and Stockpiling Agents	Banned by toxicity (upper threshold)	Banned by toxicity (lower threshold) and purpose as determined	Allowed (determined by agreement as being required for civil use and identified by formula)	N/A (at least one component may fall into foregoing categories)
Filling of Military Ordnance	N/A	N/A	Banned on basis of intent or end use	Banned on basis of intent or end use

<sup>9</sup> The formula approach is considered to be useful in the case of older single purpose toxic agents because (a) the exhaustive surveys that have been undertaken since World War I have not produced compounds significantly better than those already known and (b) there may be no incentive to find new chemicals in this range of lethality when the supertoxics exist on one hand and where there are dual purpose agents available on the other hand. If in any event such chemicals were discovered, they could be added to any list of specifically proscribed compounds [footnote in original].