CANADA

THE CHEMICAL WEAPONS CONVENTION AND THE INTERNATIONAL INSPECTORATE: A QUANTITATIVE STUDY

AUGUST 1990

CANADA

THE CHEMICAL WEAPONS CONVENTION AND THE INTERNATIONAL INSPECTORATE: A QUANTITATIVE STUDY

AUGUST 1990

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES

(Cont'd)

PREFACE

This paper was first published in May 1990 for distribution to Canadian government agencies in order to promote discussion on issues related to the proposed Chemical Weapons Convention. At this stage of the negotiations, it was considered necessary to have a better understanding of the organizational requirements at the international level. This paper attempts to provide a model costing of the international organization required by Article VIII and by the verification provisions of Articles III, IV, V, VI and IX of the "rolling text" (CD/961). The study involves a number of explicit assumptions about sites, numbers of inspectors, the duration of inspections, and unit costs. This allows the development of an overall cost of an inspectorate based on the present requirements of the rolling text and, at the same time, is suggestive of additional costs to be incurred if other inspection modalities are added to the inspectorate's tasks.

The paper was written by a consultant from the University of Saskatchewan in conjunction with the Verification Research Unit of External Affairs and International Trade Canada. The paper makes an estimate of the approximate size and cost of an International Inspectorate and is offered to stimulate further discussion and debate on the financial implications of the proposed verification regimes. It does not necessarily reflect the views of the Canadian government.

EXECUTIVE SUMMARY

The purpose of this study was to use information freely available in the open literature and attempt to provide a costing of the various verification activities required by the draft Chemical Weapons Convention and also for those other verification modalities currently under discussion at the Conference on Disarmament.

It is not yet possible to provide a precise estimate since there are many unknown parameters such as the number of CW stockpiles and production facilities, the number of industrial sites liable to inspection and the potential number and nature of challenge inspections. The same is true of the current debate on various Ad Hoc verification measures. Nevertheless there is sufficient data to develop a proximate model that, even though inexact, would provide a basis for further discussion.

The process involved estimating the number of sites that would require inspection, the number of inspectors required, the number of days an inspection would take and the number of days that any inspector could be expected to be on the road. This, together with an estimate of the cost of keeping an inspector in the field, can be used to develop costs for each inspection activity and hence a cumulative cost for the inspectorate on an annual basis.

On the basis of the above considerations and corresponding assumptions, it appears that in the order of 600 inspectors would be required and that the organization would cost about 120 million dollars per year, with about half of the costs being related to the monitoring of the destruction of chemical weapons and production facilities.

It will be clear that these estimates might need to be revised in view of early destruction by the USA and USSR of some quantity of their CW respective stockpiles even prior to entry into force of a global Chemical Weapons Convention. Similarly, it will be seen that estimates of USA and USSR stockpiles were based on information in the public domain prior to May 1990.

Since the analysis is based on a modular process, it should be comparatively straight forward to amend both the numbers and costs as more reliable data becomes available.

THE CHEMICAL WEAPONS CONVENTION AND THE INTERNATIONAL INSPECTORATE: A QUANTITATIVE STUDY

1. General

In 1987, a study for the Canadian government analyzed the draft text of a Chemical Weapons Convention (CD/734) with a view to understanding the personnel requirements which flowed from those articles (III, IV, V, VI and IX) which are concerned with the verification of compliance. The broad outlines of the results were presented to the Conference on Disarmament (CD) in CD/823 in March 1988. No attempt was made to quantify that study because of a lack of information on chemical weapons stockpiles, chemical weapons production facilities, and the extent to which the civilian chemical industry would be drawn into the problem of monitoring the non-production of chemical weapons. This was changed to some extent by the Soviet presentation at Shikhany in October 1987 of their "standard" chemical weapons. The latter information was presented to the CD in CD/789. The United States has also presented detailed papers, CD/424 and 830, on the composition of their CW Stocks. Since then there have been a number of trial inspections carried out in the civilian chemical industry related to problems of non-production. Enough data is now available to attempt to develop a quantitative model of the manpower needs of an International Inspectorate.

In spite of the dramatic moves towards openness in providing information, a good deal more would be required before

an exact model could be constructed. The data on the number of stockpiles is not available for all potential States Parties, the actual size and composition of stockpiles is still a matter of dispute, the number of production facilities is a matter of conjecture, the complexities of inspection of the civilian industry are not well understood, and the number and nature of challenge inspections an unknown factor. The impact of the other kinds of inspection being discussed will also have to be assessed.

2. The United States of America

(I) Stockpile. There is a great deal of consistent information on the location of these stockpiles, the chemical agents concerned and the munitions involved. The actual size of the stockpile is secret but there is sufficient data in the public arena for a reasonable assessment to be made.

The United States has two nerve agents in storage: VX as a persistent and GB (Sarin) as a non-persistent nerve agent. There is also a small quantity of Tabun (GA) in one ton containers. Persistent mustard is stored in three formulations: H, HD and HT, with a small residual supply of Lewisite (L) at Tooele. The following table gives location, agent tonnage as a percentage, and agents stored.

Table 1: Locations of US Stockpiles

Location	Agent Tonnage (%)	Agent
Tooele	42.3	L, H, HD, HT, GB, VX, GA
Pine Bluff	12.0	HD HT, GB, VX
Umatillo	11.6	HD, GB, VX
Pueblo	9.9	HD, HT
Anniston	7.1	HD, HT, GB, VX
Aberdeen	5.0	HD
Newport	3.9	VX
Lexington Blue Grass	1.6	H, GB, VX
Oconus	6.6	-

Hence there are eight storage sites in the continental United States (Conus) since the closure of Rocky Mountain Arsenal. The remainder is stored in two sites outside the continental U.S. (OCONUS), in the Federal Republic of Germany and on Johnston Atoll in the Pacific, where the first large scale demilitarization plant is being built. Fifteen types of munitions were displayed to the Soviet delegation visiting Tooele in 1987.

As part of the modernization (binary) programme, the United States Army was committed to the destruction of obsolete unitary munitions. According to the related Environmental Impact Statement, it was decided that disposal at existing sites was the best solution and that incineration was the preferred procedure. Three types of plants are needed:

(i) Munitions (mixed) Facility (MMF), capable of processing a range of agents and munitions;

(ii) Bulk Facility (BF) at Aberdeen and Newport;

(iii) Modified BZ Facility (MBZ) at Pine Bluff;

The third type would be used for lethal agents after the demilitarization of BZ was completed. Each facility would have the same basic design, modified by the categories and quantities of munitions involved.

Table 2: Planned Disposal Facilities

Location	Plant
Tooele	MMF, BF
Pine Bluff	MBZ
Umatillo	MMF
Pueblo	MMF
Anniston	MMF
Aberdeen	BF
Newport	BF
Lexington	MMF with single projectile line

These facilities would be standardized and all plants would use equipment developed and tested at the JACADS (Johnston Atoll Chemical Agent Disposal System) programme as well as utilizing other technological improvements from the CAMDS (Chemical Agent Munitions Disposal System) test programme at Tooele. The disposal plans are summarized in Table 3.

[redacted] **Table 3: Summary of Disposal Plan**

Depot (%)	Agent	Form	Disposal	Time (yr.)
Tooele, 42.3	H	Projectiles, TC*	MMF	4
	HD	Cartridges, Projectiles, TC	BF	4
	HT	Cartridges, Projectiles,		
	GB	Cartridges, Projectiles, Rockets, Bombs, TC		
	VX	Projectiles, Rockets, Mines Spray T, TC		
		TC		
Pine Bluff, 12.	HD	Cartridges, TC	MBZ	?
	HT	TC		
	GB	Rockets, TC		
	VX	Rockets, Mines		
Umatillo, 11.6	HD	TC	MMF	3
	GB	Projectiles, Rockets, Bombs, TC		
	VX	TC		
Pueblo, 9.9	HD/HT	Cartridges		
	HD	Projectiles	MMF	1
Anniston, 7.1	HD, HT	Cartridges, Projectiles, TC	MMF	3
	GB	Cartridges, Projectiles, Rockets, TC	BF	3
	VX	Cartridges, Projectiles, Rockets, Mines, TC		
Aberdeen, 5.0	HD	TC	BF	2
Newport, 3.9	VX	TC	BF	2
Lexington, 1.6	H	Projectiles, TC	MMF	1
	GB	Projectiles, Rockets, TC		
	VX	Projectiles, Rockets, TC		

*TC = one ton container
Compiled from various sources

The United States has by now gathered considerable experience in the destruction of chemical weapons. Until 1969 the accepted methodology of destruction included ocean dumping, land burial and open pit burning. Since then considerable effort has been put into developing alternative technology, and between 1974 and 1983 some 7.6 million kilograms of chemical warfare agents were destroyed, as shown in the following table.

Table 4: Agent Disposal Experience

Location	Agent	Agent Wt x 1000 kg	Completion Date
Rocky Mountain Arsenal (R.M.A.)	Mustard (bulk)	2,814	March 74
	Sarin (tanks)	174	Nov. 74
Edgewood Arsenal	Concrete Drums	15	Aug. 75
R.M.A.	Sarin (bulk)	1,638	Nov. 75
R.M.A.	Sarin (M139 bomblets)	35	Aug. 76
R.M.A.	Sarin (M34 clusters)	1,877	Sept. 76
Dugway P.G.	M55 Rocket	24	Sept. 76
	Bomblets	8	Sept. 77
Tooele	M55 Sarin Rocket	58	June 81
R.M.A.	1D sets	17	Jan. 83
R.M.A.	Carbonyl Chloride	945	Sept. 82

In the above programmes, the mustard was incinerated and the Sarin chemically neutralized. The experimental and development programme at Tooele (CAMDS) is based on the incineration of all agents and this plant was used to design a destruction plant for Johnston Atoll (JACADS). This facility is now expected to become operational in mid 1990 and be used to design the CONUS operations. The aim would be for other plants to be operational by 1991. The total cost of the disposal

programme is now projected to be in excess of $3 billion, but the President's Commission on Chemical Weapons suggested that the original estimate of $2.3 billion could have an error factor of 2 to 3.

The actual size of the United States CW stockpile is classified, but its percentage distribution is known and so the actual size could be reconstructed from the other available data. An estimate of 32,000 to 34,000 agent tons for the United States stockpile is reasonable but there also has been a debate as to how much of this stockpile is useful.

(II) Chemical Weapons Production Facilities. The United States submitted a paper, CD/849, to the CD on its production facilities in July 1988. The paper noted that tens of millions of dollars would be required to eliminate a production facility, that two to three years would be required for the planning/public review process, and that the destruction phase would take at least two years after this review process was completed. Table 5 lists the status of the CWPF.

Table 5: Chemical Weapons Production Facilities (CWPF)

Location	Agent	Status
Rocky Mountain Arsenal	Sarin (GB)	Standby 1957
Newport	VX	Standby 1969
Pine Bluff	Difluoro (DF)	Operational Binary
	QL	Operational Binary
Muscle Shoals	Dichloro	-
Aberdeen	Pilot Plants	-

3. USSR

(I) Stockpile. Prior to 1987, the only information available on Soviet stocks of chemical weapons was derived from intelligence sources, and estimates of Soviet supplies ranged from 250,000 to 750,000 tons. In 1987, the USSR confirmed that it possessed chemical weapons, but stated that it had stopped production. It also stated that all such weapons were stockpiled on its own territory and that all other Warsaw Treaty countries neither produced nor stockpiled such weapons. It further announced that it was building a chemical weapons destruction facility at Chapayevsk in Kazakhstan. Subsequently, it stated that its chemical weapon stockpile did not exceed 50,000 agent tons.

In October, 1987, representatives from the Conference on Disarmament visited Shikhany to witness a demonstration of a mobile destruction facility and to briefed on Soviet CW capabilities.* The following table, based on CD/789, gives a summary of the CW Agents in the USSR's stockpile.

---

*The information provided was subsequently presented to the CD by the USSR in its paper, CD/789.

Table 6: Soviet Army CW Agents

Agent Types	Delivery System
Blister Agent	
Mustard/Lewisite	Chemical Bomb Spray Tank
Lewisite	Artillery Shells
Nerve Agent	
Sarin	Artillery Shells Rockets Chemical Bombs
VX	Artillery Shells Rockets Tactical Missiles
Viscous VX	Tactical Missiles
Thickened Soman	Spray Tanks
Irritant	
CS	Hand grenades

The USSR has provided no information on CWPF or their locations, but there is speculation in the literature[1] that there are ten production locations and nine stockpile locations.

---

1 Soviet Chemical Weapons Threat, 1985, Defence Intelligence Agency, U.S.A.

4. France

In September 1988, President Mitterrand stated before the UN General Assembly that France "has no chemical weapons". Until this declaration, there were those who believed France to be a CW possessor. For example, a 1970 report suggested that the Service des Poudres factory at Point-de-Clair specialized in chemical weapons[1], while Stashevsky[2], claimed that France possessed an offensive CW capability comprising some 450 tons of chemical agent in 7,500 tons of munitions. Moreover, in 1987, the French delegation to the CD proposed basing the order of destruction of CW on the concept of "security stocks", involving the maintenance of a CW stock at a secret location, which seemed to some to suggest that France either possessed or intended to acquire CW stocks. Also relevant was a 1987 announcement of the appropriation of 700 million francs as part of a five year plan which apparently provided for the production of chemical weapons. For these reasons, and these alone, France is considered separately.

---

1 J. Pergent, 1970. Services des Poudres. Force aériennes françaises, 24, 89-102 quoted by J.P. Perry Robinson in Chemical Weapons: Destruction and Conversion, Sipri, 1980.

2 G. Stashevsky, Chemical Weapons: The View from Moscow, Novosti Press Agency, Moscow, 1988

5. The Middle East

There has been considerable speculation in the open literature about the number of possible chemical weapons production facilities and chemical weapons stockpiles in the Middle East. Recent statements by the President of Iraq provide official national confirmation of the various documentation available in the public domain, to the effect that Iraq possesses a significant CW stockpile and CW production capacity.

Iraq is said to have mustard and nerve gas facilities at Samarra north of Baghdad, in a plant built for the Iraqi State Enterprise for Pesticide Production (SEPP) in 1975. A BBC report indicated that this plant has the capacity to produce mustard, sarin and tabun. Another plant is also believed to be at Al Fallujah. Syria was reported to have acquired a chemical weapon capability and a production facility located in a desert site north of Damascus. The most recent controversy relates to the allegations that Libya is developing a chemical weapons program and that a factory, being built at Rabta about 50 miles south of Tripoli, has a large chemical weapons production capability. It has been claimed that Iran is developing a chemical weapons production capability and has stockpiled chemical weapons.

Egypt was reputed to have a chemical weapons capability in the early 1960's, when there were reports of the use of CW in the Yemen. There is a very recent report that Egypt has

attempted to improve its capabilities in chemical weapons production by acquiring chemical plant components from Western sources. The Egyptian government has denied that the facility is related to weapons purposes.

Claims have also been made that Israel has chemical weapons and a production capacity for mustard and nerve agents at Dimona, a town in the Negev desert.

6. Former Possessors of Chemical Weapons

When the Chemical Weapons Convention comes into force, there will be a requirement relating to former chemical weapons production facilities operational at any time since (1.1.1946). There will be a need to make declarations on such facilities and verification requirements. Table 7 lists countries which are reported to have produced or held stocks of chemical weapons at one time. There may well be great difficulty in reassembling the data required by the Chemical Weapons Convention.

7. Proliferation

By proliferation, this paper means the attempt by nations to acquire chemical weapons, not necessarily a chemical weapons production capability. In spite of attempts by the "Australia group" and others to curb the export of key

Table 7: Former Possessors of Chemical Weapons and Facilities

Australia	Italy
Canada	Japan
China	Kenya
Czechoslovakia	Nigeria
Egypt	Poland
France	Singapore
Germany (FRG and GDR)	South Africa
Hungary	USSR
India	UK
Indonesia (Netherlands)	USA

Source: based on a table from SIPRI Yearbook 1988 p. 103.

intermediates using export controls and warning lists, proliferation is claimed to be increasing. The concern is that as one country acquires, or is thought to have acquired, an offensive chemical warfare capability, its neighbours may believe that they need a corresponding capability. This is of particular concern in the Middle East where the alleged acquisition of chemical weapons together with potential missile delivery systems cannot be ignored. The concept of proliferation is not readily quantified. No one openly admits to being in the market for chemical weapons or their precursors, but one of the effects of the Iraq-Iran war was the build-up of an infrastructure for the manipulating and rerouting of chemical exports.

The following table includes those which have recently been the subject of most discussion with respect to possession of chemical weapons.

Table 8: Known and Suggested Chemical Weapons Possessors

Known	Suggested	
USA	Angola	Laos
USSR	Burma	Libya*
Iraq	China	North Korea
	Cuba	Pakistan
	Egypt	South Africa
	Ethiopia	South Korea
	France*	Syria*
	India	Taiwan
	Iran	Thailand
	Israel	Vietnam*

* The asterisks indicate those countries which have been the subject of most speculation.

8. Chemical Weapons Stockpiles

Entry into force of a Chemical Weapons Convention will take place after an agreed number of nations ratify it as States Parties. It is likely that the initial period between opening for signature and entry into force will take two to three years and involve in the order of fifty to sixty signatures. The actual number will have a bearing as the size of the inspectorate required since many of the inspection activities are mandated to take place almost immediately after entry into force.

Not later than 30 days after entry into force, the States Parties will have to submit the declarations required by Articles III, IV, V and VI. If they possess chemical weapons they will have to provide for immediate on-site inspection and submit general plans for the destruction of weapons with detailed

plans being required 6 months after entry into force. The actual destruction phase should begin 12 months after entry into force for a State Party. Some matters such as the order of destruction have yet to be resolved.

Table 9 indicates what each and every State Party must be able to do to demonstrate compliance with the CWC. There will have to be sufficient inspectors available to verify compliance with the States Parties' obligations.

Table 9: Time Scale for Initial CWC Activities

1.	Entry into force
2.	Declarations within 30 days
3.	Provide for on-site inspection
4.	Submit general plans for destruction
5.	Submit detailed plans within 6 months
6.	Have destruction facilities ready to commence Destruction within 12 months

Each State Party will have to comply with items 2 and 3; all possessor States Parties will additionally have to cope with items 4 to 6 but may well have difficulties with the timeframe for 6.

The requirements for each chemical weapons stockpile as far as the inspectorate is concerned is that they must know where each stockpile is located, the composition of its contents and the types of munitions involved i.e. they must first be able to verify the State Party's declaration of compliance. The inspectorate must then have the power to verify that the site is

secured, seal its contents and maintain its integrity until a destruction site becomes available. They may then have to be continuously present at the destruction site until all of the stockpile has been destroyed. Hence there are two operational sequences for the inspectorate: Phase 1 is the verification of the stockpile and sealing the facility until the destruction commences. Phase 2 is the continuous on-site inspection of the destruction facility. The composition of the inspection team will vary with the tasks involved, and there may well be an overlap between the requirements.

Table 10: Unitary Chemical Munitions Stockpiles of USA and USSR

Country		Agent Tons*	Agents
USA	8 [conus]	(32,000)	VX, GB, GA, H, HD, HT, L
	1 [FRG]	(500)	
	1 [Johnston Atoll]	(1,600)	
USSR	(9)	50,000	VX, GB, H/L, L, GD

* ( ) estimates appearing in unofficial sources.

Since the disposal plant for destruction of chemical weapons on Johnston Atoll is scheduled to begin demilitarization of its stocks in 1990 one can eliminate that facility, apart from the verification of its destruction, since it should have completed destruction activities by 1994, before a CWC is likely to come into force. Hence the number of stockpiles in the United

States is likely to be 8. There is only one CW depot in the Federal Republic of Germany, and all stocks located there will be removed by 1990. There will be about 34,000 agent tons and corresponding munitions to be destroyed over a nine year period; of course if the destruction plants are not available on time then the period will be shorter for destruction. The target amount for destruction will be approximately 3,500 agent tons per annum.

The USSR has stated that it does not have any chemical weapons outside its territory and that none of its allies has chemical weapons. For the purposes of this analysis it is assumed that there are nine stockpiles in the USSR. Thus there will be a need to destroy over 5,000 agent tons per annum in the USSR and probably nine sites where destruction could take place.

The phase 1 requirement for the inspectorate will be the verification of the contents of eight stockpiles for the United States and nine for the USSR. The location and percentage of agent tons is known for the US stockpiles and if the Oconus stocks have been destroyed previously then a total of 32,000 tons remains to be destroyed at eight locations. The Phase 1 task involves 18 CW stockpiles whose contents will have to be verified and then sealed. These stockpiles will contain a minimum of 80,000 agent tons and consist of at least nine CW agents. It is unlikely that more than half of the stock will be in bulk; the remainder will involve at least thirty different types of

munitions. Individual stockpiles seem to vary from about 500 to 13,500 agent tons in the United States, and one might expect similar variations in the USSR.

The number of additional stockpiles of chemical weapons is a matter of conjecture and discussions on proliferation have suggested that there might be 20 or 30 countries attempting to acquire a chemical weapons capability. The assumption in this paper is that there may be a total of twelve additional possessors, and that the inspectorate will have to plan for 12 additional stockpiles likely to consist mainly of mustard with some tabun and sarin.

This scenario then suggests that there could be 29 CW stockpiles, 8 USA, 9 USSR and 12 others, i.e. 14 Declarations of CW possession involving 29 locations that will require on-site inspections to verify their contents. The inspectors will have to be able to seal and ensure that no weapons leave these stockpiles until the destruction plants are operational, and then oversee the transfer processes required in the event that a State Party determines to build fewer destruction facilities that it has CW stockpiles. This phase should be completed in the first year, but environmental impact studies could easily lengthen the period considerably if insufficient preplanning has been done of destruction or if there is a need to import the destruction technology. Although the draft CWC mandates that destruction is

to begin one year after entry into force, if facilities are not planned soon enough this timeframe will be difficult to meet.

One can divide chemical weapons stockpiles into two groups; one at which destruction facilities will be built and another where the stocks will have to be moved for demilitarization. It would be logical to assume that the former will be where the larger stockpiles are located and, since the destruction facility should be under construction before entry into force if the State Party is to meet its goal of commencing destruction within 12 months, these sites should have inspectors permanently present. This would give a requirement for permanent inspection teams at the 8 United States sites and the 9 USSR sites to carry out initial verification, application of seals to weapons and/or silos, site closure and the review of the planning and construction of the destruction facilities for verification purposes.

Of course, if a destruction plant were already available, the task would become one of ensuring that destruction of weapons and agents could be verified. The Environmental Impact Statement (EIS) developed by the United States for obsolete unitary weapons shows that three types of plants will be constructed there and that each will only be capable of dealing with one agent at a time. Therefore some reconfiguration of the plant and its protective system will be required to implement an agreed order of destruction of the various agents. It is

suggested that the initial inspection team could have as many as five inspectors. This would mean that the CW stockpiles of the superpowers would absorb 85 inspectors on-site at their major installations. It should be noted that this assumes that the inspectorate will be continuously present at a stockpile site where destruction will eventually take place. There is a requirement for their presence until a monitoring system is installed and operational as well as for continuous presence during active destruction periods. The number of five inspectors is consistent with trial inspection experience but if a facility has multiple destruction lines or operates more than one shift then these numbers will have to be increased.

The other assumption concerning stockpiles was that 12 other nations would declare the possession of chemical weapons. The stockpiles could be small. Verification and auditing are unlikely to be labour intensive but politically will probably require teams of three inspectors. The long term securing of the facilities might be difficult, given their probable locations. Initial inspection would require 36 inspectors who also may have to be continuously present at these sites.

Hence this study suggests that CW stockpile management could require 121 inspectors present full time on-site. The initial assessment is that there will be a requirement of 40 inspectors for the United States, 45 for the Soviet Union, and 36

for all other stockpiles. A key question then is: how many inspectors would be required to keep that number in the field for 365 days per year? If it is assumed that one inspector is available for 220 days per year, then the basic planning factor is 1.66 or 66, 75 and 60 inspectors for the U.S., U.S.S.R., and others, respectively. It is also assumed that inspection of CW stocks and their destruction could be a full-time assignment without rotation to other duties at headquarters.

Table 11: Inspection Requirements for Stockpiles - Year 1

	Stockpiles	Inspectors	Total Inspectors (1.66)
USA	8	40	66
USSR	9	45	75
Others	12	36	60
Total	29	121	201

Phase 2, the actual destruction of chemical weapons, should begin 12 months after entry into force. This will be very difficult to accomplish unless the facilities are already under construction, especially where there is a need to hold environmental impact hearings and develop such criteria as may be required by national legislation. This could easily occupy two years, i.e. planning of destruction facilities must begin before entry into force. Such considerations have already led the United States to plan the construction of incineration facilities at all continental stockpile sites to destroy obsolete unitary munitions. The USSR had indicated the construction of one pilot

facility at Chapayevsk, but recently downgraded it to a training facility. It does not seem realistic that one plant in the USSR would be sufficient, since they have 50,000 agent tons to be destroyed. The USA will require nine destruction plants to fulfill their requirements to destroy their obsolete unitary weapons by 1997 at 8 locations. Hence the assumption in this paper is that the USSR will require essentially the same number of destruction facilities to destroy their larger stockpile, and an estimate of 9 Soviet destruction complexes; one at each presumed stockpile location. The actual number will be a function of:

(i) the distribution of CW agents between bulk and munitions,
(ii) the number of different agents in the stockpile,
(iii) the quantities and types of munitions in stock,
(iv) the agreed order of destruction,
(v) rates of destruction.

It is unlikely that the other possessors will be able export their CW to other State Parties for destruction. So, if there are 12 other possessors, each will have to construct a demilitarization facility and the inspector requirement could rise from 3 to 5 at each site for a total of 60 inspectors. There would likely be a greater requirement for assistance with the design and construction of the plants, and perhaps more

assistance from the International Authority by the provision of expert advice.

Hence there is a planning requirement for approximately 201 inspectors for the first phase and increasing to 241 for monitoring the actual destruction at twenty-nine sites.

Table 12: Inspector Requirements for CW Stockpile Destruction

	Stockpiles	Inspectors	Total Inspectors (1.66)
USA	8	40	66
USSR	9	45	75
Others	12	60	100
TOTAL	29	145	241

9. Chemical Weapons Production Facilities

At present, only the United States has made declarations on existing production facilities (CWPF). Some countries, such as Canada and the U.K., have provided data to the international community on old production facilities, long since destroyed. Other data is based on discussions in the open literature. The following table summarizes this data on former facilities based on information provided to the Conference on Disarmament.

This suggests that there will be 23 possible facilities to be controlled by the inspectorate after formal declarations are made and that there may be approximately 23 declarations of former facilities (the actual number will depend upon the date on which they ceased operation). The 23 CWPF will require the continuous presence of inspectors once their destruction commences. Before this, the inspectorate has to verify declarations and ensure that the facility is closed, that any existing raw materials or stockpile are sealed and that no other activities are carried out except those mandated by the closure or environmental safety. The number of inspectors required at each CWPF is a matter of debate; the minimum is one but that is likely to be impractical, especially at the larger facilities, and undesirable for a number of reasons. Some will need permanent inspection immediately while others will require regular intermittent inspection. Also there will be some overlap with actual stockpiles. It is difficult to assess the number of inspectors required. Each facility will have to be visited 60 days after initial declarations to audit inventories, place seals and install monitoring instruments. Their continuous presence may be required until subsidiary arrangements are made and instruments are functioning. If we assume two inspectors

[redacted] Table 13: Chemical Weapons Production Facilities

CWPF*

Country	Number
USA	5
USSR	(10)
France	(1)
Iraq	(2)
Iran	(1)
Syria	(1)
Libya	(1)
Egypt	(1)
Israel	(1)
Total	23

Former CWPF**

Country	Number
UK	8
Canada	1
Japan	1
Indonesia	1
Australia	(1)
China	(1)
Czechoslovakia	(1)
Italy	(1)
Kenya	(1)
Nigeria	(1)
Germany	(1)
Hungary	(1)
India	(1)
Poland	(1)
Singapore	(1)
South Africa	(1)
Total	23

* Number in brackets unconfirmed

** Number in brackets unconfirmed, moreover there is no agreement on how to deal with former CWPF that have previously been destroyed.

permanently at each site, then 46 inspectors would have to be assigned; and to cover holidays etc. this would equate to 76 inspectors using 1.66 as the planning factor. If destruction begins on schedule then there would be a continuing need for their presence. It would thus appear to be a reasonable assumption that 75 inspectors will be required to deal with the destruction of CWPF. The length of time that inspectors will need to be available depends on agreement as to when all such CWPF are to be dismantled.

There will be costs associated with verification activities related to former CWPF depending upon the actual date of closure of those facilities. It is unlikely that this would cost more than an inspector year in total so that it could be subsumed in the 75 estimate.

Hence this preliminary review suggests that 75 inspectors will be required initially for the Chemical Weapons Production Facilities.

10. Costs Associated with Securing Facilities

There is only one detailed account in the literature that attempts to provide costs for using remote sensing to monitor facilities. This was an attempt to apply "Recover" technology to CW and was described by Japan in 1985 in CD/619. Their illustrative figures are given in the following table:

Table 14: Costs of Applying Recover Technology to CWC

Stockpiles Facilities:	$152,000
Production Facilities:	$184,000
Elimination Facilities:	$300,000
Permitted Production:	$300,000

These are the costs associated with verifying the inactive status of stockpiles and production facilities and the monitoring of activities at destruction plants and of permitted production.

Table 15: Cost of Electronic Monitoring of Facilities

Facilities	No.	Cost ($ million)
Stockpiles	29	4.4
Destruction Sites	29	8.7
CWPF	23	4.2
Total		17.3

Hence, an estimate of the cost of electronically securing all of these sites would be about $17 million in 1985 dollars based on the tentative Japanese analysis. A more recent US estimate, CD/CW/WP 268, suggests that the cost of collecting data from all sites by satellite could be about $72 million.

The assessment of the actual cost per inspection is difficult. The only analogy is the Safeguards Division of IAEA.

Its projected 1990 costs are $57,816,000. There are 292 inspectors and approximately 205 other employees in this division. The budget projection covers salaries, travel, training, equipment and other support services, and so one could conclude that the average sum required to keep each inspector in the field is $200,000[1]. Using this figure we can project the following inspection costs.

Table 16: Estimate of Inspection Costs

Activity	Inspectors	Cost ($ million)
CW Stockpile	201	40.2
increasing to	241	48.2
CWPF	75	15.

This leads to an estimate of an inspectorate size ranging from 276 to 316 to supervise the destruction of all chemical weapons and the corresponding production facilities at a cost of $55 to $63 million. There is also an initial capital cost of electronically securing the sites of about $17 million.

---

[1]This is likely to be a minimum figure since some aspects of safeguards are funded directly by States Parties.

Of course where inspectors are permanently present the need for electronic securement could be substantially reduced or eliminated.

11. Activities Not Prohibited by the Convention

Article VI is the arms control component of the proposed CWC. The thrust of this article is to control toxic chemicals seen to be a risk to the convention while, at the same time, interfering as little as possible with the legitimate practices of the chemical industry. The aim is to prevent production of chemical weapons agents, not to control the chemical industry. The most dangerous chemicals will be found on schedule 1 and these will not likely be found in the commercial industry. The major permitted production requiring international inspection will be for protective purposes and this will have to be carried out at secure facilities under government control. In principle, each State Party could operate a facility that could produce chemicals on schedule 1 up to an annual aggregate limit of one metric tonne. This would be a Single Small Scale Facility (SSSF).

Single Small Scale Facility (SSSF)

Each State Party that operates a SSSF will have to provide initial and annual declarations and also advance

notification of any planned changes to these declarations. The main aim of the verification activities will be to confirm the declarations made on the production of schedule 1 chemicals and the aggregate amount in stock. The monitoring of SSSFs will involve on-site inspection and likely on-site instruments. Each facility will be subject to an initial visit intended to verify its capacity, to develop procedures for subsequent visits and the installation of instruments, and to develop a facility agreement.

From a planning perspective one has to estimate how many such facilities might exist, how long the initial inspections might take, and the approximate duration of the annual inspections. In principle, such inspections could last for the lifetime of the CWC. If one assumes that all NATO and WTO countries have an SSSF, this gives a total of 23, although there might be fewer, and one might speculate that there could be 20 other such facilities worldwide. This means that one would have to plan on 43 facilities. Initial inspections could last for a week and require from three to five inspectors. There may then be a requirement to install instruments at these facilities as soon as practicable thereafter but preferably within the first year. The installation processes are also likely to take a week at each site but likely employ technical assistants under the supervision of one inspector. Thereafter the annual inspections are unlikely to require more than two days per SSSF per annum; instrument maintenance may cause additional inspection needs. In

CD/619, Japan estimated that this cost of electronic monitoring of a permitted facility would be $300,000 per year. Hence there will be a first year requirement for 5 inspectors per inspection, which could reduce to 3 thereafter, and a capital requirement of $12,900,000 based on the "Recovery" model. This leads to an estimate of 25 inspectors initially, reducing to 6 annually after the first year if the inspection takes only two days to complete.

Table 17: Inspection Costs for SSSFs

Inspectors (Year 1)	25	5,000,000
Capital		12,900,000
Inspectors (annual)	6	1,200,000

12. Verification of Non-production

The problems of development of quantitative criteria for an International Inspectorate are greatest with regard to Article VI and its annexes. These annexes have been developed on the basis of the risk that the various chemicals and their production facilities present to the aims of the Chemical Weapons Convention. No account has been taken of the complexities or the potential costs of the inspection regimes nor the potential reach of the Convention into the civilian chemical industry.

The first attempt at looking into inspection needs related to industry was made by the Netherlands in CD/445 of 1984.

The starting point was that compliance with a CWC could best be assured by inspection of the chemical industry to ensure that there was no undeclared production of super-toxic lethal chemicals or key precursors. It was noted that such visits would require industrial co-operation and that they must not compromise industrial secrets. It was stressed that all plants that could produce STLCs should be declared as well as those plants which actually were producing STLCs and key precursors. The former is not yet agreed in the negotiations.

It was assumed that such inspections would be systematic but random, and that the nature of the inspections would depend on whether the plant actually produced STLCs or key precursors, or only had the capability to do so. In the case of actual production, the quantities produced would have to be reconciled with the declarations and a check made on the non-production of undeclared toxic chemicals. The second type of inspections would only need to determine non-production. The paper also noted that the only alternative for checking CW-capable plants was challenge inspection.

The calculations in CD/445 assumed a ratio of 1.8:1 for support staff to inspectors working from headquarters, that inspectors would achieve 40 days/year of inspection, and that a national organization would collect the required basic data.

This led to an estimate of 10-15 inspectors for random inspection and of 30-40 for the verification of non-production i.e. a total of 55 inspectors plus 100 support staff to deal with what is now schedule of Article VI. This number of inspectors would be required for the ongoing (permanent) aspects of the Convention and the suggested inspections of CW-capable facilities.

An examination of the organization required to make the chemical weapons ban effective was presented by the United Kingdom in CD/769. It suggested that at least 60 inspectors and 120 support staff would be required to deal with the initial demands of the Convention.

A recent study by Beck[1] attempted to develop a cost analysis based on the Netherlands paper (CD/445), an extended list of possible CW processors[2], the illustrative schedules of chemicals in the rolling test (CD/782), and the World Directory

---

1 Verifying the Projected Chemical Weapons Convention. A Cost Analysis. Herbert Beck, AFES PRESS No. 13, Mosbach, 1988

2 J.P. Perry Robinson in SIPRI Chemical and Biological Weapons Studies Vol. 4, Oxford University Press, 1986

on Chemicals[3], used as a source of information on potential suppliers of the chemicals on the schedules. The conclusions of that study show an increase in the estimates of inspector requirements, and are compared with CD/445 in the following table.

Table 18: Inspection Requirements for Non-Production

	CD/445		H. Beck
Sch 2 Plants	50		150
Insp. Frequency (yr)*	1: 1.5		1: 1.5
Inspectors	3		3
Inspection time (dy)	5		5**
Inspectors	10 - 15		40
CW Capable Plants	500	Schedule 3	500***
Insp. Frequency (yr)	1: 3		1: 3
Inspectors	3		3
Inspection Time (dy)	3		3
Inspectors	30-40		40

* An inspection frequency of 1:1.5 means that, on average, a plant will be inspected every 18 months but the inspection will be random in that it can occur at any time in the period even in consecutive months.

** Figures not stated but assumed to be the same as used in CD/445.

*** Beck uses the Netherlands figures for CW capable facilities and states that these represent schedule 3 plants. CD/445 does not attempt to suggest inspections for that category.

The table shows how sensitive the inspector estimates are to the factors listed: the number of plants, the frequency of inspections, the number of inspectors involved and the length of

---

3 Directory of World Chemical Producers, Oceanside, 1984

the inspection. If, for example, one were to change the inspection frequency, of one inspection every eighteen months to one per annum, the Netherlands' estimate would change to 19 and Beck's to 56.

It would seem, therefore, to be important to examine these parameters more closely in order that we might improve upon previous estimates or at least be aware of the sources of their shortcomings.

Schedule 2 Plants

The original Netherlands estimate of 50 companies as producers of key precursors to STLC was too low since it essentially only included western nations. The more complete analysis by Beck indicated 68 potential suppliers at the end of 1984. A similar analysis of J.P. Robinson's extended list of chemicals gave 206 companies involved in the production of chemicals which could be of concern to the Convention. All of this suggests that the correct number of schedule 2 producers may be somewhat less than 200 but substantially more than 50. A problem for the analysis lies in the unavailability of information on chemical producers in CMEA countries, the Developing World, and China. Given the known production of chemical weapons by the USSR and the extent of the chemical industry in other parts of the world, there must be additional producers of schedule 2 chemicals. To this must be added the

fact that only primary producers have been identified in this study and so there will be other facilities such as processing plants which would merit inspection. This means that Beck's estimate of 150 schedule 2 plants is a reasonable starting point for such calculations, with 200 being an intuitive upper limit for such facilities.

Inspection Frequency for Schedule 2 Plants

Both papers take an average inspection frequency of once every 18 months for these plants. This seems to be too great an interval between inspections; annual inspection would be more appropriate. These is also an obligation for an initial visit by inspectors, followed by the development of facility attachments for each site before the random but routine inspections commence on a regular basis related to the required declarations. This means that each facility may have to be visited twice in the first year for information purposes before a regular frequency can be set for each location. In this paper, it is assumed that each schedule 2 plant may be inspected twice in the first year and annually thereafter. This does not include visits for either the installation or maintenance of equipment or seals required on-site by the inspectorate.

Number of Inspectors

The number of inspectors allocated to each on-site inspection in the above papers is three. However, for certain tasks, it is likely too low. The development of facility attachments, in particular, could involve more personnel. Five inspectors is more realistic, and that number is used in this paper. The installation of equipment or seals should be done by technical support staff of the inspectorate and these activities should be supervised by at least one inspector.

Inspection Duration

The figure of five days was used in the above papers and seems to be appropriate for planning purposes in this paper.

CW-Capable Plants

In CD/445, the Netherlands developed the concept of "verification of non-production in other plants" but, as yet, the rolling text does not require such inspections. If such a concept were to be pursued (and the latest proposals for Ad Hoc Verification may have overtaken this), then there would have to be some means, such as an Annex to Article VI dedicated to such facilities to allow for such plants to be identified. If this were to be done, the problem would then be to estimate the number of such plants and the stringency of the inspection to which they

would be subjected. CD/445 assumed 500 plants worldwide without giving a basis for this figure.

It is expected that the type of inspection procedure that would be applied to CW-capable facilities would be patterned upon those for known schedule 2 facilities. The major differences would be in the frequency of inspection and in the probable absence of information derived from initial visits and facility attachments. This would make inspections more difficult and perhaps require more than five inspectors in the team. The suggested frequency in CD/445 of once in 36 months is low but probably the best attainable. Hence, this paper has assumed that the number of inspectors be set at five and initial inspections would probably require five days.

The actual number of CW capable plants can only be a matter of conjecture at this stage, but the number suggested by the Netherlands in their paper is probably an underestimate (see discussion below on ad hoc verification). The figure of 1000 used in this paper is probably conservative for the number of plants that could be involved.

Schedule 3 Plants

Currently in CD/961, schedule 3 chemicals and facilities are not subject to routine inspection; verification would only

involve monitoring through data collection. It seems unlikely that this situation will continue without some provision for a mechanism by which anomalies or ambiguities in the data provided by a national authority are reviewed. It is also possible that there could be a concern about the capability of these facilities to produce schedule 2 chemicals. Hence this paper assumes that there might be inspections at schedule 3 facilities and that these would be less extensive than those required for schedule 2 or in relation to the proposal for CW-capable facilities. Assuming a frequency of one inspection per year, that no more than three inspectors would be involved, and that no inspection would last for more than three days, one could estimate the requirements for such inspections.

The major problem is in assessing how many plants are involved. Beck's analysis of schedule 3 production suggested that 78 companies might be involved (possibly with more than one location per company). The number of CMEA operations is understated: e.g. the GDR is not listed in Beck's paper, even though it is known to produce some substances such as phosgene (at Schwarzheide). However, the actual number is not likely to be much larger, since there is a tendency in industry for the concentration of activities related to the production of chemicals used in large commercial quantities. For the purposes of this paper, the actual number of plants is assumed to be of the order of 100.

International Inspectors and an Inspector - Year

We have already discussed a number of factors or assumptions relating to the computation of inspector numbers. A central one is that each inspector can manage 40 inspection days per year, where a permanent or lengthy presence is not required. Clearly any improvement on this will reduce the actual number of inspectors. However it should be emphasized that the number 40 derives from observations of IAEA inspection activities. Although that Agency has a goal of 100 inspection days per inspector, which would be roughly half a normal working year, an examination of the Agency's statistics indicates an average of 40 to 50 inspection days per inspector. This seems to be due to a number of reasons: training, travel time, designation to specific countries, requirements for relatively short term contracts for inspectors, holidays and so on. It would seen unlikely that a fledgling organization could do better, and the need for randomizing inspections may well exacerbate the problems, particularly in regard to the availability of designated inspectors. Furthermore, the IAEA has no real equivalent to challenge inspection. Hence this paper will continue to use the number forty as an average number of inspection days per inspector in relation to routine random inspection to verify non-production of chemical weapons in commercial facilities.

Inspection Needs in Non-Production

The result of this review shows that there are three possible cases to consider in relation to inspectors: (i) monitoring schedule 2 production facilities; (ii) monitoring facilities deemed to be CW-capable; and (iii) monitoring of schedule 3 production facilities. It should be stressed that at this point in the negotiations only (i) has been agreed; (ii) is still being discussed; and (iii) seems to be a possible outcome of questions that might arise in relation to declarations on schedule 3 chemicals and facilities. The other situations are examined as an aid to assessing the implications for the Inspectorate.

Table 19: Estimates of Inspectors Required for Various Inspection Types

A. Inspectors for Schedule 2	
Schedule 2 Plant	200
Inspection Frequency	1 per year
Inspectors/Inspection	5
Duration	5 days
Inspectors	125
B. Inspectors for CW-Capable Plants	
CW-Capable Plants	1000
Inspection Frequency	1 every 3 years
Inspectors/Inspection	5
Duration	5 days
Inspectors	208
C. Inspectors for Schedule 3	
Schedule 3 Plants	100
Inspection Frequency	1 per year
Inspectors/Inspection	3
Duration	3 days
Inspectors	23

Once again, these figures show how sensitive the calculations are to the parameters listed, and indicate that considerable care should be taken in laying down the methodology of inspection with too great a precision as it may lead to unnecessarily high inspection costs.

Assuming that the cost per inspector is $200,000, then one can tabulate the following costs (Table 20). The projected cost of schedule 2 inspection is $25 million and would increase approximately 20% if schedule 3 is added. The addition of CW-capable facilities more than double the cost.

Table 20: Inspection Costs

1.	Schedule 2	125	$25,000,000
2.	CW-capable	208	$41,600,000
3.	Schedule 3	23	$ 4,600,000

13. National Trial Inspections (NTI)

In an attempt to remove some of the uncertainties in our understanding of the problems associated with the inspection process in the chemical industry, a template was prepared for national trial inspections (CD/CW/WP 213). A number of NTIs have now taken place, and a review of them should lead to a better assessment of their value. A preliminary examination of the reports available leads to the table below and is used to improve the estimate of the number of inspectors required to give assurance of the non-production of schedule 1 chemicals and that

industrial facilities used for schedule 2 chemicals are not used for purposes prohibited by the Convention.

The reports show the importance of initial visits and the need for more than four inspectors for each visit. The time allotted varied from one-half day to three days and, if combined with the preparation of a facility attachment, took several days. As expected, the number of inspectors does not change for the preparation of facility attachments, but the latter activity could require up to 10 days. The time required for routine inspections can be shortened if there is sufficient effort placed on initial visits and the preparation of facility attachments.

Table 21: National Trial Inspections

Country	I. Visit (I)(T)	FA (I)(T)	Inspection(I)(T)
Australia	Y (4)(0.5)	Y (5)(1.0)	Y (5) (2.0)
Brazil	Y (6)(1.0)	N	Y (6) (1.0)
Belgium	--	--	Y (3) (1.0)
Czecho-slovakia	Y (4)----------six visits----------		Y (4) (1.0)
FRG	Y (5) (1.0)	Y (5) (1.0)	Y (5)
France	Y (3) (1.0)	Y (3) (0.5)	Y (3) (2.0)
Finland	Y (5) (1.0)	--	Y (5) (1.0)
GDR	Y (5)-------several visits, 4 days---		Y (2) (2.0)
Hungary	Y (team)	Y (team)	Y (team)
Italy(2)	Y (team)	Y (team)	Y (team)
Japan(3)	Y (5)----------several days---------		Y (5)
Netherlands	Y (7)	Y (7)	Y (7) (1.0)
Sweden	Y (3)(2.5)	Y (3)(10)	Y (3)(1)
USA	Y(6)(2.5)	Y (6)(1.25)	Y (6)(1.7)
USSR	Y (4) (3)	Y (4)(2)	Y (4)(1)

I = inspectors, T = time in days, FA = Facility Attachment
Y = Yes N = No

One could conclude that teams of 4 to 6 inspectors will be desirable, and the size should depend on whether the facility is single or multipurpose. The length of the initial visit is dependant on the quality of the declarations made but would likely take from 3 to 5 days. It seems difficult to assess how long it would take to develop a real facility attachment, but it could be an extended process and in the NTI'S ranged from one-half to ten days. It also seems unwise to attempt to combine such visits given the time pressures that there will be on the Secretariat to deal with all the initial national declarations immediately after entry into force. It is possible that random routine inspections could be done in three days or less, especially if the preliminary work is done well. No views were expressed in the inspection reports as to the frequency of inspection except by the USSR, in CD/894, where they suggested as many as four routine inspections per year. Several reports emphasize that the teams may have to be accompanied by interpreters.

From the above it seems that initial inspections will involve at least five inspectors and that these inspections are unlikely to take less than 5 working days. There is a strong possibility that there will be a need for two inspections per facility in the first year to deal with facility attachments, but then subsequent random inspections of schedule 2 facilities might be carried out in three days or less. This would reduce the inspectorate requirement considerably.

14. Challenge Inspections

The demand for challenge inspections is difficult to quantify but it is essential to discuss it and bring out the technical problems associated with managing challenge inspections. The initial concept of challenge as a "safety net" for the Convention led to the view that it would not be used frequently and CD/445 suggested that the number of challenge inspections would be low. In fact, they did not assign any permanent inspectors to this function. More recently, Beck assumed that there will be a group of inspectors assigned to challenge inspection because of its short-notice characteristics, and that fifty to eighty inspectors could be required.

Although the broad outlines of the rights and obligations associated with on-site inspections by challenge have been extensively debated, no text has entered the draft CWC as yet. In essence, it has all but been agreed that every State Party has the right at any time to request an on-site inspection of <u>any site</u> on the territory of another State Party in order to clarify doubts about compliance with the Convention.

The factors to be assessed in attempting to quantify the inspectorate requirements are:[1]

(i) the number of States Parties;
(ii) the efficiency of routine verification of compliance;
(iii) confidence level in routine verification;
(iv) undeclared sites

It is also generally thought that the most use will be made of challenge during the destruction phase i.e. the first ten years.[2] Apart from this, it is the initial data exchange of national declarations from States Parties that will likely generate the background information that could lead to challenges.

Requests for challenge inspection could occur in relation to:

(i) Stockpiles,
(ii) Chemical Weapons Production Facilities,

---

[1]At this point in time it is impossible to assess the number of military locations that would be subject to challenge

[2]This will be affected to a very large degree by the number of State Parties adhering to the Convention.

(iii) Chemical Weapons Destruction Facilities,

(iv) Permitted Production of Schedule 1 chemicals for protective purposes,

(v) Non-production in the Civilian Chemical Industry,

(vi) Production of Schedule 2 and 3 chemicals in commercial facilities, and

(vii) Allegations of Use.

As well, items (i) to (vi) could involve either military or civilian facilities and so may generate problems associated with sensitive military installations or the confidentiality of industrial processes. The challenges could involve declared sites or those which remained undeclared. In principle the problems associated with item (vii), allegations of use, are different since they would imply that other aspects of the Convention have previously been violated. Hence the assessment of numbers of inspectors should differentiate between items (i) to (vi), since these should be variants of routine inspections triggered by challenge, and item (vii) which could well require a different inspection modality.

The following table summarizes earlier assumptions concerning the number of facilities requiring inspection under the CWC. This list of locations can be divided into two: items 1 to 3 involve destruction and permitted production; while items 4 to 6 cover activities not prohibited by the Convention

but involve activities or facilities which, if misused, could pose a risk to the Convention. Items 1 and 2 should essentially be subject to continuous monitoring and item 3 will undergo rigorous inspection before the development of facility attachments as well as systematic on-site inspection, so these locations should not give rise to many challenge inspections. The facilities declared under item 4 also will be subjected to the development of facility attachments and to random routine inspections and so, again, should not contribute greatly to challenge inspections. Consequently, challenge inspections associated with schedule 2 should either relate to undeclared

Table 22: Inspection Locations for Challenge Inspection

1.	CW Stockpiles	29
2.	CWPF	23
3.	SSSF	43
4.	Schedule [2]	200
5.	CW capable *	1,000
6.	Schedule [3]*	100
	Total locations	1,395

* No agreed routine inspection in rolling text, but any location is liable to challenge inspection.

facilities or to the misuse of declared facilities between inspections. The facilities associated with schedule 3 will be declared and the production monitored by data exchange. If no inspection modality is developed to review ambiguities or anomalies in the data received by the Technical Secretariat, then inspection by challenge is the only current remedy available in

that any ambiguities would have to be reported to the Executive Council. If the matter is not then resolved it could lead to challenge. It also seems an extreme measure to uncover what might, in most cases, be no more than a technical violation of the Convention. Discussions of these problems have led to the concept of ad hoc verification, which will be examined later.

This analysis suggests that it will be those facilities thought to be "CW-capable" that might generate the most challenge inspections outside the military area. These are currently undeclared facilities because they have no present activities related to any schedule. Unless some other form of verification is developed to deal with these, challenge inspections would be the only means to ensure that any concerns about such facilities - concerns perhaps deriving from other sources of information - could be resolved.

If on the basis of the above discussion, one assumes that the number of locations that could be declared is in the 1400 range and that of these, roughly 1100 are not currently subject to inspection, then we might estimate the number of inspectors required for Challenge Inspections would be affected by the following assumptions:

(i) 1100 locations

(ii) on average, that there might be one challenge inspection per location over a five year period

(iii) 5 inspectors per inspection

(iv) 5 days duration

On this basis, 138 inspectors would have to be involved in this activity. If we use the same frequency of inspection as that proposed for routine inspections (i.e. one every three years), then the number of inspectors would be 230. It should be noted that there would be a trade-off in costs between routine and challenge inspections: the more routine inspections there are, the fewer the challenges that may be required.

Allegations of Use

Allegations of use, especially if novel agents are involved, will be very difficult for the inspectorate to investigate without assistance from other experts. The demands of the inspectorate will be difficult to quantify but it is unlikely that there would be more than one allegation of use annually, if any. An investigative team could be of the order of 10-20 persons about half of whom would be inspectors. Even if the on-site inspection lasted for four weeks, this would only amount to 280 working days or about seven inspectors. The organization should be able to cope with such demands without any additional resources for labour but there would be a need for capital expenditures to ensure that such investigative teams were properly equipped. Planning should be such that two teams could be put into the field if necessary.

15. Ad Hoc Verification

In recent years, there has been growing concern that the verification regime envisaged under the Convention might not be adequate and should therefore be supplemented by some ad hoc systems of on-site inspections. As noted before, both the Netherlands and Beck addressed aspects of this problem; and there has been a number of other proposals advanced to come to grips with it.

The first hint of some unease as to how the verification protocols were developing came as a result of the first Australian trial inspection, held in 1986 (CD/698). This trial inspection was developed to verify the non-diversion of chemicals from peaceful uses. The Australian government came to the conclusion that material accounting alone would not guarantee that there was no illicit production of designated chemicals, and that a system of "spot checks", or "confirmation visits", would be required to augment the regime envisaged for chemicals produced in large commercial quantities.

Later, the Federal Republic of Germany, in CD/791 voiced its doubts about the comprehensiveness of the verification measures in Article VI, suggesting the possibility that non-declared use of substances controlled under this Article could remain undetected. It was suggested that there were two situations; a misuse of production facilities declared in

schedules 2 and 3; and the misuse of undeclared production facilities that remained outside the routine verification system. This led them to suggest that the international authority would require another type of routine inspection, which they called an "Ad Hoc check". These checks would be carried out at short notice within the chemical industry to ascertain whether any scheduled substances were being produced at any production facility. This idea was substantially enlarged upon in CD/869, highlighting the fact that many chemical production facilities would not have to be declared under the provisions of Article VI. Thus the proposal for Ad Hoc checks would require that all CW capable production facilities be subject to a form of routine on-site inspection. This would be in addition to the verification regimes currently in Article VI. The routine character would be ensured by random selection and be based upon "National Registers" of relevant facilities, to be supplied by States Parties. The aim would be to ensure no misuse of the facilities for illicit production at the time of the visit. No facility agreements would be required. Clearly a large number of establishments could be subjected to Ad Hoc checks.

The arguments for and against Ad Hoc checks have now been widely debated. The fundamental problem is the potential magnitude of the inspection task. An appropriate definition of the chemical industry would be difficult to frame but, as suggested by the Netherlands, one might use the "Indexes to the International Standard Industrial Classification of all Economic

Activities" published by the United Nations. Preliminary estimates of the number of such facilities range from 50,000 to 100,000, and this seems to be a reasonable guess since individual estimates from industrialized countries range from 250 to several thousands for such chemical facilities. Hence this effort would involve a major allocation of resources even if carried out in a minimal way. This would dramatically increase both the size and cost of the International Inspectorate; also this type of inspection would be driven entirely by the size of the chemical industry in a particular country and not necessarily related to the degree of risk posed to the Convention. Given its random nature and the number of facilities involved, its direct impact on the problem of undeclared facilities has been questioned. The following table can only be considered suggestive of the dimensions of the tasks involved:

Table 23: Ad Hoc Checks

No. of facilities	50,000 - 100,000
Inspection frequency	1 every 5 years
Inspectors/Inspection	2
Inspection duration	2 days
Inspectors	1000 - 2000

In another attempt to deal with the problem of undeclared facilities, the UK delegation tabled an alternative proposal (CD/909). It suggested that the main areas of concern included: Schedule 3 chemical production facilities, undeclared

industrial chemicals facilities, undeclared military facilities, undeclared activities, other facilities not subject to routine inspection.

In view of the very large number of facilities involved and the relatively low risk of inspection under a random system, the U.K. proposed a non-selective approach, called "Ad Hoc Inspections", that would involve inspections by the Technical Secretariat that would be initiated on the basis of proposals from State Parties. The total number of inspections would be constrained by a quota system that would limit the number that a State Party could propose, or be obliged to accept, in given year.

On the basis of the U.K. approach, details of which remain to be elaborated, the following table should also be considered suggestive of the potential cost dimensions.

Table 24: Ad Hoc Inspections

Max. No. of Inspections/ State Party	4 per year
State Parties	150
No. of Inspectors/Inspection	5
Inspection duration	2 days
Inspectors	150

Once again, this analysis shows that such a procedure would have significant cost implications for the Convention. Any movement towards inspections in excess of these currently required for schedule 2 and suggested by some for schedule 3 lead

to cost escalations and a decision will have to be made as to the balance between the confidence gained from additional inspection versus their fiscal costs.

More recently, Australia presented a Discussion Paper (CD/CW/WP.286) that sought to combine the main elements of both approaches. It proposed that national registers be used as the basis from which plantsites could be selected by States Parties (and, possibly, the Technical Secretariat) for on-site inspections, this time called "Ad Hoc visits", with limits (quotas) on the total numbers that would be requested or received annually. The Federal Republic of Germany also presented a further paper (CD/984) elaborating on how such national registers might be developed, while the USA has most recently submitted a paper (CD/300) which builds upon the Australian paper and proposes appropriate amendments to the draft convention. Given the fact that these latest proposals are currently under active discussion in the Ad Hoc Committee and its working groups, it is difficult to quantify with any degree of precision what the costs might be of "Ad Hoc visits". It could be roughly of the same order of magnitude as those assumed for the U.K. proposal for "Ad Hoc inspections".

16. The International Authority and Technical Resources

Thus far, this paper has concentrated on the number of personnel necessary to carry out the inspections likely required

under a Chemical Weapons Convention. Apart from the obvious fact that the inspectors will be highly trained individuals, nothing has been said about the skills involved, the equipment needed, nor the facilities required at the headquarters of the organization. Amongst the Technical Secretariat's responsibilities are listed the following:

(i) execute verification measures,

(ii) provide technical assistance to States Parties,

(iii) provide administrative and technical support to the Conference of States Parties and all subsidiary bodies.

The Technical Secretariat must have the skills and resources to deal with verification of compliance with the Convention, including

(1) monitoring the secured stockpiles of chemical weapons,

(2) monitoring the destruction of chemical weapons,

(3) monitoring secured chemical weapon production facilities,

(4) monitoring the destruction of chemical weapon production facilities,

(5) receiving, compiling, analyzing and distribution of data on chemicals on schedules 1, 2 and 3,

(6) monitoring SSSFs,

(7) conducting routine inspections of ...,

(8) conducting challenge inspections,

(9) providing assistance to States Parties,

(10) conducting other inspections (e.g. Ad Hoc verification).

The verification of compliance will require the analysis of data acquired from declarations, routine inspections, the use of on-site instruments, the engineering inspection of plants destruction, overseeing the destruction of chemical weapons and of their production facilities, the monitoring of the non-production of schedule 1 chemicals except for permitted purposes, the monitoring of schedule 2 production, and data analysis on schedule 3. Challenge Inspections could involve all of the above skills as well as others in the case of verifying of allegations of use of chemical weapons.

Wherever the headquarters of the Agency is established, there will be an administrative component, a laboratory component, a data management centre, and, probably, a training centre. There will be significant equipment needs for the analysis of chemicals and for the analysis of data collected from declarations or on-site inspections. There will also be a need for portable equipment for the inspectorate. It is also possible that there will be a requirement for the establishment of regional centres.

It seems important that the Technical Secretariat have its own laboratory with the appropriate state-of-the-art

equipment. It will have to develop its own analytical methodologies to deal with the analysis and monitoring of all the chemicals on schedules 1 and 2. Similarly it will have to consider technical problems associated with the addition of new chemicals to schedule 2. It will have to license designated laboratories in various countries and agree on analytical procedures with National Authorities. The laboratory will be expensive to set up and maintain at the leading edge as technology evolves. It will require the following equipment:

Infra-red Spectrometers (Fourier Transform),
Ultra-violet Spectrometers,
Mass Spectrometers (gc-ms, tandem, quadropole),
Nuclear Magnetic Resonance Spectrometers (hydrogen, carbon and phosphorous),
Gas chromatography,
High Pressure Liquid chromatography,
C, H, N, P Analysis,
Computer equipment for laboratory data management,
Enzymatic Analysis.

Some of these problems have recently been addressed by Finland in a working paper, CD/CW/WP 253, and in the report of the Instrumentation Group, CD/CW/WP 272.

In addition to the equipment required for the laboratories, there will be a need for computer networks to deal

with the enormous data flow from all of the declarations and the ensuing on-site inspections.

The initial set-up costs for the organization as it is referred to in Article VIII will be high and difficult to estimate. They will be a function of the following:

the location of the Headquarters,
the size of the inspectorate and support staff,
the central laboratory,
the computer facilities, and
the training of inspectors.

Such a facility could not be built and equipped without a substantial financial outlay, the actual costs will relate to where the headquarters are established. There will also be significant annual capital costs associated with re-equipping such a major organization.

17. The Size of the Inspectorate and the Technical Secretariat

This section reviews the estimates given earlier and gives a projection of the size of the inspectorate based on the inspection tasks required by the current rolling text. To this basic estimate is added further inspectors needed as a consequence of the additional inspections that might result from any additional verification tasks, such as Ad Hoc Verification. In addition to the inspectors, there will be need for support

staff for the Technical Secretariat. As a general rule, there are approximately two support staff for every professional and, in the case of the IAEA this is roughly three to two. The actual number will not affect the cost estimate since the $200,000 includes such staff but it will clearly affect the physical size of the headquarters required to house the Technical Secretariat.

The data on Stockpiles, Production Facilities and Single Small Scale Facilities will be dealt with as a unit since they all relate to the destruction of weapons and the permitted production of schedule 1 chemicals for protective purposes. This is collected in Table 25.

Table 25: Stockpiles, CWPF and SSSF

Facilities	Number	Inspectors
CW Stockpiles (Year 1)	29	201
CW Stockpiles (Year 2)	29	241
CWPF	22	75
CWPF (former)	23	(1)
SSSF (Year 1)	42	25
(Year 2)	42	6

This projection suggests that between 320-340 inspectors will be required to supervise the destruction phase of the CWC and oversee the operation of the SSSFs, and will cost 64 to 68 million dollars. If we use the Japanese cost projection (1985 dollars) for the electronic securement of all sites, approximately 30 million dollars of capital would be required for this task alone, exclusive of recurring costs relating to

equipment for inspectors.

As far as the monitoring of schedule 2 facilities is concerned, the current estimate is that there could be 200 such facilities and this would require about 125 inspectors at a cost of 25 million dollars.

This means that the inspection tasks currently envisaged under Articles IV, V, and VI of the draft Convention would require 445 inspectors at a cost of 89 million dollars, before consideration of challenge inspection.

An assessment of the possible inspector needs for challenge inspection is quite formidable and requires a number of assumptions as discussed earlier. This paper assumes that there could be as many as 220 such inspections per year and that it would require 138 inspectors. This would cost about 27 million dollars.

This leads to an estimate of a requirement for 583 inspectors at a total cost of 116 million dollars to carry out inspections currently proved for in the draft Convention.

All other inspection modalities under discussion would increase these costs and, as well as debating the pros and cons of the increased security that would result from additional

verification schemes being in place, one must have some idea of the additional costs which might accrue from them. These costs are considerable but they would be reduced somewhat by the concomitant reduction in challenge inspections which should result.

The actual inspection of schedule 3 facilities should not appreciably affect the cost of the inspectorate since it is unlikely to cost more than 5 million dollars or absorb more than perhaps 23 additional inspectors.

The more difficult problems result if one considers adding a routine inspection for what have become known as "CW capable plants". It seems likely that about 1,000 such facilities exist and that the proposed inspection regime would require about 200 additional inspectors over the base number postulated.

It is very difficult to project costs for Ad Hoc verification at this time given the present status of the debate in Geneva. There will be national costs in developing the required national registers and the annual cost to the Secretariat will be a function of their number and complexity. The cost of the proposed Ad Hoc visits is unlikely to be less than that suggested for Ad Hoc Inspection or about $30 million.

Table 26 summarizes the currently required inspection needs as mandated by the rolling text, CD/961. In round numbers, this exercise suggests that the Technical Secretariat will require about 600 inspectors to carry out its prescribed functions. The addition of support staff would bring this number up to at least 1000. If about half of the inspectors are absent at any given time, then the headquarters must be able to accommodate about 700 workers at any given time. It is projected that the annual cost of the Technical Secretariat will be about 120 million dollars and that there could be a one-time cost of up to 30 million dollars to electronically secure all sites. It is impossible to make any meaningful cost-estimate for the headquarters infrastructure at this time since neither its location is known nor the level of support which might be available from the host country.

Table 26: Inspections Required by the Rolling Text

Activity	Inspectors	Cost ($ million)
CW, CWPF and SSSF	340	68
Schedule [2]	125	25
Challenge	138	27
Total	603	120

BIBLIOGRAPHY

The Arms Control Reporter, 1984 to present, Institute for Defence and Disarmament Studies, Brookline, USA.

The Agency's Programm and Budget for 1989 and 1990, International Atomic Energy Agency, Austria, 1989.

Application of (Nuclear) Safeguards Remote Verification Technology to Verification of a Chemical Weapons Convention CD/619, July 1985.

Beck H., Verifying the Projected Chemical Weapons Convention. A Cost Analysis, AFES Press No 13, Mosbach 1988.

Canada Handbook for the Investigation of Allegations of the Use of Chemical or Biological Weapons, November 1985.

Chemical and Biological Weapons Vol. 4, 1986, Sipri, Stockholm.

Chemical Stockpile Disposal Program, CD/711, July, 1986.

Chemical Stockpile Disposal Program Final Programatic Environmental Impact Statement, Vol 1-3, Aberdeen Proving Ground, Maryland, USA, January 1988.

Chemical Weapons Convention Bulletin Nos. 1 to 4, Federation of American Scientists, Washington, USA, 1988 and 1989.

Deterring Chemical Warfare: US Policy Options for the 1990's, H. Stringer, Institute for Foreign Policy Analysis Inc., Cambridge, Mass., 1986.

Destruction and disposal of Canadian stocks of World War II Mustard Agents CCD/434, July 1974.

Disposal of Chemical Agents CD/173, April, 1981.

Estimation of tasks for, size of, and necessary resources for a Technical Secretariat under a Chemical Weapons Convention, S.J. Lundin, SIPRI, 1989.

Factors Involved in Determining Verification Inspectorate Personnel and Resource Requirements, CD/823, March 1988.

Information on the Presentation at the Shikhany Military facility of standard chemical munitions and of technology for the destruction of chemical weapons at a mobile facility, CD/789, December, 1987.

Information Presented to the Visiting Soviet Delegation at the Tooele Army Depot, 18-21 November, 1987, CD/830, April, 1988.

The Invisible Bomb, F. Barnaby, Tauris, London, 1989.

Methodology and Instrumentation for Sampling and Analysis in the Verification of Chemical Disarmanment Vols A1, A2, B1, B2, B3, B4, B5, C1, C2, C3, C4, D1, and E1, The Ministry for Foreign Affairs of Finland, Helsinki, 1977 to 1988.

Making the Chemical Weapons Ban Effective, CD/769, July 1987.

National Implementation of the Future Chemical Weapons Convention, Eds T. Stock and R. Sutherland, SIPRI - Oxford University Press, 1990.

National Trial Inspections, Australia CD/910, Belgium CD/917, Brazil CD/895, Czechoslovakia CD/900, Finland CD/CW/WP233, F.R. Germany CD/912, France CD/913, GDR CD/899, Hungary CD/890 add 1, Italy CD/893, Japan CD/CW/WP228, Netherlands CD/924, Sweden CD/CW/WP216, Switzerland CD/CW/WP247, USA CD/922, USSR CD/894, Chairman's Papers CD/CW/WP213, 236, 217, 237 and 248.

Past Production of Chemical Warfare Agents in the United Kingdom, CD/856, August 1988.

Report of the Chemical Warfare Review Commission, Chairman W.J. Stroessel, 1985.

Report of the Ad Hoc Committee on Chemical Weapons to the Conference on Disarmement, CD/961 February 1990.

Report of the Technical Group on Instrumentation, CD/CW/WP272, January 1990.

Size and Structure of a Chemical Inspectorate CD/445 March, 1984.

Soviet Chemical Weapons Threat, 1985, Defence Intelligence Agency, U.S.A.

Systems Study of an International Verification Organization on Chemical Weapons, Canada, October 1987.

The Soviet Biochemical Threat to NATO, John Hensley, St. Martin's Press, New York, 1987.

Stashevskey G., Chemical Weapons: The View from Moscow, Novosti Press Agency, Moscow, 1988.

Sipri Yearbook 1988, Oxford University Press, 1988.

Thatcher G., Poison on the Winds, The Christian Science Monitor Special Report, December, 1988.

Verification of Non-Production of Chemical Weapons and their Precursors by the Civilian Chemical Industry. Trial Inspection of an Australian Chemical Facility CD/698, June 1986.

Verification of Non-production. The case for Ad Hoc Checks, 791 CD/79, January 1988.

Verification of Non-production of Chemical Weapons Ad Hoc Checks, CD/869, September 1988.

Verification Laboratory, General Features and Instrumentations, CD/CW/WP253, June 1989.

Verification of the Chemical Weapons Convention: Practice challenge inspections of military facilities, CD/921, June 1989.

Yellow Rain, Sterling Seagrave, M. Evans and Company, New York, 1981.