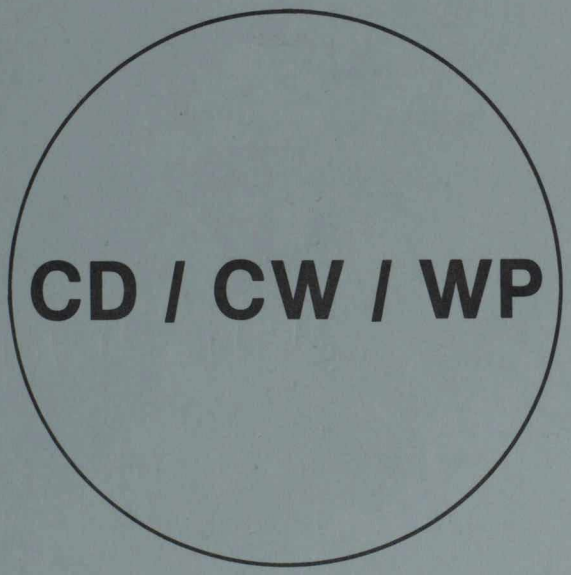
CONFERENCE ON DISARMAMENT

CHEMICAL WEAPONS

WORKING PAPERS OF THE

Ad Hoc COMMITTEE ON CHEMICAL WEAPONS 1989



COMPILED BY:

ARMS CONTROL AND DISARMAMENT DIVISION OF

EXTERNAL AFFAIRS AND INTERNATIONAL TRADE CANADA

OTTAWA, CANADA

FEBRUARY 1990

CONFERENCE ON DISARMAMENT

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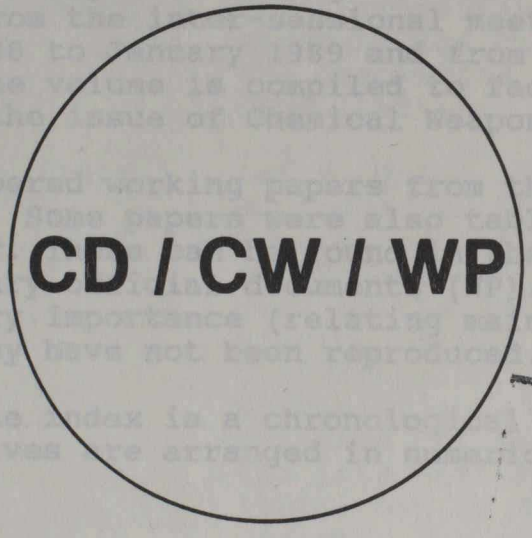

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PREFACE

CD/CW/WP

This volume covers working papers (CD/CW/WP) tabled in the Ad Hoc Committee on Chemical Weapons (AHCCW) during its 1989 sessions from February 1989 to August 1989. Also included are working papers from the inter-sessional meetings of the AHCCW from December 1988 to January 1989 and from November 1989 to January 1990. The volume is compiled to facilitate discussions and research on the issue of Chemical Weapons.

Not all numbered working papers from the AHCCW have been reproduced here. Some papers were also tabled in plenary and given a CD/number. These can be found in the appropriate annual volumes for plenary official documents (WP). Other papers were of such transitory importance (relating mainly to procedural matters) that they have not been reproduced.

Note that the index is a chronological listing while the documents themselves are arranged in numerical order by CD/CW/WP. number.

Chemical Weapons Working Papers Submitted to AHCCW of the CD 1989 Chronological Index

1989

Serial	Reference	Country	Description	Date
418.1	CD/CW/ WP.214	UK	Identification of chemical substances	2.12.88
418.2	CD/CW/ WP.215	GDR	Chemical weapons convention: Protection of confidential information	8.12.88
418.3	CD/CW/ WP.216	Sweden	Report on a Swedish national trial inspection	9.12.88
418.4	CD/CW/ WP.217	AHCCW	Trial inspections: Working paper by the Chairman of the Open-Ended Consultations	15.12.88
419	CD/877	Italy	Letter dated 12 January addressed to the Secretary-General of the Conference on Disarmament from the Head of the Permanent Mission of Italy to the Conference on Disarmament, transmitting a document entitled "Proceedings of the international forum on 'total ban of chemical weapons: The problems of verification', Rome, Villa Madama, 19-20 May 1988 (also issued as CD/CW/WP. 218)	13.1.89
421.1	CD/CW/ WP.219	AHCCW	Draft report of the Ad Hoc Committee on Chemical Weapons to the Conference on Disarmament on its work during the period 17 January to 3 February 1989 (Not Reproduced)	1.2.89
423.1	CD/CW/ WP.220	Italy	Provision of data relevant to the chemical weapons convention	3.2.89

Serial	Reference	Country	Description	Date
423.2	CD/CW/ WP.221	Norway	Provision of data relevant to the chemical weapons convention	9.2.89
424.1	CD/CW/ WP.222	AHCCW Chairman	Organisational framework for work during the 1989 session (Not Reproduced)	17.2.89
425	CD/890 and Add.1	Hungary	Report on the first national trial inspection (also issued as CD/CW/WP.223 and Add.1)	20.2.89
426	CD/893	Italy	Letter dated 24 February 1989 from the Permanent Representative of Italy addressed to the Secretary-General of the Conference on Disarmament Transmitting an interim report on a trial inspection of two italian chemical facilities (also issued as CD/CW/WP.224)	24.2.89
427	CD/894	USSR	Letter dated 27 February 1989 from the Representative of the Union of Soviet Socialist Republics addressed to the President of the Conference on Disarmament transmitting a text of the report on the national experiment on trying out procedures of systematic control of the non-production of chemical weapons in industry, held in the USSR (also issued as CD/CW/WP.225)	28.2.89

Serial	Reference	Country	Description	Date
429	CD/899	GDR	Letter dated 10 March 1989 addressed to the President of the Conference on Disarmament from the Permanent Representative of the German Democratic Republic transmitting the text of a working paper entitled "Report on the national trial inspection of the GDR undertaken in a facility of the chemical industry (also issued as CD/CW/WP.227)	10.3.89
429.1	CD/CW/ WP.228	Japan	Report on national trial inspection	13.3.89
430	CD/900	Czecho-slovakia	Report on the conduct and results of the national trial inspection (also issued as CD/CW/WP.229)	15.3.89
431	CD/901	France	Chemical weapons convention: Confidentiality (also issued as CD/CW/WP.230)	16.3.89
431.1	CD/CW/ WP.231	Canada	Definitions, schedules and toxic chemicals	17.3.89
432	CD/895/ Rev.1	Brazil	National trial inspection technical report (also issued as CD/CW/WP.226/Rev.1)	21.3.89
434	CD/909	UK	Chemical weapons convention: Ad Hoc inspections (also issued as CD/CW/-WP.232)	30.3.89
434.1	CD/CW/ WP.233	Finland	Report on the national trial inspection of Finland at a civilian chemical facility	4.4.89
435	CD/910	Aus-tralia	Letter dated 4 April 1989 addressed to the Secretary-General of the Conference on Disarmament from the Permanent Representative of Australia transmitting a	5.4.89

Serial	Reference	Country	Description	Date
			document entitled "Report of an Australian national trial inspection" (also issued as CD/CW/WP.234)	
437	CD/912	FRG	Report on a national trial inspection (also issued as CD/CW/WP.235)	7.4.89
437.1	CD/CW/ WP.236	AHCCW	Trial inspections: Working paper by the Chairman of the Open-Ended Consultations	7.4.89
437.2	CD/CW/ WP.237	AHCCW	Trial inspections: Working paper by the Chairman of the Open-Ended Consultations	10.4.89
437.3	CD/CW/ WP.238	Austria	Provision of data relevant to the chemical weapons convention	10.4.89
437.4	CD/CW/ WP.239	UK	Verification of the non-production of chemical weapons: An illustrative example of the problem of novel toxic compounds	11.4.89
438	CD/913	France	National trial inspection (also issued as CD/CW/-WP.240)	11.4.89
438.2	CD/CW/ WP.241	GDR	Multilateral trial inspections (MTIs)	12.4.89
439	CD/916	France	The scientific advisory council (also issued as CD/CW/WP.242)	17.4.89
440	CD/917	Belgium	National trial inspection (also issued as CD/CW/-WP.243)	17.4.89
441.1	CD/CW/ WP.244	AHCCW Chairman	Programme of work of the Committee during the second part of the 1989 session (Not Reproduced)	13.6.89

Serial	Reference	Country	Description	Date
442	CD/921	UK	Verification of the chemical weapons convention: Practice challenge inspections of military facilities (also issued as CD/CW/WP.245)	14.6.89
442.1	CD/CW/ WP.247	Switzerland	Report on the national trial inspection	16.6.89
442.2	CD/CW/ WP.249	UK	Report on a national trial inspection of an industrial chemical facility	21.6.89
443	CD/922	USA	Report on a United States national trial inspection exercise (also issued as CD/CW/WP.250)	22.6.89
443.1	CD/CW/ WP.246	Japan	Guidelines for initial visit and verification inspection	22.6.89
445	CD/924	Nether lands	Report on a national trial inspection (also issued as CD/CW/WP.251)	23.6.89
446	CD/925	Netherlands	An attempt to verify non-production in a chemical plant (also issued as CD/CW/WP.252)	23.6.89
446.1	CD/CW/ WP.248/ Rev.1	AHCCW	National trial inspections: Final report by the Chairman of the Open-Ended Consultations	23.6.89
446.2	CD/CW/ WP.253	Finland	Verification laboratory: general features and instrumentation	26.6.89
452.1	CD/CW/ WP.254	Canada	Case study of unusual epidemiological findings caused by a toxin	3.8.89
453.1	CD/CW/ WP.255	UK	Analytical techniques for a chemical weapons convention	9.8.89

Serial	Reference	Country	Description	Date
453.2	CD/CW/ WP.256	AHCCW	Working paper by the Chairman of Working Group 1 on Article VI	14.8.89
453.3	CD/CW/ WP.257	AHCCW	Report of the Chairman of Working Group 1 on his consultations on trial inspections	14.8.89
453.4	CD/CW/ WP.258	AHCCW	Suggested guidelines for schedule 1 in the Annex on chemicals	14.8.89
453.5	CD/CW/ WP.259	Canada	Pinacolyl alcohol	14.8.89
454	CD/948	Austria	Letter dated 10 August 1989 addressed to the Secretary-General of the Conference on Disarmament by the Permanent Representative of Austria transmitting a document entitled "Preliminary report on an Austrian national trial inspection (also issued as CD/CW/-WP.260)	14.8.89
455	CD/949	Czecho-slovakia	Data relevant to the convention on the complete and general prohibition and destruction of chemical weapons (also issued as CD/CW/WP.261)	15.8.89
455.1	CD/CW/ WP.262	AHCCW	Draft report of the Ad Hoc Committee on Chemical Weapons to the Conference on Disarmament (Not Reproduced)	
456	CD/950	FRG	Report on a trial inspection to test the validity of a proposed format for ad hoc on-site verification (also issued as CD/CW/-WP.263)	17.8.89

Serial	Reference	Country	Description	Date
459.1	CD/CW/ WP.264	USSR	Provision of data relevant to the chemical weapons convention	21.11.89
459.2	CD/CW/ WP.265	USA	Demilitarization and disposal of US chemical warfare agent and munitions	11.12.89
459.3	CD/CW/ WP.266	USA	Sample preparation, preservation, security and transportation under the chemical weapons convention.	11.12.89
459.4	CD/CW/ WP.267	USA	The use of instruments in chemical process monitoring or demilitarization of chemical weapons.	11.12.89
459.5	CD/CW/ WP.268	USA	Use of a satellite network for collection of data from facilities.	13.12.89
459.6	CD/CW/ WP.269	UK	Instrumental approaches to non-intrusive analytical techniques for inspection and verification	12.1.90
459.7	CD/CW/ WP.270	Switzerland	Verification of a treaty on a chemical weapons ban: Chances and limits of process monitoring.	18.1.90
459.8	CD/CW/ WP.271	Netherlands	The role of military detection and monitoring equipment for the verification of non-production of chemical weapons.	18.1.90
459.9	CD/CW/ WP.272	AHCCW	Report on the Technical Group on Instrumentation	22.1.90

The following documents of the AHCCW, which do not contain any substantive material or are draft reports, are not reproduced but are listed here for identification:

Serial	Reference	Country	Description	Date
421.1	CD/CW/ WP.219	AHCCW	Draft report of the Ad Hoc Committee on Chemical Weapons to the Conference on Disarmament on its work during the period 17 January to 3 February 1989 (Not Reproduced).	1.2.89
424.1	CD/CW/ WP.222	AHCCW Chairman	Organisation framework for work during the 1989 session (Not Reproduced).	17.2.89
441.1	CD/CW/ WP.244	AHCCW Chairman	Programme of work of the Committee during the second part of the 1989 session (Not Reproduced).	13.6.89
455.1	CD/CW/ WP.262	AHCCW	Draft report of the Ad Hoc Committee on Chemical Weapons to the Conference on Disarmament (Not Reproduced).	

CONFERENCE ON DISARMAMENT

CD/CW/WP.214 */
12 December 1988

Original: ENGLISH

Ad Hoc Committee on Chemical Weapons

UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

Identification of Chemical Substances

In March 1986 the Delegation of Canada to the Conference on Disarmament tabled CD/679 on the Identification of Chemical Substances. In this paper it was suggested that specific chemicals of relevance to the Chemical Weapons Convention (CWC) be identified not only by the nomenclature of the International Union of Pure and Applied Chemistry (IUPAC) and in terms of their structural formulae but also by means of their Chemical Abstracts (CAS) registry numbers. In this system each chemical entity is assigned a unique CAS registry number. Thus staff of the Technical Secretariat and others responsible for administering the Convention would be able to refer unambiguously to particular substances.

During negotiations of the 1986 session of the CD it was agreed that the CAS registry numbers be incorporated into the Schedules of Article VI. Owing to the fact that some of the specific chemicals on the Schedules exist in more than one stereoisomeric form the United Kingdom suggested that, where assigned, the CAS registry number be stated for each form. This proposal was introduced subsequently as a footnote to Schedule [I].

The Annex to this paper lists for substances in Schedule [I] the CAS registry numbers of the stereoisomers and geometric isomers for which these numbers have been assigned. The United Kingdom proposes that this listing of CAS registry numbers be incorporated appropriately into the rolling text of the Convention.

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*/ Reissued for technical reasons.

ANNEX

1. O-Alkyl alkylphosphonofluoridates

eg. Sarin: O-isopropyl methylphosphonofluoridate (107-44-8)

Stereoisomers:

R-(-)-O-isopropyl methylphosphonofluoridate (6171-94-4)
S-(+)-O-isopropyl methylphosphonofluoridate (6171-93-3)

Soman: O-pinacolyl methylphosphonofluoridate (96-64-0)

Stereoisomers:

C(+)P(+)-O-pinacolyl methylphosphonofluoridate (22956-47-4)
C(-)P(-)-O-pinacolyl methylphosphonofluoridate (22956-48-5)
C(+)P(-)-O-pinacolyl methylphosphonofluoridate (24753-15-9)
C(-)P(+)-O-pinacolyl methylphosphonofluoridate (24753-16-0)

2. O-Alkyl N,N-dialkylphosphoramidocyanidates

eg. Tabun: O-ethyl N,N-dimethylphosphoramidocyanidate (77-81-6)

Stereoisomers:

(+)-O-ethyl N,N-dimethylphosphoramidocyanidate (93957-08-5)
(-)-O-ethyl N,N-dimethylphosphoramidocyanidate (93957-09-6)

3. O-Alkyl S-2-dialkylaminoethyl alkylphosphonothiolates

eg. VX: O-ethyl S-2-diisopropylaminoethyl methylphosphonothiolate (50782-69-9)

Stereoisomers:

(R)-O-ethyl S-2-diisopropylaminoethyl methylphosphonothiolate (65167-63-7)
(S)-O-ethyl S-2-diisopropylaminoethyl methylphosphonothiolate (65167-64-8)

4. Sulphur mustards

No stereoisomers or geometric isomers.

5. Lewisites

Lewisite 1: 2-chlorovinyldichloroarsine (541-25-3)

No stereoisomers.

Lewisite 1 (continued):

Geometric isomers:

(E)-2-chlorovinyldichloroarsine	(50361-05-2)
(Z)-2-chlorovinyldichloroarsine	(34461-56-8)

Lewisite 2: bis(2-chlorovinyl)chloroarsine (40334-69-8)

No stereoisomers

Geometric isomers:

(E,E)-bis(2-chlorovinyl)chloroarsine (only geometric isomer with a CAS registry number)	(50361-06-3)

Lewisite 3: tris(2-chlorovinyl)arsine (40334-70-1)

No stereoisomers

No CAS registry numbers assigned to geometric isomers.

6. Nitrogen mustards

No stereoisomers or geometric isomers

7. 3-Quinuclidinyl benzilate (6581-06-2)

Stereoisomers:

(R)-3-quinuclidinyl benzilate	(62869-69-6)
(S)-3-quinuclidinyl benzilate	(62869-68-5)

8. Alkylphosphonyldifluorides

No stereoisomers or geometric isomers

9. Ethyl O-2-diisopropylaminoethyl alkylphosphonites

No stereoisomers or geometric isomers.

CONFERENCE ON DISARMAMENT

CD/CW/WP.215
8 December 1988

Original: ENGLISH

Ad Hoc Committee on Chemical Weapons

GERMAN DEMOCRATIC REPUBLIC

Working Paper

Chemical Weapons Convention
Protection of Confidential Information

I

When a Convention on the Prohibition of Chemical Weapons enters into force, the conditions required for the protection of confidential information of States Parties should have been created. This applies to information obtained in the implementation of the verification measures in chemical industry (Art. VI) as well as in the field of chemical weapons (Art. IV) and chemical weapons production facilities (Art. V). Information obtained by challenge-verification measures (Art. IX) shall be protected, too.

In its working paper CD/CW/WP.194 of 18 March 1988, the delegation of the German Democratic Republic has proposed to ensure the conditions for confidential information protection by the implementation of three main principles. With a view to making a contribution to the work in Group A, the following additional considerations regarding these three principles are submitted.

II

1. Precise definition of what information is required

This principle has to be taken into account in the further elaboration and refinement of provisions on declarations, on-site verification and models for agreements relating to facilities under routine inspection (facility attachments). Art. VI, para. 9 places the Technical Secretariat in the fulfilment of its verification activities under the obligation to obtain only the necessary information and data and to protect confidential information. Since this obligation should apply in general to all verification activities, similar provisions need to be included in Articles IV, V and IX.

The inspection mandate, as required in the Guidelines on the International Inspectorate, will play an important role in keeping the activities of inspectors conducting a routine inspection within the aforementioned limits. In the event of challenge inspection, a similar effect will have to be ensured by a precise request, on the one hand, and by specific procedures laid down in guidelines or manuals etc., on the other hand.

2. The proper personal conduct of inspectors

The fundamental provisions are contained in Art. VIII D (Technical Secretariat), supplemented by the Guidelines on the International Inspectorate.

In addition, the following provisions could be considered for inclusion in Annex to Art. VIII D:

- Each employee of the Technical Secretariat - of the Inspectorate or of the professional and clerical staff - shall enter into an individual secrecy agreement.
- Job descriptions for each employment would make it possible to regulate the flow of information according to the principle "the need to know".
- Minimum time periods for employments should be fixed in order to prevent unnecessary fluctuations within the staff of the Technical Secretariat.
- Provisions on penalties applicable in the event of violations of obligations concerning the protection of information by members of the Technical Secretariat.

3. The establishment of a régime governing the handling and protection of confidential information by the Technical Secretariat is provided for in the text of Art. VIII D as a task to be carried out by the Director-General. Some main principles could be agreed upon in order to provide the basis for this régime. These principles could encompass:

A

1. No information obtained by the Organization in connection with the implementation of the Convention must be published or otherwise released, if not exceptionally provided for under B.

2. All information supplied to the Technical Secretariat shall be handled confidentially. With a view to protecting this information the régime has to ensure the following:

- Each employee shall only have access to that kind of information necessary for the fulfilment of the function emanating from the relevant job description.

- Code numbers instead of country or facility names in reports or means limitating the access to computers shall be used, as appropriate.
- Verification records, samples, analysis and other information from on-site verification activities shall be kept within the premises of the verification unit (Inspectorate). Special protection measures shall be applied in case material of this kind should temporarily be taken out of the Inspectorate, following a decision of the Director-General of the Technical Secretariat.
- Material classified as highly confidential shall only be accessible to a very limited number of senior officials. This shall apply especially to code numbers and pass words for access limitation to computers shall be included in this list.

3. Information that is only required for the inspection of a specific facility and calls for special protection shall be kept under lock and key at this facility in conformity with the agreement to be concluded on the basis of a relevant model.

It should be considered to provide for the possibility to store information at the National Authority of a State Party.

B

Exceptions to the principle of the confidential handling of information shall be made in regard to the following subjects:

1. Information material on the implementation of the Convention shall be submitted to the United Nations or published otherwise. Furthermore, information of general interest containing e.g. aggregate data on verification activities and general experience in the field of economic and technical co-operation shall be disseminated without restriction. This material shall be compiled and released in accordance with the decisions of the [Consultative Committee] [General Conference] or the Executive Council. Other material may be released without restriction with the expressive consent of the State Party to which the information refers.

2. States Parties shall be provided with information necessary for the exercise of their rights and for the fulfilment of their obligations under the Convention, under the proviso that it should exclusively be used for this purpose. Such information shall encompass:

- information pertaining to declarations of States Parties;
- general reports on the results and the effectiveness of verification activities;
- reports and information furnished by the Executive Council and other information to be supplied to all States Parties in accordance with the provisions of the Convention;
- information supplied to specific States Parties in accordance with relevant procedures.

This information has to be released by the Director-General of the Technical Secretariat.

III

States Parties should undertake to use the information they received from the Organization exclusively in connection with their rights and obligations under the Convention and to refrain from any unauthorized publication of this information. A relevant provision could be set forth under Art. VIII D, paragraph 7.

CONFERENCE ON DISARMAMENT

CD/CW/WP.216
9 December 1988

Original: ENGLISH

Ad hoc Committee on Chemical Weapons

SWEDEN

Report on a Swedish National Trial Inspection

Introduction

During the summer session of 1988, at the request of the Chairman of the Ad hoc Committee on Chemical Weapons, informal open-ended consultations were held to prepare the ground for multilateral trial inspections in the chemical industry. The result of these consultations, contained in document CD/CW/WP.213, were introduced to the Conference at its plenary meeting on 13 September 1988 by the Ambassador of Sweden. The aforementioned document was introduced to assist interested States in their preparations for the national trial inspections.

Pursuant to the initiative launched by the Ad hoc Committee to undertake trial inspections in order to expedite work on the Convention and to assess whether the proposed provisions relating to on-site inspections provide the necessary assurance to States Parties that civil facilities are used only for purposes not prohibited by the Convention, Sweden performed a national trial inspection (NTI) in November 1988.

The Swedish experiment was carried out at a multipurpose facility under the provisions of the Annex to Article VI [2]. This working paper is intended to present the results of the experiment on the basis of the format contained in document CD/CW/WP.213. An outline of the "facility attachment", elaborated during the experiment, is annexed.

A. GENERAL APPROACH

1. Objectives of the National Trial Inspection

The objectives of the NTI were those set forth in CD/CW/WP.213.

2. Provisions in the Draft Convention under which the National Trial Inspection took place.

The Annex to Article VI [2].

3. Type of on-site inspection

An initial visit for familiarization purposes, for determination of the inspection plan, and for collection of information for the "facility attachment", followed by a routine on-site inspection.

4. Advance information

4 a. Declarations

An initial declaration, relating to the production during 1987 at the specific facility, according to the provisions in the Annex to Article VI [2], a corresponding, updated advance notification relating to the production during 1988, and an advance notification for 1989.

4 b. Agreement on inspection procedures

After the initial visit, a "facility attachment", based on the "Model for an agreement relating to facilities producing, processing, or consuming chemicals listed in Schedule [2]" (CD/874, pp. 125-128), was negotiated and elaborated by a controller group. This "facility attachment" is further described in the Annex.

5. Type of facility inspected

The facility inspected could be characterized as a multipurpose facility being part of a complex.

6. Type of declared activity at the facility

Production during the report year of listed chemicals. The NTI took place when the declared activity was being carried out.

7. Actual activity at the facility

The actual activity at the facility at the time of the inspection was qualitatively as declared but in excess of declared quantities. An intentional complication, consisting of a 10 per cent reduction of the production figures declared by the facility, was introduced by a controller group with the consent of the facility management in the advance notification relating to the production during 1988.

B. DETAILED APPROACH

1. The inspection mandate

The inspection mandate was negotiated between the facility management and a controller group. It regulated, inter alia:

- areas to which the inspectors had access;
- records to be made available to the inspectors;
- services and operations to be provided by facility personnel upon request;
- the right for inspectors to supervise facility personnel performing such operations;
- the right for inspectors to access areas not specified in the "facility attachment", as well as to have samples taken at sampling points not specified.

2. Composition of the inspection team

The inspection team consisted of:

- an analytical chemist (Ph.D.), research officer at the Swedish Defence Research Establishment;

- a chemical process engineer (D.Eng.Sci.), research officer at a technical university;

- a factory inspector (M.E.), deputy chief of the local division of the Swedish Labour Inspectorate.

3. Inspection equipment

Inspection equipment was furnished by the facility.

4. Activities prior to the arrival of the inspection team on-site

The facility was notified of the exact inspection date one month in advance.

5. Advance preparations on-site

A controller group arranged accommodation for inspectors in a nearby city. No physical preparations on-site were undertaken. The facility designated points of contact and informed relevant personnel.

6. Escort and points of contact arrangements

Only escorts from the facility were provided. Points of contact were specified in the "facility attachment"; the inspectors met these points of contact during the initial visit.

7. Other participants

The NTI was managed by a controller group from the Swedish Defence Research Establishment. A limited number of representatives from concerned governmental agencies took part in the NTI as observers.

8. Duration of inspection and initial visit respectively

- Initial visit: 2.5 days

- Preparation of "facility attachment": 10 days

- Inspection (actual visit): 1 day

- Inspection (report preparation): 1 day.

9. Measures to protect confidential information

Being civil servants, the controller group and the inspectors were subject to the Swedish Secrets Act, which, inter alia, contains provisions prohibiting civil servants from divulging classified information. The extent to which information had to be classified was indicated by the management.

10. Opening conference

During the opening conference, the inspectors addressed the inspection activities and specified services likely to be needed from the facility. A facility representative informed about safety regulations and current activities. The opening conference lasted less than one hour.

11. Types of records needed and/or audited

For information on different types of records, see the Annex. The feedstock records were the most relevant, and all such records pertaining to the current calendar year (January-October) were examined.

The resulting material accountancy balance was cross-checked by sampling other records and notes (inventory movement reports, feedstock accountancy notes, batch orders, loading and shipping reports).

12. Plant orientation tour

The orientation tour encompassed the facility and the surrounding complex.

13. Inspection of areas and facility equipment

The facility areas (two process platforms, feedstock storage, end-products storage, production office, and analytical laboratory) were inspected in detail, including examination of reaction vessels, process equipment, control room, and key measurement points. The pipelines carrying end-product from the process to the storage were not checked. Some facility personnel were interviewed.

14. Inspection of operation procedures

During this inspection, special attention was paid to the extent to which safety equipment and procedures occurred or were used, which could have enabled handling of super-toxic chemicals.

15. Sampling and sample-taking procedures

The sample-taking was performed by facility personnel whenever requested by the inspectors. However, the inspectors refrained from requesting such sample-taking that would have interfered with normal process operations or caused great inconvenience to the facility.

16. Handling of samples

The inspectors supervised both sample-taking and handling of samples on-site. A person, specially appointed by the controller group, transported samples to the off-site laboratory.

17. Analysis of samples

The samples were analysed immediately on-site; off-site analysis was performed the following day.

18. Types of analyses

The analyses were only for the presence of declared chemicals. Since the samples were found to contain high concentrations of the declared chemicals (confirmed by the off-site analysis), the analysis for the presence of other Schedule [2] chemicals appeared unnecessary.

19. Documentation of the inspection

20. Evaluation by inspectors

The evaluation of inspection activities and information gathered during the inspection included such aspects as:

- the possibility for undeclared conversions between routine inspections;

- the extent and accuracy of data provided by the facility;

- the co-operativeness of the facility;

- difficulties encountered during the inspection.

21. Closing conference

No closing conference was required.

22. Anomalies, disputes and complications

The introduced intentional complication was disclosed by the inspectors. Due to a misunderstanding during the preparation of the advance information for the trial inspection, the handling of a few tonnes of a Schedule [2] chemical was included in the advance notification for 1988 instead of the initial declaration for 1987. This anomaly was disclosed by the inspectors. No other ambiguities were disclosed.

23. Report of the inspection team

The inspection report included:

- an account of actual inspection activities;

- examples of essential inspection activities permitted by the mandate but not performed;

- the material accountancy balance;

- results of the analyses;

- meter readings;

- accounts of salient visual observations;

- conclusions.

The report was prepared off-site the day following the inspection.

24. Impact of the inspection on facility operations

The NTI did not incur any actual production losses, but facility key personnel had to spend working time on the NTI activities. Compilation of material for and negotiation of the "facility attachment" required approximately 5 man-days, whereas the inspection required less than 2 man-days.

25. Other matters

C. SPECIFIC ASPECTS - CONCLUSIONS

1. The inspection mandate

It was found exceedingly difficult to define a tight mandate which, at the same time, would in all cases allow the inspectors to fulfil the overall objectives of the inspection. For this reason, the inspectors were given a rather broad mandate which included, inter alia, the possibility for sample-taking at other than predetermined points and access to any area within the complex.

It was not possible to define an unequivocal meaning of the expression "least intrusive manner", compatible with a requirement for a speedy and efficient accomplishment of the inspection objectives.

2. Composition of the inspection team

The present size and composition of the inspection team was found to be adequate for the trial inspection, but the team would have benefited from the presence of an additional inspector with accountancy experience.

Because of the presence of controllers during the trial inspection, no leader for the inspection team had been designated. On the basis of the inspection experiences, it was concluded that it is highly desirable that one of the inspectors is designated as team leader and has the final say during the inspection, e.g. on matters relating to interpretation of mandate and agreed procedures.

Had the verification of records during the inspection been extended to a complete auditing (a likely situation during a "real" inspection) instead of examination of selected record samples, a team of three inspectors would have been too small. Probably, at least 5-6 inspectors would have been required if the inspection were to be completed within 3-5 five days.

3. Inspection equipment

4. Activities prior to the arrival of the inspection team on-site

Although the facility management was informed of the timing of the inspection one month in advance, this had not actually been necessary. According to the management, even an inspection without any notice period would have been feasible as far as the management was concerned. Difficulties could however arise if the inspection team were to arrive (without any previous notice) outside office hours or during the vacation period.

5. Advance preparations on-site

6. Escort and point of contact arrangements

These were found to be essential. The co-operative attitude of the escorts from the facility greatly facilitated the inspection. The presence of escorts did not in any way interfere with the inspection effort.

7. Other participants

8. Duration of inspection and initial visit respectively

A "real" inspection would most likely have required at least 3-5 days, probably even longer time, because of more extensive records examination and sample-taking (cf. remarks under 2 and 15-18). The actual duration of a "real" inspection would be highly dependent upon whether it took place during actual production or during an interim period. Also the quality of the "facility attachment" will have a considerable influence on the duration of an inspection.

A "real" initial visit would probably require at least 5 days for, inter alia, extensive verification of information supplied, photographic documentation of the equipment in order to facilitate future detection of any undeclared changes, and familiarization with the records sytem.

9. Measures to protect confidential information

Because of the special situation at the trial inspection (all inspectors being Swedish government employees already under oath), no conclusions can be drawn.

10. Opening conference

One hour was more than sufficient time. However, this presupposes that the inspectors are very well acquainted with the "facility attachment". In the case of frequent inspections at short intervals, the opening conference might be very brief.

11. Types of records needed and/or audited

It was not possible for the inspectors to know in advance exactly what information and data would constitute the minimum required to fulfil their mandate. "Excess" data had therefore to be requested in order to ensure that all relevant data would be included.

The function and interrelationship of the various records kept at the facility must be established in detail already during the initial visit.

12. Plant orientation tour

13. Inspection of areas and facility equipment

Extensive photographic documentation of the equipment during the initial visit, as well as application of seals at critical connections during a first routine inspection, would facilitate the detection of any undeclared changes or conversions between routine inspections.

14. Inspection of operation procedures

The production losses observed in the inspected process were small, amounting to a few per cent. They were therefore deemed not indicative of diversion for undeclared purposes.

It was found impossible to verify the exact quantities being processed at the time of the inspection. This would have required the previous installation of sealed flow meters, etc., or an extension of the inspection up to the time when the (batch-type) processing had been completed.

15-18. Sampling and sample-taking procedures, handling of samples, analysis of samples, and type(s) of sample(s)

Some types of sample-taking were found to be very difficult because of the lack of suitable sampling points. During an initial visit, points should be identified where the inspectors expect frequent sample-taking to be required and, if necessary, then be equipped with suitable sample-taking devices. Otherwise, the sample-taking might be very time-consuming, hamper the operation and even involve a loss of production.

Special arrangements will be required for the transport of samples to off-site laboratories for analysis. A sealable box, designed in conformity with air traffic safety regulations, should be developed.

Certified reference chemicals for the analyses, both on-site and off-site, should be supplied by the Technical Secretariat.

The preservation of duplicate samples might be difficult if the samples are less stable; duplicate samples which have been stored at different temperatures could after a while differ in composition.

19. Documentation

It was found difficult to determine the degree of confidentiality required for each piece of information. In many cases, a compilation of data from a part of the inspection would be highly confidential (in the opinion of the facility management), whereas an isolated piece of data would not create any confidentiality problem. It was concluded that all specific documentation used or generated during the inspection had to be treated as confidential.

20. Evaluation by inspectors

A check-list would have been beneficial.

21. Closing conference

22. Anomalies, disputes and complications

Although no specific conclusions can be drawn on the basis of only one trial inspection, it should be noted that not only the intentional complication but also an unintentional anomaly was disclosed.

23. Report of the inspection team

A standardized report format is essential.

In order to facilitate future routine inspections at the facility, a detailed inspection report would be useful. However, such a report would then have to include confidential information to such an extent that it could hardly be brought from the premises of the facility.

For inspections, where no unresolved ambiguities remain, an "unclassified" supplementary version of the inspection report appears feasible. This report could be based, inter alia, on a list of yes-or-no type questions.

24. Impact of the inspection on facility operations

The present trial inspection did not hamper actual operation or the safety of the facility. However, since facility personnel had to escort and assist the inspection team, the performance of their ordinary duties was delayed.

25. Other matters

The co-operation of the facility staff appeared essential for a speedy and efficient inspection.

At least one of the inspectors ought to be fluent in the language used at the facility. Examination of records with the assistance of interpreters would be very time-consuming.

The "facility attachment" is the primary information source for the inspectors. If it is to be useful, it must be comprehensive and thus include confidential information which might have to be kept under seal at the facility. In such a case an inspection might begin with a "refresher session" during which the inspectors consult the complete "facility attachment" and finalize the inspection plan.

ANNEX

OUTLINE OF THE "FACILITY ATTACHMENT"

This outline is based on the "Model for an agreement relating to facilities producing, processing, or consuming chemicals listed in Schedule [2]" (CD/874, pp. 125-128). Significant parts of that Model which were not included in the present "facility attachment" have been marked thus: /<not included>/; significant additions have been underlined thus: addition to the Model.

1. Identification of the facility

/<(a) Facility identification code>/

(b) Name of the facility

(c) Owner of the facility

(d) Name of the company operating the facility

(d') Main orientation of the facility

(d'') Facility type

(e) Exact location of the facility

- Location of the complex
- Location of the facility within the complex, including the identification of the specific buildings and structures
- Location of relevant support facilities within the complex: /<research and>/ technical services, laboratory, /<medical centres,>/ waste treatment plants

(f) Determination of the areas and places to which inspectors shall have access.

2. Information on the facility

The agreement is based on the design information obtained during the initial visit on [date of visit]. Design information includes:

(a) Data on the relevant production processes:

- type of process;
- process equipment and pipelines identification and location;
- recipe, input and output volumes;
- process parameters;
- measurement points, process control rooms;

- production capacity (actual and theoretical).

/<(b) Data on processing with conversion into another chemical (description of the conversion process, process engineering particulars and end-product)>/

/<(c) Data on processing without chemical conversion (process engineering particulars, description of the process and the end-product, concentration in the end-product)>/

(d) Data on waste treatment (disposal and storage, waste treatment technology, /<recycling>/)

(e) Data on safety and health measures at the facility

/<(f) Data on clean-up procedures and general overhauls>/

(g) Data on feedstocks used in the production or processing of declared chemicals (identity of chemical, type and capacity of storage)

(h) Maps and plans of the facility, including data on infrastructure for transportation (site maps showing all buildings and functions, /<pipework,>/ roads, railways, fences, mains electricity, water and gas points, and diagrams indicating the relevant material flow at the designated facility).

(h') Description of transports:

- type of material transport into and out of the relevant processes;

- type of transport for shipping end-products;

- routines for material weighing at loading and shipping.

/< 2.1 Storage of information

Designation of information, provided about the facility under paragraph 2, which shall be kept by the Technical Secretariat under lock and key at the facility. (In the event of unresolved ambiguities, the organization shall have the right to study such information.)>/

3. Number and modalities of inspections

/<After the initial visit, the number and modalities of inspections shall be decided by the Technical Secretariat on the basis of guidelines (compare CD/CW/WP.167, page 63), subparagraph 5.ii. and CD/CW/WP.167, Appendix II, page 3).>/

4. Verification measures and identification of the specific areas of the facility to be inspected

(a) Identification of the relationship between feedstocks and the quantity of end-products

(b) Identification of key points for measurement (KMP) and sample-taking (STP)

(c) Identification of methods for continuous monitoring /<and surveillance>/:

/<- key points for the application of monitoring and surveillance measures>/

- installed instruments and devices, /<seals and markers, methods to check the proper functioning of those instruments, servicing of installed instruments>/

/<- activities to be undertaken by the State Party concerned with a view to providing the conditions necessary for the installation and proper functioning of the devices>/

(d) Certification of relevant losses within the production process /<and their implications for key measurement points (KMP)>/

5. Inspection activities

5.1 Mode of routine inspection

Specified detailed inspection plan.

5.2 The scope of the inspection effort in agreed areas under ordinary circumstances

Access to the area to be inspected, including all key points. Activities comprise:

(a) Examination of relevant records

(b) Identification of relevant plant equipment

(c) Identification and validation of measuring equipment (examination /<and calibration of measuring equipment; verification of measuring systems using, as appropriate, independent standards>/)

(d) Taking of analytical samples

(e) Verification of chemical inventory records

- verification of the operator's inventory-taking for completeness and accuracy

- verification of the quantities of feedstocks

(f) Observation of operations relating to movement of chemical substances in the plant

/<(g) Installation, servicing and review of surveillance and monitoring instruments>/

/<5.3. Specific arrangements for the use of special equipment

As the need arises, specific arrangements for the use of special equipment, as requested by inspectors.>/

6. Provisions governing sample-taking, on-site analyses of samples and on-site analysis equipment

(a) Routine sample-taking (standardized procedures)

(b) On-site analyses (provisions concerning on-site analyses, analytical methods, equipment, precision and accuracy of analyses, storage of samples)

(c) Duplicates and additional samples

6'. Provisions governing off-site analyses of samples

7. Records

7.1 Type of records

(a) Accounting records:

- feedstock records (quantities of feedstock in storage; quantities leaving/entering storage; specific stock notation
- inventory movement reports (notes source by company name and country; date; quantities and identity of the material received)
- feedstock accountancy notes (quantity shipped; company name and country of destination; date shipped)
- weighing records (quantities shipped/loaded)
- loading and shipping reports.

(b) Operating records:

- batch orders (quantity raw material used; quantity of end-product; quantity of by-products; notation of each batch)
- priority lists (daily lists of facility operations)
- analysis reports (batch number; date; quality)
- facility safety committee protocols.

(c) Calibration records

Information on the functioning of analytical/monitoring equipment.

7.2 Identification, location and language of records

7.3 Access to records

7.4 Retention period of records

8. Services to be provided by the facility

Point of contact for each type of service, e.g.

- operator assistance
- /<medical and health services>/
- material accountancy
- storage
- analytical laboratory
- management.

9. Specific facility health and safety rules and regulations to be observed by inspectors

10. Changes, revision and updating of advance information to be provided on the facility

/<11. Interpretation services>/

CONFERENCE ON DISARMAMENT

CD/CW/WP.217
15 December 1988

Original: ENGLISH

Ad Hoc Committee on Chemical Weapons

TRIAL INSPECTIONS

Working Paper by the Chairman of the Open-ended Consultations

Introduction

During an informal exchange of information held under the auspices of the Chemical Weapons Committtee on 7 December 1988, 14 delegations reported that they had carried out or were engaged in preparations for national trial inspections (NTI). A summary of the information provided during the meeting is given below.

Australia:

NTI: November 1988.

Provisions: Annex to article VI [2] (specially designated chemical).

Report: Beginning of spring session.

Remark: The NTI was conducted at a multipurpose complex part of an agricultural/chemical firm mainly producing herbicides.

The inspection team consisted of five persons: a senior official from the Department of Foreign Affairs and Trade; a defence scientist from the Material's Research Laboratories; a chemical engineer nominated by the company itself; an inspector from the Dangerous Goods Branch of the Victorian State Government Department of Labour; and an Auditor from the Department of Foreign Affairs and Trade. In addition, there were observers from the Department of Defence Material's Research Laboratory, Defence Policy Advisers, and one generalist chemist. The co-operation from the firm was excellent. Preparations were made on the basis of the Chairman's working paper, CD/CW/WP.213, and conducted over a six-week period during October/November including an initial visit and the negotiation of a detailed facility attachment.

The trial inspection tested procedures for routine inspections in relation to Schedule [2]. This company produces no chemicals currently listed under Schedule [2] or Schedule [3] of the rolling text of the Chemical Weapons Convention. For the purposes of the inspection, di-nitro used in the batch production of trifluoralin at one plant in the complex was treated as if it were a Schedule [2] chemical. Activities included chemical, water and air sampling at agreed key measurement points.

Australia is currently considering the possibility of further trial inspections in the first half of 1989.

Belgium:

NTI: Preparations are under way.

Finland:

NTI: Spring 1989.

German Democratic Republic:

NTI: October 1988.

Provisions: Annex to article VI [2].

Report: Beginning 1989.

Remark: The NTI was carried out at a multipurpose facility of a pharmaceutical enterprise. The inspection was performed on the basis of a facility attachment and of an additional verification approach elaborated in advance during previous visits to the facility. The inspection team consisted of scientists, representatives of the chemical industry, the Ministry of Foreign Affairs, and the Ministry of National Defense. The experiment was conceived as a routine inspection aimed at verifying the non-diversion of dimethylaminoethanol, of non-conversion of that substance into the corresponding Schedule [1] chemical and in verifying non-production of other chemicals listed under Schedule [1]. CD/CW/WP.213 had been useful in preparing and performing the NTI.

Germany, Federal Republic of:

NTI: December 1988.

Provisions: Annex to article VI [2].

Hungary:

NTI: December 1988.

Provisions: Annex to article VI [2] (specially designated chemical).

Report: January 1989.

Remark: The NTI was carried out at a single purpose facility being part of a huge pharmaceutical and chemical complex. The facility produces a chemical called Benomyl (reg. No. 17804-35-2). For the purpose of the trial inspection one of its precursors Carbendazim (reg. No. 10605-21-7) was specially designated as a Schedule [2] chemical.

During a previous visit initial declarations were verified and information gathered for a facility attachment. During preparations as well as during the actual trial inspection, care was taken to protect the interests of the plant, in particular commercial and industrial confidentiality. However, a sufficient degree of instrusiveness was exercised to verify that no diversion was possible. The experiment was carried out during actual production of Benomyl. However, production records for the report year as well as for shorter periods were also audited.

The inspection team consisted of a representative of the Foreign Ministry, a representative of the Ministry of Trade and four chemists, one of them from the Ministry of Defence. No inspection equipment was used and no samples taken during the inspection.

Italy:

NTI: December 1988 (two inspections).

Provisions: Annex to article VI [2].

Remark: The Italian Government, through arrangements with the Italian chemical industry, has made available two plants to conduct a trial inspection on 16-18 December. The first plant, located in Aprilia produced in the past a Schedule [2] compound, diphenyl-hydroxyacetic acid. The inspection at such a plant, aiming at verifying the continuing non-production of the mentioned compound, might have some distinctive features of a challenge inspection. The second plant, located in Colleferro has stopped producing diphenyl-hydroxyacetic acid. However, for the specific needs of the trial inspection, its managers have accepted to re-establish such a production, only for a limited period. The inspection at this plant, aiming at verifying that the chemical produced there is not diverted or used for purposes not permitted under the Convention, might have some distinctive features of a routine inspection.

The presence also of foreign scientists and experts is to be expected.

Japan:

NTI: November 1988 - January/February 1989 (several inspections).

Provisions: Annex to article VI [2].

Report: Spring 1989.

Netherlands:

NTI: Preparations are under way.

Provisions: Annex to artile VI [2].

Report: First half 1989.

Remark: Results of visits to Schedule [3] facilities may be made available to the Ad Hoc Committee. A first trial inspection was carried out in the Netherlands in 1986. It has been reported in CD/CW/WP.141 and 142.

Sweden:

NTI: November 1988.

Provisions: Annex to article VI [2].

Report: December 1988.

Remark: The NTI was carried out at a multipurpose facility being part of a complex. The experiment was divided into phases. The first phase was an initial visit for familiarization purposes and especially for gathering the information required for a facility attachment. The second was the actual elaboration of the facility attachment, and in the third phase the trial inspection took place. The information that was available for the inspectors consisted primarily of the facility attachment, but also an initial declaration relating to 1987, an up-dated advance notification relating to the production during 1988 and an advance notification for 1989. This information was, however, not correct because an intentional complication had been introduced by the controllers in the advance notification relating to 1988. The production figures that the facility had declared had been reduced by 10 per cent for the purpose of the trial inspection. The inspection was carried out during actual production.

Switzerland:

NTI: Spring 1989.

Remark: Multipurpose facility.

Union of Soviet Socialist Republics:

NTI: December 1988.

Provisions: Annex to article VI [2].

Report: Beginning 1989.

United Kingdom:

NTI: Early 1989.

Provisions: Annex to article VI [2].

Remark: The selected facility makes an organo-phosphorus compound. An initial visit and preparations for a facility attachment are under way.

United States of America:

NTI: Early 1989.

Provisions: Annex to article VI [2].

Report: Before end of spring session 1989.

Remark: The United States of America selected an organo-phosphorus facility that produces a Schedule [2] chemical. The plant is highly automated. An initial visit to acquire technical information necessary for planning specific inspection procedures has taken place. CD/CW/WP.213 has proven valuable for the preparations.

Italy	CD/CW/WP.218	Letter Dated 12 January Addressed to the Secretary-General of the Conference on Disarmament from Head of the Permanent Mission of Italy to the Conference on Disarmament, Transmitting a Document Entitled "Proceedings of the International Forum on 'Total Ban of Chemical Weapons: The Problems of Verification', Rome, Villa Madama, 19-20 May, 1988" NOT REPRODUCED (see WP volume)	Also issued as CD/877 13 Jan. 89

CD/CW/WP. 219 Draft Report of the Ad Hoc Committee on Chemical Weapons to the Conference on Disarmament on Its Work During the Period 17 January to 3 February 1989 1.2.89

NOT REPRODUCED

CD/CW/WP.220
3 February 1989

Original: ENGLISH

CONFERENCE ON DISARMAMENT

Ad Hoc Committee on Chemical Weapons

ITALY

PROVISION OF DATA RELEVANT TO THE CHEMICAL WEAPONS CONVENTION

1. In April 1988, on behalf of a group of western countries including Italy, the Federal Republic of Germany submitted document CD/828 proposing a voluntary exchange of data on chemical productions relevant to the Chemical Weapons Convention, prior to its entry into force.

Italy deems the exchange of data essential, as it enhances mutual trust and represents an important prerequisite in view of the finalization of the Convention, since it can help to define the size, scope and costs of the envisaged International Inspectorate.

In the light of the experience acquired in other disarmament negotiations, the Italian Government believes that by fostering trust and wider transparency prior to the agreement, significant progress can be achieved towards a timely identification of the most appropriate solutions and a more effective implementation of the Convention.

It is in this spirit that Italy is submitting disaggregated data on all chemicals relevant to the Convention that were produced, used or imported by the Italian chemical industry during 1987 as a contribution to a rapid and satisfactory conclusion of the negotiations under way.

2. This document contains a national answer to the exercise proposed by the Federal Republic of Germany. The data on the production and use by Italian industries of chemicals relevant to the Convention were provided on a voluntary basis by the Italian Chemical Industries Federation, of which not all Italian chemical producers are members. Notwithstanding the impossibility of an absolute guarantee on the completeness of the information provided, the number of Italian facilities that either produce or use the compounds included in lists (2) and (3) is, within a small margin of error, as indicated in the annexed documentation. The data provided refer to the already approved sections of lists (2) and (3) and concern 1987. The data will be completed or updated as required.

ATTACHMENT 1

TYPE OF DATA	ANSWER	NOTES
1. - Presence of chemical weapons on own territory	No	
- Possession of chemical weapons on territory of another State	No	
2. - Aggregate number of facilities for the production and consumption of chemicals in lists (1), (2) and (3)	22	1/
3. - Types and names of chemical weapons produced	Italy neither produces nor possesses chemical weapons	
- Types of chemical weapons munitions stored; chemical weapons agents in bulk	None	
- Names of chemicals in lists (1), (2) and (3) produced in the chemical industry	List (1): none; List (2): 2,2 Diphenyl-2-hydroxy-acetic acid; List (3): Phosgene Hydrogen cyanide	2/
4. - Plans and methods for the destruction of chemical weapons, including the number of facilities and the anticipated length of their operation during the 10-year destruction period	None	

1/ None of the facilities produce or store chemical weapons or produce or process chemicals in list (1). No thresholds are set. Seven facilities produce chemicals in lists (2) and (3), while the other 15 facilities use chemicals in lists (2) and (3).

2/ The Italian law provides for severe limitations on the transport of Phosgene and Hydrogen cyanide.

ATTACHMENT 2

LIST OF CHEMICALS RELEVANT TO THE CHEMICAL WEAPONS CONVENTION
PRODUCED BY THE ITALIAN CHEMICAL INDUSTRY IN 1987

A. LIST 2

1. 2,2 - Diphenyl - 2 - hydroxyacetic acid (Benzilic acid): produced in 1 plant located in central Italy in the quantity of approximately 13 tons, of which:

   - 7 tons used in the production of diphenylacetic acid;

   - 6 tons sold (2 in Italy and 4 abroad).

B. LIST 3

1. Phosgene: produced in 3 plants in northern, central and southern Italy, respectively, for a total amount of 110,470 tons, of which:

   - 105,770 tons (in 2 plants) totally and exclusively used for the production of polyurethane resins;

   - 4,700 tons (in 1 plant) totally and exclusively used for the production of polycarbonates.

2. Hydrogen cyanide: produced in 3 plants, 1 of which in northern Italy and 2 in southern Italy, for a total amount of 49,720 tons, of which:

   - 14,000 + 10,000 tons (in 2 plants) as a by-product of acrylonitrile synthesis (completely burned on site);

   - 25,720 tons (in 1 plant) totally and exclusively used for the production of plastics.

* * *

ATTACHMENT 3

LIST OF CHEMICALS RELEVANT TO THE CONVENTION USED BY THE ITALIAN CHEMICAL INDUSTRY IN 1987

A. LIST 2

1. 2,2 - Diphenyl - 2 - hydroxyacetic acid (Benzilic acid): used in 3 plants located in northern Italy, for a total amount of less than 1 ton per plant. */

2. Quinuclidin-3-ol: used in 2 of the aforementioned plants located in northern Italy, for a total amount of less than 1 ton.

3. N.N - Diisopropylaminoethyl - 2 chloride: used in one plant located in northern Italy, for a total amount of less than 1 ton.

B. LIST 3

1. Phosphorus trichloride: used in 12 plants located in northern and central Italy, for the following amounts:

   1 plant: less than 1 ton
   1 plant: 2 tons
   6 plants: less than 30 tons
   4 plants: more than 30 tons.

2. Phosphorus oxychloride: used in 3 plants, located in northern and central Italy, for a total of less than 30 tons for each of the plants. **/

3. Phosgene: used for a total amount of 110,470 tons in the 3 plants that produce this chemical in northern Italy, as indicated in Attachment 2, item 1B.

4. Hydrogen cyanide: captively used for an amount of 25,720 tons in 1 plant. The remaining amount of 24,000 tons is completely burned on site in 2 plants (see Attachment 2, item 2B).

* * *

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*/ One of the 2 plants also uses Phosphorus trichloride and is thus included in the 12 plants that use this chemical (see item 1B in List 3).

**/ The 3 plants also used Phosphorus trichloride and are thus also included in the 12 plants that use this chemical (see item 1B in List 3).

ATTACHMENT

LIST OF CHEMICALS RELEVANT TO THE CONVENTION IMPORTED
IMPORTED BY THE ITALIAN CHEMICAL INDUSTRY IN 1987

A. LIST 2

1. Quinuclidin-3-ol: imported for total amount of less than 1 ton (see Attachment 3, item 2A).

2. N.N - Diisopropylaminoethyl-2-chloride: imported for a total amount of less than 1 ton (see Attachment 3, item 3A).

B. LIST 3

1. Phosphorus oxychloride: 160 tons imported, marketed and partly re-exported.

2. Phosphorus trichloride: 2,290 tons imported, marketed and partly re-exported.

3. Triethyl phosphite: 1 ton used for the production of re-agents.

* * *

CONFERENCE ON DISARMAMENT

CD/CW/WP.221
9 February 1989

Original: ENGLISH

Ad Hoc Committee on Chemical Weapons

NORWAY

Provision of data relevant to the Chemical Weapons Convention

In order to contribute to the negotiations on the Chemical Weapons Convention, Norway presents below data according to the outline in document CD/828 of 12 April 1988.

The data in Tables 1 and 2 reflect the situation in Norway at the beginning of 1989 based on an extensive survey co-ordinated by the Division for Environmental Toxicology of the Norwegian Defence Research Establishment. The chemicals included in the survey were those given in the provisional lists of the Schedules [1], [2] and [3] chemicals in document CD/874 of 12 September 1988. The thresholds for production and consumption were for Schedule [1]: 100 grams/per year, Schedule [2]: 1 ton/year and Schedule [3]: 30 tons/year.

Table 1

NORWAY

Type of Data	Answer
1. Presence of CW on territory	No */
Possession of CW on territory of another State.	No
2. - Aggregate number of facilities for the production and storage of CW.	None
- Aggregate number of facilities for production, processing and consumption of permitted chemicals on Schedules [1], [2], [3] above thresholds indicated in this document.	None
3. - Types and names of CW agents produced.	Not applicable **/
- Types of CW ammunition stored; CW agents in bulk.	Not applicable
- Names of chemicals on Schedules [1] [2] and [3] produced in the chemical industry.	None
4. Plans and methods for the destruction of CW including the number of facilities and the anticipated length of their operation during the 10 year destruction period.	Not applicable

*/ Remnants from World War II dumped in Norwegian waters are not included.

**/ Norway does not possess chemical weapons. The Norwegian Government has stated that chemical weapons will not be stationed on Norwegian territory.

Table 2

NORWAY

Breakdown of answers to question 2 in Table 1

	Quantity (per year)	Number of locations
Schedule [1]		
Production	More than 100 grams	None */
Consumption	More than 100 grams	None **/
Schedule [2]		
Production	More than 1 ton	None ***/
Processing/consumption	More than 1 ton	None ***/
Schedule [3]		
Production	More than 30 tons	None ****/
Processing/consumption	More than 30 tons	None ****/

*/ One facility synthesizes nerve agents and mustard gas in quantities totalling 10-50 grams per year for permitted medical, protective and research purposes.

**/ Two facilities (including the synthesizing facility) use nerve agents and mustard gas in quantities totalling 10-50 grams per year for permitted medical, protective and research purposes, inter alia the Norwegian research programme on verification of alleged use of chemical weapons.

***/ Number of individual facilities producing or consuming Schedule [2] chemicals. Criterion: More than 1 ton per year.

****/ Number of individual companies producing or consuming Schedule [3] chemicals. Criterion: More than 30 tons per year. One company previously reported to consume phosphorus oxychloride in quantities of about 1 ton per year has now discontinued this process (ref. document CD/397 of 19 July 1983).

CD/CW/WP.222	Organisational Framework for Work During the 1989 Session	17.2.89

NOT REPRODUCED

Hungary	CD/CW/WP.223 and Add.1	Report on the First National Trial Inspection NOT REPRODUCED (see WP volume)	Also issued as CD/890 and Add.1 20 Feb. 89

Italy	CD/CW/WP.224	Letter Dated 24 February 1989 from the Permanent Representative of Italy Addressed to the Secretary-General of the Conference on Disarmament Transmitting an Interim Report on a Trial Inspection of Two Italian Chemical Facilities NOT REPRODUCED (see WP volume)	Also issued as CD/893 24 Feb. 89

USSR	CD/CW/WP.225	Letter Dated 27 February 1989 from the Representative of the Union of Soviet Socialist Republics Addressed to the President of the Conference on Disarmament Transmitting a Text of the Report on the National Experiment on Trying Out Procedures of Systematic Control of the Non-Production of Chemical Weapons in Industry, Held in the USSR NOT REPRODUCED (see WP volume)	Also issued as CD/894 28 Feb. 89

Brazil	CD/CW/WP.226/ Rev.1	National Trial Inspection: Technical Report NOT REPRODUCED (see WP volume)	Also issued as CD/895/- Rev.1 21 Mar. 89

GDR	CD/CW/WP.227	Letter Dated 10 March 1989 Addressed to the President of the Conference on Disarmament from the Permanent Representative of the German Democratic Republic Transmitting the Text of a Working Paper Entitled "Report on the National Trial Inspection of the GDR Undertaken in a Facility of the Chemical Industry" NOT REPRODUCED (see WP volume)	Also issued as CD/899 10 Mar. 89

CONFERENCE ON DISARMAMENT

CD/CW/WP.228
13 March 1989

Original: ENGLISH

Ad Hoc Committee on Chemical Weapons

JAPAN

Report on National Trial Inspection

Pursuant to the proposal on National Trial Inspection (NTI) made by the Ad Hoc Committee in its summer session of 1988, Japan has conducted a series of on-site inspections since last autumn. This Working Paper is intended to present the results of our experiment on the basis of the elements contained in document CD/CW/WP.213. It is hoped that this report will contribute to the progress of the on-going treaty negotiations as well as to the development of effective means of verification. It is important, in this respect, to follow up fully the results of NTI performed by interested States, for example, through the convening of experts' meetings.

I. General information on a Japanese NTI

1. Type of inspection

Routine inspection on production facilities as provided in the Annex to Article VI [2].

2. Facility inspected

Three facilities which are producing chemicals listed in Schedule [2] of the Annex to Article VI [2], including those placed under "To be discussed further".

3. Type of facility inspected

Three facilities inspected are characterized respectively as a single-purpose production facility, a facility where listed chemicals are produced as an intermediate material, and a multipurpose production facility.

4. The contents of the experiment

The experiment took place in accordance with the procedures set forth in the Annex to Article VI [2], namely, (1) an initial declaration - (2) an initial visit - (3) consideration of a "facility attachment" - (4) an on-site verification inspection. In practice, the experiment was conducted with emphasis on (2) above.

The detailed information is as follows:

(1) Initial declaration

Specific information on the items set forth in the Annex to the document CD/874 was provided in advance by the inspected facilities.

(2) Initial visit

An initial visit took place in accordance with the following order.

(a) Opening conference

Introduction of participants

Explanation on the CW Convention

(b) Explanation by the facility side

(i) Explanation on the general situation of the facility and on the contents of the initial declaration.

(ii) Explanation of additional information.

(1) process flow sheet

(2) plot plan

(3) kinds of raw materials and methods of handling up to the storage facilities

(4) outline of production equipments, storage equipments and shipment equipments as well as measuring methods of products

(5) general disposal method of wastes and effluent

(6) outline of records on production and shipment (how to make daily records, monthly records and annual records. Samples of those records)

(7) material balance

(8) methods and routes of the initial visit

(c) Observation on-site

(1) observation tour by bus (to confirm the explanation already made on the facility)

(2) observation tour in the plants concerned (to confirm the explanation on (2) (b) (ii) (1)-(5))

(3) confirmation of sampling points

(d) Questions and answers, discussion

Requests for additional information or documents as required.

(3) Consideration of a "facility attachment"

Views were exchanged on inspection procedures, etc., in accordance with "Model for an Agreement A" (p. 125, CD/874)

(4) Verification Inspection

When an initial visit took place, some inspections were additionally conducted with an actual verification inspection in mind.

5. Duration of inspection

Several days for each facility.

6. The inspection team

Some five officials from the Ministry of International Trade and Industry (MITI) who have expertise on matters such as chemical plants and chemical analysis.

II. Items for consideration

Our comments based upon the experiment are as follows (the items correspond to those in B. "Detailed Approach" of document CD/CW/WP.213):

1. The inspection mandate

Needless to say, it is the objective of inspection to achieve the aim set forth in paragrpah 4 of the Annex to Article VI [2]. As a rule, inspectors are empowered to fulfil the objective of inspection under certain restraints. It is, however, dangerous to depend solely on the subjective judgement of each inspector to see whether or not the objective is achieved. It is conceivable that, even at the same facility, the contents or results of inspections may differ, and thus cause complication.

With regard to an initial visit, no specific restrictions are envisaged on the activity of inspectors. Therefore, we find it necessary to elaborate a "model" guideline even before the conclusion of the treaty, while acknowledging that such a guideline is expected to be finally worked out, possibly at the level of the Technical Secretariat, on the conduct of inspectors especially in the initial visit.

In so doing, we believe that it is possible for us to grasp the extent to which the chemical industries will be affected by the performance of inspections.

2. The inspection team

(1) The size of the inspection team

The Japanese NTI took place with the participation of five inspectors. An interpreter is needed for conducting international inspections at facilities in Japan. Even if inspectors act in one group, it may be difficult for one interpreter to take care of more than one group, it may be difficult for one insperpreter to take care of more than five inspectors.

(2) Necessary skill

Inspectors need to have sufficient knowledge of chemistry and at the same time be well acquainted with the Chemical Weapons convention. (In Japan, it is necessary for inspectors to speak at least English).

In addition, such specialists as analytic chemists, chemical engineers and data specialists may also be required.

It is desirable that the interpreters sufficiently understand technical terms relating to the convention.

(3) Protection of confidential information

What is of concern most about the activity of inspectors is the problem of how to protect confidential information which comes to their knowledge in the course of inspection. Inspectors should ot be allowed to disclose to any unauthorized persons any classified information even after they leave the Organization.

It is necessary, therefore, to establish a system whereby inspectors pledge, at the time of employment in the Organization, not to accept employment for a certain period of time after their resignation in a workplace where confidential information acquired in conducting inspections can be used. It may also be necessary to work out a mechanism for ensuring that inspectors keep their pledge mentioned above.

3. Inspection equipment

(1) There may be facilities which have equipments like a flowmeter, a thermometer, a pressure gauge and their recorders, which are useful as supplementary instruments to carry out verification activities. In this case, those equipments available on-site can be used effectively.

(2) Inspectors can install on-site monitoring instruments with a view to reducing the frequency of inspection as indicated in the report on instrumental monitoring of non-production (CD/881 p. 121).

From this point of view, such equipments as proposed last year by the Federal Republic of Germany in CW/WP/204, i.e., automatic sampling devices could be very useful.

4. Activity prior to the arrival of the inspection team

As regards the advance notification on the arrival of the inspection team, "12 hours in advance" and "48 hours in advance" are proposed in the Annex to Article VI [2]. It is the view of the representatives of the companies involved in our NTI that 12 hours is not enough for them to ensure that the necessary facility staff are ready for the team. Considering the time required for inspectors to move from the point of entry into the State to the inspected facility, it is appropriate to notify the arrival of the team 48 hours in advance.

5. Advance preparations on site

(1) Inspection related costs should, in principle, be borne by the Organization. The facility side is, however, expected to co-operate with the inspection team, in securing the facility personnel receiving the team, providing inspectors' work space, the communication between inspectors and the Technical Secretariat, and so on.

There may be cases when it is difficult to arrange a proper accommodation for inspectors due to seasonal or regional reasons.

(2) In a country like Japan, whose language is rarely used abroad, interpreters play a very important role at the time of inspection. Therefore, if the facility side hopes to have an interpreter, in addition to an interpreter or interpreters provided by the Organization, in order for its views to be fully communicated, consideration should be given to employing such an interpreter, possibly at the expense of the Organization.

6. Escort and points of contact arrangements

Representatives from the inspected State Party should meet inspectors at a point of entry into the State and escort them to the inspected facility.

7. Other participants

Only inspectors, representatives of the inspected State Party, interpreters, and the facility personnel should participate in the inspection activities.

8. Duration of inspection and initial visit respectively

(1) An initial visit would require at least several days (but not exceeding one week) because it is necessary to have detailed discussion on the contents of the "facility attachment". The verification inspection, which takes place in accordance with the agreed procedures, may not need to last for more than a day (apart from the time required for sample analysis), if there arises no specific doubt.

(2) On matters to be considered in deciding the frequency of inspections, proposals have already been made as set forth in page 117 of document CD/881. The following two points may be worth further consideration, judging from the experience of our NTI.

(a) With regard to a multipurpose plant, it is most desirable that inspection takes place during actual production of listed chemicals, taking into account the necessity of ensuring the protection of know-how relating to the production of chemicals not listed in the convention.

The frequency of inspection could be decided, for instance, in proportion to the production ratio of listed chemicals at the multipurpose facility inspected and thus should be at a lower level than in case of inspection on a single-purpose plant.

(b) With regard to a plant where listed chemicals are produced only as an intermediate material, the frequency of inspection should be reduced in comparison with a single-purpose plant, while due consideration should be given to the possibility of listed chemicals being taken out.

9. Measures to protect confidential information

(1) In order to protect confidential information, it is important to consider protection measures in concrete terms for each type of inspection as well as for each category of facility. It was recognized, however, as a result of our experiment, that there would be a certain limit for the protection of specific information. It is essential, therefore, to impose strict restrictions upon inspectors in order to protect confidential information (See 2. above). From this point of view, "Guidelines on the International Inspectorate" contained in document CD/881 provides a useful basis, which should be elaborated further.

Moreover, it is considered necessary to have in-depth discussion on how to work out strict procedures for the selection of inspectors, what kind of sanctions should be imposed upon inspectors in case of the leakage of confidential information. Furthermore, it is necessary to consider the possibility of introducing a "penal" provision in case that an inspector acts in violation of the provsions on the protection of confidential information. As to the "penal" provision, an idea might be to impose restrictions upon the right of the State Party, from which the inspector concerned comes, to recommend its nationals as inspectors for a certain period of time. (It is essential that interpreters employed by the Organization should also be obliged not to leak confidential information.)

(2) In case of a verification inspection, the facility attachment itself can largely contribute to ensuring the protection of confidential information. In case of an initial visit, however, it is necessary to ensure the protection of confidential information further by means of working out an appropriate set of guidelines on an initial visit, as referred to in II.1. above, since there are no concrete restriction measures envisaged to protect confidential information in that case.

(3) At this present juncture, we have the following two points in mind as ideas relating to concrete methods of inspection which might contribute to the proection of confidential information.

Note: This problem, which is one of the focal points of NTI, merits further consideration in detail, taking into account the results of other NTIs.

(a) A possibility of the idea of "step-by-step inspection"

- A method of dividing inspection into three stages and evaluating the result of inspection at the end of each stage. In case no doubt arises as a result of the evaluation at the end of each stage, inspection will be terminated at that point and will not proceed to the next stage.

- The adoption of this idea might be conducive to lessening the burden of inspection on civil facilities which give rise to relatively little suspicion. The essential problem, in this regard, is how to classify inspection items into each of three stages. While it is inevitable that inspection items for each stage differ from facility to facility, it seems worthwhile to work out common guidelines on this subject.

(b) Further consideratin on "Verification measures and identification of the specific area(s) and place(s) of a facility to be inspected" (Model for Schedule [2] facilities, CD/881, p. 125)

- The objective of inspection can be basically achieved by means of checking "input" of raw materials and "output" of products through a material balance.

- In principle, the intermediate process of production like reaction process should fall outside the scope of inspection because it relates to know-how which is closely guarded by commercial plants.

- Careful consideration should be given to avoiding unnecessary exposures of such a process to inspection, especially with respect to those facilities which produce listed chemicals solely as an intermediate material or only consume listed chemicals.

10. Opening conference

It is important to confirm fully the contents of the facility attachment at the opening conference for a verification inspection.

11. Types of records needed and/or audited

(1) It seems very difficult to have general provisions on records since the contents of records differ from facility to facility. However, records necessary to be checked are basically those relating to production, material, wastes and shipment. However, the name of each customer or the specific name of the destination and the price should be excluded from the check list, since they are considered the information of highest confidentiality for companies.

(2) Records are, in general, categorized as annual (and semi-annual) records, monthly records, daily records, payment slips for each item and so forth. In principle, the checking of monthly records only should sufficiently meet the objective. As a concrete method of checking, the following step-by-step approach is conceivable: first, the confirmation of reported data by checking monthly records; second, the confirmation of reported data by checking daily records and others of a randomly selected month; in case no doubt arises at the end of the second step, the checking will be terminated and in case any doubt arises, a further checking will be conducted.

12. Plant orientation tour

In case of an initial visit, inspectors should be allowed to walk through not only the plant concerned but also the whole facility. In case of a verification inspection, however, it is considered basically sufficient for inspectors to have access only to the plant inspected. When considerable changes are made to the facility concerned (e.g. the construction of new plants), inspectors might be allowed to walk through the whole facility to see if any anomalies exist.

13. Inspection of areas and facility equipment

(1) Areas necessary to be inspected are sufficiently listed up in paragraph 13 of the annex to article VI (2). Among areas listed in the annex, however, there are some places which may not necessarily be essential as indicated in 9. above.

If there are other areas which should be subject to inspection, it might be possible to include such areas in the faciity attachment in accordance with the specific characteristics of each facility.

(2) In concluding a facility attachment, items subject to inspection need be considered, taking into account the specific situation of each facility. As stated in 1 above, however, consideration could be given to working out common guidelines on items subject to inspection.

14. Inspection of operation procedures

(1) A control centre which observes the operation of plants needs to be included in areas subject to inspection. In principle, inspectors themselves should not be allowed to operate or to direct the facility personnel to operate the plant, since it could not only hamper the proper operation of the facility but also could be dangerous. Notwithstanding the above-mentioned principle, whenever the inspectors request the representative of the facility to operate the plant in order to fulfil their mandate, they should be most cautious, taking into account the safety and security requirements of the plant.

(2) Inspection activities should be limited to the monitoring of operation procedures of the facility actually taking place during the inspection period and to the receiving of explanations about ordinary operation procedures by the representative of the facility.

15. Sampling and sample taking procedures

16. Handling of samples

17. Analysis of samples

(1) The taking and analysis of samples are not indispensable in performing the inspection, but can be regarded as a useful objective measure in order to dissolve suspicions.

(2) What is subject to sample-taking should be decided among materials, end-products and waste materials in the facility attachment, with due regard to the characteristics of the facility. There does not seem to be a compelling need for sampling intermediate products in verifying non-production of CW.

(3) Concrete procedures on sampling could be as follows:

(a) At an agreed sampling point, sample-taking prior to the arrival of inspectors and/or sample-taking in the presence of inspectors are both permitted.

(b) Samples taken are to be divided into six portions, two each for the use of inspectors, the Government of the inspected State, and the inspected facility respectively. Analysis is performed on one of two samples prepared for inspectors' use. The facility has the right to analyse one of its samples. If any problem arises as a result of the sample-analysis, additionalsample analysis would be required on samples prepared for the use of Government and the facility.

(c) Until the results of sample analysis become definite, six portions of samples as mentioned in (b) should be sealed and kept so as not to be tampered with, seeing to it that they are properly preserved.

(d) As a rule, samples should be analysed within the boundary of the facility inspected. However, if an off-site analysis is necessary since equipments for analysis are not available on-site, samples taken could be transferred to a designated laboratory in the inspected State, accompanied by inspectors and representatives of the inspected State. We do not believe it desirable that analysis is conducted outside the inspected State except under specific circumstances, for instance, non-availability of means of analysis in the State, from the viewpoint of ensuring that samples taken be not tampered with. Consideration should be given to allowing the facility personnel to be present at the off-site analysis.

The necessity, conditions and locations of off-site analysis need to be provided in the "facility attachment".

(e) Analysis equipment available at the facility should be made full use of. It is desirable for the facility to furnish such equipment for the purpose of inspection. Consideration should be given in this case to allowing the facility personnel to perform the analysis under the surveillance of inspectors. In case of an off-site analysis, a third person may perform the analysis in the presence of inspectors, representatives from the inspected State (and from the inspected facility).

In the case that inspectors bring in analysis equipments, inspectors themselves should perform the analysis in the presence of representatives from the inspected State and the inspected facility.

18. Types of analyses

Types of analyses are presumably different according to the kind of sample to be analysed or the objectives of verification to be achieved by the analyses.

For example:

- in case of precursors analysis, check whether the precursors used are the ones declared.

- in case of chemical products analysis, analyse only for the presence of the chemicals declared. If there are a lot of impurities contained, analyse only for the presence of Schedule [1] chemicals related to the product concerned.

- as for wastes, identify the presence of chemicals declared or analyse for the presence of Schedule [1] chemicals related to the product concerned.

However, it is necessary to consider further how to analyse for the presence of Schedule [1] chemicals since the use of gas-chromathography requires a standard sample which is hard to obtain.

19. Documentation of the inspection

(1) All documents provided by the facility on the occasion of on-site inspection, and the notes taken by inspectors themselves during the inspection, should not be permitted, in principle, to be taken out.

The inspectors, however, may take out indispensable documents with the facility side consenting in the presence of the representatives of the inspected State, in compliance with the "facility attachment".

The facility concerned should not hesitate to agree to the inspectors taking out documents of low confidentiality and of a general nature.

(2) Information acquired during on-site inspections can be confidential in many cases. For that reason, if the inspection lasts for more than a day, even inspectors' notes need be kept in a safe installed in the facility every time after the daily inspection. In so doing, the risk of leakage of confidential information will be reduced.

20. Evaluation by inspectors

(1) The inspection will be carried out on the basis of "data provided by the facility", "visual observation" by inspectors and "sampling". In the case of "sampling", it is considered possible for the inspectors to pass objective judgement on the "sample" in question. As for the "data provided by facility", it also seems possible to assess them objectively in light of the initial declaration, in the manner described in 11. above.

(2) As for "visual observation" it may be more difficult for inspectors to evaluate objectively their own visual observation because their judgement may be affected by their subjective impressions.

In order to prevent inspectors from making a subjective evaluation, a common check list with which inspectors evaluate their visual observation should be established (e.g. existence of suspicious pipes which are connected with another reaction vessel, excessive protection or safety equipments etc.).

Because of the difficulties involved in coming to objective judgements and dispelling all suspicions only by means of visual observation, it would be advisable to conceive of visual observation in the exercise of the function of inspectors as a means of confirmation and evaluation of the data and samples taken. It is not considered appropriate to request the inspected facility to submit detailed equipment-specification of the plant in relation to visual observation.

21. Closing conference

(1) At the closing conference, it is necessary to classify documents clearly into those which can be taken out, those which are kept in the facility and those which should be destroyed. Documents which can be taken out should be limited as much as possible to those agreed on with the facility side based on the facility attachment (e.g. the outline of the facility). Documents to be kept in the facility should meet the needs of inspectors as much as possible.

(2) In case there is any suspicion upon the completion of a verification inspection, it is important for inspectors to explain clearly the details of the suspicion at the closing conference in order to avoid unnecessary troubles with the inspected State and the facility side.

22. Anomalies, disputes and complications

(1) Minor changes on the plant are made ordinarily to raise the productivity. It is therefore necessary to see to it that these changes do not cause unnecessary complications.

(2) When anomalies are found in a verification inspection, both inspectors and the facility side should make efforts to solve the problems in accordance with the facility attachment. Clear rules should be established regarding how to solve a situation where the suspicion is not cleared despite the efforts of the parties concerned or where there are differences over the interpretation of the facility attachment.

23. Report of the inspection team

(1) It is desirable to make a common format on the inspection report. The report could be based, where possible, on a list of "yes-or-no" type (format to be further considered) with brief annotations by inspectors as to how they have come to the judgement.

(2) Inspectors should prepare, at least, a draft report at the time of the inspection. (Consideration should be given as to how to handle the draft report in relation to the representives of the inspected State, taking account of the possibility of checking on-site, when necessary, whether there are factual misunderstandings in the report.)

24. Impact of the inspection on facility operation

(1) If the name of an enterprise which undergoes inspection based on the Chemical Weapons Convention is made public, this may give rise to a public misunderstanding that the enterprise in question manufactures chemical weapons or dangerous materials. It is feared that the company's image may be consequently hurt or that there may arise unwarranted suspicion on the part of residents around the inspected facilities. This may be due to the special circumstances in Japan, but when an inspection is conducted on a facility of a private enterprise, it is necessary to take these circumstances into consideration.

(2) When the organization of the CW convention bears all the expenses, the inspection conducted in a reasonable way will not be a heavy burden on the facility which manufacture chemical materials listed in Schedule [2] of the Annex to Article VI [2]. Considering that the facilities concerned manufacture chemical materials which can also be materials for chemical weapons, it seems natural that those facilities will have to bear some burden.

III. Conclusion

The national trial inspections gave the Government and the private enterprises a useful opportunity to identify problems related to verification systems envisaged under the CW Convention. We now think it necessary to study the following matters, based on the results of NTIs. We will also consider the possibility of conducting an additional NTI, if necessary, based on the results of NTIs implemented by other countries.

Matters to study:

1. To work out a "model" guideline for an initial visit, including concrete or detailed methods of the visit.

2. To work out a guideline concerning the detailed procedures for a verification inspection (e.g. an idea of a "step-by-step" inspection could be considered).

3. To further consider possible factors identified to determine the number, intensity, duration, timing and mode of inspections of facilities handling Schedule [2] chemicals of CD/881, p.117.

4. To consider further "Guidelines on the International Inspectorate" of CD/881, pp.98-107.

5. To make a check list for the evaluation of the inspection.

6. To consider the format of the inspection report.

7. To clarify the procedures for solving conflicts relating to routine inspection.

Czecho-slovakia	CD/CW/WP.229	Report on the Conduct and Results of the National Trial Inspection	Also issued as CD/900 15 Mar. 89

NOT REPRODUCED
(see WP volume)

France	CD/CW/WP.230	Chemical Weapons Convention: Confidentiality NOT REPRODUCED (see WP volume)	Also issued as CD/901 16 Mar. 89

CONFERENCE ON DISARMAMENT

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Ad Hoc Committee on Chemical Weapons

CANADA

Definitions, Schedules and Toxic Chemicals

Introduction

The Ad Hoc Committee on Chemical Weapons is again deeply involved in issues relating to Article VI on the non-production of chemical weapons. in particular, discussions have commenced on supertoxic lethal chemicals (STLCs) and it has been proposed to expand Schedule [2] to incorporate Schedule [...] as part B since the two verification procedures are quite similar. However, the assignment of chemicals to schedules on the basis of toxicity categories is incomplete and additional criteria have been difficult to formulate.

It is possible that some of the problems may be related to inconsistencies in the application of the definitions in Article II, resulting from the rapid progress in other parts of the rolling text. The definitions should be reviewed especially as they relate to schedules and the application of toxicity categories. The following charts and discussions are an attempt to show how the problems of definitions, toxicity and lists are interrelated and to underscore the need for review and revision.

CHART I

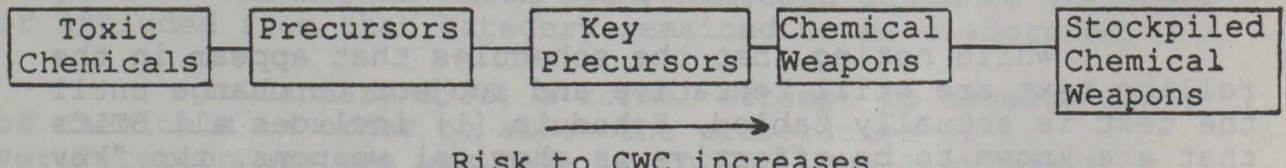
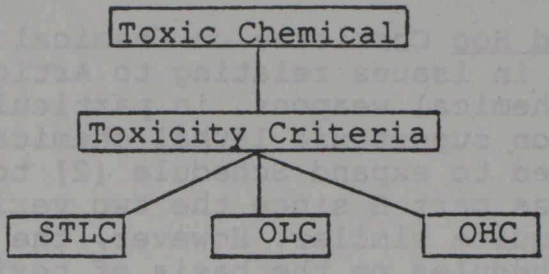


Chart I indicates that, in principle, all toxic chemicals could pose a risk to the Convention but that, in practice, the risk increases as one comes closer to those chemicals which could be used as chemical weapons, and that the risk is greatest with those that have the physical characteristics that make them suitable for loading, storage and dissemination in munitions.

Chart II shows graphically the division of toxic chemicals into super toxic lethal chemicals,(STLC) other lethal chemicals (OLC) and other harmful chemicals (OHC); where as such they are all defined as chemical weapons "except for such chemicals intended for purposes not prohibited by the Convention..." The category of ultra toxic chemicals that has been proposed should be considered as a subdivison of supertoxic lethal chemicals even though special procedures may eventually be needed to deal with them.

CHART II



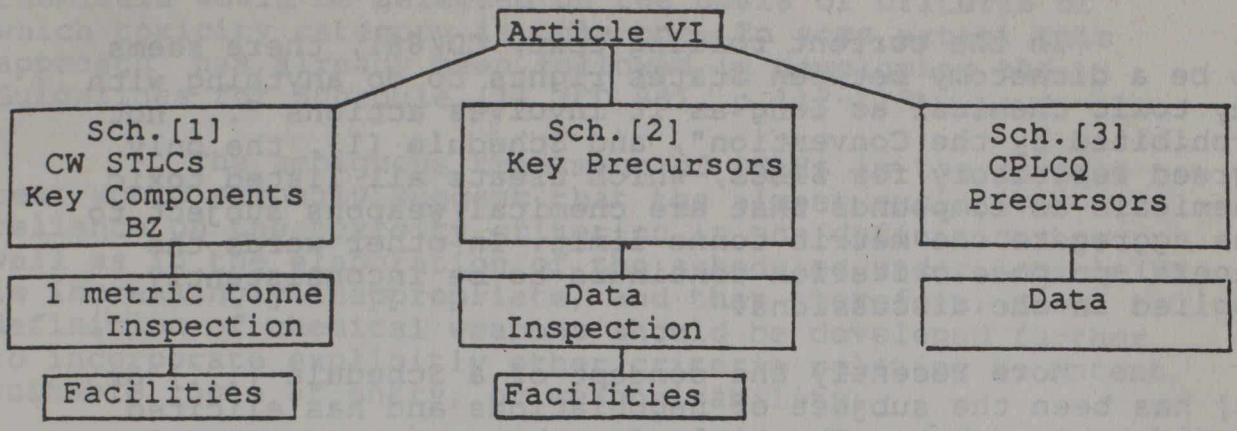
This paper seeks to demonstrate that the definitions relating to chemical weapons must be reviewed and the titles of the various annexes must be modified, not only to reflect their current contents but also to enable additions to be made to schedules should circumstances require it in response to new information.

Article VI and Schedules [1], [2] and [3]:

The methodology developed to date for the verification of non-production is outlined in Article VI, and the schedules of chemicals found there are based on the degree of risk that they are deemed to pose to the objectives of the Chemical Weapons Convention (CWC).

While noting that the schedules that appear in the rolling text are still tentative and subject to change until the text is actually tabled, Schedule [1] includes all STLCs that are known to be effective as chemical weapons, two "key components" (weaponized key precursors) and the incapacitant BZ; Schedule [2] contains key precursors for those in Schedule [1]; and Schedule [3] lists both highly toxic chemicals produced in large commercial quantities (CPLCQ) with previous use as chemical weapons, and compounds that are precursors to those on schedules [1] and [2]. Chart III shows the regimes that flow from the proposed Annexes to Article VI.

CHART III



Use of Toxicity Categories

The current understanding of toxicity categories including supertoxic lethal chemicals had already been incorporated into CD/416 in 1983. They were defined as chemical weapons "except such chemicals intended for purposes not prohibited by the Convention..." and were so categorized only on the basis of a toxicity criterion with a "median lethal dose which is less than or equal to 0.5 mg/kg...", and this definition remains in the current rolling text (CD 881).

It follows from this that the draft CWC recognizes that there are, in principle, STLCs that are chemical weapons and those that are not. There has been little debate on the consequences of this division until recently. In CD/636 in 1985 a category of "STLC with no use as a chemical weapon" was proposed with the caveat " ...shall be strictly limited to these amounts which can be justified for such purposes". The way in which such chemicals could be included or excluded from that category remained to be elaborated.

In January 1986, a formal attempt to develop lists of chemicals in order to allow the elaboration of verification regimes was made in CD/651. The listings A, B and C were made to permit the "...establishment of sound criteria for identifying relevant chemicals". Thus the relatively detailed elaboration of non-chemical weapon STLCs was lost and replaced in CD/727 of fall 1986 by the brief statement that each State Party has the right to "...develop, produce, otherwise acquire, retain, transfer and use toxic chemicals and their precursors for purposes not prohibited by the Convention". In the course of these developments Annex VI.[1] was proposed for STLCs with the general proviso that the annexes would include "toxic chemicals.... which could be used for purposes prohibited by

the convention as well as facilities which produce, process or consume these toxic chemicals..."

In the current rolling text, CD/881, there seems to be a dichotomy between States rights to do anything with any toxic chemical as long as it involves actions "... not prohibited by the Convention", and Schedule [1], the only agreed repository for STLCs, which treats all listed toxic chemicals as compounds that are chemical weapons subject to the aggregate one metric tonne limit. In other words the general purpose criterion continues to be inconsistently applied in the discussions.

More recently the concept of a Schedule [...] or [4] has been the subject of negotiations and has elicited considerable debate. The title for this proposed schedule is, "Production of STLCs not listed in Schedule [1]". Such chemicals are to be monitored as in Schedule [2] except that various production thresholds will dictate monitoring procedures. As is currently being discussed in Working Group 4 it is now proposed to place all of these chemicals in Schedule [2], although as structured in CD 881 this schedule was set up for key precursors for those chemicals that appear on Schedule [1], and is unrelated to other kinds of chemicals or toxicity. There has also been no criteria developed to distinguish between those STLCs that could be used for chemical weapons and those that would have no chemical weapons value.

There have also been few attempts in the schedules to deal with other lethal chemicals and other hazardous chemicals that could be used as chemical weapons other than the placement of BZ into Schedule [1] and the possibility that some widely produced toxic chemicals in Schedule [3] may fall below the supertoxic lethal threashold.

Schedule [3] is currently directed at chemicals that are produced in large commercial quantities (CPLCQ) and could be used for chemical weapons purposes. There are in fact two classes currently listed: large scale production chemicals previously used as chemical weapons, and other chemicals that are mainly precursors to known chemical weapons.

Discussion:

The fact that more than one type of chemical appears on Schedules [1] and [3] and discussions seem intent on developing Schedule [2] in the same way suggests that toxicity categories are no longer the only criteria for the schedules. Perhaps a more reasonable approach would be to view the schedules as incorporating three verification or

monitoring procedures of decreasing control with which are associated lists of the chemicals to be monitored. The chemicals would be selected on the basis of criteria of which toxicity category is only one. To some extent this approach has already been followed in developing the Guidelines for Schedule [1] (CD 881, p.112-113).

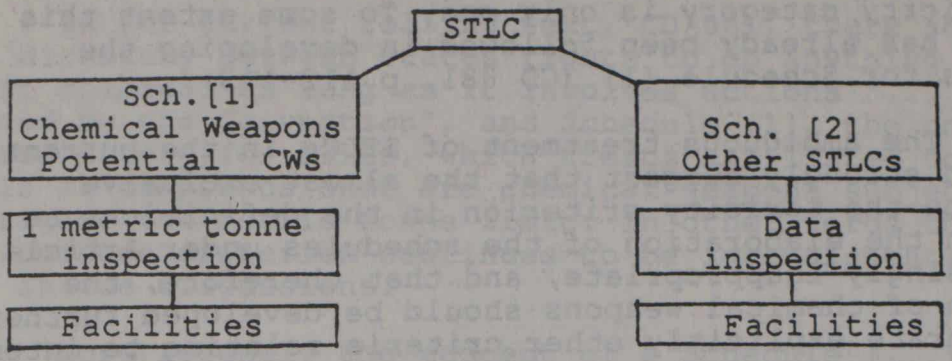
The ambiguous treatment of STLCs in the current text would strongly suggest that the almost exclusive reliance on the toxicity criterion in the definitions as well as in the elaboration of the schedules under Article VI is increasingly inappropriate, and that therefore, the definition of chemical weapons should be developed further to incorporate explicitly other criteria relating to intent, suitable route of entry, or weaponizability.

The title of Schedule [1] should be changed to clearly indicate that those chemicals are controlled because they have been used or stockpiled for chemical weapons purposes or have characteristics that make them readily usable as chemical weapons. In other words, those STLCs included are listed as chemical weapons not only on the basis of toxicity but also on the basis of additional criteria. This, of course, means that there will have to be additional provisions for the listing of the remaining STLCs and other toxic chemicals of particular concern to the Convention.

As it stands in CD 881, Schedule [2] is devoted to key precursors and so is related solely to potential production of Schedule [1] chemicals. As is currently being discussed in Working Group 4, it would be even more useful if it were to be extended to encompass other chemicals that pose a particularly serious risk to the Convention e.g., other potential agents, penetrants, etc., and other STLCs which do not appear on Schedule [1]. In the latter instance it is not necessarily the chemical itself but its production facility that would be of concern to the Convention.

Chart IV shows a proposed division of STLCs into those currently known to have chemical weapon utility, with the addition of potential chemical weapons based on some appropriate criteria, as falling into Schedule [1]. Other STLCs (known or upon discovery) would enter a revised Schedule [2]. This means that these STLCs would be monitored under a data reporting regime with random inspections that would be directed mainly at the production facilities in order to ensure that prohibited chemicals are not being produced.

CHART IV



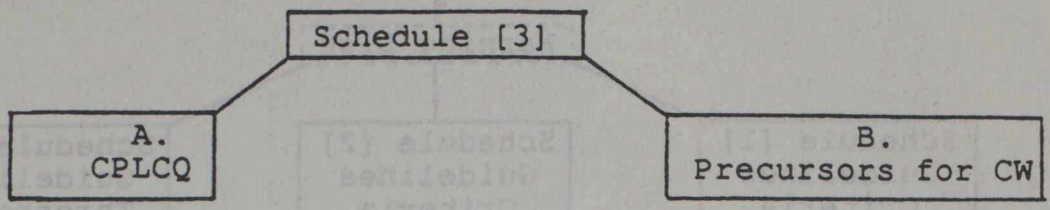
The concept of placing STLCs that are potential chemical weapons into Schedule [1] is not without precedent as such chemicals would already be included through application of many of the Guidelines for Schedule [1] (CD 881, p.112). In addition, most members of the families of chemicals listed in schedule [1] of which sarin, soman,tabun and VX are examples can only be described as potential chemical weapons since they have not been specifically identified or weaponized.

Since the number of other STLCs in Schedule [2]B would still be quite large, it would be necessary to apply additional criteria so that those that would be of no use for chemical weapons need not be listed. It may also be useful to apply thresholds to the production of Schedule [2]B chemicals below which it would not be necessary to apply verification procedures.

In order to deal with novel agents and toxic chemicals of particular concern falling into the other lethal and other hazardous categories, it may be useful to include them in Schedule [2]B as well, provided they have no other apparent use. Those produced in quantities above the agreed threashold for Schedule [3] would be placed there.

A formal division of Schedule [3] into two parts as shown in Chart V would take into account the differences in the scale of production and the consequent differences in reporting regimes. These are: [3]A, chemicals produced in large commercial quantities; and [3]B, other precursors to chemicals on Schedules [1] and [2].

CHART V



This approach could assist in the application of random inspection procedures to this schedule.

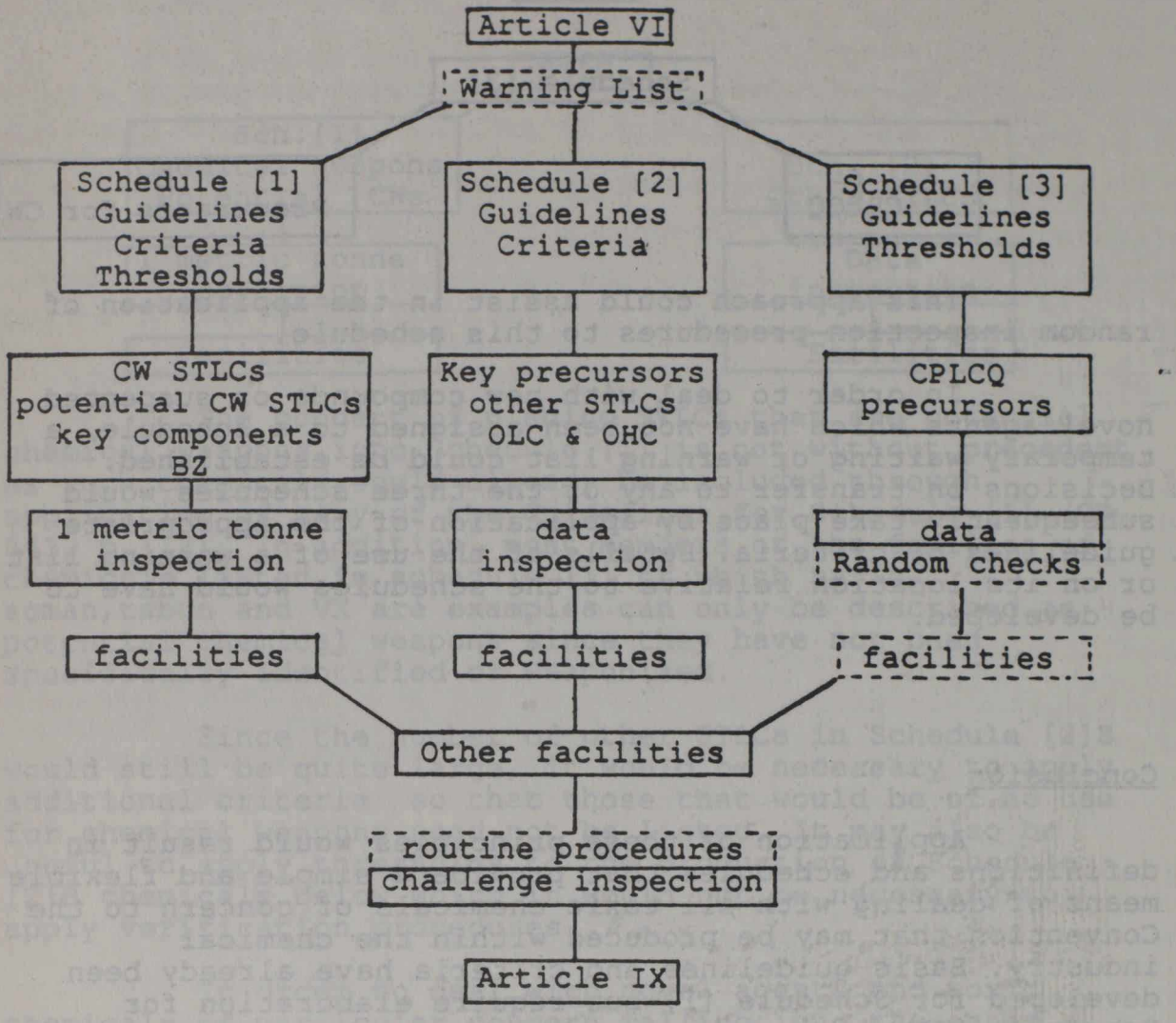
In order to deal with new compounds or suspected novel agents which have not been assigned to a schedule, a temporary waiting or warning list could be established. Decisions on transfer to any of the three schedules would subsequently take place by application of the appropriate guidelines or criteria. Details of the use of a warning list or on its location relative to the schedules would have to be developed.

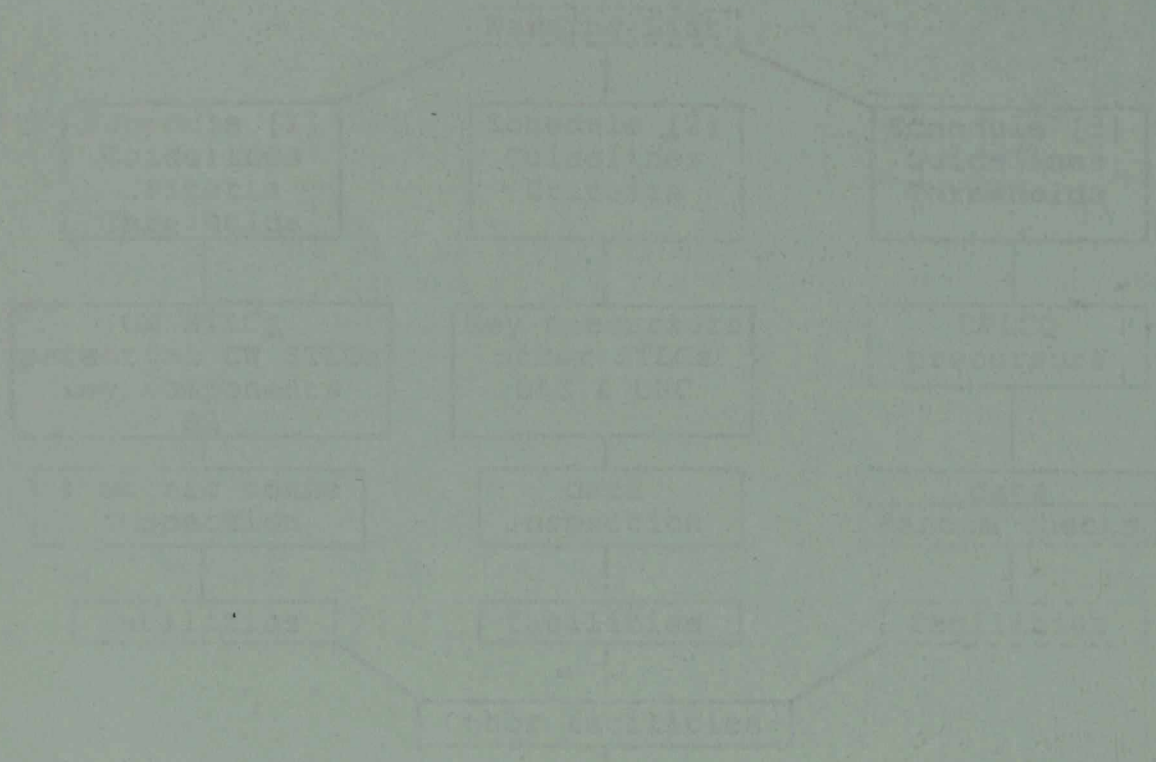
Conclusion

Application of these principles would result in definitions and schedules that provide a simple and flexible means of dealing with all toxic chemicals of concern to the Convention that may be produced within the chemical industry. Basic guidelines and criteria have already been developed for Schedule [1] but require elaboration for Schedule [2]B.

A final flow diagram summarizing the overall process is shown in Chart VI. A direct relationship to Article IX and challenge inspection may also be drawn. Some delegations have also noted intermediate opportunities for additional routine procedures as shown with dotted lines..

CHART VI


Article VI
Warning List
Schedule [1]
Guidelines
Criteria
Thresholds
Schedule [2]
Guidelines
Criteria
Schedule [3]
Guidelines
Thresholds
CW STLCs
potential CW STLCs
key components
BZ
Key precursors
other STLCs
OLC & OHC
CPLCQ
precursors
1 metric tonne
inspection
data
inspection
data
Random checks
facilities
facilities
facilities
Other facilities
routine procedures
challenge inspection
Article IX



UK	CD/CW/WP.232	Chemical Weapons Convention: AD Hoc Inspections NOT REPRODUCED (see WP volume)	Also issued as CD/909 30 Mar. 89

CONFERENCE ON DISARMAMENT

CD/CW/WP.233
4 April 1989

Original: ENGLISH

Ad hoc Committee on Chemical Weapons

FINLAND

Report on the National Trial Inspection of Finland at a civilian chemical facility

Introduction

In implementing the initiative of the Ad hoc Committee on Chemical Weapons to undertake trial inspections in chemical industry facilities producing Schedule [2] chemicals, Finland undertook an inspection in March 1989. There are no facilities in Finland producing Schedule [2] compounds. Therefore, the inspection was carried out at a plant producing pesticides of low toxicity. The part of the facility that was chosen for inspection produces two closely related carbamate-type pesticides.

A. GENERAL APPROACH

1. Objectives of the National Trial Inspection

The objectives were those set forth in CD/CW/WP.213.

2. Provisions in the Draft Convention under which the National Trial Inspection took place

The Annex to Article VI (2).

3. Type of on-site inspection

Owing to the lack of time, the inspection was a combination of an initial visit and a routine inspection. Three of the four inspectors were familiar with the facility before the inspection and two inspectors had had previous access to detailed information on the process equipment.

4(a) Advance information

An initial declaration relating to the production of the two pesticides during 1988 at the inspected facility, and an advance notification relating to the production planned for 1989 was given at the start of the inspection. Details of the processes were explained by the facility operator with the aid of lay-outs and flow-charts.

4(b) Agreement on inspection procedures

A preliminary inspection plan was sent to the facility two days before the inspection. The plan states the main inspection procedures and the information which should be available for the inspectors at the working room.

During the inspection it was pointed out by the facility management that if the facility attachment is used to guide the work of the inspectors in a very detailed manner, the facility personnel very soon realizes, for example, which records and which sampling points have to be modified if illegal production is planned. It is essential to leave some flexibility to the inspections.

5. Type of facility inspected

The facility inspected could be characterized as a modern, completely automated, multipurpose facility being part of a complex. Multipurpose in this context means that the facility can produce structurally closely related carbamates. The process is a multistep batch process. A new batch can be started before finishing the previous one. The products are solid.

6. Type of declared activity at the facility

As neither of the two produced chemicals are on the lists, the more abundantly produced carbamate, phenmediphame, was included in Schedule [2] for the purpose of the inspection while the less abundantly produced carbamate, desmediphame, was included in Schedule [1]. The NTI took place when phenmediphame was produced as declared.

7. Actual activity at the facility

The actual activity at the facility at the time of the inspection was in conformity with the declarations. The purpose of the inspection was to verify by sampling and analysis whether there had been any "illegal" (for the purpose of the inspection) production of desmediphame.

B. DETAILED APPROACH

1. Inspection mandate

A broad inspection mandate was negotiated between the facility management and the inspection team. The mandate did not limit the access to any part of the facility. The inspection team decided to inspect the process of phenmediphame synthesis only and leave the synthesis of one of the precursors uninspected as the precursor is used for the production of both carbamates.

2. Composition of the inspection team

The inspection team was formed by:

- two chemical process engineers (M.Sc.(Eng.)) from the Technical Inspection Centre; one of them acting as the team leader;
- an analytical chemist (M.Sc.) from the Project on the Verification of Chemical Disarmament;
- the director (Pharm. Dr.) of the Project on the Verification of Chemical Disarmament;
- an observer from the Ministry for Foreign Affairs of Finland.

3. Inspection equipment

Inspection equipment was furnished partly by the inspected facility (liquid chromatograph) and partly by the inspection team (air sampling).

4. Activities prior to the arrival of the inspection team on-site

The facility was notified of the exact inspection date about two weeks in advance. Detailed notification was made 48 hours in advance.

5. Advance preparations on-site

No physical preparations on-site were undertaken. The facility designated the point of contact and informed relevant personnel. A separate working room was provided for the inspectors where complete documentation of the facility was made available.

6. Escort and points of contact arrangements

Escorts from the facility were provided. Contact persons were introduced to the inspection team at the beginning of the inspection.

7. Other participants

8. Duration of inspection

The inspection lasted for two days. The first day was devoted to the opening conference, plant orientation tour, inspection of the equipment and records. The second day was devoted to sample-taking and on-site analyses.

9. Measures to protect confidential information

All inspectors signed a secrecy agreement which is binding for the next ten years. The extent to which information had to be classified was indicated by the management.

10. Opening conference

The opening conference was not that of an inspection but of an initial visit. The inspectors received detailed information on the facility, processes and records.

11. Types of records needed and/or audited

All types of records kept by the facility were demonstrated to the inspectors with special emphasis on those needed for material accountancy. The monthly balance sheet of raw materials versus products was the most relevant one, which must be cross-checked through other records in an actual inspection. Complete material accountancy was not performed.

12. Plant orientation tour

The orientation tour encompassed the facility and the surrounding area.

13. Inspection of areas and facility equipment

The facility areas (the whole production unit, delivery and storage of feed chemicals, packaging unit of the finished products, finished product storage, and waste incineration unit) were inspected in detail, including examination of reactors, other process equipment, completely automated control room, key measurement points, and analytical laboratory.

14. Inspection of operation procedures

During the inspection, special attention was paid to the extent to which such safety equipment and procedures were used, which could have enabled handling of chemicals in Schedule [1].

15. Sampling and sample-taking procedures

Sample-taking from processes and from waste was performed by the facility personnel whenever requested and was documented by the inspectors. The inspectors collected samples outside the reactors such as wipe samples from the production premises (equipment), and from the surroundings of the packaging line. Air samples were collected from the packaging line and warehouses.

16. Handling of samples

The inspectors supervised collection of samples by the facility personnel. The inspector marked the samples with codes only (no names of the facility, facility personnel or inspectors) and protected them from access by unauthorized persons before transport to the off-site laboratory.

17. Analysis of samples

The samples from the process and some samples from the premises were analysed immediately on-site; environmental samples and those from the premises were analysed in the laboratory of the Project the following week.

18. Types of analyses

The analyses were both for the detection of the "illegal" pesticide and for the absence of chemicals in Schedules [1] and [2].

19. Documentation by inspectors

Description of the samples marked with codes were recorded in the verification book of the inspector. Records of the on-site analyses were kept and taken to the laboratory of the Project.

20. Evaluation by inspectors

The evaluation of the inspection activities and the information gathered during the inspection included:

- the possibility for the detection of undeclared production between routine inspections
- the extent and accuracy of the information provided by the facility
- the readiness of the facility for co-operation.

21. Closing conference

No closing conference was required.

22. Anomalies, disputes and complications

No anomalies were disclosed during the inspection.

23. Report of the inspection team

The report will include data on:

- an account of inspection activities
- results of the analyses
- accounts on visual observation
- conclusions.

24. Impact of the inspection on the facility operations

Loss of working time for the management and the escorts was the only impact on the facility.

25. Other matters

C. SPECIFIC ASPECTS - CONCLUSIONS

1. Inspection mandate

A broad mandate which restricted the work of the inspectors as little as possible was maintained.

2. Composition of the inspection team

The size of the inspection team was found adequate for the technical aspects of the trial inspection. It was confirmed that the team must also include at least one experienced material accountant.

3. Inspection equipment

The analysts had consulted the chief analyst of the facility before the inspection and received reference samples for the team. On the basis of these

discussions it was decided not to bring a gas chromatograph of the Project to the inspection site as it is not suitable for the analysis of carbamates. The air sampling equipment was brought by the inspectors.

Samples from processes and from the production premises were analysed with a high pressure liquid chromatograph by the facility personnel but according to the method of the inspectors and supervised by the inspectors.

4. Activities prior to the arrival of the inspection team on-site

According to the management the length of the advance notification is of no importance as long as the inspectors arrive during the usual office hours.

5. Advance preparations on-site

6. Escorts and point of contact arrangements

These were found to be essential. The co-operation of the escorts greatly facilitated the inspection but did not interfere with the inspection activities.

7. Other participants

8. Duration of inspection

The inspection was a combination of an initial visit and an inspection with sample-taking. Detailed information was available for the inspectors on process equipment, lay-out, flow-chart, sampling points, and analytical methods before the actual visit. Instead, the inspectors were not familiar with examination of the records and determination of the material accountancy.

It would probably take only one to two days for an experienced inspection team to perform a "real" inspection, provided that inspectors can inspect equipment, records and perform sample-taking and on-site analysis as separate teams.

9. Measures to protect confidential information

A considerable part of the information obtained by the inspectors was of confidential character. Handing over the information to the TS would pose no difficulties provided that data can be protected against unauthorized access. The lay-outs, detailed flow-charts and photographs were considered as information preferably stored on-site.

As a general principle, on-site analyses would be preferred by the management. However, when samples are taken to any off-site laboratory their marking with codes only is preferable over signed samples as the analytical laboratory would not be interested in finding confidential information on samples of unknown origin.

10. Opening conference

11. Types of records needed and/or audited

The overlapping of various records at the facility was extensive. Use of raw materials and the production could be verified through several records. Accordingly, the production of undeclared batches or undeclared chemicals is extremely difficult if all the records are inspected. However, this is very time-consuming.

One indicator for more extensive cross-checks could be the variations in the monthly reports on production versus used raw materials as it would reveal e.g. other production, idle days, and the production not meeting the specification requirements.

The possibility to use the information contained in the sales records would make it possible to construct a complete material balance and to make cross-checks of the declarations of the suppliers, producers, consumers and distributors.

12. Plant orientation tour

13. Inspection of areas and facility equipment

Photographic documentation during the initial visit would facilitate detection of undeclared modifications made to the equipment between the inspections.

14. Inspection of the operation procedures

The inspection revealed features which ruled out the possibility that the facility could be used for the production of very toxic chemicals without modifications to the equipment.

15. Sampling and sample-taking procedures

Sample-taking from the process was found easy due to permanent sample-taking devices for process control purposes allowing sample-taking from hot reaction mixtures during the process.

Wipe samples were found extremely important when traces from previous production were sought. The collection of air samples from warehouses and packaging lines was also found useful. Clear indications of the previous production were also obtained from containers of liquid waste before the incineration.

16. Handling of samples

After their collection the coded samples were stored in a cold box until the analysis.

17. Analysis of samples

Before the on-site analysis of the process samples, the liquid chromatographic separation and the determination of the two carbamates was tested with control samples brought by the inspectors. This was found extremely important since the analysis method for the process control of the facility is optimized to be as quick as possible, and, accordingly, did not separate the closely related compounds. This is adequate for the facility because it knows what is being produced. As the inspectors have to verify the non-production of certain specified chemicals they cannot rely on the process control analyses designed for other purposes. All the on-site analyses of the process samples would have been useless without the previous testing of the method.

The analyses of the process samples confirmed the declarations of the facility and gave no indication of any undeclared production. However, the on-site analysis of the wipe samples, and waste samples revealed clear indication of the previous production of the "illegal" carbamate. This indication was later confirmed in the off-site laboratory. According to the records of the facility this production had been stopped already two months before the inspection. These findings underline the importance of the samples collected outside the process equipment.

The high field NMR spectrometer present at the facility was not used for the analysis because modern spectrometers are computer controlled and every instrument has its own operational characteristics. This means that the inspection team will not be able to operate the instrument independently. Furthermore, if the operator of the facility runs the instrument, it is very difficult for the inspector to verify correct setting of the instrument parameters. Instead of running the spectrum of the inspected compound, the operator may print a reference spectrum from the library of the instrument.

The carbamates degrade at an elevated temperature in the gas chromatograph. Indirect gas chromatographic evidence on the composition of the samples was obtained in the off-site laboratory through the degradation products of the carbamates. The qualitative and quantitative results showed, however, good correlation with the results obtained on-site by the liquid chromatograph. Confirmatory analyses were made in the off-site laboratory by mass spectrometry.

18. Types of analyses

The samples were analysed both for their carbamate content and for the absence of chemicals included in Schedules [1] and [2]. The latter analyses were made with a two-channel gas chromatograph using retention index monitoring and both universal and selective detectors.

A liquid chromatograph equipped with a UV detector is not suitable for monitoring of chemicals in Schedules [1] and [2] since the sensitivity of detection is very poor.

19. Documentation of the inspection

Generally all data should be considered confidential.

20. Evaluation by the inspectors

21. Closing conference

22. Anomalies, disputes and complications

23. Report of the inspection team

A standardized format is essential.

24. Impact of the inspection on facility operations

25. Other matters

26. Instrumental monitoring of the facility

The inspectors and the management discussed the possibility of having TS-owned instrumentation at the facility for continuous monitoring of the production. The use of loadmeters and flowmeters would not be too difficult. Compound-specific detection of the products would be difficult due to the reaction mixture being partly crystallized at an early stage of the process even at elevated temperatures. This will hamper both in-line detection (near infrared or infrared spectrometers) or sampling due to clogging of the sampling lines. Use of chromatographic or mass spectrometric monitors would not be feasible.

When automatic monitors are used, it is important to make sure that the monitors cannot be circumvented by running processes in other closely located process lines using flexible pipelines.

Australia	CD/CW/WP.234	Letter Dated 30 March 1989 Addressed to the Secretary-General of the Conference on Disarmament from the Permanent Representative of Australia Transmitting a Document Entitled "Report of an Australian National Trial Inspection" NOT REPRODUCED (see WP volume)	Also issued as CD/910 5 Apr. 89

FRG	CD/CW/WP.235	Report on a National Trial Inspection	Also issued as CD/912 7 Apr. 89

NOT REPRODUCED
(see WP volume)

CONFERENCE ON DISARMAMENT

CD/CW/WP.236
7 April 1989

Original: ENGLISH

Ad Hoc Committee on Chemical Weapons

TRIAL INSPECTIONS

Working Paper by the Chairman of the Open-ended Consultations

Introduction

An informal exchange of information was held on 29 March 1989 under the auspices of the Ad Hoc Committee on Chemical Weapons. So far 18 delegations have reported that they have carried out or are engaged in preparations for National Trial Inspections (NTIs). Four additional delegations thus have undertaken or are planning NTIs, as compared to the previous exchange of information on this issue on 7 December 1988 (CD/CW/WP.217). A summary of the information provided is given below. Unless otherwise indicated, the NTIs took place under the provisions set forth in the Annex to Article VI [2].

Australia:

NTI report: CD/910.

Remarks: Australia conducted an NTI at a multipurpose complex of an agricultural chemical company. At present, the company produces no chemicals currently listed under Schedule [2] of the Rolling Text, but for the purposes of the inspection "Dinitro" was defined as a Schedule [2] chemical.

The report on the NTI contains a number of conclusions and observations, including comments on Models for an Agreement, a suggested check-list of equipment relevant to the production of Schedules [1] and [2] chemicals and a note on the inspection team's use of a vapour monitor to check for the absence of vapours of Schedule [1] chemicals.

Austria:

NTI report: Expected during the summer session 1989.

Remarks: It is envisaged that an NTI might take place within two months, concentrating on Schedule [3] chemicals.

Belgium:

NTI report: Expected in mid-April 1989.

Remarks: An NTI has been conducted at a facility which does not produce a listed chemical. Samples were taken at the end of the batch process in order not to disturb the normal production activity, although the deterrent effect of the verification system would be reinforced if the samples could be taken at any point. It was concluded that the inspectors needed to be in a position to seal the samples. Moreover, it may prove appropriate that a representative of the host country fix a second seal on the samples. Further, it was pointed out that it is necessary to elaborate procedures for the stockpiling and transport of samples. It was not possible in this case to verify the possible presence of prohibited substances in the storage area by verifying the computer listings. Finally, it was concluded that an inspection of this type can be carried out without significant interference with the normal operations of the chemical complex.

Brazil:

NTI report: CD/895/Rev.1.

Remarks: The NTI was carried out at a multipurpose facility, being part of a petrochemical complex and operating on a batch system. For the purpose of the trial inspection monoisopropylamine (MIPA) was defined as a Schedule [2] chemical. The team of inspectors was provided by another company of the same complex. The scope of the inspection was to verify the non-production of Schedule [1] chemicals, the veracity of the initial declaration of the facility and the non-diversion of MIPA. The trial inspection consisted essentially of data collection to prepare a material balance during the inspection day, as well as a material balance for the total period of the MIPA campaign.

Czechoslovakia:

NTI report: CD/900.

Remarks: The preparation, carrying out and evaluation of the NTI testifies to the fact that the relevant verification provisions as contained in CD/881 are suitable for the verification of non-production of chemical weapons in the civilian chemical industry. The experiment confirmed the importance of facility attachments. The time necessary for the preparation and conclusion of the inspection if undertaken without interruptions may be approximately one week. The minimum number of inspectors required could be

estimated to three persons. Access to all information should be limited basically to the head of the inspection team. The use of national technical instruments during an inspection is preferable.

Finland:

NTI report: CD/CW/WP.233.

Remarks: The NTI took place at a facility producing two closely related carbamates of low toxicity. The inspection was a combination of an initial visit and a routine inspection with some sampling and analysis done both on-site and off-site. The main objective was to test whether it is possible, by sampling and analysis, to find evidence of a previous production. Evidence was found of production which ceased two months before the inspection.

France:

NTI report: Expected in mid-April 1989.

Remarks: The initial conclusions on the recent national trial inspection are being developed.

German Democratic Republic:

NTI report: CD/899

Remarks: A multipurpose production unit designed for the production of different kinds of chemicals which may be used as pharmaceuticals was used for the NTI. Firstly, the possibility of verification of non-diversion, that is, by material balance accountancy and material balance verification, means of book-auditing procedures and physical measurement was assessed. Secondly, the possibility to verify the non-production of Schedule [1] chemicals was assessed.

Germany, Federal Republic of:

NTI report: CD/912.

Remarks: The NTI took place at a multipurpose facility producing a small amount of a Schedule [2] chemical, being part of a large complex of more than a hundred facilities. Some problems were identified: Firstly, it might in some cases be very difficult to single out one facility from a huge number of similar facilities in different plants, which together form a huge complex. Secondly, the manifold technical possibilities inherent in multipurpose facilities. A third problem area is the fact that substances subject to the Convention can also be produced in other facilities being part of the whole complex but at the same time not necessarily subject to declaration. A fourth problem identified is the advance notifications of Schedule [2] chemicals, which might sometimes prove to be difficult due to practical and economic reasons.

Hungary:

NTI report: CD/890 and CD/890/Add.1.

Remarks: The National Trial Inspection consisted of an initial visit to a facility and the preparation of a facility attachment. For the purpose of the NTI, the chemical carbendazim was designated as a Schedule [2] chemical. The inspected facility was a single purpose facility being part of a complex.

The inspection took place during normal operation of the facility and was carried out on the basis of a detailed inspection mandate. The inspection team was divided into two groups, which worked separately but met during the closing conference for the elaboration of common conclusions. Samples were not taken during the inspection, but parameters for sample-taking were established, as were requirements for analysis of samples.

Italy:

NTI report: CD/893.

Remarks: The Italian Government, through arrangements with the Italian chemical industry, made two plants available for a trial inspection with international participation. First, a familiarization visit was conducted and a model for a check-list was drawn up. On the basis of the familiarization visit and the answers by the facilities, facility attachments were elaborated. The preparation of the inspections and the inspection report was carried out by international participants. Some preliminary conclusions may be drawn. The international character of the inspection did have some negative impact on the data available during the inspection and more data could have been made available if confidentiality guarantees were given.

Japan:

NTI report: CD/CW/WP.228.

Remarks: NTIs on three facilities were conducted. Some specific aspects in the report are: Firstly, the initial visit has the potential of revealing more sensitive information than on-site verification inspection which is based on facility attachments. It is necessary to work out model guidelines for the initial visit. Secondly, several points are considered in relation to confidential information. Thirdly, matters relating to interpreters need further consideration. Fourthly, it may be necessary to address in a more detailed manner the report by the inspectors, including its format.

Netherlands:

NTI report: Expected in June 1989.

Remarks: This NTI will take place in a multipurpose plant working on intermediates for pharmaceuticals. It consumes a Schedule [2] chemical, triphenylmethylphosphoniumbromide, which is an extremely unlikely precursor for chemical weapons but still formally belongs to Schedule [2]. The inspection will take place in May 1989 and will consist of two parts. One part is the routine inspection for a Schedule [2] chemical. The second part is to test several aspects of the ad hoc check type of inspections to ensure that the plant is not making any other undeclared compounds.

Sweden:

NTI report: CD/CW/WP.216.

Remarks: The NTI took place at a multipurpose plant and consisted of three parts: an initial visit, the elaboration of a facility attachment and the inspection itself. For the purpose of the inspection an intentional complication was introduced which was also disclosed during the inspection. Some conclusions are: Firstly, the current provisions in the Annex to Article VI [2] provide useful guidance on the conduct of inspections. Secondly, the contents and quality of the facility attachment are of great importance. Thirdly, guidelines regarding the initial visit might be required. Another area where further work might be needed is guidelines regarding procedures for off-site analysis.

Switzerland:

NTI report: Expected in mid-April 1989.

Remarks: The NTI took place in a multipurpose facility not producing any chemical listed in any of the three Schedules. A chemical was therefore defined as a Schedule [2] chemical and another chemical, which could theoretically be produced from the first one, as a Schedule [1] chemical.

Union of Soviet Socialist Republics:

NTI report: CD/894.

Remarks: An NTI was conducted at a facility producing N,N-dimethyl- and N,N-diethylaminoethan-2-ols. The initial visit included a detailed inspection of the facility areas, the production path and records. During that inspection a facility attachment was elaborated. The routine inspection was carried out after the monitoring equipment was purchased, installed, and adjusted. The readings of these instruments, installed for verification purposes, were checked and compared with the records. On-site analysis of

samples for the presence of the declared chemicals was carried out. Possible violations of the current provisions and means for detecting them were studied from a theoretical standpoint. This NTI demonstrated the practical applicability of the provisions of the Annex to Article VI [2] of the draft Convention.

United Kingdom:

NTI report: Expected during the early part of the summer session 1989.

Remarks: The NTI consisted of three phases: Firstly, a visit to the facility to be inspected in order to explain the NTI purpose. This plant produces dimethyl methylphosphonate, a chemical on Schedule [2]. Secondly, a visit to elaborate a facility attachment and an inspection programme. Thirdly, the inspection itself. The inspection had a number of objectives. One was to test the facility attachment to see if it provides a useful basis for conducting the trial inspection. Another to assess the viability of inspection and sampling procedures involved in routine inspections. Finally to check the material balance of the chemicals used during the synthetic process.

United States of America:

NTI report: Expected during the early part of the summer session 1989.

Remarks: The inspected facility produces a Schedule [2] chemical, dimethyl methylphosphonate (DMMP), from a Schedule [3] chemical, trimethylphosphite (TMP). Some of the DMMP is used at the facility. The principal objectives were to evaluate the ability to determine whether Schedule [1] chemicals had been produced, whether types or quantities of Schedule [2] chemicals not included in the declaration had been produced, to determine physical constraints, the impact of an inspection on a facility, and finally the preparation needed. The inspection was governed by a mock facility agreement and a detailed document on inspection procedures. Activities included: Examination of process equipment, auditing of records, and collection and analysis of samples. Some preliminary conclusions might be drawn: Firstly, it will be difficult to define the area to be inspected precisely. Secondly, a very thorough initial visit is essential for effective inspection. Thirdly, a NTI does not reflect the tensions that will undoubtedly arise during the course of an actual inspection. Fourthly, it is essential to carry out off-site analysis, in searching for traces of Schedule [1] chemicals. Finally, it is clear that at the multilateral phase of trial inspections, confidentiality will be an important issue.

CONFERENCE ON DISARMAMENT

CD/CW/WP.237
10 April 1989

Original: ENGLISH

Ad Hoc Committee on Chemical Weapons

TRIAL INSPECTIONS

Working Paper by the Chairman of the Open-ended Consultations.

Introduction.

As a follow-up to a stocktaking meeting on 29 March 1989 on the National Trial Inspections (NTIs), the result of which is summarized in CD/CW/WP.236, two Open-ended Consultations on NTIs with the participation of experts were held on 31 March and 5 April 1989 under the auspices of the Ad hoc Committee on Chemical Weapons. The aim of these consultations was to provide an opportunity for interested delegations to discuss results and conclusions from the NTIs. An outline for the consultations, based on CD/CW/WP.213 and the then existing reports on NTIs, had been distributed in advance.

This Working Paper is an attempt by the Chairman to summarize some points made during the consultations. References to relevant parts of the "Rolling Text" of the draft Convention on Chemical Weapons (CD/881) have been added in order to facilitate further work on the next envisaged stage: Multilateral Trial Inspections.

GE.89-60612

1. The inspection mandate

CD/881 p. 77 paras 9-10, p. 99 paras III.1-2.

Guidelines for the initial visit are needed. The problem of confidentiality is considerable during the initial visit, inter alia because the inspectors at this stage do not know the degree of confidentiality of the information they request.

2. Composition and organization of the inspection team

CD/881 p. 98 paras I.1-3.

A team size of 4-6 inspectors was generally regarded as adequate, though the size may depend on facility-specific factors. It was pointed out that the initial visit might require a larger team than the routine inspections. Various types of expertise required were mentioned, including general chemistry, chemical engineering and analysis, chemical instrumentation, and, especially, industrial auditing.

Most experts felt that a team leader, designated by the Director-General of the Technical Secretariat, was desirable. A view was expressed that not all team members should have access to all confidential information; in some cases it could suffice if the team leader and another inspector had this access.

3. Inspection equipment

CD/881 pp. 78-79 paras 14 (c) second tick and 14 (d) third tick, p. 98 para II.1 (c), pp. 121-123, p. 126 para 5.3.

Attention was drawn to the usefulness of a portable vapour agent monitor.

4. Declarations and other activities prior to the arrival of the inspection team on-site

CD/881 p. 73 paras 1-2, p. 75 paras 3 (a)-(b), p. 76 para 6, p. 77 para 12, p. 78 para 14 (a).

As regards timeframes, some delegations felt that an advance notice of 12 hours would not be enough to enable the inspected facility to have all information and documentation required ready for the inspectors upon their arrival, especially if a material balance was to be established.

It was also pointed out by experts that multipurpose plants are able to shift production in accordance with new production demands, and that such production changes may not be readily foreseen.

5. Advance preparations on-site (cf. items 7 and 24)

CD/881 p. 78 para 14 (b).

By presenting detailed information which would facilitate an inspection, a facility could contribute to shortening the time required and thus reduce the burden on the facility. However, such information would be subject to confidentiality restraints. Some facilities had indicated a readiness to make design alterations in order to facilitate inspections under a Convention.

6. Escort and point of contact arrangements

CD/881 p. 76 para 8, pp. 78-79 paras 14 (c)-(d), pp. 99-100 paras 3-4.

It was suggested that the presence of an interpretor representing the facility should be accepted. Also, a representative of the National Authority could be present to advise the facility.

7. Other participants

No specific comments were made.

8. Duration of initial visit, preparation of facility attachment and inspection respectively

CD/881 p. 77 para 9.

No specific comments were made.

9. Measures to protect confidential information

CD/881 p. 78 para 14 (c), pp. 124-125 paras 2 and 2.1, cf. also p. 79 para 16, p. 100 para 6.

It was suggested that the facility attachment could be divided into two parts, of which the part containing the most sensitive information (photographs, diagrams, etc.) should be kept on-site. The four-stage classification system for confidential information had been tested and found useful also by facility management.

10. Opening conference

No specific comments were made.

11. Types of records needed and/or audited

CD/881 p. 99 para III.2, p. 127 paras 7.1-7.4.

It was pointed out that auditing of records would form a major part of an inspection. Furthermore, the confidence in the inspection result would be greater, the larger the number and types of records used. Some data in the records, which might be extremely sensitive, had not always been made available during the NTIs. Two such examples were names of suppliers and customers.

In this context, a view was expressed that such data would be needed for the establishment of a "national material balance" for a declared chemical. Such a balance might give an indication of whether diversions were taking place, whereas no conclusion on possible diversions could be drawn from the inspection of a single facility.

It was also mentioned that the auditing of records might only prove that these were consistent, not necessarily that they were accurate.

12. Plant orientation tour

A plant orientation tour might not always be required during routine inspections. However, if major changes have occurred since the last inspection, or if some inspection team members have not previously visited the facility, a plant orientation tour would prove useful.

13. Inspection of areas and facility equipment

CD/881 p. 75 footnote 1, pp. 77-78 para 13, p. 117 para 2 (b), p. 124 paras 1 (e)-(f), pp. 124-125 paras 2, 2.1, 3 and 4 (a)-(c), p. 126 paras 5.2 (a)-(b), p. 127 para 10.

It was suggested that, on the basis of NTI experiences, a redrafting of para 4 in the Model for an Agreement (CD/881 p. 125) might be considered. One delegation had made use of video recording of the NTI and indicated that such a (confidential) recording might be useful for clarification of ambiguities regarding sample-taking as well as for detection of future changes.

A view was expressed that a three-stage approach could be developed for inspections; if no anomalies were detected during one stage, the inspection would be terminated. Otherwise it would proceed to the next stage.

14. Inspection of operation procedures

CD/881 p. 79 para 14 (d) fourth tick, p. 99-100 para 4, p. 125 para 4 (d), p. 127 para 8.

The scope of the inspection has to be clearly defined, and could include e.g. the specific operation unit and associated units as well as storage areas and the control centre for the facility.

It was emphasized that the inspectors should not be allowed to operate facility equipment; this should be done, upon request, by facility personnel in the presence of inspectors.

15-18. Sampling and sample-taking procedures, handling of samples, analysis of samples and type(s) of sample(s)

CD/881 pp. 78-79 para 14 (c)-(d) and footnote 2, p. 126 para 6.

Several delegations expressed the view that off-site analysis should only be conducted if no suitable equipment was available on-site or in exceptional cases. Some delegations pointed out that off-site analysis, using ultra-sensitive techniques, might be required for proving the absence of Schedule [1] chemicals.

The scope of the off-site analysis and the origin of samples were also commented upon. Analysis for impurities could create confidentiality problems, depending upon the stage in the process at which the samples had been taken. Feedstock and end-product samples did not seem to create as much of a problem as samples taken during the actual process.

It was suggested that the identity of samples could be kept confidential during off-site analysis by a sample-coding system.

19. Documentation

CD/881 p. 79 para 16; p. 126 para 5.2; p. 127 paras 7.2-7.4.

One view was expressed that the documentation to be taken out of the inspected facility should be identified in the facility attachment. Several types of records and other data had been identified during NTIs as highly confidential, and should therefore not be taken out of the facility.

20. Evaluation by inspectors

CD/881 p. 79 para 16.

It was suggested that some guidelines for the inspectors on how to evaluate the results of various activities and their interrelationship might be desirable. It was also pointed out that, in case the inspection team was divided in separate groups during the inspection, the final evaluation had to be a joint assessment of pooled results.

21. Closing conference

CD/881 p. 79 para 16.

A view was expressed that during the closing conference, the resulting inspection documentation might be divided into what could be taken out, what should be kept at the facility, and what should be destroyed.

22. Anomalies, disputes and complications

CD/881 p. 79 para 17.

It was pointed out that disputes may occur due to the nature of facility-accountancy methods. This was exemplified by difficulties encountered in connection with use of computerized material-accounting records.

23. Report by inspectors

CD/881 pp. 78-79 paras 14 (c) and 16, p. 100 para 5, 6 and 7.

It was generally felt that a common report format was highly desirable. One delegation pointed out that a common report format might reduce subjective assessments. A draft report should be prepared by the inspectors on-site, before their departure. The report should only contain the minimum information necessary.

A view was expressed that the report might usefully be divided into two parts: one to be brought to the Technical Secretariat and the other to remain at the facility to facilitate subsequent inspections.

25. Other matters

a. Number, frequency and timing of inspections

CD/881 p. 117.

Various opinions were expressed regarding whether an inspection should take place during on-going production, between production runs or at random. As regards multipurpose facilities, it was pointed out that although a facility might be able to change its processes swiftly, pipelines and storage tanks may be dedicated to the declared production process.

It was suggested that the establishment of a material balance might be more difficult if production was taking place. It was also noted that the timing of an inspection should be such as to preclude prediction of exactly when the inspection would take place.

b. Confidentiality matters (cf. paragraph 9 above)

No specific comments were made under this item, but the problem of confidentiality was referred to under numerous other items.

c. Cost aspects

The costs of inspections would be of two types: costs for the facility due to e.g. involvement of its personnel in the inspection, and costs to be borne by the Technical Secretariat. The opinion was offered that costs of the former type would be small in comparison to the latter. It was suggested that the costs for routine inspections might be reduced in the future by use of standardized forms and equipment.

CONFERENCE ON DISARMAMENT

CD/CW/WP.238
10 April 1989

Original: ENGLISH

Ad Hoc Commitee on Chemical Weapons

AUSTRIA

Provision of data relevant to the Chemical Weapons Convention

In order to contribute to the negotiations on the Chemical Weapons Convention, Austria presents below data according to the outline in document CD/828 of 12 April 1988. Austria considers the transmission of such information as a confidence-building measure of great importance.

The data on the production and/or use of chemicals, relevant to the convention, by the Austrian chemical industry, summerized in Table 2, were provided on a voluntary basis by the member companies of the Federation of the Austrian Chemical Industry (FCIO; Fachverband der chemischen Industrie Österreichs). The data provided refer to the already approved sections of schedules 1 to 3 and concern the situation in 1988 including all information obtained by 20 February 1989. Based on the presently available evidence, the given data represent the actual situation within the member companies of FCIO, whereby a reasonable margin of error cannot be excluded.

Table 1

AUSTRIA

Type of Data	Information
1. Presence of CW on territory:	No
Possession of CW on territory of another State:	No
2. Aggregate number of facilities for the production and storage of CW:	None
Aggregate number of facilities for production, processing and consumption of permitted chemicals on schedules [1],[2],[3] above thresholds indicated in document CD/881 of 3. February 1989:	Four
3. Types and names of CW agents produced:	Not applicable *)
Types of CW ammunition stored; CW agents in bulk:	Not applicable
4. Plans and methods for the destruction of CW including the number of facilities and the anticipated length of their operation during the 10 year destruction period:	Not applicable

*) Austria does not possess chemical weapons.

Table 2

AUSTRIA

Detailed information concerning point 2 in Table 1

	Number of facilities	Chemicals produced, processed or consumed
Schedule 1	None	None
Schedule 2 and 3	Four	N,N-Dimethyl-Aminoethanol (108-01-0)
		Triethanolamine (102-71-6)
		Hydrogen cyanide (74-90-8)
		Phosphorus oxychloride (10025-87-3)
		Phosphorus trichloride (7719-12-2)
		Sulphur monochloride (19925-67-9)

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Phosgene (75-44-5): Production significantly below thresholds

CONFERENCE ON DISARMAMENT

CD/CW/WP.239
11 April 1989

Original: ENGLISH

Ad Hoc Committee on Chemical Weapons

UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

Verification of the Non-production of Chemical Weapons: an illustrative example of the problem of novel toxic compounds

Introduction

1. Considerable attention is currently being given in the negotiations to procedures for a régime of declaration and inspection of those chemicals which would pose a high risk to a Chemical Weapons Convention but are not suitable for inclusion in any of the schedules at present envisaged in the rolling text. The purpose of this paper is to present one particularly relevant example of such a chemical and to consider some of the questions which will need to be addressed to ensure that these chemicals are covered by the Convention.

2. The prohibition against chemical weapons in the Convention would apply to all toxic chemicals except such chemicals intended for purposes not prohibited by the Convention as long as the types and quantities involved are consistent with such purposes. So far provisions in the rolling text relating to verification have focused upon those chemical weapons for which information is publicly identified. Yet use or manufacture of such weapons date from either the First World War, or in the case of manufacture of nerve agents the Second World War or shortly thereafter. There have been major advances in processing and technology in the chemical industry since then. Such advances need to be embraced within the chemical weapons negotiations. The delegation of France has (in CD 747) already drawn attention to the need to ensure that the Convention will effectively respond to such industrial developments.

3. In another area of arms control the need to scrutinize the relevance of scientific advances has been acknowledged in a number of submissions to the 1986 Biological Weapons Convention Review Conference. Here attention was drawn to changes in biotechnology which make it easier to produce large quantities of certain chemicals of biological origin, such as toxins and peptides, that may have military significance. Although these developments have been noted in the context of the Biological Weapons Convention, the United Kingdom considers that these and other advances in chemical technology are also relevant to the chemical weapons negotiation.

An example of Novel Toxic Compounds

4. The general issue of novel toxic compounds can be illustrated by examining one particular compound, perfluoroisobutene (hereafter referred to as PFIB) which has been chosen less for its own particular characteristics than for the light it sheds on the category of compounds to which it belongs.

The Problem of By-Products

5. There have been references in chemical literature of the 1960's which have suggested that various poly- or perfluorohydrocarbons possessed highly toxic properties. Such substances can be produced from the thermal decomposition of plastics containing fluorine. Their toxic properties suggest that these substances might be suitable for use as chemical warfare agents.

6. One such chemical identified from the literature is perfluoroisobutene (PFIB): this has a toxicity of about 1,000 mg min./m^3 which is broadly similar to that of hydrogen cyanide. PFIB appears industrially (see Annex) as an (unwanted) by-product during the pyrolytic production of tetrafluoroethylene (TFE) from chlorodifluoromethane (CDM). TFE is a dangerously explosive substance but when it is polymerized it affords a chemically inert, non-toxic solid called polytetrafluoroethylene (PTFE). This chemical is used industrially as a lining from vessels and domestically as the non-stick coating for cooking utensils.

7. The industrial manufacture of TFE from CDM uses temperatures, dilutions and pyrolytic residence times which are selected to maximize the yield of TFE. Under these conditions PFIB by-product occurs to the extent of approximately 0.1 per cent of all pyrolysis products. However, were the reaction conditions to be altered the quantity of PFIB could be increased.

8. PFIB is not known to have any use in western civil industry and is accordingly incinerated to afford non-toxic inorganic residues. However, one of the other substances (see Annex) accompanying the manufacture of TFE is called hexafluoropropene (HFP) and the quantity of this material produced as opposed to TFE depends upon the reaction conditions selected. HFT, like TFE, has considerable application in the polymer industry, and can be pyrolized at 700-800°C to afford PFIB in yields of up to 30 per cent. Thus it can be seen that a civil fluorocarbon plant might well have the ability to produce clandestinely enhanced quantities of PFIB by selecting the appropriate reaction conditions.

Possible Implications of Novel Toxic Compounds for the Convention

9. The high toxicity of PFIB, its possible suitability as a chemical warfare agent and its potential for clandestine production at civil chemical facilities would suggest that further consideration will need to be given to it and other similar high risk novel toxic compounds subject to declaration and inspection through inclusion in the schedules of article VI. However, the case of PFIB illustrates the difficulties of bringing such a chemical into these schedules as they are currently formulated in the rolling text.

10. As PFIB has no recognized civil industrial applications and is supertoxic lethal, it may fulfil guidelines 2, 3 and 4 for Schedule [1] (CD/881, page 112). However there are two important consequences of this approach.

First, PFIB would become one of the chemicals that counted towards the one tonne aggregate of STLCs for purposes not prohibited by the Convention. Second, as all production of such chemicals (except for agreed exemptions) has to be undertaken at the single small scale facility (SSSF) it would be a breach of the Convention to produce PFIB elsewhere. The corollary of this is that manufacture of PTFE could only proceed at the SSSF. For both these reasons inclusion of PFIB on Schedule [1] as it now stands would be impracticable.

11. Since PFIB is not a key precursor its inclusion in schedule 2 as currently constructed (in CD 881) would also not be appropriate. And the apparently high degree of risk posed by PFIB to the Convention would seem to make it unsuitable for schedule 3.

12. Nor would the inclusion of PFIB in the putative schedule [...] necessarily help in view of the relatively low (kilogramme) quantities envisaged for declarations under this Schedule. The actual production of this chemical at any one plant may be very low (and it is in the interest of chemical manufacturers operating in commercial circumstances to reduce such unwanted by-products to the minimum). Yet the risks to the Convention would arise through some slight modification to the chemical process in order to optimize PFIB output.

13. These considerations indicate that the verification régime in the convention must be capable of responding effectively to new developments and new appreciations in chemistry or chemical processing technology. This is an important aspect of the wider efforts currently being made in the negotiations to ensure that the range of schedules cover all chemicals which pose a high or medium risk to the Convention. A number of valuable proposals have been made including that for the creation of a sub-schedule 2B. This may represent the way forward.

Questions for Discussion

14. The following seem to be the main questions to be considered in relation to the wider problem of novel toxic compounds:

(i) how to modify the structure and guidelines for the Schedules of Article VI in order to allow inclusion of novel toxic compounds where the degree of risk justifies it;

(ii) how to complete the inspection framework so that facilities, whether declared or undeclared, which might be producing novel agents of high or medium risk to the Convention, are covered by an effective system of inspection. The United Kingdom proposal for ad hoc inspections might assist in this regard;

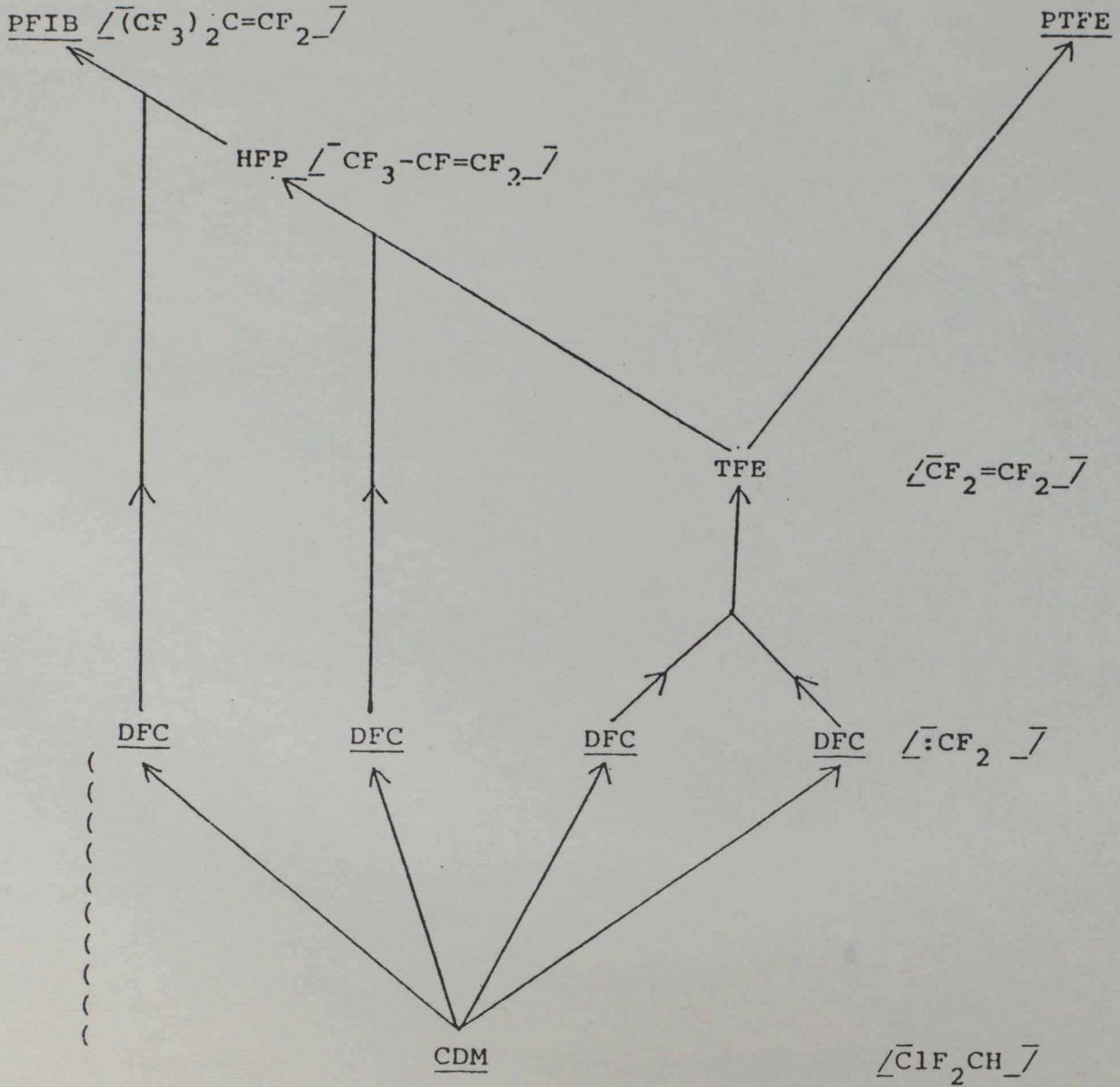
(iii) how to ensure that the Convention is responsive to scientific developments after its entry-into-force so that those new toxic agents posing a possible risk are brought swiftly to the attention of the organization. There seems a role here for individual States, the Technical Secretariat and a Scientific Advisory Council if one is established. In particular procedures will be required for speedy modification of Schedules after entry-into-force in order to include novel toxic agents of risk to the Convention;

(iv) how to meet the need for the detailed operational provisions under the various monitoring régimes to keep up with the pace of scientific advance. An ongoing process of updating will be needed after entry-into-force;

(v) are any special provisions necessary in the Convention to deal with substances of concern which arise incidentally to the production of permitted chemical?

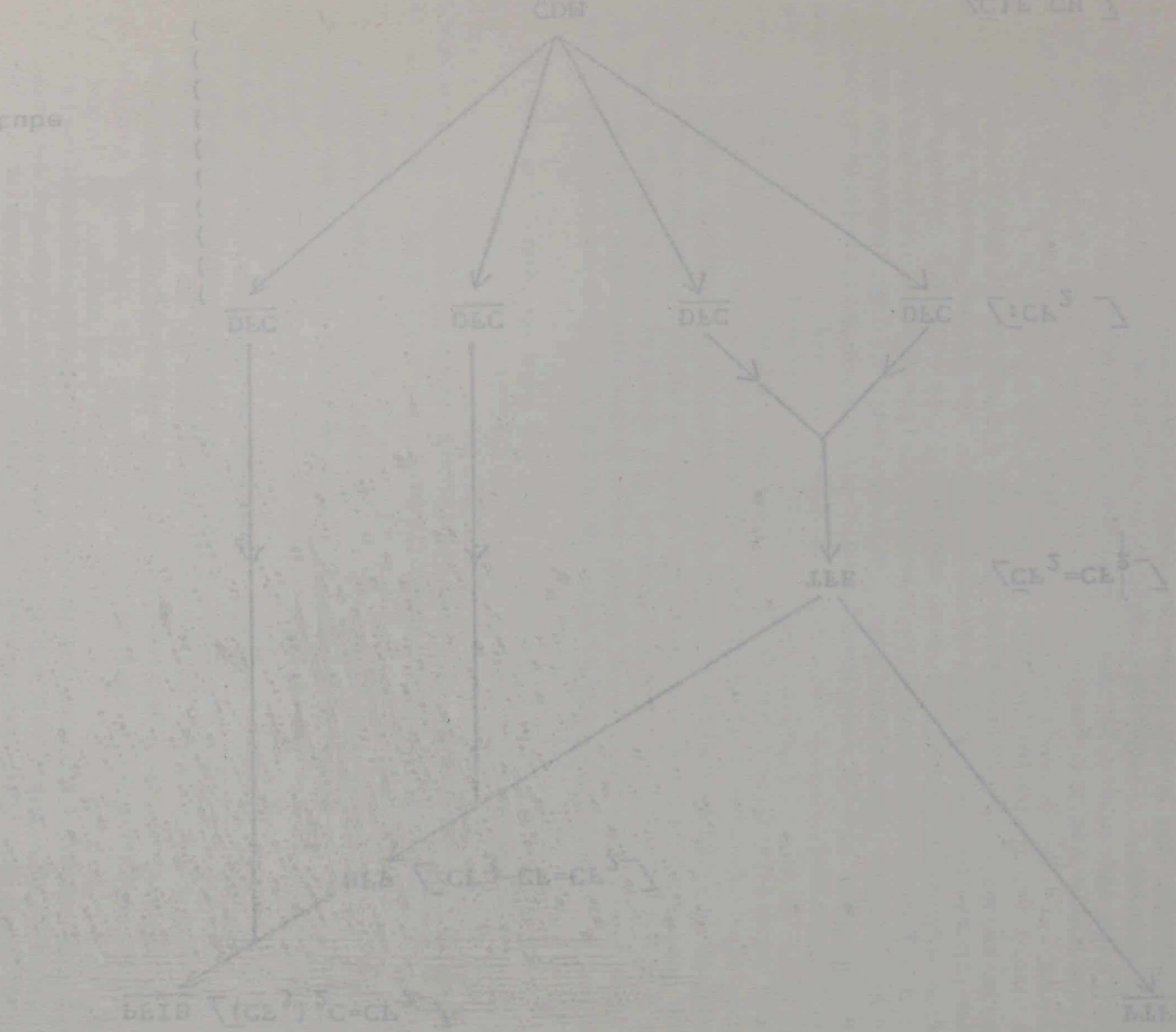
OUTLINE REACTION FOR PRODUCTION OF POLYTETRAFLUORETHYLENE/PERFLUOROISOBUTENE

FROM CHLORODIFLUOROMETHANE



700°C

Platinum tube



France	CD/CW/WP.240	National Trial Inspection NOT REPRODUCED (see WP volume)	Also issued as CD/913 11 Apr. 89

CONFERENCE ON DISARMAMENT

CD/CW/WP.241
12 April 1989

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Ad hoc Committee on Chemical Weapons

GERMAN DEMOCRATIC REPUBLIC

Working Paper

Multilateral Trial Inspections (MTIs)

A. Proposals for the preparation and conduct of MTIs

1. Valuable experience has already been gathered by National Trial Inspections (NTIs), and in discussions held during the experts weeks where information was also made available about NTIs on which no report had been given. This would allow to start the first MTIs already before the evaluation of all NTIs has finally been concluded, which will be due during the summer session.

2. MTIs should be geared to specific objectives. They should be used to complete and supplement the conclusions pertaining to the relevant provisions of the Convention. Therefore, it would be advisable to identify such issues which ought to be studied primarily on a multilateral basis.

3. One or several facilities, which seem to be most suitable, could be identified for each task. For this reason, States should indicate, as soon as possible, whether they are prepared to host a MTI.

4. MTIs should be conducted in a way being as realistic as possible in terms of a future régime. They should not simply reflect the experience and concepts developed during NTIs, but allow for direct involvement of invited participants in inspection activities. It would, however, be advisable that the host country be given a leading role in view of the fact that the invited participants will have insufficient detail knowledge about the facility in case, and taking into account time constraints for the conduct of such inspections.

5. With a view to facilitating a realistic and effective conduct of MTIs, the number of invited participants (preferably experts) should be kept within reasonable limits.

B. Possible tasks for MTIs

It is advisable to draw up a list of specific tasks to be solved by MTIs, making use of the experience and results of NTIs. For this purpose, the following problems could, inter alia, be studied:

1. Preservation of confidentiality during the initial visit and in negotiations of a facility agreement.

2. Technical aspects of material balance verification, including aspects of verification effectiveness, statistical reliability, and preservation of confidentiality.

3. Possibilities to detect illegal activities at a facility after these activities have ceased for a certain period of time.

4. The potential of instrumental monitoring at industrial facilities.

5. Technical and procedural aspects of ad hoc-type inspections and challenge inspections.

C. Organization of MTIs

1. Given the voluntary character of the participation in MTIs, these could be organized in different ways. Interested States could, e.g. reach agreement among themselves about the conduct of bilateral or multilateral trial inspections. It would, however, be good to also have some MTIs conducted directly in the framework of the Ad hoc Committee on Chemical Weapons. In the latter case, it would be essential to have a mechanism for planning these inspections, including identification of suitable tasks, the selection of corresponding facilities as well as composition of the team of inspectors and observers.

2. The following suggestions are made for such a mechanism:

- States which are ready to host a MTI could inform the Chairman of the Ad hoc Committee about their facility and the proposed objectives for a MTI.
- States could also notify the Chairman of the Ad hoc Committee of the experts they would be ready to send on inspection teams. This information should also contain details about the qualifications of the experts. Recognizing the importance of chemical expertise, diplomats could also be eligible as inspectors or observers. Furthermore, it would be appropriate if a member of the Secretariat would be one of the inspectors or observers.

- The Chairman of the Ad hoc Committee could, with the assistance of the Committee's Secretary and on the basis of consultations which he would conduct with the host State and delegations, identify and reach agreement on the specific objectives for MTIs, the corresponding facilities and the composition of the inspection team and the group of observers. It would be appreciative if the special experience of the Swedish delegation in the preparation of trial inspections could conduce to this work.

France	CD/CW/WP.242	The Scientific Advisory Council	Also issued as CD/916 17 Apr. 89

NOT REPRODUCED
(see WP volume)

Belgium	CD/CW/WP.243	National Trial Inspection NOT REPRODUCED (see WP volume)	Also issued as CD/917 17 Apr. 89

CD/CW/WP.244 Programme of Work of the Committee During the Second Part of the 1989 Session 13.6.89

NOT REPRODUCED

UK	CD/CW/WP.245	Verification of the Chemical Weapons Convention: Practice Challenge Inspections of Military Facilities	Also issued as CD/921 14 Jun. 89

NOT REPRODUCED
(see WP volume)

CONFERENCE ON DISARMAMENT

CD/CW/WP.246 */
22 June 1989

Original: ENGLISH

Ad Hoc Committee on Chemical Weapons

JAPAN

Guidelines for Initial Visit and Verification Inspection

Japan has recently submitted to the Ad-hoc Committee on Chemical Weapons a report on its national trial inspections (CD/CW/WP.228). In the report, it was emphasized that "model" guidelines needed to be worked out with regard to the initial visit and the verification inspection in order to achieve verification objectives effectively, while paying due regard to the protection of confidential information.

This Working Paper is intended to present possible elements of those "model" guidelines which could be useful in carrying out verification measures in facilities related to Article VI [2]. The paper consists of two parts, i.e. a "Mode of Initial Visit" and a "Mode of Verification Inspection".

It is hoped that this Working Paper will contribute to the development of effective means of verification, thus furthering the treaty negotiations.

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*/ Re-issued for technical reasons.

PART I: MODE OF INITIAL VISIT

1. Opening conference

- Introduction of participants (the facility side as well as the Inspector side).
- Confirmation of inspection objectives.

2. Explanation of the inspected facility

- Explanation by the facility side, using prepared materials. Questions and answers between inspectors and the facility personnel.
- Standardized format on common elements for explanation should be worked out by the Technical Secretariat. In accordance with this format, the facility side is expected to prepare documents in advance. However, when the existing documents in the facility are available for explanation, those documents could be used.

(1) Explanation of the general situation of the facility

- Outline of the facility (location of plants, for instance), final products, etc.

(2) Explanation of the contents of the initial declaration

- Explanation is made of each item of the initial declaration.
- Additional information as referred to in (3) below should be given before confirmation of records on production quantities and concrete explanation on production capacity.

(3) Explanation of additional information

- Minimum information should be requested to meet the objectives of the initial visit as indicated in Annex to Article VI [2].
- Inspectors may request necessary information, taking account of the characteristics of each facility. Common pieces of additional information could be as follows:

(a) Information on production equipments such as "process flow sheet"

- "Process flow sheet" can be regarded as an advance data for carrying out visual observation.

It needs to explain the role of main equipments of the plant, which is necessary for checking material-balance correctly. It also has to be conducive to confirming the reaction-process up to end-products, including the possibility of taking out materials in the course of reaction.

(Therefore, it is not necessary to ask for the provision of data on such details as reaction conditions of plant equipments and the quality of equipments.)

(b) Raw materials (kinds of materials and methods of delivery)

- "Materials" means, in this context, only those which are related to the chemical structure of end-products and which are needed for checking a material-balance between materials and products. Chemicals such as catalysers and solvents are not to be included.

(c) Outline of storage and shipment equipments (including methods of weighting materials and products).

(d) Outline of how to dispose of wastes and effluents.

(e) Outline of records from production to shipment.

- The facility side needs to provide samples of annual, monthly and daily reports (specific destinations can be kept secret) and explain how it makes such reports.
- As to records or books, particularly necessary to confirm the contents of initial declaration, inspectors may request their submission.

(f) Material balance

- In confirming a material balance, it is desirable to concentrate not on all raw materials but only on those materials which decide the main structure of end-products. In an ordinary case, this method is supposed to be sufficient.

(g) Other additional information (on sampling and monitoring instruments)

- As to sampling, it is desirable for inspectors to make use of sampling points already used by the inspected facility. From this viewpoint, the facility side is expected to explain if and how samples are taken.
- When there are instruments which are already installed at the facility and deemed appropriate to be used for inspection, it is desirable for the facility side to provide relevant information.

3. Observation on-site

- The observation should be made basically in accordance with the methods and routes suggested by the facility side. Those methods and routes, however, may be changed by inspectors, based on information relating to (2) and (3) of 2 above.

(1) Observation tour in the whole facility by bus

- Confirmation of explanation made in accordance with (1) of 2.

(2) Observation tour in the plant concerned

- Confirmation of information provided in 2.(2) and (3)(a)(b)(c)-(d) above by means of "walking through".
- Exchange of views on sampling points and the installation of monitoring instruments.

4. Questions and Answers

- Efforts should be made to clarify doubts or ambiguities, based on the explanation above. If necessary, additional information may be provided by the inspected facility.

5. Working out of "Facility Attachment"

- In accordance with the present "Rolling Text", a "Facility Attachment" is to be concluded within [6] months after the entry-into-force of the Convention. Since the "Facility Attachment" covers detailed items such as sampling points on which inspectors need to consult the facility side, it is supposedly difficult for inspectors to work on the "Facility Attachment" efficiently after the initial visit. In that case, moreover, inspectors may have to take confidential information out of the facility. It is, therefore, desirable to reach a basic agreement on the "Facility Attachment" at the time of the initial visit.
- In order to work out the "Facility Attachment" smoothly, it could be advisable that the facility side works out a draft "Attachment" on the basis of a "model agreement". Inspectors could then carry out an initial visit with this draft in mind and make necessary modifications of the draft at the end of the initial visit.

6. Closing conference

PART II: MODE OF VERIFICATION INSPECTION

N.B.: The mode of verification inspection could differ from facility to facility, depending upon chemical materials to be dealt with, kinds of facility (e.g. multi-purpose or single-purpose, production or consumption facility), etc. Although this may make it difficult to work out a common guideline, such a guideline is believed to be important in conducting a verification inspection.

1. Introduction of a "step-by-step inspection"

(1) As proposed in CD/CW/WP.228, it is worth while to consider introducing such a "step-by-step inspection" method as follows:

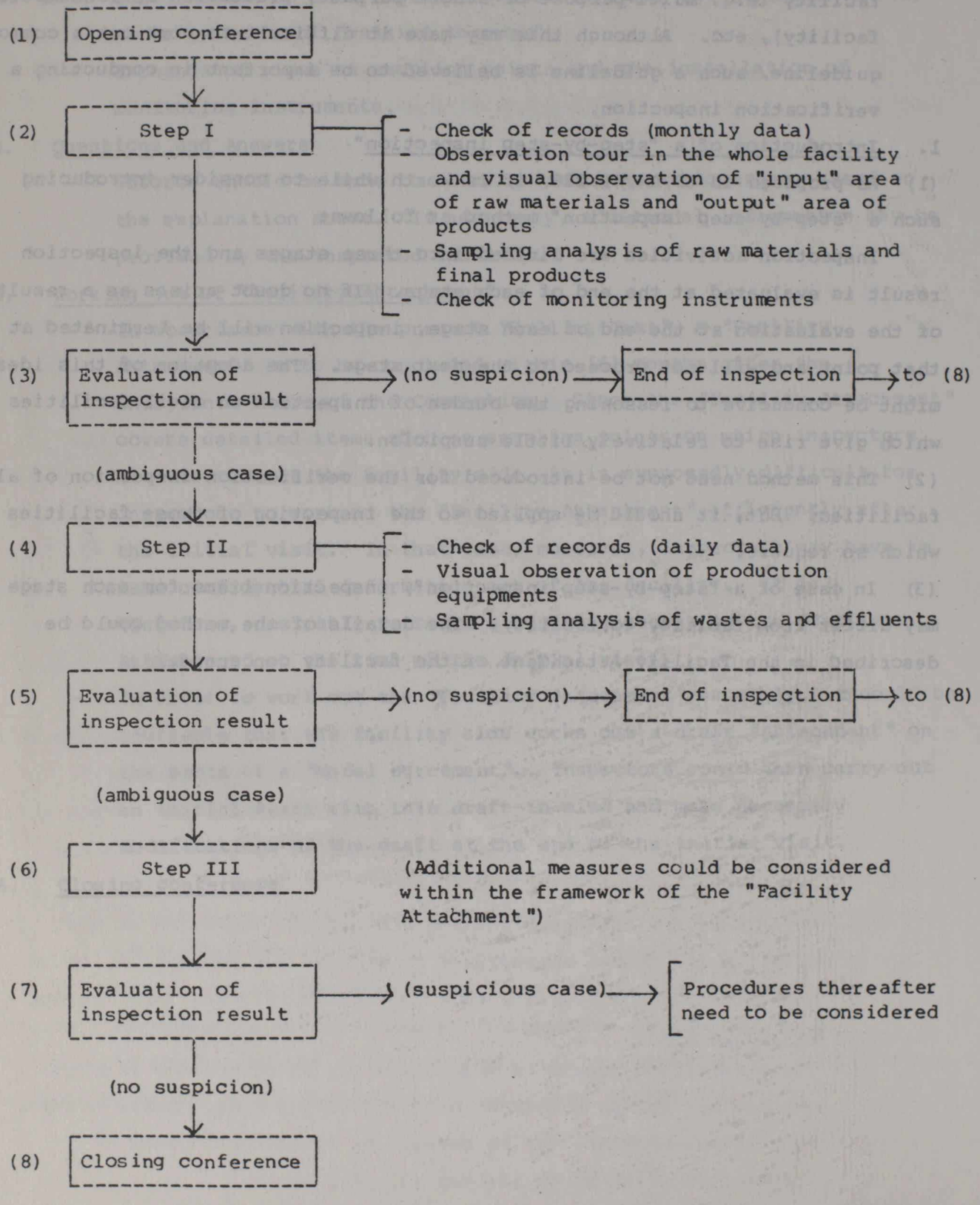
Inspection activities are divided into three stages and the inspection result is evaluated at the end of each stage. If no doubt arises as a result of the evaluation at the end of each stage, inspection will be terminated at that point and will not proceed to the next stage. The adoption of this idea might be conducive to lessening the burden of inspection on civil facilities which give rise to relatively little suspicion.

(2) This method need not be introduced for the verification inspection of all facilities. But, it should be applied to the inspection of those facilities which so request.

(3) In case of a "step-by-step inspection", inspection items for each stage may differ from facility to facility. The details of the method could be described in the Facility Attachment of the facility concerned.

2. Possible implementation scheme of a "step-by-step inspection" (at facilities producing Schedule [2] chemicals)

A. Flow Chart



B. Some details of a "step-by-step inspection"

(1) Opening conference

(i) Introduction of participants.

(ii) Explanation of the general situation of the facility (modification of the initial declaration, if any).

(iii) Confirmation of the facility attachment, documents provided, inspection method (schedule, list of documents to be inspected, monitoring instruments, etc.), and safety standards in the facility.

(2) Step I

(i) Check of records.

(a) Monthly data on production, consumed raw materials, self-consumption, shipment, disposal of wastes, storage of products, etc. for the last calendar year (and those of the current year).

(b) Material balance.

(ii) Visual observation.

(a) Observation tour in the whole facility.

(b) Inspection by means of checking "input" area of raw materials and "output" area of products.

- input (stored amounts of materials, equipments for supplying materials, etc.).

Areas where feed chemicals (reactants) are deliverd and/or stored.

Areas where reactants are processed before they are put into the reaction vessel.

Feed lined from those areas to the reaction vessel (together with only associated valves, flow meters, etc.).

- output (amount and capacity of storage, form of shipment, etc.).

Lines from the reaction vessel leading to long- or short-term storage tanks.

Lines used for further processing of the chemical concerned.

Areas for packaging and shipment of products.

(c) Check of disposal method of wastes and effluents.

Equipments and areas for dealing with wastes and effluents and for disposing of off-specification chemicals.

(iii) Sampling analysis of materials and products.

Identification of materials and products as to whether they are those reported.

(iv) Check of the functioning of the installed permanent monitoring instruments (if any).

(3) Evaluation of inspection results

(i) Inspectors evaluate:

- whether there is any ambiguity or suspicion with regard to "non-production" of Schedule [1] chemicals,
- whether there is any discrepancy with the declaration,
- whether suspicious substances were found by means of sample analysis,
- whether the objectives of verification were achieved.

(ii) If inspectors do not find the verification objectives achieved sufficiently, they could proceed to the next step, pointing out to the facility the reasons for further inspection (Step II inspection may not necessarily be carried out with regard to all items mentioned below).

(4) Step II

(i) Check of records

Daily data on production, consumed materials, self-consumption, shipment, disposal of wastes, storage of products, etc. for the last calendar year (and the current year) (e.g. inspectors check daily data of one month which is randomly selected and, if necessary, check those of another month complementarily).

(ii) Visual observation of production equipment

- exterior of the reaction vessel and its ancillary equipment.
- control devices of production equipment

(iii) Sampling analysis of wastes and effluents

Analysis for the presence of Schedule [1] chemicals concerned.

(5) Evaluation of inspection results

It is checked whether verification objectives, which had not been sufficiently achieved, have been achieved.

In almost all cases, verification objectives are supposedly attained by the end of Step II.

(6) Step III

How to carry out a Step III inspection depends on the ambiguities or suspicions which still remain at the end of Step II. (It may be found necessary, e.g. to check the capacity and quality of the reaction vessel, to check the operating temperature and pressure level of the vessel during its operation, or to analyse samples of intermediate products).

(7) Evaluation of inspection results

When suspicions still remain even at the end of Step III, further measures need to be considered. (This problem will have to be addressed not as part of routine inspection but in a broader context).

(8) Closing conference

(i) Inspectors prepare a draft report and the facility side checks facts in the draft report.

(ii) Confirmation of documents to be taken out and those to be kept in a safe for inspectors.

(iii) When an inspection fails to resolve suspicions, inspectors are expected to give the facility side a clear explanation on their suspicions. (The facility side may request inspectors to carry out a complementary inspection with a view to clearing away the suspicions, if possible, by another method which is not provided in the facility attachment).

CONFERENCE ON DISARMAMENT

CD/CW/WP.247
16 June 1989

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Ad Hoc Committee on Chemical Weapons

SWITZERLAND

Report on the National Trial Inspection

1. Introduction

In order to contribute to the progress of the on-going negotiations for a Convention of a global, total and verifiable ban of chemical weapons, and pursuant to the proposal of the Ad Hoc Committee in its summer session 1988, Switzerland conducted a National Trial Inspection (NTI) at a facility belonging to the Swiss chemical industry in the spring of 1989. Despite the short period of time available for preparation, a realistic routine inspection was carried out.

The plant, facilities and chemical substances examined in the course of the NTI were in fact unsuitable for the production of chemical weapons and chemical warfare agents. It should be stressed in this respect that the experiment took place in a country which rejects chemical weapons in all forms.

The delegation of Switzerland to the Conference on Disarmament expects the results of the Swiss NTI to be discussed by the Ad Hoc Committee with a view to improving procedures for genuine routine inspections. To this end, it is ready to discuss the results of this experiment with other delegations at the Conference on Disarmament.

This working paper presents the results of the Swiss NTI. It has been drafted in such a way that no conclusions may be drawn with respect to the identity of the inspected chemical facility or to the details of the chemical process inspected.

The facility (plant) attachment, declaration and inspection mandate, as well as the inspection report, which were made in the course of the NTI, are at present available only in German and can be requested from the delegation of Switzerland to the

Conference on Disarmament. English translations of these technical annexes will be ready by August 1989.

Preparations

All inspectors were Swiss citizens bound by strict rules regarding the protection of confidential information.

The experiment as a whole was supervised by representatives of the Swiss Government. These representatives are responsible for the contents of this report.

2. Objectives of the NTI

The NTI was planned as a routine inspection which had the following objectives:

- to determine whether, at the time of the inspection, data on the production, processing and consumption of chemicals listed in Schedule (2), together with the book-keeping and the resulting utilisation of the chemical facility were consistent with the declaration;

- and to verify that the declared facilities were not being used to produce any chemical listed in Schedule (1).

The NTI had the following objectives:

- to determine whether the inspection procedures laid down in the Draft Convention are appropriate to verify in a non-intrusive manner that the declared data on production, processing and consumption of Schedule (2) chemicals are correct;

- to determine which confidential business documents and technical data and software should be disclosed to inspectors so that the latter can fulfil their tasks in as non-intrusive, cost-effective and speedy a manner as possible.

2.1. The Degree of Realism of the NTI

In order to be certain that the NTI conformed as closely as possible to the procedures enumerated in the Draft Convention, the following precautions were taken:

- the elaboration of the facility (plant) attachment was assigned to a team A, and the inspection was carried out by a team B, a third team C assessed the results of the NTI;
- the team B was informed of the facility and chemical process to be inspected only a short time before the start of the inspection;
- in the course of organizing the NTI, much time was spent on careful preparation of the documentation in order to ensure an objective attitude on the part of the inspectors;
- the representatives of the facility who accompanied the inspectors were under orders to answer direct questions only and to be restrained in offering advice.
- the staff at the facility were not informed in advance of the objectives or the purpose of the inspection.

2.2. The Selection of the Teams

The complexity of modern chemical plants required that members of both teams A and B should have a good background knowledge of chemical engineering. Team members with only rudimentary knowledge would become over-dependent on the support and help of members of a company.

In addition, members of team B had to be familiar with the organisation and operation of a modern industrial chemical plant. Such extensive chemical expertise, together with knowledge of corresponding business administration techniques, is in fact always essential when chemical processes and mass balances have to be checked on the basis of confidential business documents and technical data provided by a chemical company. Because of the

different types of technical expertise required team B had to be split into the subdivision B "facility" and subdivision A "logistics".

It was also necessary to select team members who were familiar with the Draft Convention and general philosophy of a routine inspection.

2.3. The Selection of the Facility

In order to ensure that the facility was in fact representative for Switzerland, a modern multi-purpose facility was chosen.

A computer-controlled multi-purpose facility is a facility composed of individual modules which can be so combined that a wide range of chemical process can be carried out as required according to pre-programmed procedures arranged in batch and continuous mode.

The multi-purpose facility inspected was part of a chemical production plant which also contained other multi-purpose facilities on the industrial site of a Swiss chemical company. The site also included research, other production, storage and administrative buildings.

2.4. The Selection of the Chemical Substance

In view of the NTI's objectives of testing the provisions for inspection contained in the Draft Convention, it was in fact irrelevant whether the facility actually inspected produced, consumed or processed a Schedule (2) chemical. Nevertheless, it was important that the chemical substance selected, called substance A, should have a certain similarity to a Schedule (2) chemical. This similarity was assured as follows:

- the chemical process chosen comprised basic operations which would also take place in the production, consumption and process of Schedule (2) chemicals;

- parts of the chemical process necessitated comprehensive security measures and special procedures at the facility;

- the chemical substance A was a precursor material, which could be in a later stage be processed into an end product B;

- substance A and end product B were capable of storage.

2.5. The Confidentiality of the NTI

Far-reaching guarantees respecting the protection of confidential information and data provided by the company were an important condition for carrying out the NTI. In this connection, the following conditions were agreed with the company:

- confidential business documents and technical information, together with software, would be consulted only at the premises of the facility;

- as far as possible, only data material stripped of confidential information would be consulted.

- the teams of inspectors would consist of Swiss citizens only.

3. The Conduct of the NTI

3.1. The Elaboration of the Facility (Plant) Attachment

Following an initial visit to the facility which was subject to the declaration, a facility (plant) attachment was elaborated with the help of the company. The preparation of this document required less time than originally planned, since the information and data provided by the company were both complete and comprehensive.

Since the period allocated to the inspection was shorter than the time required for completion of the batch, it was necessary, on the basis of the chemical process itself and of the activities of the facility staff involved, to identify in the mandate

those stages of the batch which should be most appropriately subject to inspection. In this case, it was agreed with the facility staff that the beginning of the inspection should coincide with the beginning of the batch.

Although the text of the facility (plant) attachment as contained in the Draft Convention seemed quite clear about what was to be inspected, doubts did in fact arise about the precise role of this document in the inspection process for the following reasons:

- the facility (plant) attachment contains much information which is of only limited utility for the inspectors and the inspection process; the inspectors are above all interested in information which provide them with concrete indications as to how they should proceed during the inspection and the precise data which will be at their disposal;

- with regard to a complex containing many production plants with multi-purpose facilities much of the information available in the facility (plant) attachment is relevant only for a limited period of time and could indeed cease to be relevant after only one routine inspection - if, for example, production were shifted to another multi-purpose facility or if constructions and other modifications at the production plant were carried out (at the time of this particular inspection the production plant was being adjusted to new environmental provisions) or if chemical processes should be changed.

- interruptions in production due to accidents and strikes could change the prerequisites for inspection at very short notice.

For these reasons, Team A reached the conclusion that the facility (plant) attachment should contain only the following information and guidelines:

- a general description of all facilities on the site and of the chemical processes which were subject to the declaration:

- the degree of access to and conditions of use of confidential business information and technical data.

- a list of appropriate inspection tasks.

Specific information about the facility and the chemical process in question was communicated by the company in the form of an introductory briefing to team B at the beginning of the inspection.

With the assistance of company administrative staff, an inspection mandate was worked out. This contained proposals for inspection in the shape of checklists and forms. As far as possible, this mandate took account of the verification objectives contained in the Draft Convention. In addition, it was specifically tuned to the process to be inspected. However, the inspectors themselves were left to decide precisely how these instruments were to be used.

3.2. How a Declaration was to be made

No important difficulties - except for the notification of the declared facility - arose in working out how a declaration was to be made according to the model provided in the annex to Article VI(2) of the Draft Convention. All necessary information was provided by the company. For the purpose of the NTI, no aggregate national declaration regarding the production, processing or consumption of the chemical substance inspected was made.

3.3. Routine Inspection

The task of the inspectors was to determine whether the chemical plant and process inspected as well as the relevant data on the mass balance were identical with those described in the declaration. The results were to take the form of an inspection report.

4. Presentation of the Results of the NTI

In the following pages, we present the results of the NTI on the basis of the elements contained in document CD/CW/WP. 213. It also follows the format and the numbering system of this document.

A. General Approach.

1. The Objectives of the NTI.

The objectives of the NTI were identical to those set out in paragraph 4 of the Annex to Article VI(2) in the Draft Convention. However, it turned out that the provisions and guidelines for conducting a routine inspection were not sufficient to achieve the stated objectives. In following precisely the procedures laid down, the inspectors would have had to depend too much on their subjective judgements. For this reason, an additional detailed inspection mandate had to be worked out which provided the inspectors with precise guidance on how to achieve their goal in the most efficient and objective way.

2. The provisions in the Draft Convention under which the NTI took place.

The NTI was carried out according to the provisions contained in the annex to article VI(2). This type of inspection is generally described as a "routine inspection". The objectives of such an inspection is to check whether the actual production processes and uses of a facility are consistent with those described in the declaration.

In order to carry out a NTI in the form of a routine inspection, the following assumptions have had to be made:

- that the NTI in question is one of a series of routine inspections;

- that an appropriate timing for the inspection had been established together with the company at a specific moment during the interval between inspections.

In addition, support from the company was to make up for lack of specific knowledge and experience of facility routines on the part of the inspectors who were not familiar with the facility and its work processes prior to the beginning of the inspection.

3. Type of the on-site inspection

Both teams, A and B, carried out extensive initial visits. However, such visits were not sufficient to establish familiarity with the plant and the facility. The complexity of the objects to be inspected was such that these initial visits had to be supplemented by extensive briefings in order to convey precise meaning to visual observations and to provide perfect comprehension of the logistics and organization of the plant.

4. Advance information

4a. The Declaration

In order to calculate annual production capacity, it has to be assumed that maximum capacity is approximately eleven times maximum monthly capacity, since an average of one month is accounted for by the need for routine annual revision and overhaul. In order to protect the confidentiality of the inspection, all data provided by the company were included in the declaration in coded form.

4b. Agreement to inspection procedures

The facility (plant) attachment

For the purpose of this NTI, the facility (plant) attachment as provided by the model contained in Draft Convention had to be substantially modified, since the latter was intended for specific inspections of single-purpose facilities and it conse-

quently does not contain a number of important parameters required for the inspection of a multi-purpose facility. Without such modifications, it would have been impossible to make any sort of efficient inspection of the plant and facility concerned. Even after these modifications had been made, the following doubts remained which arose from the specific nature of the multi-purpose facility.

- In a chemical complex which comprises several multi-purpose facilities, the specific facility in which the declared substance is produced, consumed or processed is not expressly determined since the company reserves the right for itself to shift production from one facility to another.

  Consequently:

  a) neither the notification of the facility in the declaration nor the data contained in the facility (plant) attachment are subject to precise and unchangeable definition.

  b) the necessary specific information about the facility selected cannot be communicated prior to the inspection.

- In contrast to a single-purpose facility, a multi-purpose facility can be used for a wide range of chemical processes which are without relevance to the Chemical Weapon Convention and which should not therefore be subject to automatic disclosure to inspectors.

- At a chemical complex which may comprise fifty or more multi-purpose facilities, inspectors cannot in normal circumstances determine whether the information provided to them by the company at the beginning of an inspection is correct or not. Nor will they be able to determine at any time during the inspection whether any of the many multi-purpose facilities may be engaged in the production of Schedule (2) chemicals, or indeed in any other operations directed towards purposes prohibited by the Draft Convention, without their knowledge.

- Even in the event of doubt on this score, the inspectors might not be in a position to search for such undisclosed operations. It might easily be impossible in view of the large number of inspectors, measuring instruments and samples which would be required, to launch a preventative check of the whole complex at the beginning of the inspection.

5. Type of the facility

The facility inspected was a modern multi-purpose facility which - together with a number of other multi-purpose facilities - constituted a production plant. This plant made up part of a complex.

6. Type of declared activity at the facility

The declared activity comprised the production and procession of a chemical substance A which for the purpose of the NTI was considered as being a Schedule (2) chemical. This substance was also being stored on the site so that it could be transformed into another chemical substance B. The timing of the NTI was chosen in such a way that the inspectors were able to check critical steps of the declared production process (key points for visual observation) which resulted in the chemical substance A.

7. Activity at the facility during the inspection

The activity at the facility corresponded to the declaration. The inspection took place while the substance A was being produced and stored. The inspectors were able to observe visually important operations of the production process which resulted in the chemical substance A. Since the exclusive purpose of the inspection was to check that the declaration was correct, other matters relating to the possibility of false declarations, etc.,

were not considered. The complexity of the facility and plant inspected was sufficient to provide a realistic trial of the feasibility of the routine inspection procedures.

B. Detailed approach

1. The Inspection mandate

In order that inspection should be both speedy and effective, team A negotiated a detailed inspection mandate for team B with the company. In order to establish such a document, the team A had to be given access to many of the company's highly confidential business documents and technical information relating to the facility and the chemical process in question. In the course of these negotiations, it became clear that the guidelines and models contained in the Draft Convention were in fact of only very limited usefulness. As already pointed out, the model agreement in the Draft Convention is suitable for single-purpose facility only and for this reason does not allow for a number of the more important parameters of a multi-purpose facility.

2. Composition of the inspection team

The inspection team B was made up as follows:

- a chemist, retired, formerly head of the Swiss NBC laboratory, Spiez;

- a chemical process engineer, retired, expert on risk analysis and plant safety for chemical industry plants;

- two chemical engineers both having technical background in process engineering in modern chemical plants - at present employed in government institutes as organic and physical research chemists.

It was found that without the help and support of the facility's chemists and engineers inspection team B would have had diffi-

culties in carrying out its tasks. The NTI demonstrated that the inspectors must have specialized knowledge at their disposal. A high level of technical excellence is undoubtly an important prerequisite for the efficient realization of the routine inspection as described by the Draft Convention.

3. Inspection equipment

All the necessary inspection equipment and monitoring instruments were provided by the company. This was adequate for the purpose of the NTI. Their employment during the course of the inspection neither posed any major difficulties to the inspectors nor interfered with the normal operations of the facility. In order to maintain the standard safety precautions, it is advisable to negotiate the use of additional on-site instruments with the company prior to the inspection.

4. Activities prior to the arrival of the inspection team on-site

As provided for in the list contained in the facility (plant) attachment, the company put together the necessary documents and data for the use of inspection team B. These documents were:

- Reaction scheme;
- Chemical formulas flow sheets;
- Equipment flow sheet (multipurpose facility);
- Mass flow sheets at each process step with quantities;
- Plant (facility) utilization plan;
- Installation plan with entire apparatus and pipework;
- Inventory transaction reports (purchase, production and delivery of relevant chemical substances);

- Material requirements reports;

- Stock control sheets;

- Standard Operation Procedures;

- Batch control protocols;

- bill of material (material consumption in kg).

5. Advance preparation at the site

Following preparations were made in order to ensure that adequate inspection of both the facility and the company's data and records could take place:

- compiling the necessary documents and data for the inspection team;

- updating of confidential business documents and data for communication to the inspectors during the briefings at the beginning of the inspection;

- providing office and other necessary work space for the inspectors in the immediate vicinity of the facility to be inspected.

It should be noted that the confidential business and technical information necessary for an efficient inspection must be updated constantly. For purely practical reasons, this is a task which cannot be assigned to the inspectors.

6. Escort and point of contact arrangements

While on the company site, the inspectors were constantly escorted by representatives of the company and were given access to all building and facilities. In view of the fact that such escorts were permanently at the disposal of the inspectors, no other contact arrangements had to be made.

One of the elements that the NTI demonstrated clearly was that the presence of technically-qualified escorts with a thorough personal knowledge of the company and the facilities can greatly facilitate the work of the inspectors. Although considerable time and effort was necessary for such constant escort provision, it was of great benefit both to the inspectors and to the company.

7. Additional participants

During the inspection of the facility by team B, the head of team A was present as an observer.

8. Duration of inspection and of the initial visit

Initial visit and briefing of inspectors: half a day

Inspection: one-and a half days

Preparation of inspection report by Team B: two days

In addition, lengthy discussions for clarification between the two teams were necessitated by the fact that the facility (plant) attachment had to modified.

9. Measures to protect confidential information

Participants in the NTI who were not already subject to Swiss secrecy regulations were required to sign a secrecy agreement which remains binding for several years. It was further specified in the facility (plant) agreement that no confidential business documents and technical information provided by the company could at any time be removed from the company's premises without the consent of the company. In addition, the management reserved the right to express an opinion about the use of confidential business documents or technical information in the inspection report and if they considered it necessary to propose the removal of such information from the text.

During the NTI, it became clear that Schedule (2) type inspections cannot remain totally non-intrusive if they are to be effective in fulfilling the verification objectives. With regard to the protection of confidential business documents and technical information, the following conclusions may be drawn:

- even in the event of enforcement of the most elaborate regulations for the handling and protection of confidential business documents and technical information the inspectors would still be in a position to gain access to technological information and business documents not related to the inspection;

- a requirement for completely effective protection of confidential business documents, process information and data related to the mass balance poses major problems in view of the absolute necessity of checking the declaration against such confidential business information and technical data;

- it is inevitably the case that such documents also include information and data which are not directly related to the inspection;

- an inspection mandate which clearly lists the types of documents and records to which the inspectors must have access is the only possible instrument which can define the various sensitivity levels of confidential data on which the necessary

procedures and measures must be taken to protect the confidentiality of such information.

10. Introductory Conference

In view of all the difficulties in the way of inspecting any part of a complex consisting of several multi-purpose facilities, an introductory conference lasting four hours turned out be necessary in order to discuss the basis of the inspection mandate and the facility (plant) attachment. During this conference, the management of the company and the operators of the facility to be inspected provided following information:

- general information relating to the multi-purpose facility and its operating state at the time of the inspection;
- the nature of safety regulations at the multi-purpose facility and at the production plant;
- the technical characteristics of the multi-purpose facility (with the help of plans and layouts);
- a description of the chemical production process together with the presentation of operating records and records dealing with related accounting and logistics operations;
- an explanation and presentation of the general documentation which had been prepared by the company for the use of the inspectors.
- Decoded data on the chemical process and the quantities produced.

The introductory conference was followed by an initial visit to the plant and its surroundings, after which the company management and the operators of the facility put themselves at the disposal of the inspectors for questions and further information.

11. Types of records which may be required by the inspectors

The inspection mandate listed following types of records:

Subdivision-team "Logistics"

- Stock control sheets;
- Stock accounting books;
- Bill of material;
- Material delivery/ordering sheets;
- inventory transaction reports (purchase, production and delivery of relevant chemical substances);

Subdivision team "Plant/Process":

- Plant utilization plans;
- Mass flow sheets
- Standard Operating Procedures;
- Inprocess control procedures;
- Analytical specification sheet;
- Various facility records (cleaning records, overhaul records etc.).

12. Plant orientation tour

The plant orientation tour included only the multi-purpose facility to be inspected, as well as storage tanks, equipment and laboratories related to it. The size of the surrounding complex rendered a more extensive visit impractical and disproportionate to the inspection.

13. Inspection of areas and facility equipment.

The following facilities, plant laboratories and equipment were inspected in detail:

a) during the negotiation of the facility (plant) attachment;

- the multi-purpose facility,
- all main tanks and vessels throughout the plant for storage of raw materials, intermediate products and end products,
- all air outlets and waste water lines of the facility inspected,
- relevant chemical warehouses,
- the main analytical laboratories of the complex,

b) During the inspection

- the plant, including the multi-purpose facility, reaction vessels, storage tanks and specific installations;
- the plant laboratories;
- relevant chemical storage tanks;
- warehouses for raw materials, intermediate products and end products.

The company agreed that during the inspection photographs could be taken from several key manipulation points at the multi-purpose facility. These were included in the inspection report.

The above items available for inspection were either listed in the facility (plant) attachment or the inspection mandate or else were communicated to the inspectors at the introductory briefing. With respect to those areas and facilities listed in paragraph 13 of the annex to article VI(2), it turned out that these in fact made up only part of one production plant and its surrounding area and since access to the whole of this plant was already available there was no need for working out additional procedures in this respect.

14. Inspection of Operating Procedures

Without access to Standard Operating Procedures for checking the production of the declared chemical, the inspection would be ineffective and would certainly fail to fulfil the stated verification objectives. Thus, in drawing up the inspection mandate and elaborating the facility agreement, the inclusion of Standard Operating Procedures is indispensable. During the trial inspection, it turned out that the comparison of the operating state of the facility as well as the work procedures actually taking place with the relevant Standard Operating Procedures provided the most objective evidence that the production process being observed was in fact identical with that described in the declaration.

Standard Operating Procedures in multi-purpose facilities comprise a great deal of sensitive information about the chemical process and the general state of technology at the facility. As a general rule, companies do not apply for patents for this type of technology.

Standard Operating Procedures are specific to each company and are usually regarded as closely-guarded secrets. For this reason such documents might not necessarily be available to inspectors.

Consequently, the whole question of Standard Operating Procedures which must not only be consulted for the elaboration of the inspection mandate and the establishment of the facility (plant) attachment but are also reported to the Technical Secretariat pose a considerable problem with respect to the protection of confidential information. There are undoubtedly circumstances in which it would be impossible to exclude all such confidential information from the inspection report.

15. Samples and sample-taking procedures

Following sampling procedures were negotiated with the company:

(i) samples were to be taken by the facility staff;

(ii) sampling was to be supervised by inspection team B;

(iii) key points for sampling were to be determined on the basis of the Standard Operating Procedures;

(iv) key points for sampling were to be compatible with the normal operations at the facility as well as with the conduct of the inspection;

(v) the inspection team was entitled to require samples to be taken at points not previously determined. In the course of the trial inspection, team B made use of this right on one occasion.

These procedures were adequate in the context of the NTI. They were entirely compatible with the verification objectives stated in the Draft Convention.

16. Handling of samples

The marked samples were immediately handed over to the inspectors. Since these were analyzed on-site in the plant laboratories, there was no necessity for special measures, such as sample-splitting, sealing or the establishment of special arrangements for transport to off-site laboratories.

17. Analysis of samples

The marked samples were immediately analysed in the plant laboratories according to Inprocess Control Procedures of the company and under the permanent supervision of the inspectors. The results of the analyses were then compared with those of the reference substances.

In cases where the samples are to be checked for the absence of schedule (1) chemicals, the use of plant laboratories could pose

problems with regard to on-site availability of the necessary reference substances.

18. Types of Analysis

(i) The samples were checked for the absence of Schedule (1) chemicals;

(ii) The samples were checked for the presence of the declared substance. Both quantitative and qualitative analyses were performed.

19. Documentation of the inspection

With the help of previously prepared check-lists and forms, the inspectors of team B registered their observations and findings. These records, together with personal notes made at the time by the inspectors, were used for the final elaboration of the inspection report.

In principle, all documents and data provided by the company, as well as declared facility records and notebooks, remained under lock and key at the facility. After consultations with the company, however, certain documents and data such as photographs, simplified maps and plans of the plant and the facility were provided in order to illustrate the inspection report.

20. Evaluation by the inspectors

The accurate and complete nature of the documents provided by the company, as well as the extensive briefing at the beginning of the inspection process, contributed greatly to the latter's success. The organisational and management efficiency at the facility, together with the numerous highly-sophisticated laboratories and installations, contributed in large measure to the effectiveness of the inspection. This feature also demonstrated that the success of a routine inspection depends largely on the

readiness of the facility management and of facility operators to co-operate fully with the inspectors.

With regard to the general conduct of the NTI, the inspectors had the following observations to make:

- all complexes consisting of several multi-purpose facilities which are operated in batch mode should be subjected to frequent routine inspections in order to ensure that all such facilities are used only for declared purposes;

- the number, intensity, duration, timing and mode of inspection should be determined according to characteristics of the batch process and to the intended utilization of the facility;

- in view of fact that the plant laboratories continued their normal operations during the inspection, it was not possible to complete all the necessary on-site analyses in the time allowed.

21. Closing conference.

At the closing conference, the inspection report was discussed with the company and its content cleared of any confidential information - as far as this was possible and acceptable to the inspectors.

22. Anomalies, Disputes and Complications

No major disputes and complications occurred during the NTI. This lack of friction during the whole exercise was mainly due to extremely co-operative attitude of the company. Moreover, whenever provisions of the Draft Convention were found to be inadequate for the purpose of the NTI, the management was ready to discuss such problems as they arose and to solve them in accordance with the general spirit of the Draft Convention and of its provisions relating to routine inspection.

In the course of verification of the mass balance, a discrepancy between the declared yield and the actual yield of the chemical process was detected by the team B inspectors. This anomaly was resolved at the final conference.

23. Report of the inspection team

The draft report of the inspection of team B, together with the documents established in the course of the NTI, were evaluated by team C. This exercise showed that in order to reach an objective judgement about the finding and results of the NTI, it is essential that the highly technical report and documents be re-interpreted the team of inspectors and the controlling team working together.

24. Effect of the inspection on the operations of the facility

As a result of the thorough and careful preparatory work performed by team A and the management of the company, as well as of the prior agreement which had been reached on key points and timing of sample-taking, the NTI had no noticeable effect on the normal operation of the multi-purpose facility.

All the company's major expenses caused by the NTI were related to the disruption of the normal duties of members of the management, of the facility operators and of laboratory staff during the presence of the teams A and B at the premises of the chemical complex. The loss of working time for the company amounted to approximately 15 man days for the whole of the NTI - or to about 60% percent of the total time spent by teams A, B, C and the controlling team. However, this figure does not include the significant amount of preparatory work carried out by the company.

5. Conclusions

5.1. Team A

With respect to its tasks:

- the process of negotiating the facility (plant) attachment greatly contributes to building up a spirit of confidence between the company and the verification organization;

- the facility (plant) attachment must include a mandatory briefing at the beginning of the inspection, the main purpose of which is for inspectors to bring thoroughly their documents and data up to date;

- the "Model for an agreement relating to facilities producing, processing or consuming chemicals listed in Schedule (2)" (CD/874, pp. 125-128) is based to such a large extent on single-purpose facilities that it can hardly be used for the elaboration of a facility (plant) attachment for a multipurpose facility without very substantive modifications. In this respect, it might be more appropriate to provide guidelines for the elaboration of a facility (plant) attachment than a detailed model;

- in order to establish an effective inspection mandate which meets the aims set down for the routine inspection, comprehensive access to relevant confidential business documents and technical data and software must be required; in this respect it is particularly important that the company should provide accurate and complete documentation concerning the relevant chemical processes and other technical and business operations carried out in connection with the declared chemicals;

- in checking the accuracy of the declared quantity of a Schedule (2) substance, verification of the mass balance on the basis of the production data provided by the company is more conclusive than on-site inspections of facilities and storage houses. In highly organized and efficient chemical plants at which such numerical data verifications are possi-

ble, continuous instrumental monitoring of the declared production of Schedule (2) substances might become less important.

5.2. Team B

Regarding its tasks:

- in view of their technical sophistication and flexibility in use, modern multi-purpose facilities could probably be misused for the production of certain schedule (1) substances; in order to verify that a multi-purpose facility is not misused in such a way the following checks have to be carried out:

  a) on the accuracy and consistency of all data and documentation provided by the company;

  b) random inspection of equipment and installations, for instance storage and reaction vessels; as well as technology and safety measures.

- a comparison of visual observations of the normal activity at the facilities inspected with Standard Operating Procedures provides the most objective evidence possible that Schedule (2) substances are being produced during the inspection only in the declared quantities and according to the declared chemical processes.

- the routine inspection procedures in the Draft Convention overemphasise the importance of visual observation of installations and feeding lines and of chemical analysis of the content of reaction vessels; in particular, these provisions overlook the fact that the checking of data and documents concerning the organisation of the facility, both incoming and outgoing receipts at the production plant and at storage buildings, as well as verification of the mass balance, are indispensable in cases where it must be verified that:

- Schedule (2) substances produced, consumed or processed during the preceding period are consistent with the declared quantities.

- Schedule (2) chemicals have not been stored, diverted or used for undeclared purposes.

Regarding the trial inspection

- a single visual inspection of a multi-purpose facility operated in batch-mode corresponds to a snapshot and therefore provides only very sketchy evidence indeed of past activities; in particular, one inspection of a facility cannot verify whether the quantities of Schedule (2) substances produced, consumed or processed correspond to the content of the declaration for the production period in question; if access to the company's data and documentation were rendered impossible for reason of confidentiality, onerous measures, such as more frequent routine inspections, random ad hoc verification inspections by the staff of the Technical Secretariat, as well as instrumental monitoring of the facility, would be indispensable.

- in view of the nature of NTI, team B had to spend much time in organizing and conducting the inspection; this situation had a noticeable effect on the performance of the inspectors; in normal circumstances and using full trained and experienced inspectors, inspection of a facility and checking the material balance would be possible in half the time spent on the NTI.

- in any carefully organized and well run chemical plant, measures intended to mislead inspectors are very difficult to implement since the information content of the data and documentation which must be provided by the company is closely interrelated - and inconsistencies should be fairly easy to detect.

5.3. Team C

The trial inspection showed very clearly that the highly technical inspection report must be thoroughly re-evaluated by a competent and experienced central authority before findings can be definitively assessed and judgements on essential questions of compliance can be made.

5.4. The company

- the facility (plant) attachment must be worked out with the greatest care so that the conditions under which the inspection takes place (available documentation and data, measures to protect confidential information, the liability of inspectors) are very carefully defined and disputes on interpretation can be ruled out from the first;

- the main objective of a routine inspection should be to check - with the help of data and documentation provided by the company - whether the quantities of a Schedule (2) chemical produced, consumed or processed correspond to the declaration. This inspection is to be carried out on the assumption that the declaration is correct. For this reason, it is difficult to understand why there should be a need for onerous and time-consuming measures such as instrumental monitoring of facilities, analysis of samples taken from reaction vessels and identification of the intermediates of the production process. The objective of such verification measures can only be to detect undeclared activities prohibited by the Convention and for fall outside the stated scope and purpose of routine inspection. Such measures would be more appropriate for the conduct of inspections in connection with article IX of the Draft Convention.

5.5. Matters to be studied further in relation to the conduct of verification inspection on a routine basis.

In the course of the NTI, it became clear that several provisions of the Draft Convention concerning the verification inspection on a routine basis require further discussion. Many of the problems have still not been correctly identified and addressed in the Draft Convention. In order to identify some of these problems, we have compiled the following following list of questions which arose during the NTI:

Concerning multi-purpose facilities

In view of the sophistication and technical flexibility of multi-purpose facilities at chemical complexes which contain several such facilities, certain problems arise which are valid for any kind of on-site inspection and in particular for verification inspection on a routine basis.

1. How is it possible to determine the number, intensity, duration and timing of a verification inspection on a routine basis if the production process of the declared schedule (2) substance:

- can be shifted from one multi-purpose facility to another;

- operates in batch mode;

- is discontinuous by reason of factors relating to supply and demand?

2. What is the point of having fixed intervals between routine inspections if production batches of the declared schedule (2) substance cannot be determined in advance and are distributed irregularly over the year?

3. Is there any means other than checking mass balance at a subsequent inspection whether a declared activity has been carried out in the multi-purpose facility, either in the interval between inspection or during the inspection itself?

4. Should a company have the right at short notice and for economic or technical reasons to shift production of a declared Schedule (2) substance from a designated multi-purpose facility to another facility which has not been declared? The answer to this important question would have a major impact on the elaboration of the facility (plant) attachment and of the inspection mandate as well as on the reliability of previous declarations and notifications.

5. If the purpose of the inspection is only to check whether the declared production of a Schedule (2) chemical at a particular multi-purpose facility on the site of a chemical complex is correct, is there any justification in monitoring with instrumental devices or ad hoc checks operations taking place at other multi-purpose facility of the complex?

6. How can the production capacity of a specified multi-purpose facility be relevant, if the declared production can take place at any of the multi-purpose facility on the complex, particularly if the process is carried out so as to avoid using the available capacity in the most effective way?

Access to confidential business documents

It is normally the case that unrestrained access to all a company's business documents and production data can considerably facilitate a routine inspection. However, such access can not only raise serious problems for the company being inspected, but it may also necessitate very stringent measures to protect the confidentiality of the information in question. In this respect, there is no doubt that the following questions will have to be answered:

1. Confidential data and measures for its protection

In cases where the international inspecting team cannot guarantee the effective protection of the confidentiality of the business information and technical data provided to them by the com-

pany being inspected and is unable to admit any liability in case of a breach of such confidentiality, should the inspectors refrain from using such information and data? In this event, to which data should the access of the inspectors be restricted and what would be the consequence of such restriction on the effectiveness of a routine inspection?

2. Preparation of confidential information

Should all companies subject to routine inspections be obliged to organize their confidential data in an uniform, standard fashion, so that inspectors can more easily compare them with national declarations?

3. Criteria for the availability of data and information

Is it a realistic possibility to establish clear criteria according to which a distinction can be made between confidential business documents and technical data which must be kept under lock and key at the facility and those which may be removed by the inspectors from the premises for further examination?

4. Liability

Should the company inspected have an intrinsic right to claim liability for any economic or other damage to its interests which might be caused by any unauthorized release or misuse of confidential business documents and technical data? And precisely what authority would in fact be liable in the event of any such loss by the company?

The costs of routine inspections

Both the company being inspected and the international inspecting authority will be obliged to invest a considerable amount of time and resources in the preparation, collection and evaluation of data on the declared production processes, as well as on the visual inspection of facilities and storage houses. In this respect, the following questions will have to be answered:

1. Would it always be necessary for inspectors to monitor and observe a whole batch from beginning to the end - a task which might easily take several days?

2. Is continuous monitoring of the declared production facility in fact required at all? Is there any possibility that non-continuous monitoring of batches could endanger the objectives of the Convention?

3. Must the process of checking whether the declared data are correct necessarily take place at the same time as the monitoring of the production process? Would it be possible for all the relevant data on the mass balance to be sent for checking to the Technical Secretariat which is to be set up?

4. To what extent can a company being inspected be required to assume financial responsibility for the conduct of a routine inspection at its premises?

The Intrusiveness of a routine inspection

The Draft Convention proposes that inspections should be conducted in the least intrusive manner possible. However, we cannot see how this restriction has any justification given the fact that an effective routine inspection would not be feasible without access to many confidential business documents and technical data. The following questions arise in this respect:

1. Is there any need for a step-by-step approach to the conduct of a routine inspection if the company being inspected is in any event obliged to reveal sensitive data and information on its facilities, production batches and commercial operations?

2. Is is really necessary for the facility being inspected to be described in all its details and for the inspectors be provided with such a large amount of technical data with respect to the declared production batches?

3. On the other hand, how can an inspector check whether the declared production of a Schedule (2) chemical is correct if he

does not have access to data regarding the chemical process and the relevant Standard Operating Procedures?

4. How can an inspector decide on the necessity and timing of inspections and samplings if he is uncertain about the precise timing of the production batch and the precise course of the production process?

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NATIONAL TRIAL INSPECTIONS

Final Report by the Chairman of the Open-ended Consultations

Introduction

In the Draft Chemical Weapons Convention, a number of provisions relate to on-site inspections in the chemical industry. In order to expedite work on the Convention, and to assess whether the proposed text has adequate and practical provisions to give necessary assurance to States that industrial facilities are used only for purposes not prohibited by the Convention, a number of National Trial Inspections (NTIs) have been carried out.

The present paper contains a somewhat systematized compilation of experiences, recommendations and views recorded in national reports on Trial Inspections. For easy reference the structure of this paper follows CD/CW/WP.213 of 19 September 1988.

The purpose of this paper is to identify some problems that have been highlighted during the NTIs. It covers the preliminary summary of results from NTIs contained in CD/CW/WP.237 of 10 April 1989 and NTI reports submitted after that date.

As views from different national reports are presented under each item these views may sometimes be conflicting. Together, however, they offer a broad picture of experiences gained by NTIs. The selection of views to be reflected has been made by the Chairman of the Open-ended Consultations in order to focus on those issues which, in his opinion, seem to require further consideration.

Many useful experiences gained during trial inspections pertain to a later implementation stage of the Convention. However valuable, they would not have direct relevance for the present negotiating stage.

Reports on National Trial Inspections:

CD/890 + Add.1	Hungary
CD/893	Italy
CD/894	Union of Soviet Socialist Republics
CD/895 + Rev.1	Brazil
CD/899	German Democratic Republic
CD/900	Czechoslovakia
CD/910	Australia
CD/912	Federal Republic of Germany
CD/913	France
CD/917	Belgium
CD/922	United States of America
CD/924, 925	Netherlands
CD/CW/WP.216	Sweden
CD/CW/WP.228	Japan
CD/CW/WP.233	Finland
CD/CW/WP.247	Switzerland
CD/CW/WP.249	United Kingdom

Working papers by the Chairman:

CD/CW/WP.213, 217, 236, 237, and 248 + Rev.1.

O. Initial visit, facility attachment, declarations

The initial declaration may in some cases contain only vague information concerning quantities produced. Therefore a more detailed declaration than the one submitted in the annual report to the Technical Secretariat could be elaborated jointly by the industrial plant and the national authority during the initial visit. On the basis of this information, the Technical Secretariat should be able to recommend a specific framework for the initial visit. The contents of the initial declaration and notification have been outlined in several NTI reports.

Guidelines for the initial visit are needed in order to protect confidential information and to aid the inspectors in performing their tasks.

The trial inspections demonstrated the difficulty of defining precisely which areas and items of a chemical industry site are to be declared and inspected ("the facility") in the case of Schedule [2] chemicals. Such chemicals are typically produced in multi-purpose reactor systems. A site might consist of several production plants which in their turn may consist of several multi-purpose units. All these areas might not be included in an inspection régime under the Convention.

However, a too precise definition could hinder observations in adjoining areas that are not declared but which in many cases would be capable of producing the same substance relevant under the Chemical Weapons Convention.

Multi-purpose facilities are able to shift production in accordance with new production demands. Such production changes may not always be readily foreseen long in advance.

Advance notification of Schedule [2] production may be difficult for economic and practical reasons.

Technical changes in the facility, which might influence the course of the inspection, should be declared to the Technical Secretariat and if necessary lead to a change in the existing facility attachment.

It was generally found that standardized formats for facility attachments would be of great practical advantage, and outlines for such formats have been presented in several reports.

The NTIs have shown that in some cases the "Model for an agreement" (CD/881, pp. 124-127) has to be modified.

It was pointed out that if the facility attachment is used to guide the inspection team in a very detailed manner, it would soon become obvious which items would be of importance if cheating was being considered.

1. The inspection mandate

For each inspection under the Convention the mandate should constitute the basic reference for the Technical Secretariat, the inspectors, the National Authority and the management of the facility to be inspected. It should contain a section on general guidelines as well as a specific section, drawing on the facility attachment. The verification tasks of the inspection should be clearly stated.

However, it was also argued that the inspection mandate should make it possible for the inspectors to retain a degree of flexibility during the inspection.

2. Composition and organization of the inspection team

A team size of 4-6 inspectors was generally regarded as adequate, though the size may depend on facility-specific factors and the organization of the inspection team. The initial visit might require a larger team than the routine inspection. Various types of expertise required were mentioned, including general chemistry, chemical engineering and analysis, chemical instrumentation, and, especially, auditing of records.

It was generally considered desirable to have a team leader. A view was that not all team members should have access to all confidential information; in some cases it could suffice if the team leader and another inspector had this access.

Based upon the initial visit, the required team of inspectors could be specified on the basis of the complexity of the site and the facility characteristics.

A view was that in the selection and training of inspectors account should be taken of differences in production structures and national legislation in different States Parties to the Convention.

3. Inspection equipment

Useful and detailed proposals concerning equipment to be brought by the inspection team were put forward, inter alia, instruments for trace analysis and air sampling.

Any such equipment should conform with security rules at the facility.

4. Activities prior to the arrival of the inspection team on-site

According to several reports, an advance notice of 12 hours would not be enough to enable the inspected facility to have all information and documentation required ready for the inspectors upon their arrival, especially if a material balance was to be established. A notification time of 48 hours was, therefore, proposed. There should be simultaneous notification to the National Authority and to the facility to be inspected.

5. Advance preparations on-site

By presenting detailed information, including up-dating of confidential business documents and data, a facility could contribute to shortening the time required. Such information would be subject to confidentiality constraints.

It was recommended that the management should prepare a file for the purpose of inspections. Such a file should remain on-site.

6. Escort and point of contact arrangements

The necessity of an interpreter from the Technical Secretariat was expressed in several reports. A view was expressed that the presence of an interpreter representing the facility might also be needed. Also, a representative of the National Authority could be present to advise the facility. Contact persons should be identified at the initial visit.

7. Other participants

No specific comments were made.

8. Duration of initial visit, preparation of facility attachment and inspection respectively

The duration of the initial visit and negotiation of the facility attachment will depend on the size and extent of activities of both the declared facility and the site in question. A total of 15-20 man-days seems reasonable.

The actual inspection may take from 1-2 days, up to 3-5 days. With only one auditor, the auditing of records would require more time.

The duration may also be influenced by the degree of co-operation by the management and the experience of the inspectors.

9. Measures to protect confidential information

The facility attachment could be divided into two parts, of which the part containing the most sensitive information as identified by the facility management should be kept on-site. The four-stage classification system for confidential information in CD/881, pp. 139-140 had been tested and found useful also by facility management.

A list of the types of documents and records to which the inspectors must have access was found to be essential. This would inter alia facilitate identification of the various sensitivity levels of confidential data.

As examples of information available to inspectors only - not to be removed from the site - were mentioned:

- name of customer and buyer;
- reports on production;
- purchase price of feedstock chemical;
- names of suppliers;
- manufacturing losses;
- manufacturing costs;
- annual consumption/production;
- exact composition of end-products;
- identity of impurities;
- capacity of reaction vessels.

There seem to be different opinions between facilities on what is regarded as highly confidential information. Data which do not contribute to verification in the context of the Convention and is considered strictly confidential need not be given to the inspectors. Such data may encompass details about the production, which determine the yield of the production process (temperature, pressure, additives, reaction times, etc.).

10. Opening conference

The time required for the opening conference will depend on several factors, including:

- the size and complexity of the facility;
- whether the facility has previously been inspected;
- whether some of the inspectors are at the facility for the first time.

One hour seems to be sufficient in most cases, presupposing that the inspectors are very well acquainted with the facility attachment.

11. Types of records needed and/or audited

Auditing of records would form a major part of an inspection. Furthermore, the confidence in the inspection results would be greater, the larger the number and types of records used. Some data in the records, which were extremely sensitive, had not been made available during some NTIs.

Quantitative national data would be needed for the establishment of a "national material balance" for a declared chemical. Such a balance might give an indication of whether diversions were taking place, whereas no conclusion on possible diversions could be drawn from the inspection of a single facility. Facility records auditing may help in reaching a judgement about the level of assurance of the facility's activity. However, this auditing might only prove that declarations were consistent, not necessarily that they were accurate.

Also information relating to the average duration of a change of production run, average duration of equipment cleaning and the annual average rate of equipment utilization might be of importance.

The auditing would be complicated, if a feed chemical was used in more than one facility and/or for the production of several products, especially if the products were produced with variable yields.

The problem of discovering the existence of clandestine parallel accounting was pointed out.

A comprehensive quantity control extending beyond the inspected facility could prove useful.

In some cases a mass balance based on quantities of major feedstocks and conversion factors available in the scientific literature was considered sufficient for plausible verification, because any significant manipulation of the data could be virtually ruled out given the interdependence of the documentation.

12. Plant orientation tour

A plant orientation tour might not always be required during routine inspections. However, if major changes have occurred since the preceding inspection, or if some inspection team members have not previously visited the facility, a plant orientation tour would prove useful.

13. Inspection of areas and facility equipment

Video recording of the inspection might be useful for clarification of ambiguities regarding sample-taking as well as for detection of future changes.

A view was expressed that a three-stage approach could be developed for inspections; if no anomalies were detected during one stage, the inspection would be terminated. Otherwise it would proceed to the next stage, etc.

In order to detect any diversions, it is important to have information about the production capacities corresponding to each of the production stages.

The importance of visual observation of installations and feeding lines and of chemical analysis of the contents of reaction vessels was in some reports found to be overemphasized in the "rolling text". Instead, the importance of thorough auditing was stressed.

Diagrams of possible Schedule [2] production routes could be of assistance in looking for evidence of Schedule [1] production. Methods should be developed that allow for rapid determination of the construction material used for the process equipment.

There are ways of identifying critical technological stages or equipment; which could be related to Schedule [1] chemicals in a multi-purpose facility. Also, the extent of safety equipment usage may assist in indicating the possibilities to handle Schedule [1] chemicals.

It would be useful to develop and test methods and appliances for continuous monitoring. The need for procedures for the selection of measurement points and parameters, types of instrumentation and the decisive factors for installation of continuous monitoring has been pointed out. On the other hand the value of instrumental monitoring in other multi-purpose units at the same site has been questioned, if the purpose of the inspection is to check declared production of a Schedule [2] chemical at a particular multi-purpose facility. In some cases, compound-specific detection of products could be difficult. The possibility of circumventing automatic monitors must be considered.

14. Inspection of operation procedures

Inspection of a modern multi-purpose facility could be performed by random inspection of equipment, installations, technology and safety measures. Safety information compiled from national legislation can constitute a source of information for the inspectors but may in some cases, due to stricter regulations, also imply a risk of leaks of confidential information.

Exact quantification of an ongoing process may not be possible without installation of additional equipment. In order to protect confidential information, the inspection should be performed without looking into specific process details such as temperature, pressure, etc., which determine the yield of the end-product. Here, the use of specialized literature could assist the inspectors. Comparison of visual observations of the ongoing work at the inspected facility with the standard operation procedures of the facility was considered to provide the most objective evidence that Schedule [2] production is carried out in the declared quantities and according to declared processes only.

Inspection activities may be influenced by the timing of the inspection in relation to the stage of production campaigns. It may not always be possible for the inspectors (due to inspection time-frames and other inspection activities) to monitor and check the whole production process.

15-18. Sampling and sample-taking procedures, handling of samples, analysis of samples, and type(s) of analyses

There is a need for analytical accounting records of operations at the facility laboratory, as well as calibration/standard samples. Existing standard operating procedures at the on-site laboratory could be used for analysis of the declared chemical. The analytical capabilities of the facility in question should be indicated in the facility attachment or in the annual declaration.

A view was expressed that the inspectors should be able to take samples in areas surrounding the facility and thus have a broad mandate. Such a possibility may act as a deterrent to clandestine activities in the facility inspected.

In the case of a multi-purpose facility, the inspectors should be able to take samples in areas surrounding other units and in waste and storage areas of the industrial plant for the purpose of verifying the absence of non-declared or prohibited chemicals.

The necessity of sample-taking of intermediates in the process has been questioned. Sample-taking and analysis should not be regarded as indispensable in performing the inspection, but may provide an objective measure to dissolve suspicions.

The very composition of the samples may be sensitive. A mixture of samples may in some cases offer a solution to this problem. One suggestion was to split each sample into six parts: two each for the inspection team, the facility and the government of the State Party inspected. The possibility of taking samples during the initial visit needs further study. Such samples could serve as references during the inspection.

In cases where declared equipment is used periodically for production of other than declared chemicals subject to the Convention, it might not be appropriate to carry out other than negative sampling since complete analysis might yield commercially sensitive information about legitimate production processes.

A need exists of appropriate procedures for off-site analysis (e.g. samples storage, transportation, coding) and guidance as to when and where such analysis should be performed. Different situations have been envisaged when off-site analysis may be necessary and in what laboratory it should be performed. In some cases there was a strong resistance against removing samples for analysis outside the State Party. Off-site analysis should, according to this view, be conducted only if suitable equipment or reference samples are not available on-site. Other exceptional cases when it is required was mentioned, such as trace analysis of previous production in waste and soil samples. In other cases it was deemed necessary to use the Technical Secretariat's laboratory or another authorized laboratory outside the State Party inspected in order to obtain the most precise and quantitivately accurate results.

Off-site analysis might be required for proving the absence of Schedule [1] chemicals using ultra-sensitive techniques. Analysis of the presence of Schedule [1] chemicals needs further consideration. In some cases it may be possible to analyse the absence of Schedule [1] chemicals on-site.

In the case of a modern, computerized analytical instrumentation, the inspection team will not be able to operate the equipment independently.

19. Documentation

In some cases during the initial visit, photographs of the areas and equipment relevant to the inspection were taken under the supervision of the inspectors in order to facilitate subsequent visits, while in other cases no taking of photographs was allowed.

A handbook for the inspectors may be needed, containing inter alia a check-list of inspection tasks and indications of specific equipment required.

Two types of reports could be envisaged: one for the Technical Secretariat and another kept at the facility for future inspections.

20. Evaluation by inspectors

It must be taken into account that some types of data are subjective and others objective.

Clear guidelines and criteria for the inspectors on how to evaluate the inspection results would assist in this process.

Data and documents concerning the organization of the facility, in- and out-going receipts at the production site, storages, and material accountancy are indispensable when the objective of the inspection is to verify declared quantities, non-diversion or use for undeclared purposes.

21. Closing conference

The functions of the closing conference need to be clarified. The conference provides an opportunity to classify and decide on how to handle the documentation and to resolve remaining problems or ambiguities. The facility management could be consulted on the question of confidentiality before the release of any information.

22. Anomalies, disputes and complications

Disputes may occur regarding the facility-specific accounting methods. Especially computerized material-accounting may give rise to difficulties in this connection. On the other hand, measures intended to mislead the inspectors would be very difficult to implement since the data and documentation at the industrial site are normally closely interrelated, so inconsistencies should be fairly easy to detect. In some specific cases it would be virtually impossible to make a complete check for the presence of undeclared chemicals within a short time-frame (one day).

Procedures for the resolution of conflicts arising during routine inspections will need further clarification.

23. Report by the inspectors

When reports concern the accuracy with declarations, a common report format may be envisaged. One possibility was to divide the report into two parts, one of which confidential and the other open. One part could, for example, be brought to the Technical Secretariat, while the other would be kept at the facility and be available to facilitate subsequent inspections. If any violations of the provisions of the Convention are discovered, the part of the report sent to the Technical Secretariat could contain the details supporting the allegation, including confidential information, while the other part, with a higher degree of confidentiality, would still be kept at the facility.

A highly technical inspection report must be thoroughly examined by a competent body before it can be definitely assessed.

24. Impact of the inspection on facility operations

The impact of sample-taking from the reaction vessel during the ongoing production process may hamper its normal operation. Sample-taking at spots not usually used for this purpose may both affect operation and safety at the facility. However, with careful preparations for the inspection and prior agreement on key points and timing of sample-taking, a NTI is not likely to have any noticeable effect on the normal operation of the facility.

25. Other matters

No specific comments were made under this item.

Concluding remarks

One of the main problems identified during the NTI process has been the identification of the facility to be inspected under article VI [2]. The NTIs have been conducted at industrial sites, sometimes consisting of several production plants. The plant may consist of several multi-purpose units. There have been difficulties in specifying the facility subject to inspection, owing to the fact that such multi-purpose units are capable of easily shifting production and to the large production capacity of a plant consisting of several multi-purpose units. The declared Schedule [2] facility may be technically similar to other units at the site, which therefore have a theoretically greater production capacity for Schedule [2] chemicals. There seem to be conflicting interests: on the one hand the interest to restrict and minimize the facility subject to inspection, and on the other hand the lower level of assurance which such a tight identification could imply, given the level of undeclared potential production capacity at the same site.

The definition of the facility also influences the contents of the negotiated facility attachment. A sharp delimitation of what is subject to inspection would facilitate the accomplishment of the inspection but at the same time leave open to question whether such an inspection would give sufficient assurance of compliance. The contents of facility attachments appear to vary according to what is subject to inspection, the type of facility and process, the degree of co-operation by the management and the time used for the negotiation and elaboration of the attachment in question.

Several delegations have stated that there are some shortcomings in the "Model for an agreement" (CD/881, pp. 124-127). The current text does not seem to fit well for multi-purpose units.

The "Model for an agreement" could indicate that the facility attachment should include guidelines and information, such as:

- a general description of the whole industrial plant and all its separate units;
- a specific description of the facility;
- a list of inspection activities;
- the degree of access to and guidance on how to use confidential information.

The experiences gained during the NTIs indicated that the inspectors would have benefited from guidelines on their activities and specifications of activities to be performed during the inspection.

Procedures and guidelines for handling disputes, complications or anomalies occurring during an inspection or the initial visit are essential.

The evaluation by the inspectors could also be facilitated by some clear guidelines and criteria. The handling of the inspection report may depend on the outcome of the inspection and the agreement reached with the facility concerning handling of confidential information.

Multi-purpose units are able to shift production in order to meet new demands from consumers. The flexibility is therefore often high. Switches between two multi-purpose units may occur if the previous production was not incompatible with the planned. Such shifts could complicate the verification task. Consequently, there seems to be a need to reduce the possibility of switching declared production, in order to have a reliable facility attachment, and to reduce the need for its renegotiation.

Numerous details have been noted, and useful observations have been made also on sampling, sample-taking procedures, handling of samples, analysis and type(s) of analysis required. In this context off-site analysis has drawn considerable attention, thus reflecting the need to consider this issue further. Several suggestions have been made on off-site analysis - when it should be carried out and where - and the need for elaboration of procedures.

Diverging views of the relative importance of industrial auditing versus sample-taking and analysis seem to exist. Extensive auditing of various records has on the one hand been suggested to reduce the need for sample-taking and analysis. The possibilities of cheating has in this context been stated to be minute, due to the high level of interdependence of the records kept at an industrial site. On the other hand, the possibility of parallel record keeping could reduce the reliability of audit verification. Thus, according to this view, both sample-taking and analysis would be indispensible.

Verifying the absence of Schedule [1] chemicals at the facility implies some problems. At present no instrumentation is available that allow for easy and selective analysis of all Schedule [1] chemicals. The individually specified Schedule [1] chemicals could, however, be verified by the present instrumentation.

Differing views exist regarding how detailed an in-sight into the facility activities the inspectors should be able to have and what is deemed necessary for the purposes of inspection under article VI [2].

The role of national legislation has been addressed. A degree of knowledge of the national legislation pertaining to the chemical industry could give the inspectors a better understanding of the various procedures used and technical specifics of the inspected facility.

The nature of safety equipment and procedures at the facility may not always be indicative of the handling of highly toxic chemicals. Other technical features may give some indication of illegal Schedule [1] production. A check-list of what to look for in this context and to be included in the facility attachment of relevant information could facilitate and expedite the inspection.

The degree of detail and the number of practical suggestions contained in the NTI reports are considerable. It is therefore difficult to cover them all in a summary report of this character. The purpose of NTIs being to expedite the work on the Chemical Weapons Convention, the attention has been limited to experiences deemed to be directly relevant to the Draft Convention.

CONFERENCE ON DISARMAMENT

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Ad Hoc Committee on Chemical Weapons

UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

Report on a National Trial Inspection of an Industrial Chemical Facility

INTRODUCTION

1. In the 1988 summer session of the Ad Hoc Committee on Chemical Weapons it was suggested that interested States should conduct national trial inspections of their chemical industry on the basis of the provisions for routine verification under a CW convention contained in CD/881. The purpose of this was to help prepare the ground for multilateral trial inspections later this year and enable effective detailed procedures for routine inspections to be elaborated on the basis of practical experience. Guidelines for such national trial inspections were offered in the conference paper CD/CW/WP.213.

2. Drawing on these guidelines the United Kingdom conducted a national trial inspection of a chemical factory in the private industrial sector in March this year. The inspection was conducted as a routine inspection as envisaged in CD/881 for verification of chemicals declared under Schedule [2] of the Annex to article VI of the draft convention.

3. This report is in two sections. The first describes briefly the facility concerned and the conduct of the inspection. The second gives an assessment of the main lessons learned.

I. DESCRIPTION OF FACILITY AND TRIAL INSPECTION

A. Description of Facility

4. The factory concerned was of medium size by United Kingdom industrial standards and orientated towards organophosphorus chemicals, though not exclusively. The chemical which was the subject of our inspection was dimethylmethylphosphonate (hereinafter referred to as DMMP) a Schedule [2] chemical. It is produced at the factory in batches according to demand using

one multi-purpose reaction vessel. All the DMMP produced is sold for onward processing as a fire retardant. None is consumed on site. The single step reaction process involves the standard Arbusov rearrangement of trimethylphosphite (hereinafter referred to as TMP) using methyl iodide catalysis. The process yield is virtually quantitative. No other Schedule [2] chemicals are produced or processed at the factory.

B. Conduct of Trial Inspection

5. Officials of the Foreign and Commonwealth Office and Department of Trade and Industry paid an initial visit to the factory to brief the local staff about the background to, and aims of the exercise. This was followed by a two day familiarization visit during which a facility attachment was drawn up by a three strong inspection team comprising representatives from the Foreign and Commonwealth Office, and the United Kingdom Chemical Defence Establishment. A consultant from the United Kingdom Chemical Industries Association observed this stage of the exercise and the subsequent inspection.

6. A schematic site plan was prepared in support of the facility attachment, showing the overall outline of the factory and in more detail the disposition of those elements which constituted the declared facility within it. This was supported by photographs of key features at the site and isometric diagrams of the reactor and associated pipework and storage tanks all of which were signed by the inspectors to certify their accuracy.

7. The facility attachment and site plan were removed from the site and, together with a declaration in respect of DMMP production over the preceding calendar year as set out in article VI of CD/881, were given to a new team of inspectors, none of whom was familiar with the factory, to conduct the routine inspection. Documents giving details of health and safety regulations on-site and basic technical data on DMMP were also provided to the inspectors who comprised a representative from the Foreign and Commonwealth Office (as leader), a chemical expert from the United Kingdom Chemical Defence Establishment and a factory inspector from the United Kingdom Health and Safety Executive. The photographs and isometric process diagrams were retained in a sealed box on-site for the inspectors to open on arrival.

8. The inspection, which was observed by officials from the Foreign and Commonwealth Office, Department of Trade and Industry, Ministry of Defence and the United Kingdom Chemical Industries Association, lasted two days. It began with a short discussion between inspectors and local managers to agree a plan

for the inspection thus ensuring that relevant members of the factory staff would be available to answer inspectors' questions on their respective fields of work as required. Local health and safety regulations were also described in more detail. Photographs and isometric diagrams of the reaction process were removed from the sealed box in which they had been retained on-site. This was followed by a short familiarization tour of the facility using the photographs and site map. Appropriate personal safety equipment for the inspectors was provided by the factory.

9. The reaction vessel and associated pipework, storage tanks, etc. were then compared in detail with the isometric process diagrams to verify that no changes inconsistent with the declared activities and/or suggestive of illicit production of CW related material had been made. Samples of reactants, reaction mixture and products were taken, either by an inspector under the supervision of factory staff or by factory staff in the presence of an inspector. Initial analysis was carried out on-site in the quality control laboratory and checked against standarized samples held in the laboratory. Basic techniques such as titration and GLC were used for this. Another set of samples was removed for off-site analysis. The effluent system was also inspected and samples taken.

10. The second day of the inspection was devoted to a detailed inspection of the relevant sections of the factory records. These included both written ledgers in site offices and at the main weighbridge and the newly installed, central computerized records system. Production, operating and maintenance records were all examined. Random cross checks were made on individual entries and aggregate totals were summed to check for internal consistency.

C. Inspectors' Conclusions

11. The inspectors' unanimous conclusion was that everything was seen to be consistent with the declaration made by the factory. Quantitative checks based on the on-site records showed internal consistency to within 1 per cent which, with a simple, single stage reaction such as that involved in DMMP production, was deemed sufficient assurance of compliance. The co-operation shown by the factory personnel was also a key factor in enabling the inspectors to reach this conclusion.

II. ASSESSMENT OF THE LESSONS LEARNED

12. After analysing the results of its national trial inspection the United Kingdom concludes that the following are the principal lessons learned from it:

(a) The need to define precisely in the facility attachment using maps and grid references what constitutes the declared facility.

To avoid arguments over which parts of the site concerned should be eligible for access as required by the inspectors, we believe it is necessary to specify precisely in the facility attachment which elements of the overall site (e.g. records office, plant, access roads, etc.) constitute the declared facility. Accurate maps and grid references are necessary for this. Photographs of key features of the site can provide useful geographical confirmation to inspectors unfamiliar with it.

(b) The need to provide comprehensive guidelines for sampling and analysis procedures.

Sampling should, in the interests of safety, be carried out or supervised by facility staff. Sampling points should be agreed and clearly specified in the facility attachment. In cases where declared reaction vessels or other process equipment are used periodically for production of other than declared chemicals subject to routine verification, it is, in our view, not appropriate to carry out other than confirmatory or negative analysis (i.e. analysis to check the absence of declared chemicals) since complete analysis might yield commercially sensitive information about legitimate production processes. Such complete analysis does not seem justified for a routine inspection régime applicable only to a small proportion of facilities.

(c) The problem of Schedule [1] analysis.

As currently envisaged in CD/881 the mandate for routine inspection requires inspectors to verify not only that activities at the declared facility are consistent with the declarations under Schedule [2] but also that there are no Schedule [1] chemicals being produced. The latter can to an extent be deduced from satisfactory assurance of the former, but absolute proof could only logically be obtained through complete negative analysis of samples for Schedule [1] chemicals. Such analysis would however present an immense task since at present there is no instrumentation available of which we are aware which is capable of analysing selectively and easily for the full

range of potential Schedule [1] chemicals. This problem requires further consideration in the negotiations. It underlines the need for a concentrated effort to improve existing instrumentation. A footnote should meanwhile be added to the Rolling Text to register that verification of non-production of Schedule [1] chemicals would at this stage be less than absolute.

(d) The need to provide practicable advice to facilities inspected on a routine basis on steps which they might take to minimize the incidental loss of commercially sensitive information.

The observer from the United Kingdom Chemical Industries Association (CIA) expressed some concern over the incidental loss of unrelated information such as lists of customers and suppliers of other products during the inspection, but noted that trade associations such as the CIA could have a role in providing effective guidelines to their members to minimize such loss.

(e) The limitations for verification purposes of analysis of plant records.

The inspectors noted that without cross-referencing of records in detail to those held by consumers of the declared chemical and suppliers of the relevant raw materials, the analysis of plant records cannot provide conclusive proof of the facility's legitimacy. Clearly it would be possible, particularly with computerized systems, to create and maintain bogus sets of records. That said records checks are a valuable element in reaching a judgement about the level of assurance of the facility's activity. It was interesting too in this context that inspectors found hard copy records such as hand-written ledgers more convincing than computerized equivalents.

It should also be noted that records for more complex multistage reactions with lower and perhaps varying yields would be more difficult to analyse and reach assurance on material balance. The possibility of declared facilities keeping separate standardized records of Schedule [2] chemicals in parallel with their normal procedures was noted as being one possible means of alleviating these difficulties.

(f) The need for a standard format for the facility attachment and inspectors' reports.

Although different facilities will inevitably present slightly different problems in terms of verification there would we believe be great practical advantage in having more or less standardized formats for facility attachments and subsequent inspection reports. For the former our experience suggests that the following general format would be effective:

Facility Attachment For .....

Section 1: Identification of the facility (basic details of location and means of communication with an annex specifying items of equipment and buildings of which the declared facility is composed).

Section 2: Information on the declared reaction process (basic reaction data and process parameters; and process flow sheet showing key features and measurement, sampling and control points).

Section 3: Other information on the facility (material flow on-site for the declared process, weighing procedures and analytical equipment, health and safety data, etc.).

Section 4: Records (listing and description of record keeping procedures and where relevant records are kept).

Section 5: Suggested inspection procedure(s) (with options for sampling, etc. to clarify anomalies and with practical notes on analytical equipment, etc.).

(g) The need for clear information handling régimes to deal with the problem of confidentiality.

Our experience suggested a three tier régime would be most effective, dividing all information apart from that which is not sensitive at all into three principal categories in decreasing order of risk:

(i) to be retained under seal at the facility and to be seen but not removed by inspectors as required;

(ii) to be retained by the national authority; and

(iii) to be retained by the Technical Secretariat for internal use.

ACKNOWLEDGEMENT

13. In conclusion the United Kingdom would like to take this opportunity to record here its most sincere gratitude to the firm concerned in the United Kingdom national trial inspection. The valuable practical lessons afforded by this exercise would not have been possible without the generous help and co-operation of the firm concerned and the United Kingdom Chemical Industries Association.

USA	CD/CW/WP.250	Report on a United States National Trial Inspection Exercise	Also issued as CD/922 22 Jun. 89

NOT REPRODUCED
(see WP volume)

Nether-lands	CD/CW/WP.251	Report on a National Trial Inspection NOT REPRODUCED (see WP volume)	Also issued as CD/924 23 Jun. 89

Nether-lands	CD/CW/WP.252	An Attempt to Verify Non-Production in a Chemical Plant	Also issued as CD/925 23 Jun. 89

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CONFERENCE ON DISARMAMENT

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Ad Hoc Committee on Chemical Weapons

FINLAND

VERIFICATION LABORATORY

General Features and Instrumentation

1. INTRODUCTION

Effective verification of the future Chemical Weapons Convention will depend on the existence of a broad range of supporting instrumentation. The instruments can usefully be classified according to place of use: 1) in accredited verification laboratories charged with the most difficult analytical tasks, 2) in mobile laboratories doing on-site analysis of samples collected during inspections to civilian and military facilities, 3) at sampling locations, to aid in sample collection, 4) in chemical facilities to monitor non-production and in destruction facilities to monitor destruction, and, perhaps 5) at continuous monitoring stations for ambient air.

This paper concentrates on the type of instrumentation of the verification laboratory, at the same time examining the general features of its operation.

2 ANALYTICAL TASKS REQUIRED BY THE CONVENTION

The analytical tasks of the verification laboratories will be essentially as follows:

1. screening for and preliminary identification of compounds listed under the Convention
2. confirmation of preliminary identifications
3. structure elucidation of unknown novel agents

The first two tasks relate to chemicals listed under the Convention, monitoring of the presence or absence of known compounds. To be effective, screening methods should detect as many target compounds as possible in a single run, with a sensitivity not worse than that of the confirmatory methods. The methods used for confirmatory purposes

should yield data as compound-specific as possible so that there is no possibility of false positive results. The first two tasks will be greatly facilitated by a dedicated CW agents database.

Structure elucidation of unknown, novel agents present in trace amounts in samples with a complex environmental background is a task requiring the combined use of a variety of spectrometric and chromatographic techniques and highly sophisticated instruments. The work may be time-consuming despite the availability of advanced instrumentation. Successful elucidation will require extensive consultation of the databases for the individual instrumental techniques, in addition to the CW agents database.

Besides these three main tasks, the verification laboratory will be responsible for verification research and development, encompassing the following tasks:

4. continuous method development
5. collection of identification data on new compounds
6. updating of the analytical database
7. arranging interlaboratory comparison tests for evaluating laboratories seeking accreditation and for quality control purposes
8. helping the Scientific Advisory Council to evaluate technical information regarding new compounds to be tested, with a view to including them in the lists.[1]

Finally, there will be the following tasks to take care of:

9. preparation of the necessary control samples and division of authentic samples into three parts
10. re-coding and keeping track of all samples to be analyzed
11. training the experts in the national laboratories in relevant analytical procedures.

[1] Rotation of the Heads of the verification laboratories as members of Council might be advantageous in this respect.

3. TYPES OF LABORATORIES

So far, the number and organization of the verification laboratories serving the Technical Secretariat have not been discussed in detail. Are there to be laboratories devoted entirely to verification, laboratories having responsibility for other tasks as well as verification, (e.g. protection research or environmental analysis), or laboratories of both types?

It seems reasonable to presume that there will be at least one, maybe even a few laboratories dedicated to chemical disarmament. These laboratories would be responsible for solving the toughest analytical problems and for ongoing verification research and development. For this they would be equipped with the most sophisticated instrumentation available. The dedicated laboratories would presumably handle part of the routine verification analyses as well, and train the personnel of the national verification laboratories in relevant analytical methods.

The help of other laboratories will certainly be needed to analyze the large number of samples generated when the Convention enters into force. These laboratories could also provide expertise in specific fields of verification analysis. One very important function will be to fulfill the requirement that the most important samples are analyzed in two laboratories.

It would be highly advantageous if a number of laboratories were chosen ahead of time by the Preparatory Commission, ready for the use of the Technical Secretariat when the Convention enters into force. At that time, all declarations by the States Parties will have to be verified within a relatively short time period.

National laboratories will probably be established for the national implementation of the Convention, or alternatively existing environmental or military laboratories will be enlisted. Sophisticated instruments are very expensive, however, and it cannot be supposed that each State Party to the Convention will be able to procure them.

4. SELECTION OF LABORATORIES

The Preparatory Commission or the Technical Secretariat could accredit civilian or military laboratories to perform verification analyses upon proof of their competence in interlaboratory comparison tests and collaborative studies.

The States Parties could inform the Organization about available laboratories and their equipment and expertise. If the equipment were considered reliable enough for verification purposes (see below), the laboratory could be tested in a procedure involving the analysis of several batches of spiked and unspiked samples over a period of about one year. The laboratory would not know which samples were spiked and which were not, as all samples would be coded. Some of the analyses could be made in the presence of the personnel of the International Organization. Spikes would have to include all types of chemicals listed under the Convention, along with their degradation products. Sample pretreatment and analysis would be done according to tested standard operating procedures. A laboratory that operated faultlessly during the whole testing period would be eligible for accreditation by the Organization.

After accreditation, the continuing quality of the laboratory would need to be assured. This could be done by including spiked and unspiked control samples among the genuine samples each time the laboratory was asked to do analyses for the Technical Secretariat. The control samples would need to mimic the genuine ones as closely as possible so that the laboratory personnel would not be able to distinguish the control samples from the real ones. By sometimes submitting control samples only, the Technical Secretariat could keep the personnel of the laboratory on their toes and foil any attempts to decode samples with a view to discovering their origin. Particularly for the protection of confidential business information, sample origins must never be discoverable.

To ensure that the verification system is operative at the entry into force of the Convention, it would be advantageous to start the preparatory work immediately. The work could begin with interlaboratory tests with a view to establishing standard operating procedures for sample preparation and analysis. Afterwards, these

procedures could be used as a basis for the interlaboratory tests needed to identify competent laboratories. The work of creating procedures and evaluating laboratories could be started under the auspices of the Secretary-General of the United Nations and continue in the Preparatory Commission when it is established.

It is important that there be a sufficient number and an adequate regional distribution of approved laboratories available for the assignments, especially in a crisis situation, to guarantee impartiality and the high quality of the analyses.

5. RELIABILITY OF ANALYSES

The results of verification analyses must hold up in a court of law. This means methods that have been internationally tested and validated, standard operating procedures, and equipment meeting the specifications for verification instrumentation. The reliability of the analysis reaches an acceptable level if the laboratory obtains identical results from the same samples analyzed by at least two established methods relying on a different analytical principle.

Important samples will need to be analyzed in two different laboratories. But also in this case two different analytical techniques should be used to avoid errors inherent in a particular method. Analysis in two different laboratories would diminish the risk of false positives resulting from contamination of the samples. If contradictory results were to be obtained in the two laboratories, a third set of samples should be analyzed in a third laboratory, possibly in the presence of experts from the previous laboratories. Representatives of the national authority of the state where the samples were collected could be allowed to be present during the analysis if they so wished.

It has been suggested that the samples collected during routine on-site inspections to civilian chemical facilities should be analyzed in a laboratory of that State Party. There are two reasons why this cannot be recommended. The first and practical reason is the high cost of the instrumentation: in countries that cannot afford the required instrumentation, adequate analysis cannot take place. The second and

more important reason is the reliability: In the normal case, only suspect samples would be taken for analysis in an off-site laboratory. Asked to perform analyses in the presence of national authorities and representatives of the facility, the analyst would be under considerable pressure, and impartiality could not be guaranteed. If an analyst does not wish to find banned chemicals, there certainly are ways to avoid finding them, even in an accredited laboratory of the Organization and in the presence of an international inspector. The integrity of the same laboratory and analyst would be entirely different in the case of coded samples of unknown origin.

6. TYPES OF SAMPLES

The samples received by the verification laboratories will vary widely during the different phases of the Convention. During the first few years there will be a large number of samples collected from CW agent stockpiles whose composition must be verified to be in accordance with declaration. There will also be samples from destruction facilities, to verify that the destruction is proceeding according to declaration. The production of the single small-scale facilities will have to be verified, as well as the production of Schedule [1] chemicals outside the single small-scale facilities. Large numbers of samples will be collected during on-site inspections to facilities producing Schedule [2] compounds when their declarations are being verified. The number of samples from routine on-site inspections requiring analysis in a verification laboratory will depend on the availability of reliable on-site analysis. It is very difficult to estimate the number of samples that may be generated from challenge inspections.

The samples will vary from concentrated samples containing pure agents or agent formulates to environmental samples containing ultra-trace amounts of agents in a heavy background matrix. Among the possible matrices are agent formulates, soil, water, air, plants, adsorbents from gas masks or air filtration units, samples of human or animal origin, process samples, wipe samples, and waste samples.

7. INSTRUMENTATION

The equipment required in a verification laboratory will depend on the

tasks assigned to that laboratory. If the laboratory is tasked to monitor chemicals listed under the Convention in samples containing fairly high concentrations of these compounds (100 µg/ml) in a clean background, the demands on instrumentation will not be great. Samples of this nature would typically be collected in CW agent stockpiles, destruction facilities, and single small-scale facilitites.

By contrast, highly sophisticated instrumentation will be required in laboratories handling samples collected in a theatre of war, which are likely to contain agents in ultra-trace quantities, or samples collected in chemical facilities where attempts have been made to wash away the traces of illegal production. Often it will be difficult to know in advance the concentrations of monitored compounds in a sample. Moreover, unlike the situation in pesticide analysis, there is no quantitative limit below which CW agents may acceptably be present in samples. Thus only the most sensitive and reliable techniques can be accepted. Laboratories tasked to do structure elucidations of novel compounds will have to be equipped with state-of-the-art instrumentation if they are to handle the task in a reasonable time.

If the laboratory is tasked to analyze large series of similar samples, automated sample introduction becomes essential. Automation should also be applied to management of sample information and analysis results and to general information management.

In the following we discuss the analytical equipment needed for the verification of chemical disarmament in verification laboratories. Different aspects of the evaluation include 1) required instruments, 2) their present efficiency/reliability, and 3) approximate cost.

7.1. Screening and preliminary identification of listed compounds

When a laboratory receives a sample in a matrix, the first task will be to prepare it by dilution or concentration for analysis. Air samples collected into Tenax resin need no sample preparation but are injected directly to a thermal desorption and cold trap unit and analyzed by gas chromatography with retention index monitoring (RIM). Other samples are rapidly screened for compounds possessing cholinesterase inhibition activity, then monitored for their content of listed chemicals by high

resolution gas chromatography (GC) (volatile agents) and high pressure liquid chromatography (HPLC) (non-volatile high molecular weight and polar agents), with detection by universal and selective detectors and retention index standards (RIM).

If the monitoring analysis by gas chromatography shows two or three peaks with index values close to those of a listed compound, low resolution mass spectrometry or retention spectrometry can be used to rule out false positives. If the sample is suspected of being concentrated, e.g. an agent formulate, ^{13}C nuclear magnetic resonance (NMR) spectrometry can be used for screening. In extreme cases where the sample is suspected to be very important but dilute, tandem mass spectrometry (MS/MS) may be used without prior screening. Non-volatile compounds can be introduced by direct inlet and ionized by electron ionization or chemical ionization, or introduced through HPLC using a thermospray interface or dynamic fast atom bombardment (FAB). The ionized compounds can be monitored using multiple reaction monitoring.

Confirmation is required for all samples giving a positive or tentative result with the screening techniques. The methods used for confirmation depend on the concentration of the suspect agent and complexity of the sample matrix. If the sample gives a positive result in enzymatic screening and no known inhibitors are found, or the sample is otherwise known to be toxic, the concentrate is subjected to structure elucidation.

Enzymatic screening

A multichannel microprocessor-driven spectrophotometer is recommended for rapid enzymatic screening of large numbers of samples. The spectrometer must be able to operate at wavelengths between 405 and 420 nm and be equipped with an incubation unit offering simultaneous incubation of several cuvette blocks, with an individual timer for each block. Adjustment of the zero level before the measurement of each block eliminates the need for a separate reference solution. The cost of this spectrometer is about USD 30,000.

Gas chromatography

Two-channel gas chromatography with retention index monitoring (RIM) is used to monitor volatile compounds and for quantitation. To allow easy operation, the verification laboratory should have chromatographs equipped with different injector, column, and detector combinations.

The following instrument configurations are proposed:

- for RIM, one two-channel GC equipped with an autosampler, a split/splitless injector, two FI detectors, and 15-m SE-54 and OV-1701 columns

- for RIM, one two-channel GC equipped with an autosampler, a split/splitless injector, AT and EC detectors, and 15-m SE-30 and OV-17 columns

- for RIM of adsorptive compounds, one two-channel GC equipped with an on-column injector, AT and FP detectors, 15-m OV-17 and SE-30 columns

- for RIM of samples collected onto Tenax resin, one two-channel GC equipped with a thermal desorption and cold trap injector, 25-m SE-54 and OV-1701 columns, an AT detectors and a low resolution mass spectrometer as a second detector

- for samples with very high background, one two-channel GC for use with a split/splitless injector and 50-m columns; other equipment varies according to the task

- for screening of samples for which the complexity of the background is unknown, one one-channel GC equipped with a split/splitless injector, an FI detector, and a 15-m SE-54 column.

The autosampler should allow the sample and the retention index standards to be drawn from different vials into the same syringe.

One-channel gas chromatographs can be used for sample introduction to mass and infrared spectrometers. In addition, to allow registration of spectra of the pure compounds, it would be advantageous to have

chromatographs with a two-stage capability that can be connected to an FT infrared spectrometer and to a low resolution mass spectrometer without MS/MS capability.

The cost of a basic gas chromatograph is between USD 10,000 and 30,000 without special detectors, the datastation for RIM, or the recorder. The cost of the autosampler described is about USD 10,000.

Retention spectrometry

If retention spectrometry is used in the verification laboratory, two gas chromatographs could be devoted to it. In one GC, the column unit would be directly connected between the injector and the detector, allowing the retention spectra to be run in the basic mode. The other GC would be equipped with an analytical column, valves allowing heart-cutting in the two-stage chromatography mode, and the multicolumn unit of the retention spectrometer. The low cost and simplicity of the retention spectrometer recommend it for use in on-site tasks in the mobile laboratory. In the verification laboratory it would probably be replaced by low resolution mass spectrometry.

High performance liquid chromatography

High performance liquid chromatography (HPLC) is used to monitor and quantify thermolabile, non-volatile, polar, and ionic compounds. With a suitable interface, it is also used for sample introduction of these molecules to a mass spectrometer. The HPLC-MS combination is the preferred sensitive and reliable analytical technique for high molecular weight compounds and polar compounds, but other agents are detected as well.

- for RIM with methanol-water solvent system, one HPLC with gradient capability, temperature-controlled column compartment, autoinjector and autosampler, column switching valve allowing automatic column changes during a sequence, diode array detector, regular RP-18 column, and base-deactivated RP-18 column

- for RIM with acetonitrile-water solvent system, one HPLC, similar to the first

- for detection of enzyme inhibitors, one HPLC with gradient capability, temperature-controlled column compartment, autoinjector and autosampler, enzymatic detector, and regular RP-18 column.

- for purifying samples for analysis by other methods (e.g. IR, NMR), one HPLC with gradient capability, temperature-controlled column compartment, manual injector (sample loop volumes 100-2000 μl/), diode array detector and mass detector, semipreparative RP-18 column, and fraction collector.

Fluorometric and electrochemical detectors should be available as supplementary equipment.

The enzymatic detector consists of an autoanalyzer based on a continuous-flow principle. The construction contains a multichannel peristaltic pump for supplying the reagents and air, two thermostated water-baths (37 °C), a colorimeter with a filter of 405 nm, and the manifold.

The approximate cost of basic liquid chromatographs is between USD 30,000 and 50,000. The approximate cost of the enzymatic detector is USD 30,000.

7.2. Confirmation of preliminary identifications from concentrated samples

Preliminary identifications made on the basis of chromatographic techniques and retention indexes must always be confirmed by spectrometric methods. In concentrated or low background samples, adequate confirmation of volatile compounds is obtained using a gas chromatograph connected to a low resolution mass spectrometer (LRMS) allowing electron ionization and chemical ionization with methane or ammonia as reactant gas. In the case of non-volatile compounds, a high performance liquid chromatograph must be used for sample introduction to the LRMS. The confirmation of volatile compounds may also be made with a gas chromatograph coupled to a Fourier transform infrared (FTIR) spectrometer equipped with a light pipe. The approximate cost of the LRMS is USD 80,000, that of the infrared spectrometer USD 200,000.

Besides the hyphenated techniques, compounds purified by HPLC can be identified by a conventional dispersive infrared (IR) spectrometer using a solid or liquid sample matrix, or by any of several NMR techniques.

The present results from retention spectrometry suggest its adequacy for confirmatory identifications of compounds tentatively identified by HRGC and retention index monitoring. At the moment, however, we would recommend its use only as one of two independent confirmatory methods.

Nuclear magnetic resonance spectroscopy

At the moment, high field NMR instruments are capable of recording NMR spectra for the ^{1}H, ^{13}C, ^{19}F, and ^{31}P nuclei of pure compounds of molecular weight 350 present at 10 - 100 microgram level in suitable solvents. In favorable conditions, the highest field spectrometers enable structural data to be obtained from soluble high molecular weight compounds (1000 - 10 000) present at 1 -10 mg level. The highest field instruments are generally recommended for identification and structure elucidation. Higher sensitivity and less overlap of resonance lines followed by easier analysis of the spectra are the advantages of a stronger magnetic field. At present, the maximum field strength of commercially available NMR spectrometers is 14.1 T, which corresponds to a proton resonance frequency of 600 MHz.

The requirements for an NMR spectrometer used to produce data for an NMR database are more stringent than the requirements for identification purposes.

It is not really possible to specify a single instrument for data production, because for some compounds, those of BZ type for example, the ^{1}H spectra even at the highest field are difficult to analyze. Given the types of compounds to be included in the CW database, it would seem reasonable to have two or more spectrometers with fields differing by a factor of 2-3. The various choices might be 200 and 400 MHz, 200 and 500 MHz, 300 and 600 MHz, or even 200 and 600 MHz. The availability of spectrometers with different magnetic field strengths

is also important in checking the correctness of the obtained data sets. Data sets cannot be produced for the NMR database without the assignment of resonances. This necessitates the availability of

- high resolution (line width less than 0.1 Hz)
- high digital resolution (0.01 - 0.1 Hz)
- high stability of sample temperature (variation less than ± 0.05 °C)
- double resonance experiments $^{1}H-\{^{1}H\}$, $^{13}C-\{^{1}H\}$, $^{31}P-\{^{1}H\}$ $^{1}H-\{^{19}F\}$, $^{1}H-\{^{31}P\}$, $^{13}C-\{^{19}F\}$, $^{3P}-\{^{1}y9F\}$, $^{1}H-\{^{14}N\}$, and $^{1}H-\{^{35}Cl\}$,
- 2-dimensional $^{1}H,^{1}H-$, $^{13}C,^{1}H-$ or $^{1}H,^{13}C-$, $^{31}P,^{1}H-$, and $^{1}H,^{19}F$-COSY and ^{13}C INADEQUATE techniques.

The time consuming conventional approach to producing spectral parameters for the database — analyzing spectra by the programs LAOCON, LEQUOR, MAOCON, PANIC, or COMIC — can be speeded up by using the recently introduced automatic spectral analysis program DAISY. This approach should be especially useful in analyzing the spectra of homologue series. A necessary requirement is the possibility to transfer the original experimental data, in digital form, to the computer used for spectral analysis. Program packages like Levy's NMR 1\&2 are suitable for many tasks in spectral analysis.

The requirements of NMR instrumentation for structure elucidation of novel unknown compounds closely correspond to those described above for production of the database. 1- and 2-dimensional NOE techniques are the most important additional facilities needed.

The sensitivity of the NMR spectrometer used for identifications based on the database should be such that the signal-to-noise ratio of the analytical spectrum is large enough to allow comparison with the reference spectrum. Comparison is most convenient when the analytical spectrum is transferred to the computer used to calculate the reference spectrum from the parameters in the database, or which contains the reference spectrum library calculated at the observation frequency.

Analysis of many different compounds requires a 200-400 MHz four-nuclei (^{1}H, ^{13}C, ^{19}F, ^{31}P) spectrometer or one equipped with a tunable multinuclear probe for including frequencies for $^{1}H/^{19}F$ and $^{15}N,...^{31}P$ NMR. Of the two, the four-nuclei spectrometer is to be preferred for verification monitoring. This conclusion is based on the following considerations:

- ^{1}H, ^{13}C, ^{19}F, and ^{31}P isotopes will be the most commonly required nuclei. Nuclei such as ^{14}N, ^{15}N, ^{17}O, ^{35}Cl, and ^{75}As have only marginal use in the identification of CW agents and their degradation products.

- A completely automated production of ^{1}H, ^{13}C, ^{19}F, and ^{3P} spectra from a single sample is possible without the manual tuning necessary with a multinuclear tunable broadband probe.
- The loss of sensitivity relative to the tunable multinuclear probe is small.

Spectra of compounds containing neither phosphorus nor fluorine can be run using the NMR instrumentation commonly present in laboratories: a $^{1}H/^{13}C$ NMR spectrometer that can be automated from sample introduction to recording and plotting of spectra. With suitable computer facilities, spectra can be directly compared with library spectra for identification.

The approximate cost of the four-nuclei spectrometers mentioned above, having ^{1}H resonance frequencies of 200 and 400 MHz, is USD 250,000 and USD 500,000, respectively. At 600 MHz level, the price of the most sophisticated NMR spectrometer meeting the requirements of database creation and structure elucidation of unknown novel compounds is about USD 1.5 million.

7.3. Confirmation of preliminary identifications from dilute samples

Preliminary findings of banned chemicals in ultra-trace quantities in environmental samples must be confirmed with state-of-the-art instrumentation, making use of at least two independent techniques (e.g. MS/MS, HRMS, GC-MI-FTIR).

Mass spectrometry

High resolution sector (HRMS) and triple stage quadrupole (TSQ) mass spectrometers currently provide the most sensitive and specific means of identification and quantitation. The same instruments are suitable for the structure elucidation of unknown compounds. Modern sector instruments provide easy and sensitive monitoring using linked scan operation and high energy collisions. With a TSQ or with a sector instrument with resolution 10,000, reliable identifications (resolution 1000) can be made from 1 pg of a monitored compound.

A TSQ instrument operating in MS/MS mode is easier to use and gives results more quickly than a sector instrument. The main disadvantage is that it allows only unit resolution, compared with the resolution of 50,000 or higher achievable with a sector instrument. This means that the elemental composition of unknown compounds can be determined only with sector instruments. HRMS with multiple ion monitoring and resolution 10,000 allows selectivity and sensitivity roughly comparable to that of multiple reaction monitoring in MS/MS mode with a TSQ instrument.

The MS instruments must allow chemical ionization, negative chemical ionization, and direct inlet analysis, and interfacing with gas (GC) and liquid chromatographs (HPLC). GC/MS analysis is routine, while HPLC/MS is developing rapidly. Nowadays the most commonly used interfaces are thermospray, continuous flow fast atom bombardment (FAB), and moving belt. Thermospray is particularly useful for polar compounds with high proton affinity; nonpolar compounds with low proton affinity such as hydrocarbons are not ionized sufficiently under thermospray conditions. FAB is suitable for high molecular weight compounds such as peptides and for biological samples. The moving belt is more difficult to use than the other two interfaces. However, it has the advantage of allowing EI spectra to be recorded and thus library searches for identification. At the moment, a thermospray for interfacing the HPLC with a TSQ is routine and well suited for the monitoring of acidic degradation products of nerve agents and other polar compounds. In the case of unknown compounds whose elemental composition is sought, the HPLC must be interfaced through a thermospray to the HRMS.

Hybrid instruments combine sectors and quadrupoles in a single instrument. The hybrid spectrometers are more difficult to operate than TSQ or HRMS separately. Moreover, the efficiency of analysis is greater with two separate instruments, because the hybrid instrument allows only one analysis at a time.

In sum, the best alternative for a verification laboratory is a TSQ for monitoring of known compounds and an HRMS for structure elucidation of unknown compounds (cost approximately USD 500,000 each). Both instruments should be interfaced both with GC and HPLC. The TSQ can be used to confirm the qualitative analysis made by HRMS, and the HRMS to confirm the monitoring result obtained by TSQ. This combination satisfies the requirement for two separate techniques for reliable identification. If only one instrument is possible, the choice would be HRMS. Both instruments can be equipped with autosamplers.

Infrared spectrometry

At the moment the most sensitive technique for infrared spectroscopic identification of CW agents is Fourier transform - matrix isolation - infrared spectrometry using gas chromatography for sample introduction (GC-MI-FTIR). In this technique sample components are separated by gas chromatography, the eluted compounds in vapor form are mixed with an inert gas, usually argon, and the mixture is rapidly frozen. Because the molecules of the compounds are effectively separated in the matrix, the infrared spectrum of the compound is virtually free from the effects of hydrogen bonding and other intermolecular interactions, and most rotational components of the IR spectra disappear. This means very sharp, well-defined bands with exceptionally high peaks, and thus highly sensitive detection and high molecular specificity. The high sensitivity is also due to the possibility of collecting more interferograms from the frozen effluent than from the effluent in a light pipe as in conventional GC-FTIR, where it spends only 1-5 s. Spectra can be obtained from subnanogram-level samples, which is similar to the sensitivity of mass spectrometry. The required amount of sample for the conventional GC-FTIR with the light pipe technique is in the low nanogram range.

If a two-stage gas chromatograph is used for sample introduction, infrared spectra of pure compounds can be obtained from samples with high environmental background. If retention index standards are added to the sample and the effluent stream is split into two parts, e.g. 20% to the GC detector and 80% to the infrared spectrometer, accurate retention indexes are obtained as a complementary method of identification.

Apart from appearing sharper and more intense, matrix-isolation spectra closely resemble vapor-phase spectra. A high-resolution spectrum may be deresolved by computer allowing searching of a matrix-isolated spectrum against a vapor-phase library. At the moment the number of library MI-FTIR spectra is small compared with the number of mass spectra.

Sample introduction from a high performance liquid chromatograph is currently under development. And the instrumentation is still very expensive (about USD 500,000).

By way of conclusion, the GC-MI-FTIR spectrometer is the best choice among the IR spectrometers for a verification laboratory needing to identify CW agents in low concentrations in environmental samples. Additional low cost instrumentation (about USD 50,000) is recommended for samples analyzed in solid and liquid form.

7.4. Structure elucidation of unknown novel agents

All of the analytical techniques referred to above must be available when the goal of the verification analysis is rapid structure elucidation of an unknown compound in an environmental sample. Chromatographic techniques and enzymatic detection are used to locate the compounds. Infrared spectrometry is valuable for its specificity, especially when a reference spectrum is included in the library. If there are no reference spectra in the library, information can be obtained on the functional groups of the molecule. Combined use of HRMS and MS/MS affords detailed structural data, while NMR spectrometry is the most powerful technique for assigning the stereochemistry of the molecules.

Laboratory automation

The automation needs of the verification laboratory can be categorized into 1) management of sample information and analytical results, 2) automated processing of the measured data, 3) on-line comparison of analysis results with the reference database, and 4) documentation of the analytical results.

The verification laboratory should be equipped with a computer capable of sample information management. The same computer could be used to store reference data. In a small laboratory (less than five analysts), a microcomputer is adequate; a larger laboratory would require at least a minicomputer, with the capacity depending on the size of the laboratory.

Sample information and reference database management are most easily accomplished using a relational database. The main advantage of the relational database technique is that it can handle unexpected information needs. Several commercial programs for sample information management are available, for various sizes of computers. We have written a special program for the analytical reference database (VERIFY) for CW agents.

Nowadays almost all instruments are ready equipped with microcomputers for processing of the analytical results. This reduces the number of errors and the time needed for data processing. In selecting an instrumental data system, compatibility with the laboratory information management system (LIMS) needs to be emphasized.

Documentation will require a word-processing program. Transfer of texts from laboratory to laboratory would be facilitated if all laboratories were to use the same program. While a particular program cannot be recommended at this time, the eventual choice must allow management of text documents and incorporation of special characters, tables, pictures, molecular structures, and reactions.

The verification laboratory should also have a good statistics package for the statistical analysis of data and the clear presentation of results. Such packages are available for both micro- and

minicomputers. Tools are also needed for writing new programs as new analytical methods are developed.

8. PERSONNEL AND SPACE REQUIREMENTS

The personnel and space requirements of the verification laboratory will depend on the tasks assigned and the equipment needed to take care of these tasks.

The general rule will be one senior analyst and one laboratory assistant for each instrumental technique. Laboratory automation will help reduce the number of staff at the laboratory assistant level. Depending on the number of samples requiring preparation, the task of sample preparation will require 2-5 laboratory assistants in addition to the senior staff member. One operator will be needed for each major spectrometer and, in addition, 1-2 laboratory engineers in a laboratory equipped with several sophisticated spectrometers, operating eight hours a day, five days a week. At least two researchers will be needed for laboratory automation and quality assurance, and support staff will be needed for library information service and care of chemical, glassware, and equipment stocks.

The space of the laboratory will be divided among the instrument, sample preparation, and synthesis sections. The spectrometers will need to be housed in separate rooms located far enough apart that the electromagnetic fields are not interfering. Instrument manufacturers lay down strict requirements for air conditioning, humidity, temperature, stability of electricity, and the carrying capacity and stability of floors.

Reasonably, at least 50 - 80 m^2 laboratory space would be needed for each major spectrometer, the associated terminals and workstations, and the facilities for specific sample preparation. The personal rooms for the researchers and operators should be located close to the main room.

About 50 m^2 would be required for each of the gas and liquid chromatography laboratories, and about 100 m^2 and many fume cupboards for sample preparation. A separate laboratory for ultra-trace samples would be essential to avoid contamination. And to allow for synthesis

of CW agents as model compounds and standard compounds in gram quantities, a separate high risk laboratory would be desirable.

All in all, we envisage a verification laboratory of about 1000 - 1500 m^2. In Finland at the moment, the average cost of construction is about USD 1 million for 1000 m^2 of laboratory meeting the above requirements. The equipment is not included in this figure.

CONFERENCE ON DISARMAMENT

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CANADA

Case Study of Unusual Epidemiological Findings Caused by a Toxin

This paper contains a case study of the sudden appearance in Canadian waters of a toxin from natural sources which bears many similarities to the situation that might be expected from a clandestine attack using such a novel agent.

While it may be relatively easy to demonstrate initially that an event is due to natural sources, it may be much more difficult to obtain unqualified proof that an alleged attack has in fact taken place. This study illustrates some of the problems which could be encountered in the verification of such an event.

CANADA

Case Study of Unusual Epidemiological Findings Caused by a Toxin

1. Over the past few years, concerns have been expressed that weapons could be developed incorporating toxins or other novel agents which, in the event of their use, would present special problems of investigation. To substantiate an allegation that an outbreak of illness or a cluster of deaths was due to use of a weaponized toxin, for example, it would be necessary to trace the epidemiological findings to a source which could be shown to be the result of a hostile human act. There have been several studies of how such investigations could be carried out, including the 1985 Canadian study entitled Handbook for the Investigation of Allegations of the Use of Chemical or Biological Weapons.

2. The first challenge would be to demonstrate unequivocally that the epidemiological finding does not have a natural cause. Since an aggressor would in all likelihood take steps to mask his use of chemical or biological weapons, it is unlikely that incriminating evidence such as spent munitions with traces of the agent would be found which could be linked to the perpetrator. He might even choose to mask a potent toxin by also using a naturally occurring toxin which he would expect to be identified easily. The detection of the agent, the elucidation of the cause-effect relationship, and the evidence of the means employed might therefore require sophisticated (and lengthy) scientific investigation.

3. The causes of cataclysmic events are not always obvious. When such an event occurs, even in the absence of war, it might be attributed by the State affected to a hostile act by another State. An unexpectedly high number of casualties is not necessarily a reliable indication of an intended happening, as can be illustrated by the death of more than 1,700 people on 21 August 1986 near Lake Nios in Cameroon from what turned out to be asphyxiation by carbon dioxide attributable to a natural event.

4. A Canadian case study at Annex illustrates that the thorough investigation of such incidents can be very time consuming and expensive, and requires a wide array of scientific talents. Lessons learned from the Canadian experience include:

- Strong scientific leadership is needed to ensure that the multidisciplinary group remains focused on the problem and that resources are efficiently used. Responsibility should be assigned unambiguously.

- An organization large enough to encompass all the necessary expertise cannot be maintained on stand-by but must be planned on an ad hoc basis. Although there could certainly be a core capability in sampling and chemistry, other experts would have to be added in each case as the investigational strategy developed. The key people must be extremely flexible, knowledgeable in many fields, and innovative in their approach.

- State-of-the-art instrumentation, and experienced operators, are required. Much of this instrumentation cannot be moved.

- Certified standards are necessary to confirm the identification of the toxin. It would be useful to have sufficient quantities available to confirm toxicological findings. These are available commercially in very small quantities for many toxins.

- The elimination of natural, though unusual, explanations may be a time-consuming process and could require one or more seasonal cycles to complete.

- Access to multiyear baseline data, taken before the incident or from a very similar location, could be extremely valuable if not essential. Uncontaminated control material should be available.

- Well-managed support services are important. Sampling is an essential part of such an investigation. Careful attention has to be given to recording of data, meetings and conversations, as well as to packaging and transportation of samples, data analysis, computation, and access to library resources.

Problems of communication among disciplines, interorganizational rivalry, and competition for "ownership" of scientific data have to be coped with in any organization quickly assumbled to conduct such an investigation.

ANNEX

1. In November 1987, about 150 people became ill, mainly in the Province of Quebec; and two, or possibly three, died in circumstances which suggested an outbreak of some kind of food poisoning. The symptoms were acute gastroenteritis, mainly nausea and vomiting, but abdominal cramps, diarrhoea, anorexia, headache, intestinal bleeding and hiccoughs were also frequently reported. Of the total, 36 per cent had neurological problems as well. These included confusion, disorientation, memory loss, hallucinations, difficulty in speaking, unusual movements of the eyes and limbs, mastication of the jaw with some salivation, seizures and coma. In many cases, the symptoms were transient, but in the most seriously affected patients, who were generally elderly, the neurological symptoms persisted for several weeks or longer. It was rapidly established that those affected had eaten mussels which were traced to Cardigan River in the Province of Prince Edward Island (P.E.I.). The appropriate actions were swiftly taken to prevent consumption of mussels or other seafood from the area. In order to save the industry there was an urgent need to identify the toxin and test the safety of products so that the market could be resupplied. There was also an important, though less urgent, need to find the source of the toxin and, if possible, ensure that the mussel beds would not be contaminated again.

2. While there was never any suggestion that this event in Canada was a hostile act, it is proposed that this event is a useful case study to assist in planning for an investigation of allegation of use of a toxin weapon. The urgency with which the study was carried out is akin to what would be necessary if an attack were alleged. A special aspect is that the toxin had not been found previously in mussels or other seafood. It had been identified as a marine compound present in various algal species, but it was not known to be particularly toxic. It turned out not to be a very potent toxin since it was estimated that the mussels affected were consumed by several thousand individuals with only 150 cases of illness recorded - mainly among elderly subjects. However, some of these subjects have still not recovered.

3. The mussel toxin investigation can be broken into several phases:

(a) Recognition of the link between human illness and consumption of mussels from P.E.I.

The first cases of gastroenteritis were notified to the authorities late in November 1987. The shellfish industry is highly regulated in Canada and shellfish is one of the first suspects in any case of food poisoning. The problem was quickly tied to consumption of cultivated mussels from the Cardigan River in P.E.I. and their sale was banned on 29 November. Cultivation of mussels is a new, rapidly expanding, industry in that locality.

(b) Determination of the extent of the problem

There had been no previous problem with mussels from this area. Paralytic shellfish poisons (PSP), of which the best known is saxitoxin, had never been detected there, although PSP is an annual occurrence in adjacent regions and routine testing of shellfish at risk using a mouse bioassay is carried out by the Canadian Federal Government. PSP was eliminated as a possibility by 7 December 1987. Other possibilities considered were heavy metals, pesticides, and micro-organisms, but no evidence to support these possibilities was found. The toxin from the mussels took 2-3 hours to kill

mice instead of 5 minutes for PSP, and was preceded by a characteristic scratching motion which started after 10-30 minutes. These symptoms were only produced by extracts from mussels from the Cardigan River stock, but a few mouse deaths (inconsistent results) without scratching were recorded from mussels from the Magdalen Islands and oysters from bays in northern New Brunswick. These deaths were eventually shown to be due to low levels of PSP and to high levels of zinc respectively. Both of these turned out to be unrelated, and previously undetected, contaminants which did not make the products unfit for human consumption. In summary, there was a highly localized toxicity problem in the Cardigan River mussels due to an unidentified toxin which was not PSP or any of the other likely candidates. This was the situation on 11 December.

(c) Identification of domoic acid as the toxin responsible

1. The resources committed to this problem were considerable. On 3 December a mussel contamination task force (19 members) and a laboratory analysis working group (17 members) were set up comprising officials and scientists from several centres. These had frequent conference calls. At the peak of the crisis more than 100 people were engaged in laboratory studies, and many others were involved in sampling, transportation of samples, and recording of data. The responsible agency was the Department of Fisheries and Oceans (DFO). The Department of National Health and Welfare (DNHW) had responsibility for the human health aspects. The National Research Council (NRC) had expertise and equipment needed for solution of some of the aspects of the problem.

2. On 11 December, NRC agreed to undertake on an urgent basis the identification of the toxin using its group of scientists which had specialized in the isolation, identification and analysis of bioactive chemical compounds from marine sources. The NRC group lacked the capability to conduct mouse bioassays in-house, essential to guide the chemical studies, and this need was met by DFO from 12 December. Subsidiary objectives were to develop reliable quantitative analytical procedures and to study the origins of the toxin.

3. The toxic material from mussels was all extractable in aqueous methanol. A dose-response curve base on equivalent weight of wet tissue was constructed and two separation techniques, high voltage paper electrophoresis (HVPE) and reversed phase high pressure liquid chromatography (HPLC), were used to isolate the toxic material. It was further "fingerprinted" by determining its complete UV spectrum, and its mass spectrum, which showed a peak at m/z 312. Nuclear magnetic resonance (NMR) and Fourier transform infrared spectra gave further hints about the structure. In case the toxin was a known compound, a computer search of Chemical Abstracts and toxicological data bases was conducted. As the analytical data was refined, domoic acid emerged as a likely candidate. Comparison of the spectra of the purified toxin with those of synthetic domoic acid revealed they were identical. This stage was reached on 17 December and announced the following day, after confirmation of the NRC results by DNHW.

4. Domoic acid was present at levels up to 800 mg/kg of mussel tissue, and it was necessary to consider next whether any other toxin was present. It was concluded that there was no evidence of toxicity in the whole mussel extract which could not be accounted for by the measured levels of domoic acid in the extract. Definite conclusions were limited by the reproducibility of the mouse bioassay. When the extract was fractionated by HPLC or HVPE, the only toxic fraction was that known to contain domoic acid. Authentic domoic acid from Chondria armata produced the same characteristic scratching reflex in

mice. In summary, while no conclusive proof was possible, no evidence was found, using several search strategies, to support the presence of another toxin.

(d) Incorporation of domoic acid in Cardigan River Mussels

There are two questions to be answered: what are the food-web dynamics responsible, and why was the problem found only in the Cardigan River in the fall of 1987?

1. Once the toxin had been identified, attention was focused on how it entered the mussels. Domoic acid is not found in the meat but only in the gut contents of the mussels. It had previously only been associated with a seaweed, Chondria armata, found in the Pacific. This genus is scarce on the Eastern seaboard. In early 1988, domoic acid was found in other organisms in the Georges Bank and elsewhere, but at much lower levels. The predominant food in the toxic mussels' gut was algal diatoms of the species Nitzschia pungens. If the domoic acid were all accumulated by the mussels from their food intake rather than systhesized de novo, the source responsible must have been very abundant. While there was no evidence of Chondria, it was known that there had been a heavy bloom of Nitzschia in late 1987. Although the bloom was rapidly disappearing by mid-December, domoic acid could still be detected in plankton tow samples and even in water from the affected area. Lastly, it was shown over the winter that Nitzschia pungens grown under laboratory conditions does produce domoic acid.

2. The possibility was considered that the domoic acid might have been derived from certain herbicides used on potatoes and blueberries. One possible explanation which had been considered was that such material had somehow entered the Cardigan River watershed. This became less likely when N. pungens was found to synthesize domoic acid. It remains something of a mystery as to how domoic acid reached such levels in the fall of 1987, but was not detected previously, and why it was a problem only in the Cardigan River. Part of the explanation may be that the cultured mussel is a recent introduction and that no other organisms are feeding heavily on Nitzschia at that time of year. Another part may be that there was a heavy rainstorm in the Cardigan River area of P.E.I. on 9 September, which may have supplied a pulse of nutrients to the estuary from run-off from cultivated land and flushing of some eutrophic ponds. The following 7 to 10 days of bright sunshine, completed the requirements for a bloom, which appears to have been exceptionally heavy.

After the domoic acid disappeared, harvesting of mussels recommenced in February 1988. A careful monitoring programme was set up to ensure that the product was fit to be marketed. An increase in domoic acid, smaller than the previous year, was detected in November 1988 and the mussels were not harvested again until the content had returned below the permissible level.

Thus, the events of 1987 in the Cardigan River may have been unusual, but they were certainly not unique. It took a considerable effort over 12 months to demonstrate this. While the cause of the toxic levels of domoic acid must remain a matter of conjecture, it is generally agreed that a plausible explanation can be offered without invoking an anthropogenic cause such as point-source pollution or a hostile act.

CONFERENCE ON DISARMAMENT

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Ad Hoc Committee on Chemical Weapons

UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

Analytical Techniques for a Chemical Weapons Convention

Summary

1. This paper examines the requirements, in terms of on- and off-site instrumentation technology, and laboratory procedures, for on-site inspections including CW stockpiles and destruction facilities. Much of the information is also applicable to inspections of civil chemical facilities and the single small-scale facility.

Introduction

2. CD/881 contains provisions for monitoring compliance with the CWC, and detecting any cases of non-compliance, by amongst other activities, on-site inspections of various types of sites (including destruction, production and storage facilities) on a routine or a challenge basis.

3. Essential technological requirements for effective on-site inspections will be:

(a) capabilities for sampling and analysis (whether on-site or subsequently at an off-site laboratory) of high purity compounds to verify their identities together with trace analysis for Schedules 1, 2 and 3 compounds which may be present in otherwise innocuous materials;

(b) sampling and analysis of soil around the site and of airborne or water-borne effluent to obtain evidence indirectly of the nature of the compounds being used or produced at the site;

(c) sampling and analysis of the atmosphere at factory floor level or in storage depots to obtain information on the compounds being used, produced or stored at the site, and

(d) non-intrusive interrogation of bulk containers and munitions, the contents of which cannot be sampled for whatever reason, in order to gain information on the possible physical state and chemical composition of the contents.

4. A separate scenario concerns on-site investigations of alleged use of CW; although there is much in common between this situation and those outlined above as far as sampling and analysis requirements are concerned, there are also significant differences which are being considered by the United Nations Secretary-General's Groups of Experts and for this reason, investigation of alleged use will not be addressed further in this paper.

Aim

5. The aim of this paper is to outline and briefly assess those sampling, analytical and investigative techniques which may be relevant to the inspection scenarios outlined in the Introduction.

Sampling of Stockpiles and Destruction Facilities

6. In these situations the agents are likely to be in bulk containers or in actual munitions. In both cases it will be technically difficult and certainly hazardous to attempt to obtain samples of the contents of bulk containers or munitions unless provision for sampling has been incorporated into the design of the container or munition; it is likely that this will be the case for bulk containers but is most unlikely for munitions. However, in the case of a destruction facility, depending on its design and principle or operation, the bulk containers and munitions will need to be opened so that the contents can be extracted for destruction and it may be possible and practicable to obtain samples at this stage for definitive analytical identification either on-site or off-site.

7. Although bulk containers and munitions will be sealed to prevent leakage of the toxic contents, it is possible that very small amounts of leakage could take place to give airborne concentrations of materials which may be detected and identified using advanced specific and sensitive analytical instrumentation. The identification would probably have to be carried out off-site so there would be a requirement to sample the air through an adsorbent tube which could then be sealed and transported to a laboratory for subsequent desorption and identification of the adsorbate; equipment and techniques for such operations (sampling tubes, thermal desorption equipment,

glc equipment, mass spectrometers) are generally available although detailed experimental/operating procedures would need to be developed, proven and documented.

8. Careful consideration needs to be given to sample containers which need to be readily and effectively sealed, impermeable, convenient to use, and carry adequate provision for a legible and agreed description not only of the contents but also of the detailed circumstances under which the contents had been acquired. Again such containers are available but agreement will need to be reached on which options would be accepted as standard. This is considered further later in this paper.

On-site Analyses in a Destruction Facility

9. The requirement in this scenario is to demonstrate that the claimed agents are actually being destroyed and at the rate which is being claimed; there will also be a need to demonstrate that the stock of agents/munitions awaiting destruction at the site is of the nature, composition and quantity claimed.

10. Confirmation of the rate of destruction this could be achieved by, for example, counting munitions on sequential visits but this can so obviously be circumvented that it is probably not worth further consideration. Automatic continuous monitoring of the rate of flow of agents, decontaminants and/or fuel (if an incineration process is used) is clearly the better method. This subject is more appropriately addressed as an aspect of continuous process monitoring. It will not, therefore, be considered further in this paper.

11. The question of storage of agents/munitions at the destruction facility whilst awaiting destruction is a variation on the points already made above and does not need to be developed further at this stage in this paper. However, automatic continuous monitoring of movement of objects into and out of the storage section of the site would be well worth further consideration. Since the aim would be to record continuously and automatically the movement of objects rather than personnel it is highly likely that a system based on an induction loop would be scientifically feasible and practicable; indeed it may well be possible to utilize or adapt some of the technology developed by the IAEA for similar reasons in connection with the nuclear Non-Proliferation Treaty (NPT).

12. The stated analytical task is to monitor destruction of declared chemicals by systematic on-site analysis of samples taken during the process. This necessarily involves the unambiguous identification of the chemicals being processed on a sample basis.

13. Provided the destruction facility has been designed with the possible sampling of feedstocks in mind there should be no problems of a technical or safety nature. If sampling facilities have not been incorporated into the plant design there could be problems and sampling may then have to be carried out at the point where the agent is extracted from the containers/munitions for insertion into the destruction process (see also para. 4). Such destruction facilities should be designed with verification in mind, i.e. sampling points in accessible places. The same principles apply in IAEA safeguards.

14. Bearing in mind the need for positive, unambiguous identification of the agents being processed the appropriate analytical identification techniques are infra-red spectroscopy (IR), mass spectrometry (MS) and nuclear magnetic resonance spectrosocopy (NMR). Chromatographic techniques, such as gas-liquid chromatograph (glc) or high performance liquid chromatograph (hplc) are not completely unambiguous in this respect, although they can give very useful data, especially when used with specific and selective detectors and particularly when authentic, fully validated reference samples of the compounds of interest are available (see below).

15. As regards on-site analysis IR and MS instruments of adequate performance may be considered as transportable rather than fully portable although it may be possible to develop portable purpose-designed instruments cannot be excluded. Glc instrumentation which is transportable is available; fully portable glc instruments of admittedly lower performance, are also available. The technique of hplc may at present be considered transportable but fully portable instruments of lower but possible still adequate performance for this purpose, could well be developed. NMR techniques are usually associated with base laboratories and cannot at present be considered more than transportable at the very best and then only for low resolution instruments. This technique is, therefore, best considered from the point of view of off-site analysis; progress in miniaturization whilst retaining performance is likely to depend on progress in the area of super-conducting ceramics.

16. Quantification of the composition of compounds will not generally be required, qualitative identification of the compounds being in most cases all that is necessary. In fact, the need for quantification can be identified for only one situation, namely to confirm that the agent feedstock has the claimed composition so that the alleged rate of destruction of the agent can be checked; for example, if the feedstock contained only 10 per cent of agent, the rate of destruction would be 10 x less than if it was pure agent. Several procedures based on glc, hplc, colourimetry, spectrophotofluorimetry, etc. are available or could be readily developed for the quantification of the composition of the feedstock; such analyses could most conveniently be performed on the samples removed for identification purposes. The relevant instruments are at least transportable and, depending on specific needs, may be portable. It is not expected that there would be any major technical difficulties in making the necessary equipment available for on-site analysis.

17. Clearly these quantification analyses will need to be considered in conjunction with the continuous process monitoring required for the destruction facilities (see para. 10).

18. In addition to identifying the agents at the input point of a destructor plant, it may also provide usual confirmation if the agent being processed can be identified on the basis of its characteristic destruction products. However, this would be dependent on the detailed nature of the destruction process. If the process was dependent solely on complete incineration, the possible identification of products uniquely associated with CW agents is remote. However, if it was based on hydrolysis, for example, characteristic destruction products would be produced and possibly discharged in the liquid effluent. These could be isolated by a variety of known techniques, although detailed procedures might need to be developed and documented for particular cases. Identification could then be made using mass spectrometry. Particular powerful techniques for this approach would be combined GC/MS or LC/MS. Since the possibility of using this approach will be critically dependent on the detailed nature of the destruction process it is suggested at this stage that these comments be only noted, for further detailed discussion if or when detailed information on likely destruction processes become available.

Mobile Analytical Instrumentation

19. For the purposes of this discussion paper it is assumed that mobile analytical instrumentation refers to a vehicle-based mobile analytical laboratory. The requirement is for a large, but not excessively large, vehicle, with its own dedicated power supply from a generator and having provision for suitable containment facilities (since CW agents will need to be handled in small quantities) and with provision for filtration of airborne effluent and the safe disposal or retention of aqueous effluent. However, the overall integration of mobile and static analytical facilities into the various inspections régimes needs to be addressed.

20. Given such a facility there are no immediately foreseeable major technical problems in the installation of selected instruments such as IR, MS, GC, hplc and requisite spectrophotometers, fluorimeters, etc. It is, however, considered unlikely that the present generation or immediately foreseeable generation of NMR instruments having the required analytical capability could be installed in a mobile laboratory; this is likely to become feasible only as a result of progress in the development of superconducting ceramics, as noted above.

21. Later in this paper the need for fully authenticated and validated reference samples with associated authenticated and validated reference analytical characteristics (spectra, retention times, etc.) will be addressed. This mobile laboratory will, thererfore, in addition to the analytical instrumentation, require a computer-based reference data base of fully authenticated and internationally agreed appropriate analytical characteristics so that they can be compared directly with the corresponding characteristics measured on samples taken on site. Inspectors may well require a portable computer for recording purposes but it has yet to be demonstrated that such a highly portable computer could also accommodate the technical data base required in a mobile analytical laboratory.

Instrumentation of Off-site Laboratories

22. The phrase off-site laboratories is taken here to mean permanent, static laboratories located away from inspection sites. These will be staffed by high quality, professionally trained, experienced analytical staff. These laboratories will not compromise sophistication, sensitivity and other important characteristics of analytical identification instrumentation in

favour of factors such as portability, robustness, power supply, etc. The difference between these and mobile laboratories essentially lies less in the types of instrumental techniques but more in the higher performance associated with instruments which can only be sited in off-site static analytical laboratories; the major exception is NMR which for the immediate future can only be considered an off-site technique.

23. Instrumental techniques which are considered as minimum requirements for such off-site laboratories include Fourier Transform NMR (FT-NMR), mass spectrometry, Fourier Transform IIR (FT-IR), glc and hplc (each with a variety of selective detectors) and spectrophotometric/fluorimetric techniques.

24. It is likely that lists of laboratory analytical equipment relevant to the activities of the Group will be required.

25. The off-site laboratories will also require a comprehensive fully validated and internationally accepted and agreed computerized data base of all the relevant analytical characteristics of the compounds covered by Schedules 1, 2 and 3, together with authenticated, valid samples of analytical reference samples of all the compounds in the above Schedules. This would need to be accepted as the master data bank and reference sample bank.

Sample Transport Equipment

26. Vapour Samples. Vapour samples are most likely to be taken in air which contains very low concentrations of the vapours of interest. Consequently the air will be sampled through tubes containing an adsorbent on which the vapour of interest is concentrated and retained by adsorption prior to subsequent elution or thermal desorption for analysis. These adsorption tubes, which can be constructed out of durable materials, could be used to transport the sample after sealing both ends securely and arranging for adequate, legible and durable labelling. Careful packing into a labelled secondary container, which may well carry all the tubes arising from one site, may be desirable.

27. Liquid Samples. Sample containers for liquids need to be robust, impermeable, convenient to use and the material and construction must not contaminate or absorb the sample nor must it contain substances (e.g. plasticizers) which might contaminate the samples. These requirements will probably eliminate many plastics.

28. All sample containers will need to be easily handled whilst wearing personal protective equipment since some of the collected samples will be hazardous.

29. The capacity of the sample containers requires consideration. For samples of pure or relatively pure liquids, such as many of the agents on Schedule 1 or intermediates covered by Schedule 2, a sample size of 10-50 ml would be sufficient and would enable the sample to be divided between more than one laboratory in order to achieve independent confirmation of results or to maximize the use of analytical facilities available in different laboratories. If only one off-site laboratory were to be involved a sample size of 10 ml should be adequate. For aqueous (or solvent) solutions, such as might arise from sampling aqueous effluent where the concentration of the material of interest may be low, larger quantities will be required; a volume of 500 ml-1 litre is suggested for consideration.

30. Solid Samples. Some of the compounds on Schedules 1, 2 and 3 are solids and provision, therefore, needs to be made for the collection, containerization and transport of solid samples; in addition samples of soil may be collected from storage or waste disposal sites. The comments made above in the context of liquid samples also apply generally to solid samples with the additional requirement that the containers should have a wider opening to facilitate transfer of the sample into the container, particularly when wearing protective clothing and/or a respirator. Required sample sizes will be in the range of 10-50 gm for pure or virtually pure compounds, between 500-1,000 gm for samples which are likely to contain the material of interest at only trace levels.

31. Prior to transport away from the collection site the sample containers will need to be placed inside a secondary sealable and well labelled container constructed of a strong material to withstand possible rough handling and filled with an absorbent but resilient material to absorb any sample leakage which occurs during transit and also to further protect the primary sample container against rough handling or physical shocks.

32. The physical transport of the samples to an off-site laboratory may give rise to some difficulties. Bearing in mind that some of the samples will be highly toxic or otherwise potentially hazardous, and bearing in mind that transport of such samples by civil airlines is controlled by stringent regulation, special arrangements for rapid transport by air will need to be devised.

Calibration of On-site Instruments

33. Detailed methods of calibration will be dependent on the types of instrumentation which are finally recommended for use on-site. In general there are two basic requirements for calibration; one is to demonstrate that the instruments are accurately achieving the qualitative identification required and the second is to demonstrate that accurate quantification, where this is required, is actually being achieved.

34. For both applications there will be a requirement for a very wide range of reference samples of proven, agreed, accepted authenticity; the preparations of such reference standard samples of the compounds on Schedules 1, 2 and 3 will need to be carried out in an off-site laboratory.

35. For the calibration of identification instruments it is sufficient that the calibration sample should demonstrably be an authentic sample of the requisite compound. The quantity of compound (or its concentration if a solution is used) is not crucial.

36. For the calibration of analytical instruments which are being used to provide quantitative data the requirement is for a series of accurately prepared analytical standards containing precisely determined concentrations of the compound of interest. For quantitative calibrations, therefore, not only must the compound of interest be of reference quality but the amount present in the calibration solutions must also be of reference quality. The preparation, validation and authentication of such reference solutions will be another key role for an off-site laboratory. Indeed the role of such a laboratory will be varied and extensive. A single laboratory may indeed not be sufficient, but rather several separate accredited laboratories each having different specialized roles. This point will be developed further later in this paper.

37. The equipment required for presentation of the reference calibration standards to the identification/analytical instruments will depend on the instruments in on-site use; since a range of such equipment capable of dealing with gaseous, liquid and solution samples is available it is not expected that there will be any difficulty in selecting the ones most suitable for the purpose.

38. It is assumed that the calibration of installed identification/analytical instruments (for example for process monitoring) or sealed monitoring instruments will be carried out at pre-determined regular intervals and the above comments will, therefore, also apply.

The Role of Military Detection and Monitoring Equipment

39. In general, military detection and monitoring equipment has been developed to respond to a limited number of the CW agents in Schedule 1 of CD/881, to none of the compounds in Schedule 2 and an extremely limited number of compounds in Schedule 3. Such military equipment is, therefore, inappropriate for most of the compounds of interest.

40. Whilst the sensitivity of such equipment is adequate for CW agent vapour concentrations present under combat conditions it would probably not be adequate for the monitoring of CW agent vapour concentrations at very low or trace levels. Such equipment is, therefore, likely to lack the necessary sensitivity required in some cases.

41. Although such equipment has been carefully designed to avoid giving false positive or false negative responses this is related to combat conditions and not to the usage envisaged in the context of a CWC. Military equipment is, therefore, likely to lack the necessary high degree of selectivity and discrimination required.

42. Military equipment has generally been designed to give a qualitative, or at best a semi-quantitative response. It, therefore, lacks the precise quantitative analytical capability required in some of the scenarios already discussed.

43. Military detection and monitoring equipment has been designed to perform a single, well defined, combat-related task and in general can perform this satisfactorily. It has not been designed for the identification/analytical tasks required as part of the technical support for a CWC and is, therefore, not well suited to this task except in certain very restricted, clearly defined and highly limited situations. Although within these limitations and restrictions it performs satisfactorily, it cannot be considered a substitute for analytical instrumentation and would have an extremely limited role in complementing analytical instrumentation.

Non-intrusive Analytical Techniques

44. Although the foregoing has been based on the premise that samples of the chemicals required for analysis will be available for insertion into the identification/analytical instrument, possibly following suitable sample processing, it is most important to recognize that this may not invariably be the case. For example, acquisition of samples may not be possible during inspection of a site, or it may be considered too hazardous to try to take a sample e.g. from a munition in an ordnance storage depot. It is, therefore, essential to consider what might be achieved by non-intrusive analytical techniques, and to identify possible techniques. This section of the paper addresses these problems.

45. It cannot be expected that non-intrusive analytical techniques will provide unambiguous explicit information on the contents of any container from which a sample cannot be taken, nor is it at all likely that only one technique will be totally satisfactory; rather, a number of techniques will be used, in sequence, each technique contributing its own particular type of information to build up an overall picture.

46. One technique which could usefully be employed is "portable" X-ray equipment, for which precedents already exist, such as X-ray equipment used during security checks at major civilian airports. However, it is likely that the need, in a CWC context, to examine the interior of a container constructed of material, probably having a relatively high atomic mass, may require the use of a rather more energetic and intense X-ray source than is the case with many portable X-ray systems; the associated power requirements and need for additional shielding required for safety reasons may render such equipment transportable rather than portable.

47. The information generated, by providing a picture of the internal design of a munition, could enable an ordnance expert to deduce whether it was a conventional readily explicable design or whether there were unconventional internal design features which might denote a chemical fill.

48. A second technique which might be used could be based on ultrasonics, or possibly on subsonics. It is considered scientifically sound to expect that ultra or subsonics might give useful information on the physical state of the filling in a munition. In particular it might differentiate between bulk solid, powder and liquid. Bearing in mind that an X-ray examination as

discussed above could reveal unusual or unexpected internal design features, the association of these with a liquid fill when no liquid would be expected to be present in a conventional munition could constitute strong but admittedly still circumstantial evidence that the munition was a CW munition.

49. A third technique which may be considered is that of neutron activation analysis (NAA). Whilst this does not and cannot give detailed structural chemical information it does give information on the nuclei present. Analysis of arsenic can very readily and sensitively be achieved using thermal neutrons but the fluorine atom is more difficult and requires fast neutron activation. It may be that the nature of the neutron source and associated shielding requirements could lead to a transportable (or at worst static facility) rather than a portable instrument but this can only be assessed on the basis of further studies.

50. Provided that more than one type of atomic nucleus can be interrogated under practicable circumstances using this technique, the ratios of the elements present could give further chemical information. To give just two examples, the CW agent GB would have a P:F ratio of 1:1 whilst Lewisite would have a As:Cl ratio of 1:3.

51. Although a number of problems can be clearly envisaged, and although the information cannot reach the level of certainty associated with, for example, the analysis of a sample by mass spectrometry or infra-red techniques it is nevertheless felt that the circumstantial evidence could be very useful.

52. Non-intrusive analytical techniques, such as those outlined above, could have a very useful role to play in the course of inspections carried out under the provision of a CWC and merit further discussion. In particular, in addition to the technical aspects the situations in which such techniques could be used require clearer definition.

Accredited Laboratories

53. Reference has been made in CD papers to a laboratory or laboratories involved in providing technical support to the Inspection Team. However, a consideration of the points raised in the course of preparing this paper suggests that several separate specialized accredited laboratories will be required. Reference has already been made to the preparation of authentic, validated reference samples, reference standard solutions and a master data base; other tasks for such laboratories may also be envisaged.

54. In combination these laboratories would be required at least to have the facilities for the safe synthesis of a wide variety of highly toxic or other potentially hazardous compounds in batches of possibly 10-1,000 gm, to carry out analysis on behalf of Inspection Teams, to validate and authenticate these reference samples using a wide variety of modern and sophisticated laboratory analytical techniques, to prepare, authenticate and precisely define standard compounds and standard reference solutions for on-site calibration purposes, to generate, up-date and maintain a master reference data base on appropriate analytical characteristics of the compounds relevant to the CWC and to maintain records; these latter two tasks should be carried out with the aid of a computer. Thus between 4-6 separate experimental laboratories, plus ancillary facilities such as computer rooms, records library, etc. would be required; given the volume of work likely to be involved the figure of 4-6 experimental laboratories is likely to be the absolute minimum and will most probably be significantly higher.

55. It is likely that accredited laboratories will need to be discussed; assessment of functions and likely work load will enable a provisional estimate to be made of the number of laboratories needed.

Schedules

56. This paper has been constrained to a consideration of only those compounds listed in Schedules 1, 2 and 3. The question of how best to deal with the identification/analysis of presently unknown, undiscovered compounds which, when discovered in the future may be deemed to fall within the provision of the CWC, remains to be determined.

57. The problems associated with presently unknown compounds are great and also differ in kind from the problems considered so far in this paper.

Staffing

58. Although not directly related to the activities of the Group it may be worthwhile briefly considering the type of professional experience and expertise required to provide the instrumental and laboratory support outlined in this paper. At the least the rather large specialized training requirements arising from the nature of the samples to be handled and the circumstances under which they will be acquired will need to be emphasized.

ANNEX

Analytical Techniques for a Chemical Weapons Convention

This Annex contains tabular summaries dealing with the following variables:

(a) Table 1. Role of analysis at various sites

(b) Table 2. Instrumentation for various analytical roles

(c) Table 3. Instrumentation for Schedule 1 compounds

(d) Table 4. Instrumentation for Schedule 2 compounds

(e) Table 5. Instrumentation for Schedule 3 compounds

TABLE 1 - ROLE OF ANALYSIS AT VARIOUS SITES

Role \ Site	Stockpile	Storage	Destruction	Small-scale Facility	Production (Schedules 2 and 3)
Identification	YES	YES	YES	YES	YES
Quantitation	NO	NO	YES	YES	YES
Continuous Monitoring	NO	NO	YES	YES	YES
Non-intrusive Analysis	YES	YES	YES	NO	NO

TABLE 2 - INSTRUMENTATION FOR VARIOUS ANALYTICAL ROLES

Instrumentation / Role	Mass Spectrometry	NMR	IR	GLC	HPLC	UV-VIS Spectrophotometry Fluorimetry	Electro-chemical	X-ray	Sonics	Neutron Activation Analysis
Identification	YES	YES	YES	POSSIBLE	POSSIBLE	NO	NO	NO	NO	NO
Quantitation	POSSIBLE	POSSIBLE	POSSIBLE	YES	YES	YES	YES	NO	NO	NO
Continuous Monitoring	YES (for atmospheric monitoring)	NO	NO	YES	YES	YES	YES	NO	NO	NO
Non-intrusive Analysis	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES

TABLE 3 - INSTRUMENTATION FOR SCHEDULE 1 COMPOUNDS [1]

Instrumentation / Schedule 1 Compounds [2]	Mass Spectrometry	NMR	IR	GLC	HPLC	UV-VIS Spectrometry, Fluorimetry	Electrochemistry	Sonics [3]	Neutron Activation Analysis [4]
1.	YES	YES	YES	YES	YES	YES	POSSIBLY	YES	YES
2.	YES	YES	YES	YES	YES	YES	POSSIBLY	YES	YES
3.	YES	YES	YES	YES	YES	YES	PROBABLY	YES	YES
4.	YES	YES	YES	YES	YES	YES	PROBABLY	YES	YES
5.	YES	YES	YES	YES	YES	YES	PROBABLY	YES	YES
6.	YES	YES	YES	YES	YES	YES	NO	YES	POSSIBLY
7.	YES	YES	YES	YES	YES	PROBABLY	PROBABLY	POSSIBLY	NO
8.	YES	YES	YES	YES	NO	NO	NO	YES	YES [5]
9.	YES	YES	YES	YES	NO	YES	YES	YES	YES

FOOTNOTES :

1. The entries refer to the potential applicability of the instruments; for particular compounds procedures or reference analytical data may still need to be generated.
2. The numbers refer directly to those used in Schedule 1 of the current Rolling Text. (CD/881)
3. For liquids only?
4. Gives data on the nuclei only, not details of structure or identity.
5. May require fast neutrons for the fluorine nucleus.

TABLE 4 - INSTRUMENTATION FOR SCHEDULE 2 COMPOUNDS[1]

Instrumentation / Schedule 2 Compounds[2]	Mass Spectrometry	NMR	IR	GLC	HPLC	UV-VIS Spectrometry, Fluorimetry	Electrochemistry	Sonics[3]	Neutron Activation Analysis[4]
1.	YES	YES	YES	YES	YES	POSSIBLY[5]	POSSIBLY[5]	YES	YES
2.	YES	YES	YES	YES	NO	POSSIBLY[5]	NO	YES	YES
3.	YES	YES	YES	YES	YES	POSSIBLY[5]	NO	YES	YES
4.	YES	YES?	YES	YES	NO	POSSIBLY	YES	YES	YES
5.	YES	YES	YES	YES	YES	YES	PROBABLY	NO	NO
6.	YES	YES	YES	YES	YES	YES	YES[6]	NO	NO
7.	YES	YES	YES	YES	YES	YES	NO	YES	NO
8.	YES	YES	YES	YES	YES	YES	NO	YES	NO
9.	YES	YES	YES	YES	YES	YES	YES	YES	YES

FOOTNOTES :

1. The entries refer to the potential applicability of the instruments; for particular compounds, procedures or reference analytical data may still need to be generated.
2. The numbers refer directly to those used in Schedule 2 of the current Rolling Text. (CD/881)
3. For liquids only?
4. Gives data on the nuclei only, not details of structure or identity.
5. Dependent on the detailed structure of the particular compounds.
6. Method and procedure would need to be developed.

TABLE 5 - INSTRUMENTATION FOR SCHEDULE 3 COMPOUNDS[1, 2]

Instrumentation / Schedule 3 Compounds[3]	Mass Spectrometry	NMR	IR	GLC	HPLC	UV-VIS Spectrometry, Fluorimetry	Electrochemistry	Sonics[4]	Neutron Activation Analysis[5]
Phosgene[6]	YES	YES (^{13}C only)	YES	YES	NO	YES	NO	NO	NO
Cyanogen chloride[7]	YES	YES ($^{13}C/^{14}N$)	YES	YES	NO	YES	YES	POSSIBLY	NO
Hydrogen cyanide	YES	YES	YES	YES	NO	YES	YES	POSSIBLY	NO
Trichloronitromethane (Chloropicrin)	YES	YES ($^{13}C/^{14}N$)	YES	YES	YES	YES	YES	POSSIBLY	NO
Phosphorus oxychloride	YES	YES (^{31}P)	YES	YES	NO	POSSIBLY	NO	YES	YES
Phosphorus trichloride	YES	YES (^{31}P)	YES	YES	NO	POSSIBLY	NO	YES	YES
Trimethyl phosphite	YES	YES	YES	YES	YES	PROBABLY	YES	YES	YES
Triethyl phosphite	YES	YES	YES	YES	YES	PROBABLY	YES	YES	YES
Dimethyl phosphite	YES	YES	YES	YES	YES	PROBABLY	YES	YES	YES
Diethyl phosphite	YES	YES	YES	YES	YES	PROBABLY	YES	YES	YES
Sulphur monochloride	YES	POSSIBLY	POSSIBLY	YES	NO	PROBABLY	NO	YES	YES
Sulphur dichloride	YES	POSSIBLY	DOUBTFUL	YES	NO	PROBABLY	NO	YES	YES

FOOTNOTES :

1. The entries refer to the potential applicability of the instruments; for particular compounds procedures or reference analytical data may still need to be generated.
2. Not each of the instrumental techniques indicated is equally suitable for each of the indicated compounds.
3. The order of entry follows directly that given in Schedule 3 of the current Rolling Text, (CD/881)
4. For liquids only?
5. Gives data on the nuclei only, not details of structure or identity.
6. Although the techniques indicated could be used the fact that phosgene is normally a gas may give rise to some procedural problems.
7. Since this is a gas (b.p. 13°) there may be handling problems involved in work with this compound.

CONFERENCE ON DISARMAMENT

CD/CW/WP.256
14 August 1989

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Ad Hoc Committee on Chemical Weapons

Working Paper by the Chairman of Working Group 1

on

Article VI

Following some private consultations the Chairman of Working Group 1 on 14 July 1989 presented the attached papers as a basis for discussion on Article VI and the Annexes 2 and 3 to this Article.

In the preliminary comments made during the sessions of Working Group 1 the approach suggested in these papers was welcomed. However, it also became clear that delegations needed more time to study them before being able to make detailed comments. Thus these papers will have to be reconsidered in future discussions. In order not to prejudge such discussions, the papers have been maintained in the form they were presented.

VI. ACTIVITIES NOT PROHIBITED BY THE CONVENTION 1/ 2/

1. Each State Party has the right, subject to the provisions of this Convention, to develop, produce, otherwise acquire, store, transfer and use toxic chemicals and their precursors for purposes not prohibited by the Convention.

2. Each State Party undertakes to accept the restrictions and international verification measures as set forth in the Annexes to this Article.

3. The measures provided for in this Article and its Annexes are to verify that toxic chemicals and their prescursors are not developed, produced, otherwise acquired, stored, transferred or used for purposes prohibited by the Convention. They shall be applied to all relevant activities within the territory of each State Party, under its jurisdiction, or carried out under its control anywhere.

4. The Annexes to this Article provide for the following verification régimes:

Régime 1: Restrictions on and on-site verification of the production, processing and consumption of chemicals listed on the assigned Schedule(s) in the Annex on Chemicals

Régime 2: Data monitoring and routine systematic international on-site verification of the production, processing and consumption of chemicals listed on the assigned Schedule(s) in the Annex on Chemicals

Régime 3: Data monitoring of chemicals listed on the assigned Schedule(s) in the Annex on Chemicals 3/

5. The Schedules of chemicals contained in the Annex on Chemicals may be revised in accordance with the guidelines for Schedules of chemicals and the modalities for revision of lists and guidelines set forth in that Annex.

6. Each State Party shall make the declarations required under the Annexes to this Article and subject all facilities under its jurisdiction or control and subject to the verification régimes under the Annexes to this Article to the measures contained in those Annexes.

1/ One delegation considers that the terminology used in this Article and its Annexes should be consistent with the final definition of chemical weapons to be agreed upon.

2/ One delegation expressed the view that the question of collection and forwarding of data and other information to verify non-production requires further consideration. This delegation made reference to the Working Paper CD/CW/WP.159 of 19 March 1987, which includes draft elements for inclusion in the rolling text.

3/ The wording of this paragraph will have to be reviewed in the light of work undertaken in Group 4 on the Annex on Chemicals.

7. For the purpose of on-site verification, each State Party shall grant to the International Inspectors access to facilities as required in the Annexes to this Article.

8. In conducting verification activities, the Technical Secretariat shall avoid undue intrusion into the State Party's peaceful chemical activities;

9. The provisions of this Article shall be implemented in a manner designed in so far as possible to avoid hampering the economic or technological development of parties to the Convention and international exchange of scientific and technical information and chemicals and equipment for the production, processing or use of chemicals for peaceful purposes in accordance with the provisions of the Convention. 1/

1/ The inclusion of this paragraph in this Article is to be considered further.

Annex to Article VI

Régime 2

I. Declarations

A. Initial declarations

(a) Within 30 days of the entry into force of the Convention, each State Party shall provide the Technical Secretariat with aggregate national data on the production, processing and consumption of each chemical listed in the Schedule(s) assigned to this Annex, and on the export and import of the chemeical in the previous calendar year with an indication of the countries involved.

(b) Within 30 days of the entry into force of the Convention each State Party shall provide the Technical Secretariat with the following information for each facility, 1/ which, during the previous calendar year, produced, processed or consumed more then [1] tonne per annum of a chemical listed in the Schedule(s) assigned to this annex or which produced 2/ at any time since ... a chemical in the Schedule(s) assigned to this Annex for chemical weapons purposes: 3/

1. The name of the facility and of the owner, company, or enterprise operating the facility.

2. The exact location of the facility (including the address, location of the complex, 4/ location of the facility within the complex including the specific building and structure number if any).

1/ The definition of the term "facility" and other terms like "complex" needs to be considered (possibly for inclusion in Article II of the Convention).

According to one suggestion the term facility may be defined as "consisting of a specific operating process unit and associated feed, product handling; waste treatment and storage tanks".

2/ A view was expressed that the question of a quantitative threshold would need to be discussed in this context.

3/ The placement in the Convention of the obligation to declare facilities which produced a chemical in Schedule [2] for chemical weapons purposes needs further consideration. A view was expressed that this obligation should be included in the Annex to Article V.

4/ A definition of the term "complex" seems to be required.

3. Whether the facility is dedicated to producing or processing the listed chemical or is multi-purpose. 1/

4. The main orientation (purpose) of the facility.

5. For each chemical listed in the Schedule(s) assigned to this Annex and produced, processed, acquired, consumed or stored at the facility:

(i) The chemical name, common or trade name used by the facility, structural formula, and Chemical Abstracts Service Registry Number (if assigned).

(ii) The total amount produced, processed, consumed, imported and exported in the previous calendar year. 2/

(iii) The purpose(s) for which the chemical(s) are produced, consumed or processed:

(a) conversion on-site (specify product type)

(b) sale or transfer to other domestic industry (specify final product type)

(c) export (specify which country)

(d) other.

(iv) Which of the following activities are performed with regard to each chemical listed:

(a) production

(b) processing with conversion into another chemical

(c) processing without chemical conversion

(d) other - specify.

(v) Whether at any time during the previous calendar year it was stored on-site in quantities greater than [...] [tonnes].

1/ One delegation suggested that, in the case of a multi-purpose facility currently producing key prescursor chemicals, the following should be specified:

- general description of the products;
- detailed technological plan of the facility;
- list of special equipment included in the technological plan;
- type of waste treatment equipment;
- description of each final product (chemical name, chemical structure and register number);
- unit capacity for each product;
- use of each product.

2/ Whether the total amount is to be expressed as an exact figure or within a range is to be discussed.

6. The production capacity 1/ for the declared chemical(s).

7. [Whether the facility can readily be used to produce a chemical subject to Régime [1] or another chemical subject to Régime [2]. Relevant information should be provided, when applicable.]

B. Annual declarations

Each State Party shall annually provide the declarations required under Chapter I. A. for the previous calendar year. The declarations shall be submitted within ... months after the end of that year.

C. Advance notifications

(a) Each State Party shall annually notify the Technical Secretariat of facilities which intend, during the coming calendar year, to produce, process or consume more than [1] tonne of any chemical subject to this régime. The notification shall be submitted not later than ... months before the beginning of that year and shall for each facility include the following information:

(i) The information under Chapter A. above;

(ii) For each chemical subject to this régime intended to be produced or processed, the total quantity intended to be produced or processed during the coming calendar year and the time period(s) when the production or processing is anticipated to take place.

(b) Each State Party shall notify the Secretariat of any production, processing or consumption planned after the submission of the annual notification under paragraph (a), not later than [one month] [... days] before the production or processing is anticipated to begin. The notification shall for each facility include the information specified under paragraph (a).

II. Verification 2/

A. General Provisions

1. [Each facility declared under part I. A, B of this Annex] [Each facility which, during the previous calendar year, produced, processed or consumed more than [10] tonnes per annum of a chemical listed in the Schedule(s) assigned to this Annex] shall be subject to routine international on-site verification, through on-site inspection and use of on-site instruments.

1/ How to define production capacity remains to be agreed upon. Some consultations with technical experts have taken place on this issue. A report on these consultations is enclosed in Appendix II to facilitate further work by delegations.

2/ Some of the provisions contained in this section have general application throughout the Convention. It is understood that the retention of these will be reviewed in the light of the further elaboration of the [Guidelines on the International Inspectorate] [Protocol on Inspection Procedures].

2. The monitoring of data provided by States Parties pursuant to the declaration obligations contained in part I of this Annex and the routine international on-site verification provided for in this part of the Annex shall be to verify that:

(i) Facilities declared under this annex are not used to produce any chemical listed in Schedule [1]. 1/

(ii) The quantities of chemicals listed in the Schedule(s) assigned to this Annex produced, processed or consumed are consistent with needs for purposes not prohibited by the Chemical Weapons Convention. 2/

(iii) The chemicals listed in the Schedule(s) assigned to this Annex are not diverted, or used for purposes prohibited by the Chemical Weapons Convention.

3. The number, intensity, duration, timing and mode of inspections and monitoring with on-site instruments for a particular facility shall be based on the risk to the objectives of the Convention posed by the relevant chemical, the characteristics of the facility and the nature of the activities carried out there. 3/ 4/ The guidelines to be used shall include: (to be developed). 5/

4. The particular facility to be inspected shall be chosen by the Technical Secretariat in such a way to preclude the prediction of precisely when the facility is to be inspected.

5. A State Party shall be notified by the (Director-General of the) Technical Secretariat of the decision to inspect a facility referred to in paragraph 1 [12] [24] hours prior to the arrival of the inspection team.

1/ It was suggested that "or for any other purposes prohibited by the Convention" should be added.

2/ Opinions were expressed on the need to consider the question of the existence in a facility of excessive capacity for the production of chemicals in Schedule [2].

3/ One delegation suggested that the number of such inspections could be from one to five per year.

4/ A number of possible factors that could influence the number, intensity, duration, timing and mode of inspections have been identified and discussed. The result of this work is enclosed in Appendix II to serve as a basis for future work.

5/ It was noted that a "weighted approach" might be taken in determining the inspection régime for specific chemicals. The importance of establishing a threshold(s) in this context was also noted. It was mentioned that a threshold(s) should relate to "military significant quantities" of the relevant chemical(s).

In the event of inspections or visits to resolve urgent problems, this period may be shortened. The (Director-General of the) Technical Secretariat shall specify the purpose(s) of the inspection or visit.

6. A State Party shall make any necessary preparations for the arrival of the inspectors and shall ensure their expeditious transportation from their point of entry on the territory of the State Party to the facility. The agreement on subsidiary arrangements will specify administrative arrangements for inspectors.

7. The host State Party shall have the right to designate personnel to accompany an international inspection team. The exercise of this right shall not affect the right of inspectors to obtain access to the facility, as provided by the Convention, nor shall it delay or otherwise impede the carrying out of the inspection.

Annex to Article VI

Régime 3

I. Declarations

A. Initial Declarations

(a) Within 30 days of the entry into force of the Convention, each State Party shall provide the Technical Secretariat with aggregate national data on the production, processing and consumption of each chemical listed in the Schedule(s) assigned to this Annex and on the export and import of the chemical in the previous calendar year with an indication of the countries involved.

(b) Within 30 days of the entry into force of the Convention each State Party shall provide the Technical Secretariat with the following information for each facility, 1/ which, during the previous calendar year, produced, processed or consumed more than [30] tonnes per annum of a chemical listed in the Schedule(s) assigned to this Annex or which produced 2/ at any time since ... a chemical in the Schedule(s) assigned to this Annex for chemical weapons purposes: 3/ 4/

1. The name of the facility and of the owner, company, or enterprise operating the facility.

2. The exact location of the facility (including the address).

3. The main orientation (purpose) of the facility.

1/ The definition of the term "facility" and other terms like "complex" needs to be considered (possibly for inclusion in Article II of the Convention).

According to one suggestion the term facility may be defined as "consisting of a specific operating process unit and associated feed, product handling; waste treatment and storage tanks".

2/ A view was expressed that the question of a quantitative threshold would need to be discussed in this context.

3/ The placement in the Convention of the obligation to declare facilities which produced a chemical in Schedule [3] for chemical weapons purposes needs further consideration. A view was expressed that this obligation should be included in the Annex to Article V.

4/ It was proposed that a threshold for the dual purpose agents (Phosgene, Cyanogen chloride, Hydrogen cyanide, Chloropicrin) could be esablished at [50 tonnes/year] [500 tonnes/year] and for precursors at [5 tonnes/year] [50 tonnes/year]. The proposal was presented in an informal discussion paper dated 30 March 1987, prepared on the request of the Chairman of the Committee, by Dr. Peroni (Brazil), Lt. Col. Bretfeld (German Democratic Republic) and Dr. Ooms (Netherlands).

4. For each chemical listed in the Schedule(s) assigned to this Annex and produced, processed, acquired, consumed or stored at the facility:

(i) the chemical name, common or trade name used by the facility, structural formula, and Chemical Abstracts Service Registry Number (if assigned).

(ii) The approximate amount produced, processed, consumed, imported and exported in the previous calendar year.

(iii) The purpose(s) for which the chemical(s) are produced, consumed or processed:

(a) conversion on-site (specify product type)

(b) sale or transfer to other domestic industry (specify final product type)

(c) export (specify which country)

(d) other.

5. The production capacity 1/ for the declared chemical(s).

B. Annual Declarations

Each State Party shall annually provide the declarations required under Chapter I. A. for the previous calendar year. The declarations shall be submitted within ... months after the end of that year.

C. Advance Notifications

A State Party shall notify the Technical Secretariat of the name and location of any facility which intends, in the year following submission of the annual declarations, to produce, process or consume in quantities greater than [30] tonnes any of the chemicals subject to this régime.

1/ How to define production capacity remains to be agreed upon. Some consultations with technical experts have taken place on this issue. A report on these consultations is enclosed in Appendix II to facilitate further work by delegations.

II. Verification

The Technical Secretariat shall monitor the data provided to it under Section I. of this Annex with a view to verify that the declarations made are consistent with each other and that the quantities of chemicals listed in the Schedule(s) assigned to this Annex produced, processed or consumed are in general confirmity with needs for purposes not prohibited by the Convention. In the case of inconsistencies or ambiguities the Technical Secretariat shall clarify the situation, as appropriate. Each State Party undertakes to co-operate with the Technical Secretariat in resolving such matters expeditiously. 1/

1/ Some delegations consider that provision should be made for resort to an on-site "spot-check" inspection, if required, to verify information supplied by a State Party. Other delegations believe that the provisions of Articles VII, VIII and IX of the Convention are sufficient in this respect.

CONFERENCE ON DISARMAMENT

CD/CW/WP.257
14 August 1989

Original: ENGLISH

Ad hoc Committee on Chemical Weapons

Report of the Chairman of Working Group 1 on his Consultations on Trial Inspections

On 12 and 18 July 1989 the Chairman of Working Group 1 conducted open-ended consultations on trial inspections. Resulting from these consultations and in the light of experience with national trial inspections conducted so far he suggests the following approach for future work:

1. All States are encouraged to conduct their own trial inspections in the chemical industry to gain first-hand experience with the verification of Schedule 2 facilities. States which have already conducted a national trial inspection and wish to conduct further national trial inspections might be encouraged to conduct such trials at different types of facilities or for different types of chemical processes.

2. Trials of other inspection types, i.e. challenge inspection, ad hoc verification measures, would be particularly welcome.

3. In parallel individual States are invited to offer facilities/sites for multilateral verification experiments.

4. All multilateral trial inspections should be prepared well in light of the experience recorded in CD/CW/WP.248/Rev.1 of 23 June 1989. The preparation of multilateral trial inspections could be conducted in the framework of the Ad hoc Committee on chemical weapons. This should, however, be done without infringing too much on the time needed for the actual drafting of the Convention.

5. Rather than aiming at a comprehensive inspection scenario at this time specific objectives should be set for future trial inspections. In particular, problems which have been identified during national trial inspections conducted so far should be studied further.

6. In light of the experience made the following specific tasks could, inter alia, be addressed in trials of Schedule 2 facilities:

- problems related to the identification of a facility for the purpose of inspections and access granted to inspectors,

- translation of the verification aims into realizable verification procedures,

- the conduct of an initial visit and the drafting of the facility attachment,

- practical measures to protect commercially sensitive information (related to and not related to the Convention) during an inspection, e.g. step-by-step approach,

- specific problems related to the verification in multipurpose facilities,

- procedures for sample taking and sample analysis (on-site and off-site),

- auditing of records (types of records needed, standardization of records) and the establishment of a material balance,

- inspection equipment and development of continuous on-site monitoring equipment,

- format and drafting of inspection reports,

- procedures or devices for independently corroborating the data obtained from the inspected party.

7. In case of trial challenge inspections the following aspects seem, inter alia, to require particular attention:

- definition of a site for the purpose of a challenge inspection (relationship between the request and the conduct of an inspection),

- procedures for securing the site,

- inspection procedures in different types of facilities,

- sample taking and analysis (in particular outside chemical production facilities),

- "managed access"-procedures (measures to protect sensitive installations/information, implementation of the concept "least intrusive manner possible consistent with the aim of effective verification"),

- role of possible observer(s) of the challenging State during the inspection.

CONFERENCE ON DISARMAMENT

CD/CW/WP.258
14 August 1989

Original: ENGLISH

Ad Hoc Committee on Chemical Weapons

SUGGESTED GUIDELINES FOR SCHEDULE 1 IN THE ANNEX ON CHEMICALS

Working paper by the Chairman of Working Group 4 (Technical issues)

During the elaboration of the Annex on Chemicals in 1989 the Chairman of Working Group 4 (Technical issues) suggested the enclosed guidelines for Schedule 1 as a basis for further work. For easy reference the current guidelines elaborated in 1987 are also enclosed as well as some explanatory remarks.

Suggested guidelines for Schedule 1

The following criteria shall be taken into account when considering whether a chemical shall be included in Schedule 1:

A. For any chemical:

1. It has been stockpiled as a chemical weapon.

2. It has little or no use except as a chemical weapon.

3. It poses a particular risk to the objectives of the Convention by virtue of its high potential of use as a chemical weapon.

B. In addition, for a lethal chemical:

1. It has a chemical structure closely related to one or more lethal chemicals already listed in Schedule 1.

C. In addition, for an otherwise toxic chemical:

1. Its principal effect on man is to cause an incapacitation which can be of military significance.

[2. It has a chemical structure closely related to one or more otherwise toxic chemicals already listed in Schedule 1.]

D. In addition, for a precursor chemical:

1. It may, by participation in a reaction with other chemicals or otherwise, give, within a short time, a high yield of a lethal or otherwise toxic chemical already listed in Schedule 1.

2. The reaction, or corresponding process, may be carried out under such conditions, e.g. in munitions, that the toxic product is readily available for military use.

3. It has a chemical structure, closely related to one or more precursor chemicals already listed in Schedule 1, which corresponds to a potential lethal or otherwise toxic reaction product already listed in Schedule 1.

Explanations

A.1 tries to combine present 1. and 8. and, at the same time, make it more clear that present 8. also was applicable to precursor chemicals.

A.2 is a combination of present 3., 9. and 12 (iii), bearing in mind that, according to the definition of "chemical weapons" as contained in Article II, also precursor chemicals are "chemical weapons".

A.3 combines present 2. and 11., using the language of 11. in a modified way.

B.1 is based on present 5. and 7. whilst attempting to narrow the "related/similar" concept.

C.1 is based on part of present 6.

C.2 is based on present 7. whilst attempting to narrow the "related/similar" concept.

D.1 is a modified version of present 12. (i) which takes into account the possibility of a non-lethal precursor chemical giving rise, by induced decomposition, to a lethal chemical. Furthermore it limits the Schedule 1 precursor chemicals to those which can give rise to lethal or otherwise toxic chemicals already included in Schedule 1.

D.2 tries to merge present 10. and 12. (ii) into one criterion, whilst at the same time takes into account the new D.1.

D.3 is a new criterion to allow for "families" of percursor chemicals on Schedule 1 as long as these correspond to already listed lethal or otherwise toxic chemicals.

Remarks

Current text for Schedule 1 guidelines (CD/881 p. 112-113, English version) has been incorporated as follows:

1. in new A 1;

2. in new A 3;

3. in new A 2;

4. subsumed in new A 2 and A 3;

5. in new B 1;

6. in new C 1, also subsumed in new A 2 and A 3;

7. partly in new B 1;

8. in new A 1;

9. in new A 2;

10. in new D 2;

11. in new A 3;

12 (i) in new D 1;

12. (ii) in new D 2;

12. (iii) in new A 2.

GUIDELINES FOR SCHEDULE [1] 1/

The following guidelines, singly or in combination, should be taken into account in considering whether a chemical should be included in Schedule [1]:

1. Super-toxic lethal chemicals which have been stockpiled as chemical weapons.

2. Super-toxic lethal chemicals which pose a particular risk of potential use as chemical weapons.

3. Super-toxic lethal chemicals which have little or no use except as chemical weapons.

4. Super-toxic lethal chemicals which possess physical and chemical properties enabling them to be used as chemical weapons. 2/

5. Super-toxic lethal chemicals with chemical structure related/similar to those super-toxic lethal chemicals already listed in Schedule 1. 3/

6. Chemicals whose principal effect is to cause temporary incapacitation and which possess physical and chemical properties enabling them to be used as chemical weapons.

7. Any toxic chemical with a chemical structure related/similar to those chemicals already listed in Schedule 1. 3/

8. Other chemicals which have been stockpiled as chemical weapons.

9. Other chemicals which have little or no use except as chemical weapons.

10. Key precursors which participate in a one-stage process of producing toxic chemicals in munitions and devices. 4/

11. Key precursors which pose a high risk to the objectives of the Convention by virtue of their high potential for use to produce chemical weapons.

1/ The basis and modalities for the application and revision of the guidelines are to be developed.

2/ A view was expressed that compounds listed in Schedule [1] should possess the properties of chemical warfare agents.

3/ The view was expressed that this by itself would not be sufficient to include a chemical in Schedule [1].

4/ One delegation believes that this provision is not necessary and that it is already covered under point 12.

12. Key precursors which may possess the following characteristics:

(i) it may react with other chemicals to give, within a short time, a high yield of a toxic chemical defined as a chemical weapon;

(ii) the reaction may be carried out in such a manner that the toxic product is readily available for military use; and

(iii) key precursors which have little or no use except for chemical weapons purposes.

CONFERENCE ON DISARMAMENT

CD/CW/WP.259
14 August 1989

Original: ENGLISH

Ad Hoc Committee on Chemical Weapons

CANADA

PINACOLYL ALCOHOL

1. In technical discussions under Article VI, one of the main difficulties has been the placement onto the appropriate schedules of chemicals thought to pose a risk to the Convention. Considerable effort has already been expended to devise guidelines for this purpose, without complete success. However, it is still considered necessary to apply systematic methods, based on technical factors, to support the guidelines. For instance, in the schedules to Article VI, as originally conceived, a "key precursor" of a Schedule 1 toxic agent would normally be placed on Schedule 2, and other precursors would be included on Schedule 3. In circumstances where the risk is deemed to be high, a "key precursor" could be considered for Schedule 1. These assignments should be made by a systematic application of the guidelines based on the technical characteristics of the chemical.

2. In general, the decision as to which schedule a precursor might be assigned would be a function of the risk that the chemical poses to the objectives of the Chemical Weapons Convention, and should be taken after a careful systematic assessment of the risk involved. Consideration of an appropriate schedule should take into account not only Article VI of the "rolling text" and its related material, but also the definitions of "key precursor" and "precursor" and their characteristics as provided under Article II.

3. The purpose of this paper is to examine an additional technique which may assist in the systematic placement of a key precursor onto Schedule 1 or Schedule 2 in relation to the following sections of the rolling text:

(a) Appendix I, Article II;

(b) Appendix I, Article VI;

(c) Appendix I, Annex 1 to Article VI;

(d) Appendix I, Annex 2 to Article VI;

(e) Annex on Chemicals, Guidelines for Schedule 1; and

(f) Annex on Chemicals, Guidelines for Schedule 2A.

4. The Convention would apply particularly stringent constraints on actual production of and commercial traffic in Schedule 1 chemicals. As a result, the "Guidelines for Schedule 1" must be developed with care and applied with precision, and should only capture those substances that are of high risk to the Convention. Using the existing guidelines this would seem to include: super-toxic lethal chemical weapons; other super-toxic lethal chemicals that are closely related to weaponized super-toxic lethal chemicals so that they are serious alternatives to the weaponized chemicals; other lethal or incapacitating chemicals that possess physical and chemical properties enabling them to be used as chemical weapons; chemicals that are specialized components of binary munitions that have been developed, produced and stockpiled; and key precursors for which a high risk can be demonstrated and that have no current use other than for the production of chemical weapons.

5. Examining the existing guidelines for Schedule 1 further, it may be noted that guidelines 10, 11 and 12 apply to "key precursors" which might be considered for inclusion on Schedule 1. As a specific example, it is useful to consider the case of pinacolyl alcohol. In previous discussions there has been some disagreement as to where it should be placed. In CD/881, pinacolyl alcohol was identified as "to be discussed" under both Schedule 1 and Schedule 2 and this dichotomy is continued in the Annex on Chemicals.

6. Guideline 10 applies to the specific case of a key precursor being used in a binary system. While it may be possible to develop a binary system for the production of soman, there have been no reports that this has been done or that such binary components have been produced and stockpiled. To place pinacolyl alcohol onto Schedule 1 because it could be used as a binary component would suggest that many other chemicals, including most common alcohols, should also be on Schedule 1. Many alcohols, such as isopropyl alcohol, are produced in significant commercial quantities and cannot be placed on Schedule 1. Guideline 10 is restricted to alcohols that have been weaponized and this does not include pinacolyl alcohol.

7. In regard to guideline 11, many alcohols including pinacolyl alcohol have a prominent role in the production of chemicals on Schedule 1. It is difficult to see why pinacolyl alcohol in particular should be singled out for inclusion among "key precursors which pose a high risk to the objectives of the Convention by virtue of their high potential for use to produce chemical weapons", unless supported by the assumption that it alone has no other known use. Guideline 11 is not itself a sufficient criterion to place pinacolyl alcohol on Schedule 1.

8. One is left with guideline 12 that contains two descriptors which stress the ease of formation of a final toxic product in a militarily useful form, but this provides no further assistance than the previous guidelines in distinguishing between the relevance of one alcohol and another. The argument for inclusion of pinacolyl alcohol on Schedule 1 again seems to reduce to the third descriptor in guideline 12, that it has little or no use other than the production of a chemical weapon. This would assume that stringently constraining its production and commercial traffic would, at the most, be a minor inconvenience, except to the manufacturers of soman.

9. Relying on the criterion that a chemical has little or no commercial use at a given time, however, could be said to set up a temporal trap. While this could perhaps be justified for super-toxic lethal chemicals that have been stockpiled or used as chemical weapons, it would cause difficulties of

"principle" with industry in the case of harmless precursors for which valuable uses might be found in time. There is a rapid changeover in commercial chemicals and many that are in production today were not being used in industry even some five years ago. Thus this criterion should be used cautiously in the assignment of precursors to schedules, particularly to Schedule 1, unless the modalities for revision of the schedules provide a simple procedure for the transfer of a chemical away from Schedule 1, if and when a valuable commercial use is found.

10. In order to explore further the notion of potential commercial utility, a literature survey was carried out on pinacolyl alcohol using Chemicals Abstracts from 1975 to 1988. The survey produced 134 references from 24 countries, of which approximately 12 per cent resulted from industrial research and some 5 per cent were patent applications. The bulk of the research, 40 per cent, originated in the United States as well as half of the patent applications. The distribution of the patents and the papers that are technology-related suggest that the major possible interests involve both the petrochemical and pharmaceutical industries. There would, therefore, seem to be a modest but continuing interest in this chemical together with the beginnings of a greater industrial interest. The appended tables show the classifications and distribution of the research retrieved in this search, and are the source of these statistics. Should these sources need to be checked, a complete bibliography is available from the Canadian Mission.

11. Based on the above general discussion and on the known facts, the argument can be made that on a technical basis the risk to the objectives of the Convention posed by pinacolyl alcohol is not as high as that posed by the toxic agent it is used to produce or that posed by proven binary weapon precursors. Moreover, as the literature study indicates, other uses of pinacolyl alcohol will probably be developed in the near future. Therefore, on a systematic basis, it would seem most reasonable to assign pinacolyl alcohol to Schedule 2. However, as successful commercial uses have not yet been introduced, it is possible that other factors could override the technical evaluation and lead to assignment to Schedule 1. This would effectively preclude further development of pinacolyl alcohol for commercial purposes unless, as suggested above, the modalities for the revision of lists contain a practical mechanism which would allow such a chemical to be moved from Schedule 1 to Schedule 2 should a valuable commercial use be developed. The provision of such a mechanism in the Convention should be accomplished before it can be agreed to assign a potentially valuable chemical like pinacolyl alcohol to Schedule 1.

12. While this approach to the assignment of chemicals to schedules based on a literature survey has been used specifically for pinacolyl alcohol a "key precursor", it should be equally applicable to the consideration of other chemicals being proposed for inclusion on the schedules to Article VI.

Country	No. of Publications	(Per cent)
UNITED STATES OF AMERICA	53	(39.6)
JAPAN	11	(8.2)
CZECHOSLOVAKIA	8	(6.0)
FRANCE	7	(5.2)
CANADA	5	(3.7)
FEDERAL REPUBLIC OF GERMANY	5	(3.7)
SWITZERLAND	5	(3.7)
UNION OF SOVIET SOCIALIST REPUBLICS	5	(3.7)
NETHERLANDS	4	(3.0)
INDIA	4	(3.0)
POLAND	4	(3.0)
DENMARK	3	(2.2)
UNITED KINGDOM	3	(2.2)
AUSTRALIA	2	(1.5)
CHINA	2	(1.5)
ITALY	2	(1.5)
HUNGARY	2	(1.5)
ISRAEL	2	(1.5)
SPAIN	2	(1.5)
BULGARIA	1	(0.8)
FINLAND	1	(0.8)
SOUTH KOREA	1	(0.8)
SWEDEN	1	(0.8)
YUGOSLAVIA	1	(0.8)
TOTAL	134	

DISTRIBUTION OF PUBLICATIONS

Country	University	Industry	Government
UNITED STATES OF AMERICA	36	10	7
JAPAN	9	2	-
CZECHOSLOVAKIA	8	-	-
FRANCE	4	3	-
CANADA	4	-	1
FEDERAL REPUBLIC OF GERMANY	4	1	-
SWITZERLAND	5	-	-
UNION OF SOVIET SOCIALIST REPUBLICS	4	-	1
NETHERLANDS	4	-	-
INDIA	4	-	-
POLAND	4	-	-
DENMARK	3	-	-
UNITED KINGDOM	3	-	-
AUSTRALIA	2	-	-
CHINA	1	-	1
ITALY	2	-	-
HUNGARY	2	-	-
ISRAEL	2	-	-
SPAIN	2	-	-
BULGARIA	1	-	-
FINLAND	1	-	-
SOUTH KOREA	1	-	-
SWEDEN	1	-	-
YUGOSLAVIA	1	-	-
TOTAL	108 (80.6%)	16 (11.9%)	10 (7.5%)

SOURCE OF PUBLICATIONS

Country	Manuscript	Patent	Report
UNITED STATES OF AMERICA	48	4	1
JAPAN	10	-	1
CZECHOSLOVAKIA	8	-	-
FRANCE	4	3	-
CANADA	5	-	-
FEDERAL REPUBLIC OF GERMANY	5	-	-
SWITZERLAND	5	-	-
UNION OF SOVIET SOCIALIST REPUBLICS	5	-	-
NETHERLANDS	4	-	-
INDIA	4	-	-
POLAND	4	-	-
DENMARK	3	-	-
UNITED KINGDOM	3	-	-
AUSTRALIA	2	-	-
CHINA	2	-	-
ITALY	2	-	-
HUNGARY	2	-	-
ISRAEL	2	-	-
SPAIN	2	-	-
BULGARIA	1	-	-
FINLAND	1	-	-
SOUTH KOREA	1	-	-
SWEDEN	1	-	-
YUGOSLAVIA	1	-	-
TOTAL	125	7	2

SUBJECT OF PUBLICATIONS

Country	Science	Technology	Biology	Toxicology
UNITED STATES OF AMERICA	34	4	9	6
JAPAN	8	1	2	-
CZECHOSLOVAKIA	6	2	-	-
FRANCE	4	2	1	-
CANADA	5	-	-	-
FEDERAL REPUBLIC OF GERMANY	5	-	-	-
SWITZERLAND	5	-	-	-
UNION OF SOVIET SOCIALIST REPUBLICS	4	1	-	-
NETHERLANDS	4	-	-	-
INDIA	3	1	-	-
POLAND	4	-	-	-
DENMARK	3	-	-	-
UNITED KINGDOM	3	-	-	-
AUSTRALIA	2	-	-	-
CHINA	1	-	-	1
ITALY	1	-	-	1
HUNGARY	1	1	-	-
ISRAEL	1	1	-	-
SPAIN	2	-	-	-
BULGARIA	1	-	-	-
FINLAND	1	-	-	-
SOUTH KOREA	1	-	-	-
SWEDEN	1	-	-	-
YUGOSLAVIA	-	-	1	-
TOTAL	100	13	13	8

Austria	CD/CW/WP.260	Letter Dated 10 August 1989 Addressed to the Secretary-General of the Conference on Disarmament by the Permanent Representative of Austria Transmitting a Document Entitled "Preliminary Report on an Austrian National Trial Inspection" NOT REPRODUCED (see WP volume)	Also issued as CD/948 14 Aug. 89

Czecho-slovakia	CD/CW/WP.261	Data Relevant to the Convention on the Complete and General Prohibition and Destruction of Chemical Weapons NOT REPRODUCED (see WP volume)	Also issued as CD/949 15 Aug. 89

CD/CW/WP.262 Draft report of the Ad Hoc Committee on Chemical Weapons to the Conference on Disarmament

NOT REPRODUCED

CD/CW/WP.262 Draft report of the Ad Hoc Committee on Chemical Weapons to the Conference on Disarmament

NOT REPRODUCED

FRG	CD/CW/WP.263	Report on a Trial Inspection to Test the Validity of a Proposed Format for Ad Hoc On-Site Verification	Also issued as CD/950 17 Aug. 89

NOT REPRODUCED
(see WP volume)

CONFERENCE ON DISARMAMENT

CD/CW/WP.264
21 November 1989

ENGLISH
Original: RUSSIAN

Ad Hoc Committee on Chemical Weapons

UNION OF SOVIET SOCIALIST REPUBLICS

Provision of data relevant to the Chemical Weapons Convention

Bearing in mind that the exchange of data is one of the most important prerequisites for the stimulation of negotiations on the complete prohibition and destruction of chemical weapons, the establishment of an atmosphere of trust in the negotiations and the enhancement of the efficacy of the future Convention, the Union of Soviet Socialist Republics herewith submits data in the format proposed in document CD/828 of 12 April 1988.

The data for the chemical industry has been compiled on the basis of communications from the Ministries and government departments producing and consuming the chemicals listed hereunder.

The information is subject to further refinement in the light of developments in production and consumption and of the provisions of the relevant articles of the Convention.

The data reflects the situation at the beginning of 1989. It has been submitted in accordance with the provisionally agreed lists contained in the annexes to article VI in document CD/881 and on the basis of the following threshold criteria: one tonne per year for the production, processing and consumption of chemicals in Schedule [2] and 30 tonnes per year for the production, processing and consumption of chemicals in Schedule [3].

GE.89-63496/2184a

Annex

Type of data	Response
1	2
1. Presence of chemical weapons on own territory.	Yes. The chemical weapons stocks in the USSR do not exceed 50,000 tonnes of poisonous substances.
Possession of chemical weapons on territory of another State.	No.
2. Aggregate number of facilities for the production and storage of chemical weapons and for the production, processing and consumption of chemicals in Schedules [1], [2] and [3] above thresholds to be determined. */	101 **/
3. Types and names of chemical warfare agents produced.	The Soviet Union ceased producing chemical weapons in 1987. Blister agents: Mustard gas, Lewisite. Nerve agents: Sarin, soman, VX.
Types of chemical warfare munitions stored; chemical warfare agents stored in bulk.	Aerial chemical warfare munitions: Chemical bombs; chemical spraying devices. Chemical munitions for missiles or artillery: Chemical warheads; chemical tube-artillery munitions. Chemical rocket missiles.

*/ The question of information on toxic chemicals not listed in Schedules [1], [2] or [3] that might be relevant to the Convention requires further consideration pending futher work on the matter.

**/ Subject to adjustment.

1	2
	Chemical weapons for close combat:
	Chemical hand grenade with CS, a product not coming within Schedule [1] of the rolling text.
	A proportion of the chemical warfare agents is stored in bulk.
Names of chemicals in Schedules [1], [2] and [3] produced in the chemical industry.	Schedules [2]: */
	Chemicals containing one P-methyl, P-ethyl or P-propyl (normal or iso-) bond; Arsenic trichloride.
	Schedule [3]:
	Phosgene Cyanogen chloride Hydrogen cyanide Trichloronitromethane (chloropicrin) Phosphorus oxychloride Phosphorus trichloride Dimethyl phosphite Sulphur monochloride.
4. Plans and methods for the destruction of chemical weapons, including the number of facilities and the anticipated length of their operation during the 10-year destruction period.	In 1989, construction of a chemical weapons destruction facility was completed in the area of Chapaevsk. This facility has been transformed into an instruction and training centre for trials of chemical weapons destruction technology on inert media and the training of personnel for work at industrial facilities for chemical weapons destruction.
	In the future, ways of building other destruction plants will be defined and the plans and methods for destroying chemical weapons, with the completion of the destruction of all chemical weapons stocks within the time-limit set by the Convention, will be made more specific.

*/ According to the count that has been made, there is in the USSR a total of 30 facilities that produce, process or consume chemicals contained in Schedule [2].

CONFERENCE ON DISARMAMENT

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UNITED STATES OF AMERICA

Demilitarization and Disposal of U.S. Chemical Warfare Agent and Munitions

Summary: This paper will describe the destruction facility, the destruction criteria, the component technology, the process technology, control system and monitors and pollution abatement systems developed by the United States to dispose of chemical munitions. It represents a description of the present facilities and does not include any measures to meet the verification requirements being developed in the rolling text. These systems demonstrate that the disposal of even the most hazardous waste can be accomplished safely with minimal risk to the workforce and negligible impact on the environment.

CAMDS/JACADS

The prototype demilitarization facility, the Chemical Agent/munitions Disposal System (CAMDS) became operational in September 1979. This plant serves as the test facility to evaluate various processes for incorporation into large-scale production facilities. The first of these full-scale production facilities is the Johnston Atoll Chemical Agent Disposal System (JACADS). This facility, constructed on Johnston Island, is currently undergoing equipment testing and systemization.

The chemical munitions to be demilitarized are stored in a variety of configurations; some include fuzes, explosive burster charges, and propellant. Lethal chemical agent fills currently include mustard and nerve agents. Table 1 illustrates the various munitions that the JACADS disposal system will process.

Demilitarization Criteria and Facility Design

Disposal poses significant challenges for the following reasons:

1. Safe disassembly of the explosives and propellants
2. Disposal of the removed explosive components and propellants
3. Accessing the agent cavity
4. Disposal of the toxic agent
5. Disposal of the munition bodies
6. Disposal of the process generated wastes

TABLE 1: U.S. Chemical Warfare Munitions

Designation	Description	Fill	Explosives	Propellant	Fuze
M55	115mm Rocket	10.7 lb GB or 10.2 lb VX	3.2 Lb	19.3 lb	Yes
M23	Land Mine	10.5 lb VX	0.9 lb	None	Yes
M2/M2A1	4.2" Cartridge*	6.0 lb H/HD	0.14 lb	0.6 lb	Yes
M60	105mm Cartridge*	3.0 lb H/HD	0.26 lb	2.8 lb	Yes
M360	105mm Cartridge*	1.6 lb GB	1.1 lb	2.8 lb	Yes
M110	155mm Projectile	11.7 lb H/HD	0.83 lb	None	No
M104	155mm Projectile	11.7 lb HD	0.83 lb	None	No
M121A1	155mm Projectile	6.5 lb GB or VX	2.45 lb	None	No
M122A1	155mm Projectile	6.5 lb GB	2.45 lb	None	No
M426	8" Projectile	14.5 lb GB or VX	7.0 lb	None	No
MC-1	750 lb Bomb	220 lb GB	None	None	No
MK-94	500 lb Bomb	108 lb GB	None	None	No
TC	Ton Container	1600 lb GB/VX/H	None	None	No
TMU-28	Spray Tank	1356 lb VX	None	None	No

* A projectile, burster, fuze, cartridge casing, propellant and primer comprise a cartridge

The criteria to develop current U.S. facilities includes guidance to insure absolute safety and security rather than cost or time, maximum protection for operating personnel, absolute assurance of total containment of agent, and collection of incontrovertible data to support personnel safety, security and community safeguards. In addition to this guidance, the U.S. Army, as the executive agent, has established criteria for the storage, transportation and disposal of chemical weapons. These criteria address the following areas and influence the selection of disposal alternatives.

1. Restriction on total quantity of explosives within the process building

2. Agent emission limitations

3. Process effluent standards

4. Personnel safety requirements

The overriding facility design criteria is agent containment. By maintaining negative pressure within all processing areas, air flow is always from areas of lesser contamination potential to areas of higher potential. The resulting ventilation air is scrubbed by redundant High Efficiency Particulate Air and charcoal filters. Total containment of both overpressure and fragments from an accidental detonation is accomplished by use of a reinforced concrete structure contained within the building which is isolated by blast valves and containment dampers.

Process Technology

The specific process steps and equipment required for demilitarization are dependent on the munition type. Generically, all munition types fall into one of three categories:

1. Rockets and missiles: These thin walled munitions are processed without removal of their explosive components, except for a small explosive component in the M23 land mine

2. Projectiles and cartridges: Removal of explosives from these heavy-walled munitions is the first processing step

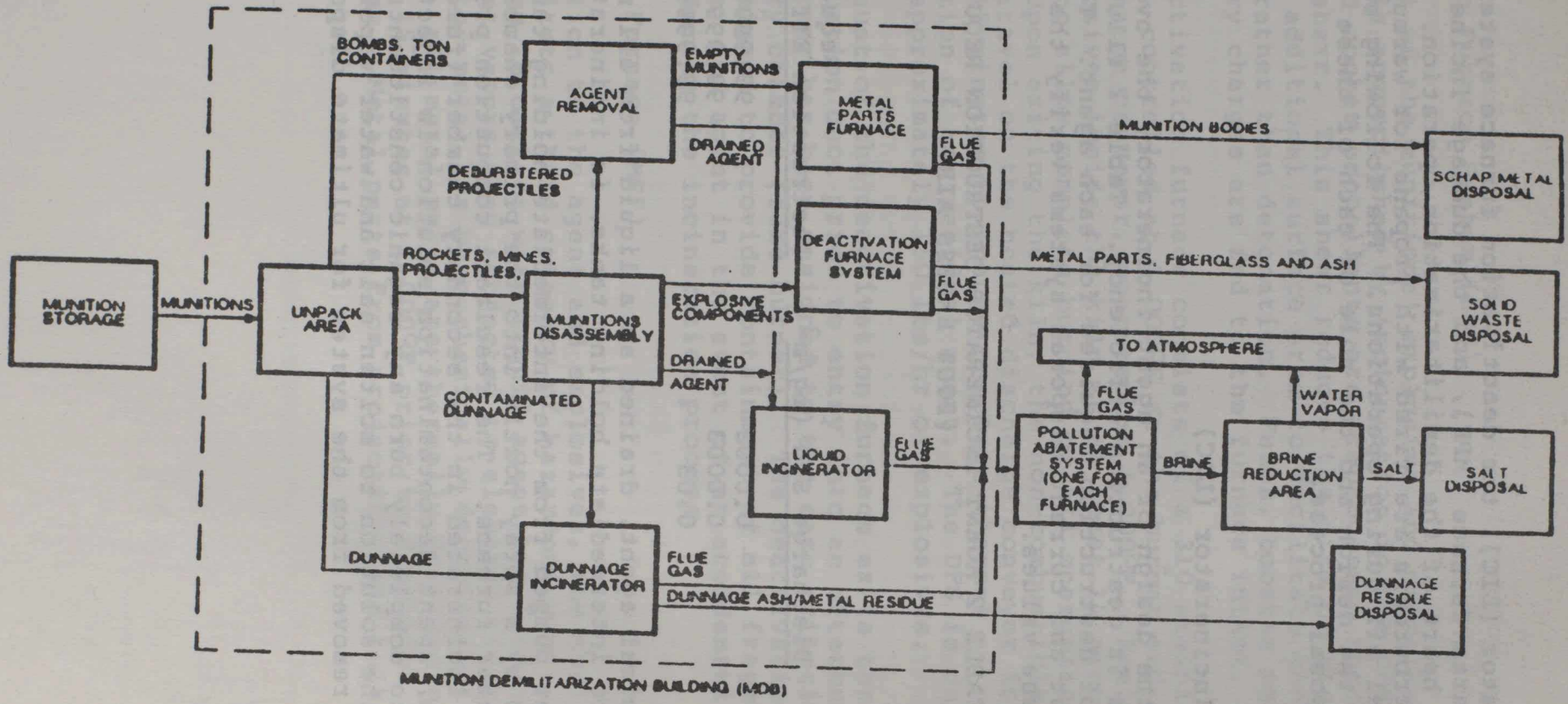
3. Bulk items: This category includes bombs, spray tanks, and ton containers; they do not contain explosives in their munition storage configurations.

For all three munition categories, the demilitarization process involves two distinct operations, preparation for thermal treatment, followed by thermal processing. Agent destruction is accomplished by incineration. Figure 1 illustrates the JACADS processing steps.

The JACADS facility has been designed with the capability to process all three munition categories. The primary process building comprises 73,000 sq ft on two levels. The second floor houses the equipment required for preparation of the munition for thermal processing. Munition processing is accomplished by machines designed and built for specific chemical demilitarization operations. This equipment includes the rocket shear machine for shearing rockets and explosives, the projectile/mortar disassembly machine for removing explosive components by reversing the assembly process, the multipurpose demil machine for draining agent from projectiles, and the bulk drain station for punching and draining bombs, ton containers, and spray tanks.

The process's four furnaces are located on the ground level, facilitating gravity feed of munition components into the furnaces. The four process furnaces: the liquid

FIGURE 1
JACADS
PROCESS FLOW DIAGRAM



NOTES:

1. MDB IS KEPT UNDER NEGATIVE PRESSURE.
2. MUNITION DISASSEMBLY PERFORMED IN EXPLOSION CONTAINMENT ROOMS.

incinerator (LIC), the deactivation furnace system (DFS), the metal parts furnace (MPF), and the dunnage incinerator (DUN) are the heart of the demilitarization operation. All furnaces and afterburners are fired with propane for warmup, and use JP-5 fuel oil during operations. The following sections discuss the design and the role of each of these furnaces in the disposal process.

Liquid Incinerator (LIC)

In the design of an agent incinerator, the overriding criteria is destruction efficiency. Table 2 illustrates the degree of destruction required for each agent. Test results from past and current disposal systems verify the capability to meet these values.

TABLE 2 AGENT INCINERATOR DESTRUCTION REQUIREMENTS
(200% EXCESS AIR)

Agent	Discharge Std (mg/m^3)	Required Destruction Efficiency (%)
GB	0.0003	99.999999
VX	0.0003	99.999999
H	0.03	99.99995

Chemical agent, drained as a liquid from all munitions and pumped to intermediate holding tanks, is incinerated in the LIC.

Agent pumped from the intermediate holding tanks is atomized by a spray nozzle into the primary chamber of the two-chamber furnace. The resultant combustion products are further incinerated in the secondary chamber (fume burner). In addition, spent decontamination solution is injected into the system to completely burn any organic constituents present and reduce the solution to molten salt and water vapor. Molten salt is removed from the system for ultimate disposal.

Deactivation Furnace System (DFS)

Disposal of the munitions' explosive and propellant components is accomplished by incineration in the DFS kiln. Bursters and rocket propellants are preprocessed through a mechanical shear. This shear reduces the size of the material and exposes additional surface area to facilitate controlled combustion rather than detonation. Fuzes, booster pellets, and supplementary charges are fed to the furnace intact.

The deactivation furnace consists of a 310 stainless steel rotary kiln, controlled at 1,000°F at the burner end, and a heated discharge conveyor, operated at 1,000°F. Residence time of the explosives inside the kiln is at least 12 minutes - sufficient to allow complete burning of all energetic material. Upon exiting the kiln, the non-combustible components travel on the heated discharge conveyor for an additional 15 minutes to insure complete thermal decontamination of any residual agent. The DFS is capable of processing approximately 150 lbs/hr of explosives.

The exhaust of the deactivation furnace exits through a blast attenuation duct prior to entry into an afterburner. The DFS afterburner has been designed to the same criteria as the LIC secondary chamber (fume burner). The deactivation furnace room was designed to provide containment of all fragments, overpressure, and agent in the event of an accidental detonation during the incineration process.

Metal Parts Furnace (MPF)

In addition to the agent and explosives, the munition metal parts constitute a third category of hazardous waste. Metal that has been in contact with liquid agent has been shown to release agent vapors when subjected to elevated temperatures, even after the metal has been chemically decontaminated. For this reason, all metal parts are thermally decontaminated to a criteria of 15 minutes at 1,000°F prior to discharge from the process areas. Metal parts from projectiles and bulk items are

processed through a separate metal parts furnace (MPF) for thermal decontamination. The throughput rates of this furnace are a function of the munition types. This roller hearth type furnace is designed to process metal parts through the furnace in reusable 3 feet X 10 feet trays with a residence time of approximately 60 minutes. In addition to the decontamination of metal parts, this furnace has been designed to incinerate a residual agent "heel" of 5% by weight of the agent fill of each munition. Exhaust gases from the MPF are incinerated in an afterburner.

Dunnage Incinerator (DUN)

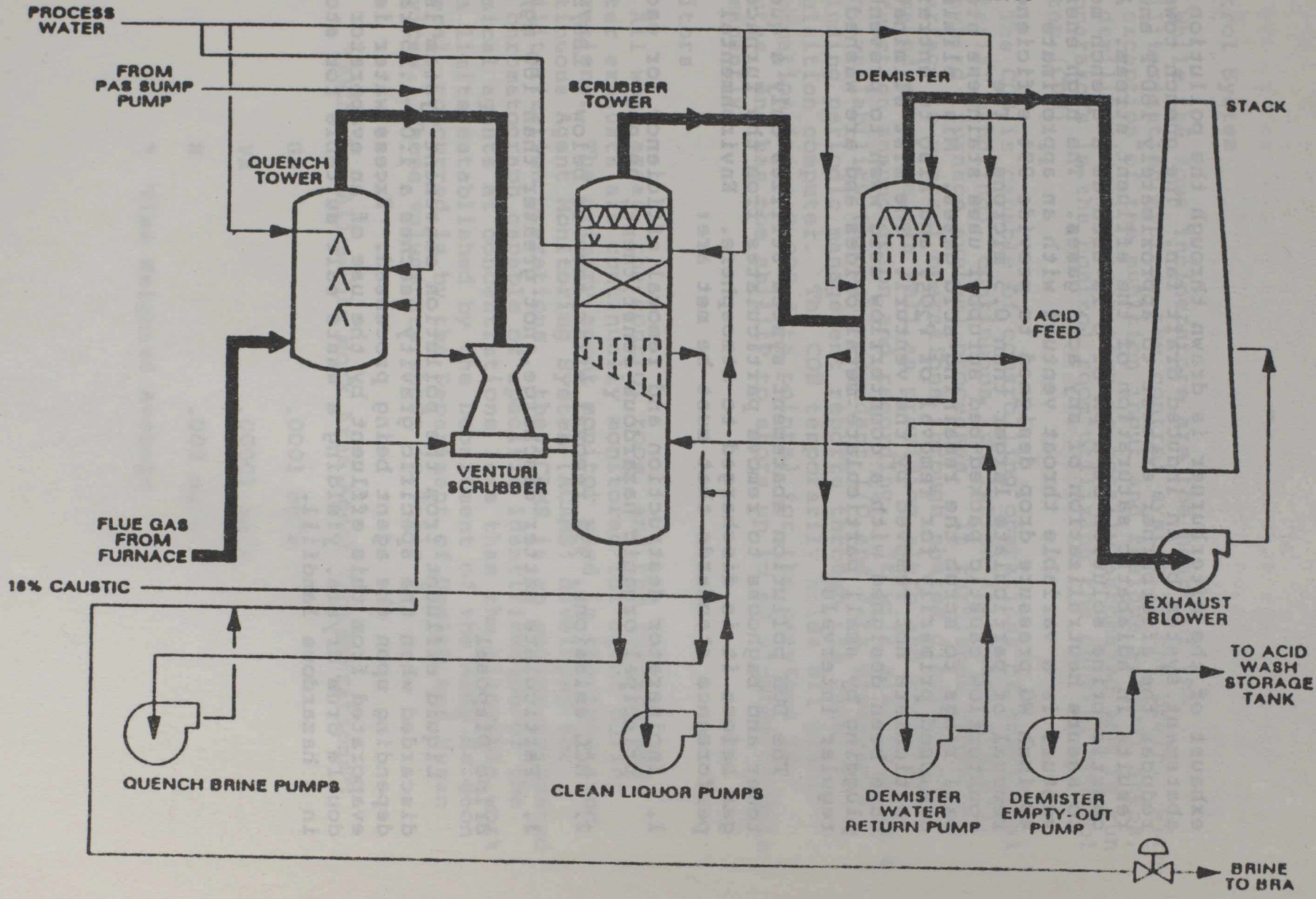
The fourth furnace system within the JACADS facility is the dunnage incinerator (DUN). This incinerator is designed to burn all process dunnage, including agent contaminated wood, wooden pallets impregnated with PCP preservatives, contaminated protective clothing, and other packaging materials. In addition, the DUN thermally decontaminates mine drums. The primary chamber is a refractory lined furnace operated at approximately 1,600°F when processing combustibles in the starved air mode. A ram feeder pushes materials into the furnace, simultaneously discharging ash from the opposite end. An afterburner assures complete incineration of all hydrocarbons. The incinerator has a throughput rate of approximately 1,000 lbs/hour of combustible damage.

Pollution Abatement Systems

Each furnace system has an independent pollution abatement system designed to scrub the products of combustion. In addition, impurities in the agents result in trace quantities of heavy metals in the furnace exhaust.

Figure 2 illustrates the basic pollution abatement system; similar systems are utilized for three of the four process furnaces (DFS, LIC, and MPF). The incinerators were designed for compliance with applicable environmental requirements. The

FIGURE 2
TYPICAL POLLUTION ABATEMENT SYSTEM



exhaust of the afterburner is drawn through the pollution abatement system by an induced draft fan. The quench tower reduces the afterburner exhaust to approximately 180°F and results in adiabatic saturation of the effluent stream. A caustic-brine solution at a pH of 8 is used as a quench media to assure neutralization of any acid gases. The high energy venturi is a variable throat venturi with an approximate 40-inch WG pressure drop designed to provide 99% efficiency in removal of particulate larger than 0.5 microns. The counterflow caustic packed-bed scrubber uses stainless steel pall rings to scrub the remaining acid gases. Mist eliminators are used primarily for removal of P_2O_5, and also to entrain particulate not removed by the venturi. The mist eliminators have been designed with a counterflow acid wash to prevent plugging by small particulate metal oxides and are washed at regular intervals.

The DUN pollution abatement system utilizes only a quench tower and baghouse to remove particulates from the furnace flue gas before it is discharged to atmosphere. Environmental performance standards that must be met are:

1. Incinerator destruction and removal efficiency for each principal organic hazardous constituent, 99.99%.

2. HCL emissions, 99% removal efficiency or below 4 LBS/HR.

3. Particulate matter discharge, not greater than 180 mg/m^3.

Brine Disposal

Liquid effluent from the pollution abatement system is discarded when the specific gravity reaches a 1.08-1.15 range, depending upon the agent being processed. Excess water is evaporated from this effluent by the use of an evaporator and double drum dryers, yielding a waste salt suitable for storage in a hazardous landfill.

Control System

While the four incinerators are the heart of the demilitarization system, the control system is the brain. With the exception of the munition input and residue removel steps, the demilitarization operation is totally automated and is run by operators in the control room utilizing the central control system (CON).

The CON is capable of controlling operations of sequential (material handling), continuous (pollution abatement system), or hybird (furnace system) processes. It furnishes operator interface to control operations through shared displays and animated graphics, as well as providing alarm and computer malfunction annunciation and recording. It will also provide a high availability through redundant I/O and data processors, including periodic management reports through the data acquisition computer. The CON temporarily holds all plant information (over 8,000 data points) for the previous 10 minutes, and has the ability to store up to 60 minutes of data permanently.

Monitors

All work areas, the control room, and the furnace and filter exhausts are continually monitored for agent during operations. The primary agent monitor used is the Automated Continuous Agent Monitoring System (ACAMS) developed for demilitarization operations. the ACAMS is an online automated gas chromatograph capable of specific identification of the chemical agents at concentrations less than the allowable work area limits established by the Department of the Army Surgeon General, concurred in by the Department of Health and Human Services. These values are shown in Table 3.

TABLE 3: Allowable Work Area Agent Concentrations*

GB	.0001 mg/m
VX	.00001 mg/m
H	.003 mg/m

* Time Weighted Average

Data from the air monitors provide a permanent record of plant emissions, as well as a record of the potential for exposure of personnel to agents. Additionally, routine medical examination of plant personnel is used to monitor indications of agent exposure.

Conclusion: Since 1970 the Army has safely disposed of over 15 million pounds of chemical agents. The results of these operations plus the procedures and equipment developed at CAMDS and incorporated into JACADS demonstrate that disposal of even these most hazardous wastes can be accomplished safely with minimal risk to the workforce and negligible impact on the environment.

NOTE: This paper has been adapted from a more detailed article which appeared in Environmental Progress (Vol. 8, No. 3) August 1989 by R. Rife, T. W. Thomas, D. W. Norbert, R. L. Fournier, F. G. Rinkes and M. S. Bononew "Chemical Demilitarization: Disposing of the Most Hazardous Wastes".

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Sample Preparation, Preservation, Security and Transportation under the Chemical Weapons Convention

Summary: This paper provides a description of methods for obtaining, preserving and transporting samples of highly toxic chemical agents, degradation products and biomedical material regarded as analytically important in the support of a Chemical Weapons Convention.

Introduction: A critical assumption in Chemical Weapons Convention technical discussions continues to be that analytical samples obtained under a wide variety of circumstances ranging from verification of declared stockpiles to examination of the casualites of alledged use, will be subjected to chemical analysis. Hence, the techniques for preserving the chemical integrity as well as the identity, authenticity and origin of collected samples assumes an importance equal to the reliability of the analytical methods selected to support the Convention.

Credible samples and their subsequent analysis are an integral part of the verification process whether acquired as part of an inspection regimem or in the investigation of proscribed production or alleged use. The details of sample acquisition methods and the formidable problems of sample transport are described in the following paragraphs derived from operational manuals largely designed to instruct troops assigned to operate in contaminated environments under emergency conditions. Thus, the tone of the instructions is insistent and the methods are rigidly defined. It is clear, however, that some methods described will not scale to the enormous numbers of samples required by a verification regime for declared chemical stocks. Environmental and biomedical samples may be more directly accessible by methods similar to those outlined. Nonetheless, the descriptions provide a point of departure for devising generally acceptable methods for sampling and transport of a spectrum of toxic materials.

Samples from facility inspections:

All samples should be taken in accordance with an agreed upon plan with revisions gained from the Facility Agreement and the opening conference. Samples to verify a declaration or support a material balance determination should be analyzed on-site, if feasible as provided for in subsidiary agreements. Quadruplicate samples should be taken with one retained by the facility, one used for on-site analysis, one for off-site analysis, and one held for future reference or independent analysis. All samples should be taken by, or in the presence of the inspection team. Samples should be sealed and labeled by tamper-proof methods that ensure sample identity and maintain a custody chain until analysis is completed. Sampling procedures should attempt not to interfere with routine facility operation nor affect the operating safety of the facility.

Bulk Storage of Schedule 2/3 Chemicals: Within the site, samples should be taken from both temporary and permanent bulk product storage areas. The samples should be taken from labeled drums and unit containers, tank cars or tank trucks declared to contain the CW agent.

Waste and byproducts: Samples should be taken from waste or by-product streams, holding tanks or impoundments used in the waste system. Waste stored for off-site shipment also should be sampled.

Wipe samples: Wipe samples should be taken only within the facility. A sufficient number of samples to allow division among analytical laboratories should be taken. The definition of sample areas should be related as closely as possible to the specific facility and declaration.

Feedstocks: Samples should be obtained from drums, tank cars and trucks, portable containers, as well as fixed storage, holding tanks, feed lines and reactors.

Products and in-process materials: Both in-process (as specified in the facility agreement) and final product samples should be taken.

Sampling techniques: The sample should be taken with a non-contaminated sample device. If it is taken through a fixed, existing sampling port or line, the path should be flushed with the material to be sampled to ensure that the sample is free of any prior contaminants. The flushed material should be saved, since if a violation occurred, the violator may have forgotten to flush the sample line before he changed the contents of the containing vessel.

The sample should be captured in a suitable clean, contamination-free, teflon or glass container that is numbered, tared, and can be overfilled with nitrogen gas and sealed shut immediately with a non-contaminating, non-absorbing, tamper resistant closure or seal. The sample container should be prefilled with an inert gas, such as nitrogen, in order to maintain the chemical purity of the sample.

The samples should be properly identified as to where each was taken, the time of day, month, and year, who took the sample, how it was taken, and a brief description of the material (color, physical form, etc.). The data on the sample should be entered on the numbered label or tag attached to the sample container along with the name and signature of both the sample taker and the inspector who witnessed the sample being taken.

The size of the sample and the number of quadruplicate samples should be determined by the need for analysis by the Technical Secretariat, by the facility personnel, and retention sample for recheck if required. If simultaneous samples can be taken, then allocation of the samples can be made at the time of sampling. If only one sample can be taken, its size should be such that division of the sample will not be a cause for dispute. The division must take place at the inspected facility in the presence of the inspector and the facility representative.

The sample to be removed should be appropriately sealed, e.g., placed in a mylar bag, resealed, or seal with wax, and the bag again identified as above with tags, labels, etc. Each sample should normally be placed in its own mylar bag, although under some circumstances, similar samples may be grouped together in the same overall bag. The bags should then be placed in a portable cold storage chest which can also be sealed, tagged, labeled, and secured for transport in a manner designed to preserve the chain of custody. Procedures, containers and seals employed by the IAEA to transport radioactive materials might provide a foundation on which to build. A record of the bags and the cold box container, the contents, numbering system, etc., should also be kept in the inspector's record book. It is important to be able to have a custody record from the time the sample is taken until it has been analyzed at the off-site analytical laboratory. The custody record should be continued in the lab.

Seals should be broken only in the presence of an authorized Technical Secretariat representative. If safety or other considerations make it necessary, at any time, to break the seal on a sample containing plastic bag, or cold box, a written record should be kept as to who broke the seal, why it was broken, and how long a period elapsed before resealing, and who resealed the material. Resealing should occur as soon as possible and new seals or tags numbers entered into the record book. The old seals should be retained and should accompany the material to the laboratory for analysis.

Sampling equipment: This should include, but is not limited to the following:

Collectors - clean bottles, vials, gas tubes, tubes, vacuum bottles, etc. The size and number of each container should be determined by the nature of the facility. All sample containers should be numbered, clean, durable, sealable, and be tared, where possible.

Sampling Aids - should include core or thief samplers, bottom samplers, liquid and solid waste samples, augurs, recorder, and a calculator. The Inspection Team may also need to carry supplies of distilled water, reagent grade solvents, and containers to clean the samplers and decontaminating solutions to aid in a spill.

There should also be a sufficient amount of labels, receipts, stickers, seals, etc., (pre-numbered and with space for dating, signature, and printed identification), recording notebooks and other record keeping documentation, as appropriate.

Sample Storage/Transport - should include numbered cold boxes which can be secured and sealed for sending sets of samples to a controlled and secured laboratory, perhaps analogous to the containers used to transport certain radioactive materials.

Sampling Equipment:

The samples to be transported for off-site analysis should be packaged as described above and repackaged in safe/secure refrigerated containers according to safety product information (include in container) and shipped in accordance with pertinent national environmental and public health regulations to the central laboratory for analysis. At the laboratory the samples will be unpacked, identified and weighed in accordance with the procedure for chain of custody of samples and verified with the identification provided by the inspectors. The material courier receipts will be documented to assure sample integrity and control.

Tags and seals: Sealing and identification devices must be simple, relatively inexpensive and unique on the basis of features easily and permanently affixed to a sample. Verification of the authenticity and the integrity of the seal also should be relatively simple. In many existing and proposed systems, the seal is simple but the method for authentication is prohibitively complex. The following candidate methods preserve identity of samples from collection to analysis and satisfy a major verification problem, i.e., keeping track of samples in transit. Three dimensional reflective systems, passive interrogation systems with unique identity, methods that exploit biological specificity, and methods for permanently affixing tags and seals are relatively mature technologies that can be incorporated into sampling and transport schemes to ensure integrity.

Samples from alleged use:

Procedures for collecting, packaging, documenting and transporting suspect chemical agent samples from the field to a laboratory for analysis must preserve the integrity and identity of the samples in order to provide credibility. Samples containing CW agents or other routine chemicals can be divided into environmental (aerosols or vapors, liquids, soil, vegetation, used ordnance etc.,) and biomedical samples (urine, blood, sputum, organs, tissues etc., from acutely ill or dead casualties. Transporting such samples requires proper packaging to ensure the safety of personnel who may handle the samples in transit. In suspected use situations, background samples from "clean" areas should be taken by identical methods to provide a baseline. Personnel collecting the samples should be wearing appropriate protective equipment.

a) Environmental samples:

Methods for collecting environmental samples will depend on the sample type and the conditions affecting the collection, e.g., soil type, weather, age, etc. The samples must be documented, preserved and transported and require the same assurances of authenticity as the declared specimens. A suggested sampling kit (Annex 1) provides a starting point for the design of a kit to be assembled by an Inspectorate for the collection of environmental samples. Sample collection methods are illustrated by the following exerpts:

Liquid aerosol/vapor samples: An electric or hand pump should be used with care taken to record the volume of the sample and the type of collection tube employed.

Vegetation samples: collect material from several locations within the area taking care to preserve surface deposits of dust etc. The sample size should be several leaves or handfuls of grass. Place the sample in a bag containing all pertinent collection information and seal.

Soil samples: Collect samples from areas stained or otherwise discolored. Collect similar samples beyond the perimeter of the suspect area. The sample volume is approximately that of a cigarette pack laying on its side. With a small scoop, place the specimen in a bag, include complete documentation and seal.

Collection of Water Samples: Use an appropriate test kit to determine the presence of chemical agents and record the results on a Sample Documentation Form. Take samples at standing pools or along streams where contamination is suspected. Bulk water samples (preferred when oily globules or suspended salide are present) are collected by skimming surface water into a teflon bottle. Fill the bottle, screw on the top and ensure that the seal is leak-proof with parafilm or plumber's anti-seize tape. Mark the sample identification number on the bottle.

When using the C-18 SepPak Cartridge for liquid sampling, the following should be considered: the C-18 SepPak cartridge extracts and concentrates contaminants in water. Methanol and distilled water is used to prime the SepPak. 200 ml of sample water is drawn slowly through the cartridge with a 50 ml springe. Discard the liquid and syringe and place the cartridge in a teflon bottle marked with a sample identification number. When obtaining a sample of sludge on the shore or in a shallow bottom, scoop the top of the solids with an open teflon bottle; close the bottle and seal it with parafilm. Mark the bottle with an identification number.

Packaging Samples: Place several sample bags in one regular bag. Place the reference samples in a separate regular bag. Do not overfill. Press excess air from the bag and seal the adhesive end. Seal the package with tape and mark sample identification number(s). Include the Sample Documentation Form. The outside of the sample container should be decontaminated and monitored before transport. The samples should be refrigerated or chilled immediately. Do not freeze. Small animal samples are packaged in the same fashion as other samples. Ordnance or remnants of munitions and protective equipment or clothing constitute important sources of CB agents for identification purposes. Only qualified ordnance experts should collect such items but the general procedures for collection and packaging are the same as for other materials.

b) Biomedical Samples

The best biomedical sample is an acutely ill soldier or a cadaver. Sample Documentation Forms and symptoms are to be completed on all biomedical samples. In addition, a copy of the physical examination or an extract of significant findings are to be enclosed with the biomedical samples. Additionally, the following samples should be collected whenever casualties occur and should be collected in triplicate. Once collected, the samples should be refrigerated or chilled immediately. DO NOT FREEZE. An equipment list containing components of a suggested medical sampling kit is included in Annex 2. Medical personnel should perform biomedical sample collection to ensure that a valid sample is obtained. The following is guidance to be used in sample collection:

o Collect samples from patients during acute phase and at day 7.

o Collect urine samples (20-50 ml per sample x 3) in urine specimen cups, secure the top with wide tape, and place in individual sealable mylar bags..

o Collect whole blood or serum samples (5 ml per sample x 3) in red-top blood tubes and place in individual, sealable mylar bags.

o Collect sputum only from acutely ill patients (x 3). They should be collected in urine cups. Secure the cup with a wide tape and place in individual sealable mylar bags.

o Collect cerebral spinal fluid (2 ml per sample x 3) in red-top blood tubes and place in individual, sealable mylar bags.

o Take at least 30 grams of organs/tissues (human, postmortem x 3), place in a sterile container in individual, sealable mylar bags, and refrigerate immediately; liver, spleen, lung, subcutaneous fat, cerebral spinal fluid, kidney, heart, and brain.

- o Collect at least two mediastinal lymph nodes.
- o Photographs and questionaires should be employed where appropriate.

Packaging Biomedical Samples: Place the mylar bag(s) or sample container in a plastic bag. Remove excess air and seal tightly. Mark the container with a sample identification number. Place 1-2 inches of packing material (vermiculate, foam, etc.) around the sample bag in a rigid container. Wrap jars, tubes, or specimen cups in a bubble wrap or other suitable material so they do not move in the container. Place a lid on the container and seal with the wide tape.

Transport of Samples: Place the environmental and biomedical samples in an insulated chest ensuring that the sample is packed tightly and an adequate supply of refrigerant is available. Seal the chest with appropriate tamper-resistant seals and label accordingly. The procedure should further meet the specifications for etiologic agents and toxic material shipments. All sample transfer must be documented with appropriate courier receipts to ensure a legal chain of custody of the shipment.

Conclusions

Procedures for sample management to assure credible evidence with compliance of the terms of the draft convention to ban chemical weapons use or production have been developed. It is hoped that a set of procedures can be standardized which will be usable for all potential circumstances. Such procedures are necessary to provude confidence in the overall verification of such a convention. The foregoing discussion presents a number of factors that need to be considered in developing them, and, in some cases suggests procedures that might be utilized. In all cases, the procedures should be standardized for use in all situations.

Annex 1

SUGGESTED EQUIPMENT LIST -- ENVIRONMENTAL SAMPLING KIT

Number	Description
20	Labels, paper, pressure sensitive
1	Tape, pressure sensitive adhesive
2	Forceps (dressing for solid handle)
2	Micro spatula with teflon ends
2	Scoop, 2 oz
2	Spatula, spoon type with teflon
10	Sample bottle, 6 oz, teflon type
3	Eye dropper with rubber bulb
10	Insulated bags, mylar or equiv
4	Sep-Pak C18
2	Syringe, hypodermic 50 or 60 ml
4	PFA tubing
1	Marking pen, waterproof
4	Tenax tubes
10	Razor, surgical prep
4	Pad, cooling chemical 4S
4	Piglette for Tenex Tubes
1	Tape, anti-seizing
1	Personal air sampler (PAS 1000 or equivalent)
1	Methanol, 4 oz
1	Water, distilled
1	Matches, waterproof
10	Sample Documentation Form
10	Material Courier Receipt

Annex 2

SUGGESTED EQUIPMENT LIST -- MEDICAL SAMPLING KIT

Number	Description
60	Urine specimen cups
24	Red top blood tubes
80	Insulated bags, mylar or equivalent
90	Labels, paper, pressure sensitive
2	Tape, pressure sensitive adhesive
8	Syringe, hypodermic 50 ml
8	18 gauge needles
1	Making pens waterproof
6	Razor, surgical prep
4	Forceps
1	Pad, chemical cooling, 4 ea
1	Insulated chest
5	Sample documentation forms
1	Materiel Courier Receipt

NOTE: Above kit is designed to obtain samples from two patients and two cadavers.

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UNITED STATES OF AMERICA

The Use of Instruments in Chemical Process Monitoring or Demilitarization of Chemical Weapons

SUMMARY: This paper provides an overview of some current, commercial chemical process monitoring practices, how they relate to Chemical Weapon Convention requirements to monitor the production of chemical warfare agents and their precursors, and the similarities to chemical weapon destruction and disposal operations required by the Convention. It also presents a number of factors that should be considered in selecting or designing instruments for use in monitoring chemical processes under the prospective Chemical Weapons Convention. It is important to note the presence of inspectors will also be required to effectively verify that provisions of the treaty are being met.

INTRODUCTION: The Chemical Weapon Convention negotiations envisage that all extant chemical weapons and chemical warfare agent will be irreversibly destroyed. In addition, they prohibit the new production of such chemicals by prescribing that facilities used to produce those chemicals be shut down and subsequently destroyed. Further, diversion of permitted production of key precursors for those agents and of other lethal chemicals is also prohibited. All these functions must be performed in such a way that there are no detrimental effects on the environment. To verify that such provisions are fully complied with, it is likely that it will be necessary to use on-site inspectors who will use a variety of instruments to monitor production and destruction processes. In some cases, such monitoring will be aimed at confirming that production activities have been shut down, and in others the focus will be on measuring various parameters of permitted production or destruction activities. This paper highlights only one type of available monitoring means - instrumentation. It is important to realize that this is only one of several methods that will be used to monitor declared stockpiles and facilities under the convention. Another means of monitoring is the frequent presence of human inspectors which have unique capabilities to perform as an adaptable and flexible resource which can interact with other parts of the monitoring system.

Current monitoring practices in chemical industry tend to serve three purposes: 1) environmental concerns (e.g., minimize and document gaseous, liquid or solid emissions into the environment); 2) quality control (e.g., that end products meet production specifications); and 3) economic (e.g., that raw materials, equipment, utilities and other process variables are used to best commercial advantage). Because these issues are also of concern with respect to CWC activities, it is instructive to consider current industry practice as the Conference on Disarmament deliberates the use of inspectors and instruments to verify compliance in the areas of process monitoring and chemical destruction.

MONITORING SYSTEM: A monitoring system may consist of most or all of the following components: instruments or sensors to collect the data of interest; data processing, storage, analysis, and transmission; and in addition to these, human participants are required, either as plant operators or inspectors. Depending on the case-by-case monitoring requirements, these components may be quite simple or rather complex; elementary or sophisticated; inherently reliable or difficult to maintain; single-purpose or multipurpose; analog or digital; almost fool-proof or easy to circumvent; manpower intensive or able to operate without much human interaction; located in or near the process equipment or remotely, perhaps even at considerable distance, from the process; inexpensive or costly. In addition, they may operate in-line (where a sensor's probe is inserted into a process stream to collect the data of interest) or on-line (where samples are extracted from the process stream for measurement or analysis). These dimensions will be elaborated briefly below.

Complexity: Tenperature and pressure sensors, for example, are simple, widely used instruments that are likely to be needed to monitor certain aspects of the CW Convention--whether to provide coarse data to reveal if a former production facility has been restarted, or to provide exact data to indicate that illicit chemical agents are not being produced during a certain reaction. Sophisticated analytical instruments--e.g., gas chromatographs, mass spectrometers, etc--may be needed to shed light on allegations of illegal production prohibited agents, or to analyze degradation products from demilitarization or destruction operations.

Single- or Multi-purpose: While most process sensors are likely to be single-purpose instruments, analytical chemical instruments may vary widely. Chemical detectors sensitive only to certain nerve agents may be utilized, for example, to warn inspectors of leaking munitions or bulk storage containers. To detect and distinguish between the wide variety of CW agents, key precursors, and other lethal chemicals, on the other hand, it probably will require analytical instrumentation with very broad capabilities.

Operator sophistication required: Advanced analytical instruments often are used only by highly trained chemists, while chemical warning detectors are issued to entry-level military personnel. Similarly, certain data recording and analysis equipment requires considerable operator skill, while other applications can be satisfied with simple recording devices no more complex than elementary audio tape recorders used by today's teenagers. Inspectors must be trained professionals capable of fulfilling this wide variety of tasks.

Susceptibility to circumvention: Chemical analytical techniques may be spoofed by sprinkling related compounds around to mask traces of illicit materials or to produce large numbers of what later are seen to be false alarms. In addition, careful clean-up efforts may further reduce even trace amounts of chemicals. Setting up parallel process streams, or even relatively small piping sections thereof, also could circumvent process monitors, for example. Careful design of monitoring systems may complicate such attempts, however--perhaps by incorporating multi-phenomenology sensor packages, etc.

Reliability: Certain provisions of the CW Convention may be monitored by the use of sensors which of necessity must operate reliably for periods of weeks or perhaps months at a time. Other monitoring devices that may have human operators will have to be quite reliable as well, to avoid frequent and costly maintenance requirements. A critical aspect of each instrument is that its mean-time-between-failure (MTBF) is kept appropriately low, and that it be further minimized by a scheduled preventive maintenance program. Such sensors must operate reliably as a system as well.

Digital or analog: Analog control devices, which date back to the 1950s, tend to be reliable, easily calibrated, and offer relatively simple control options. A disadvantage, however, is the high cost of transmitting its signal (either low voltage electrical signal or a pneumatic signal) over even short distances. The use of an analog-to-digital converter reduces that problem, however, but introduces the requirement to validate the conversion factors and algorithms. Digital monitors, essentially adapting computers to control activities, simplify the data transmission problem, but increase the requirements for calibration and maintenance (needed parts and labor may be in short supply in many parts of the world).

Human operators or inspectors may serve a variety of functions, with their exact role depending on the verification requirements, the characteristics and complexity of the process to be monitored as well as of the instruments used in monitoring, and possibly even the experience and training of those inspector/operators. Generally, inspector/operators would read, record, and report process data collected by the process instruments. They also might examine raw materials and feedstocks, end-products, and waste streams for unusual activity. A necessary task for human operators/inspectors--whether permanently stationed at a particular facility or on a periodic visit thereto-- will be the calibration, checking, and maintaining of monitoring instruments, data collection, recording and transmission equipment. The inspector also serves as a flexible and adaptable check in a hostile environment. During disposal operations for chemical munitions and agents, for example, it is expected that human inspectors will be present continuously. Thus, they would, in principle, be able to monitor activity in the facility as well as overseeing the instruments that are collecting process data. This may also be case during critical operations when the single, small-scale production facility is in operation. The human inspector should interact with the instruments to provide the most effective means of verification.

The instruments themselves serve a key role in process monitoring, but also in situation-dependent and various ways. For example, in a former production facility it is likely that instruments will collect such data as reactor or steam line temperature, vibrations in pipes, utility usage, valve body position, etc--minimal, essential data to confirm that chemical production has not resumed.

In a plant that is operating, on the other hand, it may be necessary to monitor process parameters such as reactant quantities, reaction temperature, pressure and flow, etc, in addition to the variables mentioned above. Further, if the plant is capable of producing CW agent or key precursors, more extensive instrumentation may be required as well as on-site inspection personnel. Both on-line and in-line instruments may be utilized to determine composition of key components, as well as temperatures and pressures of reactor vessels. In the case of CW agent disposal, analytical instruments may be necessary to identify input agents or destruction products, composition of effluent streams, environmental emissions, etc.

Before monitoring instruments can be selected, it will be necessary to study the specific process employed at a particular facility--something that is to be described and declared under terms of the CW Convention. Here also, well trained professionals who are knowledgable of the process are required to select and install instrumentation appropriate to the process. A good quality instrument, well-designed for the application at hand, properly located and installed, and adequately maintained, should provide accurate, consistent, and reliable data.

To maximize the credibility of the data produced from any monitoring system, it may be necessary to incorporate tamper-resistant features. Some would make it very difficult for someone to gain access to the sensor or its data, while others would simply leave tell-tale marks if such tampering were to be attempted.

The data relevant to monitoring the CW Convention may contain either or both sensitive military security information or proprietary business information, both of which must be protected from unauthorized disclosure. Not only must the International Organization ensure that procedures and personnel policies provide such protection, but it may be necessary either to encrypt the data (so that only the transmitter and receiver know the substantive content of the data) or authenticate the data (by which the data are transmitted in clear text, but a coded word is appended to the end of the data stream to reveal any tampering with the data).

Data collection and processing, the second element in the monitoring system, functions principally to collect the process data and prepare them for transmission off-site for further analysis and storage. In many cases, that will mean the use of a local data collection network that ties together the several monitors that are used at each facility. In order to eliminate the reliability problems associated with there being a single, critical node in that network, there should be more than one data collection mode providing redundant coverage of the sensors. Effective verification can be improved by the frequent presence of inspectors which would probably decrease the quantity of instrument data that would need to be transmitted from a site. In some cases, it may be possible that no data need be transmitted. Some of the data will be needed in near-real-time by officials at the International Organization, while others may have a timeliness value that allows them to be stored on-site for retrieval during periodic visits by inspectors. Dataproduction rates, and corresponding storage and/or transmission rates, will vary according to the types of instruments used and the complexity of the monitoring system. With the large number of sites having a potential need to be monitored, it will be necessary to match the size of the data transmission subsystem to that of the monitors utilized. Multiplexors should be examined for combining several data streams--whether from several sensors each at the same facility, or possibly from several sensors located at different sites. Another aspect of the data transmission subsystem is the issue of how to transmit the data back to the International Organization. In some cases, it will be necessary to plan for

the availability and use of satellite channels. Obviously, that will necessitate transmisssion units on the ground at the site where the data are gathered and receiving units on the ground at the central facility operated by the International Organization.

POTENTIAL PROBLEMS: Despite the high reliability of a process monitoring system containing quality hardware and software, there are many potential problems to be addressed to assure that the collected data are accurate, honest, and timely. Intentional and unintentional tampering with the monitoring instruments is not something that can be overlooked and may be very difficult to police especially without the presence of on-site inspectors. Nevertheless, a verification system cannot operate effectively unless these concerns are addressed.

It was suggested earlier that the quality of the data collected is dependent on the raw data generated by the measuring instruments. These instruments must be properly maintained and frequently calibrated to ensure accuracy. These actions are usually labor-intensive and highly dependent on the skills and knowledge of the technicians servicing the equipment. Sometimes, this operation may, of necessity, interfere with the production process--for example, pipe joints may leak in the sensing area creating hazardous situations which must then be secured. Or the instruments may interfere with smooth flow of materials through pipes or other equipment. Material flows may have to be stopped on occasion in order to repair an instrument problem.

Unfortunately, today's commercial instruments are not designed to be tamper-resistant. Intentional modification of the calibration can, for example, make large chemical flows appear to be small; or vice versa. In addition to incorporating such tamper-resistant features for treaty verification (e.g., enclosing sensors, instruments, and/or data transmitters in a box which can be opened only by authorized inspector personnel), a good material balance (perhaps using a simulation software package) may detect some tampering.

Other types of problems may involve transmission of the data signal to the receiver. A break in the signal wire, for example, can cause a break in the data stream perhaps for a significant period--whether the break was intentional or not. Process operating conditions during this time will be unknown and changes in production rates or products could go unnoticed. Thus the human inspector has an important function to perform.

A hardware failure in the data collector, the communication equipment, or the computer may also result in data loss. Although such equipment is generally of high reliability, it is a problem that can not be ignored. Further, the "uptime" of such equipment is directly related to the skill and speed with which maintenance personnel diagnose and repair the hardware.

An additional issue that must be considered in the design of monitoring instruments is the possibility of deliberate cheating. It could range from a quick, one-time attempt to produce some scheduled chemicals to a conscious, continuing attempt to produce large quantities of proscribed chemicals. Attempts at such cheating, if they were to occur, might be hidden within a large facility being monitored or at an undeclared and unmonitored location. Existing widely are specialty chemical facilities with corrosion-resistant equipment which can be readily adapted to make chemical weapon agent or key precursors. Similar facilities to produce new types of specialty chemicals (e.g., polymers, agricultural products, pharmaceuticals, etc) are sure to be built in the future, raising the possibility of production by unmonitored equipment. These possibilities further raise the need for full time on-site inspectors in critical facilities.

CONCLUSIONS: Current process monitoring practices for normal industrial purposes can serve as the foundation for instruments and monitoring technology which can be adapted and tailored for monitoring chemical weapons production, non-production, and destruction. Much of the instrumentation is available or technically feasible; only engineering the technology into instruments tailored for CW Convention verification use is

needed (a non-trivial task, in some cases). Any monitoring system must safeguard intellectual property, must be carefully designed and chosen, must be properly installed and checked-out, and must be properly maintained and calibrated. Trained professional inspection teams will be needed to perform this wide variety of functions. In addition, the development of qualifications for the inspectors and an appropriate training curriculum needs to be developed if the verification system is to become effective. Substantial work remains to develop such verification systems so that they have the proper combination of features to protect sensitive or proprietary information, collect data needed to assure compliance with the Convention, can be operated reliably by the Technical Secretariat, and are inexpensive enough to be procured in the quantities needed. At best, it will probably take several years to identify necessary technologies and develop specialized hardware for an effective monitoring system for all recognized sites. The proper combination of inspectors and instruments needs to be fully explored for maximum effectiveness of the verification system. That work should take into account many factors or dimensions--some of which are enumerated in this paper.

CONFERENCE ON DISARMAMENT

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UNITED STATES OF AMERICA

Use of a Satellite Network for Collection of Data from Facilites

INTRODUCTION

Under the future Chemical Weapons Convention, a substantial number of facilities would be subject to international monitoring. These facilities would include chemical weapons storage sites, chemical weapons production facilities, chemical weapons destruction facilities, and civil facilities that produce or consume key precursors. Monitoring would be conducted by inspectors and on-site instruments.

The monitoring activities would produce a substantial amount of data that would need to be transmitted to Technical Secretariat headquarters for processing and analysis. The resources required have not yet been determined, however.

This paper summarizes the results of research by the United States to develop cost estimates for a data-collection system that would make use of existing satellite networks. A more detailed description of this research is given in the appendix. The system discussed in this paper is not intended as a U.S. position, but rather as an illustration of how one possible data collection system might be constructed, and to provide a general idea of the associated costs. Other possible alternatives are the international telephone network, existing data networks, or a dedicated satellite system. The paper addresses only the communications requirements; it does not address the questions of what type of information would be collected, or how the information would be protected. These issues affect primarily the selection, design and installation of sensors and have little impact on the design of the communications component of the data collection system.

DATA COLLECTION REQUIREMENTS

At present the number of facilities from which information would need to be collected is not known. For the study it was assumed that the number of facilities would range from 50 to 500.

Previous studies have shown that geographical distribution of the facilities is an important factor in determining costs for data collection. Since the geographical distribution of the facilities to be monitored under the future Convention is not yet known, the following three configurations have been postulated: a) a substantial number of facilities is within a small geographical area, which also contains the headquarters of the Technical Secretariat; b) a high concentration of facilities exists somewhere far away from the headquarters of the Technical Secretariat; c) the facilities are scattered widely around the globe. The data-collection system analyzed in the U.S. study is based on combinations of these configurations. In the study it was found that the capital costs under the various assumed scenarios converge as the number of facilities approaches 500; therefore, the cost estimates presented in this paper are based on a system of 500 facilities. If the number of facilities is much larger than 500, the increase in capital costs will consist primarily of equipment costs and will be proportional to the number of additional facilities. The impact of the system development costs will be insignificant for such large number of facilities. On the other hand, the operating costs will not be proportional to the number of facilities, because satellite service charges are based on transponder leasing. Each transponder can accomodate a maximum number of system data and it has a fixed leasing cost regardless of how much capacity is utilized. As the number of facilities increase beyond 500 there would be a need for additional transponders causing a quantum increase in the operating costs of the system. Since neither the actual number of facilities nor their geographical distribution are not know, parametric studies involving a larger number of facilities would not provide significantly greater insight into the issues addressed in this paper.

Most information would flow from the facility to the Technical Secretariat. This might include reports or requests from inspectors, data submitted by the facility, or data generated by on-site monitoring instruments installed for verification purposes.

Information might also be transmitted from the Technical Secretariat to the facility. This could include instructions to the inspectors, reference data from a central data base requested by inspectors, and electronic checks of monitoring instruments.

The amount of data generated at each facility will depend on the size and nature of the facility and on the monitoring requirements established for the facility in the convention. Preliminary analyses showed that more than 80 percent of the data (equal approximately to 500 single-spaced typewritten pages per day) would be generated by on-site monitoring instruments, in particular, TV surveillance systems. Therefore, the system specifications used in the study are based on the need to transmit instrument data from each of the facilities to the headquarters of the Technical Secretariat.

DATA COLLECTION SYSTEM

Data from each facility would be transmitted to the Technical Secretariat from a satellite earth terminal located at the facility. Figure 1 shows a possible configuration of such a terminal. These transmissions will be via one or more geostationary satellites which provide either global or regional coverage. The INTELSAT system provides global coverage while regional networks, typically at the national level, provide regional coverage. Examples of regional systems with the corresponding areas of coverage are given in Table 1.

If a facility were located in an area where there is regional service, small-size satellite earth stations could be used; in that case, regional data collection centers with large terminals would be needed. Data would be sent from the facility to the regional center and then to the Technical Secretariat through the INTELSAT system. This approach is feasible if many facilities are within the area of coverage of a regional system. On the other hand, if few facilities are scattered in areas not covered by a regional system, large terminals would be needed at each facility to transmit the data directly from the facility to the Technical Secretariat through the INTELSAT system. At the headquarters of the Technical Secretariat, or near it, a large-size central satellite terminal would collect the data transmitted from the remote earth terminals. Figure 2 shows the earth as viewed by an INTELSAT satellite over the Atlantic Ocean. The cross marked "INTELSAT" indicates the position of the satellite in geostationary orbit. The second cross marked "EUTELSAT" indicates the geostationary

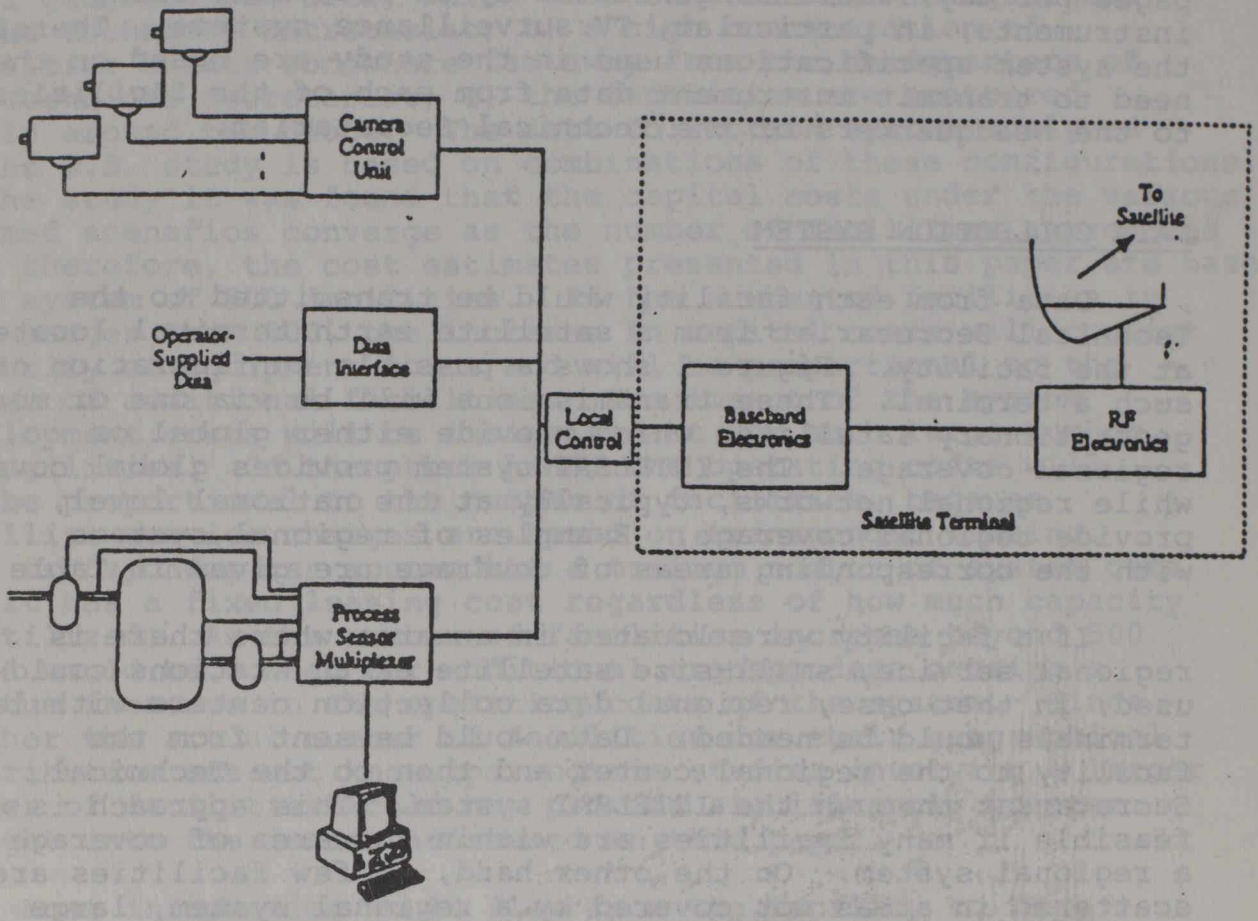

FIGURE 1. TYPICAL REMOTE MONITORING INSTALLATION

TABLE 1

REPRESENTATIVE REGIONAL SATELLITE SYSTEMS

System	Coverage Area
American Satellite Co.	United States
Arabsat	Arabia, North Africa
Aussat	Australia, Papua-New Guinea
Embratel	Brazil
Eutelsat	Europe, Iceland
GTE Spacenet	United States
Hughes Communications	United States
Insat	India
Intersputnik	(Note)
MCI Communications Corp.	United States
Morelos	Mexico
Perumtel	Indonesia
Sakura	Japan
Telecom	France, French Guiana, Africa
Telesat Canada	Canada

NOTE: Intersputnik signatories include Afghanistan, Bulgaria, Cuba, Czechoslovakia, Hungary, German Democratic Republic, Laos, Mongolia, North Korea, Poland, Romania, the Soviet Union, Vietnam, and the People's Democratic Republic of Yemen.

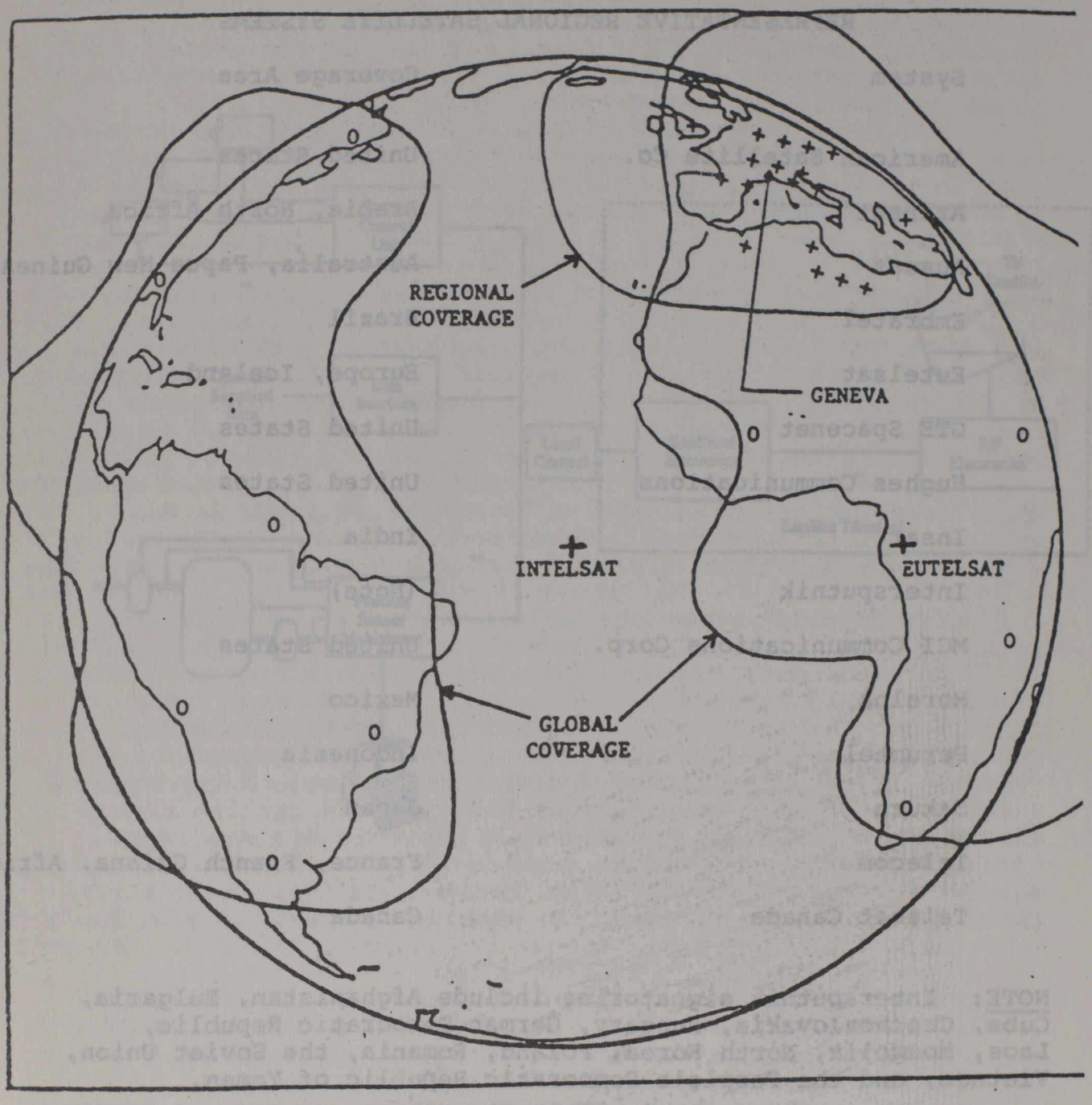

FIGURE 2. EXAMPLES OF CONFIGURATIONS OF FACILITIES COVERED BY SATELLITE SYSTEMS

location of a EUTELSAT satellite. Examples of configurations of the geographical distribution of hypothetical facilities are also shown as they would be viewed from the INTELSAT satellite. The x's indicate a high concentration of facilities in an area served by a regional satellite network, while the o's denote locations of scattered hypothetical facilities served by a global satellite network.

Since the capital costs of the terminals are roughly proportional to their size, cost could be minimized through proper system design. If many facilities are concentrated in an area where satellite coverage is sufficient, a regional system would be cost-effective because the lower cost of small-size terminals would more than offset the cost of the additional regional terminal. If the facilities are scattered over a very large geographical area, however, a regional system with small local terminals would not be possible.

The estimated costs of the data collection system are composed largely of capital costs and operating costs. Capital costs generally cover all items necessary to place the system into operation. (Sensors or other data processing equipment from which data are collected are not included in this study). Operating costs have three major components: satellite leasing services, operating personnel, and maintenance. Each of the cost factors is discussed below, with costs estimated in 1988 US dollars.

Capital costs cover equipment purchases and development efforts. Equipment purchase costs are proportional to the number of facilities. Development costs are more difficult to estimate because there is a system cost independent of the number of facilities and a second component dependent on the number and type of facilities. It is realistic to assume that there is substantial commonality among the development activities for most sites. On the basis of these assumptions, the total capital costs for a system covering 500 facilities would range from US$42,000,000 to US$72,000,000.

Since the remote terminals would operate unattended, there would be no personnel costs associated with them, except for maintenance. Personnel would be required, however, at the central terminal and at the one postulated regional terminal. This cost is calculated at US$700,000 per year.

In the absence of a detailed system design, annual maintenance costs have been estimated at ten percent of equipment costs. This is a standard industry practice in such cases.

Addition of the three cost components yields a range for annual operating costs of US$5,800,000 to US$11,300,000 for a system of 500 facilities.

Cost data are summarized in Table 2. The high capital cost figure is based on the rather pessimistic assumption that each facility requires its own unique development effort. The high and low figures for the operating costs are derived from extreme combinations of the three postulated geographical distributions of the facilities.

TABLE 2

DATA COLLECTION COSTS FOR 500 FACILITIES

(in millions US$)

	High	Low
Capital		
Equipment	30	30
Development	42	12
TOTAL	72	32
OPERATING (Annual)		
Sat. Leasing	7.6	2.1
Personnel	0.7	0.7
Maintenance	3.0	3.0
TOTAL	11.3	5.8

CONCLUDING COMMENTS

The analysis reported in this paper was based on deliberately conservative assumptions about the number of facilities and the amount of data transmitted from each facility. The analysis assumed that a substantial number of facilities are included in the system and that a substantial quantity of data is collected daily from each facility. Costs might be reduced appreciably if fewer facilities were actually included or if continuous instrumental data transmission were triggered by a specific event. While the cost estimates are biased toward the high side, they provide an indication of the order of magnitude of the costs involved in establishing a data collection system for verification purposes.

By way of comparison, if it is assumed that video surveillance exists in only 50 facilities while the remaining 450 facilities generate primarily process monitoring data the cost figures change substantially. Although there has not been a detailed analysis of such a scenario, some rough cost figures can be extrapolated.

If if is assumed that all 500 facilities have their own satellite terminals but only 50 transmit video surveillance data, the capital costs would remain unchanged while the operating costs would be close to US$5,000,000 per year. If, on the other hand, the process monitoring data are transmitted via telephone channels, and only 50 facilities have satellite terminals, the capital costs would be reduced to about US$17,000,000 while the operating costs would be increased to about US$8,000,000 per year.

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UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

Instrumental Approaches to Non-Intrusive Analytical Techniques for Inspection and Verification

INTRODUCTION

1. The verification provisions elaborated in CD952 would require on-site inspection of a variety of civil and military sites. Specific mention is made of the importance of instrumental and technological support to implement these provisions. The Technical Group on Instrumentation under the valuable Chairmanship of Dr Rautio of the Delegation of Finland has moved this subject forward significantly.

2. In August 1989 the UK tabled a paper (CD/CW/WP 255) describing analytical techniques appropriate to a Chemical Weapons Convention (CWC) in which, amongst other topics, reference was made briefly to the likely need for non-intrusive and non-destructive analytical techniques. Three such techniques were identified as worthy of more detailed consideration; X-ray methods, ultrasonic methods and neutron activation analysis.

3. This paper summarizes some perceptions of the feasibility of using these three methods for the on-site examination of containers, from which samples are not available, in order to gain information on the relevance of the nature of the contents in respect of the CWC.

BACKGROUND

4. Unambiguous information on the nature of compounds present at stockpiles, destruction facilities, declared production facilities, civil industrial facilities or permitted small-scale facilities can only be obtained by taking a sample of the compound for analysis by sophisticated instrumental techniques such as nuclear magnetic resonance spectroscopy, infra-red spectroscopy and mass spectrometry. These fundamental techniques may be interfaced with such sample processing techniques as gas-liquid chromatography or high performance liquid chromatography. Confirmation of the identity of the samples can be achieved by direct comparison with authenticated reference data or with an authenticated specimen of the indicated compound.

5. In some cases it may not be possible to obtain the samples required for such analysis. It may be impossible practically to acquire a sample, or too hazardous to try to take one; this might well be the case when verifying the type of fill contained in munitions in an ordnance storage site. It is therefore necessary to consider what information can be obtained by the use of non-intrusive analytical techniques and to identify such possible techniques.

6. It is not expected that non-intrusive analytical techniques will provide unambiguous identification of the contents of containers from which a sample is not available; nor is it likely that a single non-intrusive analytical technique will be entirely satisfactory. Rather a number of techniques will need to be used, each technique contributing its own particular type of information to build up an overall picture.

POSSIBLE TECHNIQUES FOR NON-INTRUSIVE ANALYSIS

X-Ray Methods

7. The use of X-ray methods is one technique considered to be of potential value in enabling a picture to be obtained of the interior of sealed containers such as munitions and bulk storage containers. Comparison of such an X-ray picture of the internal construction of a munition with a data base for other, conventional, munitions or direct observation of the X-ray may enable conclusions to be drawn regarding the likelihood of the particular munition under examination having a chemical fill; the necessary data bank will need to be developed and practical means of carrying out the comparison on site will need to be devised. The simple exercise of taking two X-ray pictures of the same container when inclined at different angles can, for example, reveal a liquid fill by the movement of the meniscus. Use of X-ray methods may, however, also reveal other details of the internal design and construction of such sealed containers in addition to providing information on the possible nature of the fill.

8. Following the first meeting of the TGI the UK has held discussions and observed demonstrations of X-ray methods for non-destructive inspection of materials with experts, including some from manufacturers and suppliers. The conclusions so far drawn are encouraging.

9. Portable equipment is available, although developed for other uses. X-ray equipment designed specifically to support CWC on-site inspections will be readily transportable but may not be man-portable; similar comments apply to gamma radiography (see below). The power and shielding requirements referred to in CD/CW/WP255 do not appear to impose such significant constraints as was anticipated at the time that paper was written.

10. An unexpected finding was that a modification of X-ray methods, using gamma radiography, may well enable information to be obtained on the physical state of the contents of a sealed container and in particular whether it has a 'liquid' fill. This merits further study in order to assess the feasibility and practicality of using X-ray/gamma radiography to deduce the presence of a liquid fill in sealed containers.

11. It is likely that sufficient information is already available to permit the construction, by suitable combination of existing modules, of a demonstration instrument specifically for CWC use once the specific instrument design parameters have been identified. These need to be related directly to the perceived role and concept of use of such an instrument in supporting on-site verification inspections. The definition of the role and detailed concept of use, therefore, needs to be defined and agreed.

Ultra-sonics

12. Some discussions have been held with experts in the field of ultra-sonics and it has been confirmed that ultra-sound could give information on the physical state of the contents of a sealed container. In particular it may well be possible to distinguish between contents that are solids, are powders or are liquid. Information may also be elucidated on particle sizes in the case of powders and on viscosity and density of any liquids present in sealed containers, thus further characterising the

contents. This, however, remains to be demonstrated and will require computer-based advanced signal processing and data analysis techniques.

13. In contrast to X-ray examination the state of the art on ultra-sonics for the support of CWC initiated inspection/verification regimes is less advanced; more research is therefore required before prototype instruments can be designed and constructed.

14. The detailed concept of use and roles for ultra-sonic and X-ray instruments will be very similar; the same basic data should cover both types of instruments.

15. Discussions to date indicate that an ultra-sonic probe designed to support CWC on-site inspections, together with its power source and signal processing/data analysis accessories, will be readily transportable and may possibly be man-portable.

Neutron Activation Analysis

16. This technique cannot give precise structural chemical information but would be able to provide detailed information on the atomic nuclei which are present within a container. The presence of elements such as phosphorus and fluorine (nerve agents), sulphur and chlorine (mustard agent), arsenic (Lewisite) in significant amounts may indicate the presence of compounds which are of particular relevance to a CWC.

17. A number of aspects of this technique require further investigation. For example it is not certain whether the atomic nuclei of particular interest to a CWC can be effectively probed if they are screened by materials which are typically encountered in munitions casings and as storage containers; it may be difficult to recover sufficient gamma ray energy from the activated nuclei through the material of the container. A more complete assessment of the utility of this promising technique for verification purposes requires experimentally based studies.

18. It is clear that neutron activation analysis requires advanced signal and data processing as integral design components. Such components are also likely to enable the technique to generate ratios of selected elements of CW interest, a possibility already noted in CD/CW/WP255. This information, although not as conclusive as analysis of a sample by NMR or IR methods will be as definite as any non-intrusive method can be in evaluating whether the contents of a sealed container are of potential CWC interest.

19. A neutron activation analysis instrument designed specifically for the support of on-site inspections will be transportable but it is doubtful that it will be man-portable. The shielding and power requirements are not now anticipated to exercise such serious constraints as was at one time expected.

20. The need to define precisely the roles and concepts of use, under the inspection regimes of the CWC, for non-intrusive analytical techniques apply equally to neutron activation analysis. Once this and the relevant performance characteristics have been defined design and construction of a prototype instrument intended specifically for CWC use could probably quickly follow completion of the studies referred to above.

CONCLUSIONS

21. The combined use of X-ray or gamma-ray spectrography, ultra-sonic techniques and neutron activation analysis will enable some chemically relevant information to be obtained on the contents of containers without the need to physically remove a sample of the contents for full and unambiguous analysis. The required instruments will be transportable; depending on the detailed requirements the instruments may in some cases even be portable.

22. In total, information will be obtained on the internal structure of the containers, the physical state of the contents (solid, powder or liquid), possibly on the particle size of powders and on the viscosity and density of liquids, on the identity of the atomic nuclei present and possibly on the relative proportions of those nuclei. Such information will be of value to inspection teams carrying out on-site inspections (routine and challenge) under the provisions of the CWC.

23. Non-intrusive analytical techniques cannot give unambiguous information on the detailed chemical identity of the compounds under examination; a judgement will need to be made as to the overall value of such techniques in the light of the other verification technologies available and their applicability to the full range of chemicals of concern to the CWC.

24. The inspection regimes which verification technologies are required to support, and the related concepts of use of the relevant instrumentation, must be more clearly and precisely defined before the design and construction of demonstration/prototype instruments is commenced. Once these inspection regimes and concepts of use have been defined it is likely that construction of prototype X-ray and neutron activation analysis instruments, for field evaluation, could be undertaken relatively quickly with little further research being required; ultra sonic techniques require further research before detailed design and construction of a prototype can be contemplated.

CONFERENCE ON DISARMAMENT

CD/CW/WP.270
18 January 1990

Original: ENGLISH

Ad Hoc Committee on Chemical Weapons

SWITZERLAND

Verification of a Treaty on a Chemical Weapons Ban: Chances and Limits of Process Monitoring */

The verification of non-production of chemical weapons and control of permitted production are key elements of a chemical weapons convention. The purpose of this paper is to show the original role of process monitoring in the chemical production industry and to give an industrial view of the chances and limits of process monitoring under a future Convention on chemical weapons.

PROCESS MONITORING IN CHEMICAL PRODUCTION

Any chemical production process is decisively influenced by mainly two factors:

- Equipment;
- Physical/chemical variables such as:
  - . Flows
  - . Composition of raw materials
  - . Temperature/pressure profiles.

The equipment is normally dedicated to manufacture a specific chemical compound (single-purpose plant) or a certain category of products (multi-purpose plant). Application and suitability of different production facilities are not further investigated here.

The other factors defining the process have to be tightly controlled to ascertain that the desired product is effectively produced with the required quantity. Control in this sense means:

- Act, based on process know-how (= feedforward control; for example predefined sequence of feeding raw materials);

*/ Presented at the Conference on Disarmament: Technical Group on Instrumentation, Geneva, Switzerland, 6 December 1989.

- React, based on observations from the running process (= feedback control; for example stop heating when the temperature is too high).

These observations which are needed for controlling the chemical production process can be called process monitoring.

Besides visual observations there are principally two main groups of measuring techniques:

(a) Measuring devices for physical variables

Instruments for monitoring elementary physical variables such as temperature, pressure, flow and weight are in widespread use. They are present state of technology and their costs range from several hundred dollars to about $10,000.

(b) Measuring devices for concentrations

Contrary to the group (a) instruments, these measuring systems are normally much more complex and require a high level of maintenance. Standard analytical methods were introduced for process monitoring only some 10 years ago. The total investment costs for the the installation of such a process analyser can range up to $200,000.

For these reasons devices to measure concentrations are normally restricted to those cases where they are really needed.

PROCESS MONITORING UNDER A CHEMICAL WEAPONS BAN

Under a chemical weapons ban provisions would be needed to monitor the civil chemical industry to provide confidence that prohibited activities were not undertaken. There are principally two situations where process monitoring could play a helpful role:

1. Production of excessive volume of Schedule 2 chemicals

The aim of this control régime is to verify that quantities produced processed and consumed in declared facilities are consistent with purposes not prohibited by the Convention. Principally this is an inventory problem which has to be solved by standard bookkeeping in combination with flow measurements. Adequate instruments for determining flows and quantities during production and shipment are available today with accuracies better than 1 per cent. However significant attention must be given to different sources of errors, as for example:

- Bypassing of flowmeters;
- Variation in by-products;
- Variation in recycle streams.

2. Production of Schedule 1 chemicals

The aim of this control régime is to confirm that chemicals listed in Schedule 1 are not produced, processed and consumed at declared facilities. This verification task can be fulfilled by two different methods:

- Deviations in the regular production procedure can be detected by recording temperature, pressure and flow profiles, which are unique to a specific reaction. Monitoring large amounts of variables and evaluation with today's methods of computer technology, as for example artificial intelligence or pattern recognition, could be a reasonable procedure to prevent tampering because all measured values have to match in many facets.
  However, this monitoring technique is limited in certain cases as for example the production of phosphorus insecticides, which have very similar production procedures to the corresponding nerve gases.
- Detection of undeclared chemicals listed in Schedules 1 and 2 in the production facilities could be done by analytical methods.
  As mentioned above, corresponding instruments (process analysers) are today in most cases tailor-made, expensive and highly demanding in service. The most promising analytical development which in the future could overcome these problems is near infra-red spectroscopy with fibre optics. The NIR spectrum as a distinct fingerprint of every molecule is a suitable tool for distinguishing different substances. This measuring technique has several advantages as for example simple sensors and its applicability to gases, liquids and solids. However for a widespread use great efforts have to be made in expanding the library of spectra and improving the mathematical tools for evaluation of the spectra (chemometry), which could also be a valuable method to prevent tampering.

CONCLUSIONS

Process monitoring is used as a standard tool in chemical industry to observe and control production processes. Besides the widely used methods for measuring physical variables, there are also process analysers available today for detecting concentrations. However for financial reasons and because of their high demands of maintenance, these instruments are restricted to the most relevant parameters.

The advanced methods of process monitoring in combination with thorough knowledge of the declared production process can theoretically guarantee an effective verification of non-production of chemicals listed in Schedules 1 and 2. However, these high technology instruments are very damageable and intentional or unintentional tampering can never be excluded. Therefore expense and profit of process monitoring under a chemical weapons treaty have to be evaluated very carefully and this strategy would have to be compared with the expense and profit of on-site inspections.

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Ad Hoc Committee on Chemical Weapons

THE NETHERLANDS

The role of military detection and monitoring equipment for the verification of non-production of chemical weapons.

Summary.

The possible role of military chemical weapons detection and monitoring equipment during inspections to verify non-production of Schedule 1 chemicals is discussed. The conclusion is drawn that this type of equipment can have an appropriate role with respect to the detection of the great majority of Schedule 1 chemicals. Additional development may yield dedicated instruments that can be used as preselectors during inspections.

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The Chairman's summary of the meeting of the Technical Group on Instrumentation of July 1989 concluded that military chemical weapons detection and monitoring equipment could not be relied upon as means of verification of non-production of chemical weapons. It might indicate recent production but could also raise false alarms. Moreover, it was not certain whether the sensitivity and specificity of detection equipment was satisfactory.

In this paper we will not debate the validity of the above mentioned arguments in detail, but we would like to point out several advantages of using military chemical weapons detection and monitoring equipment in the verification process of the non-production of chemical weapons.

During a recent trial inspection in the Netherlands, military detection kits proved useful. The inspection consisted of a routine inspection of a Schedule 2 facility and an *ad-hoc* inspection (CD/925). During the latter, water samples were analyzed with the Netherlands military water sampling kit and air samples with the gas reconnaissance kit of the Netherlands armed forces to determine the presence of chemical weapons agents.

Verification in a chemical production facility may lead to a large amount of samples. As a result, the inspection team may have to wait a fairly long time for the results of the analyses and therefore may be unable to react on its findings. In such a case, the use of military chemical weapons detection and monitoring equipment during an inspection may accelerate the process by acting as a qualitative sieve or as a pre-selector. This type of equipment is capable (or should be capable) of detecting, to a significant degree, the present or recent production and storage of a majority of Schedule 1 chemicals.

It is precisely this type of violation of the Convention which requires a fast response by the inspection team. In case of positive detection, there is a fair chance that a violation has taken place. As a consequence the inspection team knows that it should take subsequent samples in a selective and safe way, whereby the necessary safety measures are observed with respect to the transportation of the samples. This does not mean that after a negative result of the detection reaction no samples should be taken, but only to indicate that the inspection team can be guided in their decisions on where to take samples and how many.

Many types of equipment nowadays exist that can perform the tasks described above, including both laborious "wet-chemical" methods and advanced automatic detection and monitoring devices. Military detection and monitoring kits are usually easy and fast to operate, of limited size and weight as well as robust.

Concerning the sensitivity, the Netherlands detection kits used during the trial inspection had the following specifications :
-Gas detection kit: G/V agents (0.002-0.005 mg/m^3), mustard (0.27 mg/m^3), lewisite (3.5 mg/m^3).
-Water testing kit: G/V agents (0.02-0.04 mg/l), mustard (2-4 mg/l), arsenicals (1-2 mg/l).
It is probable that these specifications are adequate to meet the requirements of detecting any present or recent production or storage.

With respect to selectivity and specificity, it goes without saying that a false negative result has, politically and legally, less far-reaching implications than false positive results. As has been stated before, a negative result does not mean that no samples will be taken. Some false positive results will occur as we have observed during the trial inspection. In some cases inorganic chemicals in high concentrations - like hydrogen chloride, sulphur dioxide, nitrogen dioxide, chlorine or ammonia - can interfere with the detection reactions giving rise to similar or different colours as those expected with the target chemicals. In all cases these phenomena could be explained easily.

Most available military detection and monitoring equipment is incapable of detection of all chemicals in Schedule 1. The introduction of additional detection reactions or even new detection technologies could yield dedicated verification instrumentation. If the equipment is used in the way described, i.e. as a qualitative sieve prior to sampling and subsequent identification and quantification, there is no special need for quantitative requirements for detection and monitoring except of course for the detection limits.

Conclusions.

It may be concluded that military detection and monitoring equipment can be helpful during inspections if it is used as a qualitatieve sieve or pre-selector to establish present or recent production and storage of Schedule 1 chemicals. In this way application of the equipment may help to stem the expected large stream of samples.

Dedicated detection and monitoring equipment can be developed starting from military equipment by introducing special requirements with respect to sensitivity and selectivity and by developing additional reactions in order to be able to detect all Schedule 1 chemicals.

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Ad Hoc Committee on Chemical Weapons

REPORT OF THE TECHNICAL GROUP ON INSTRUMENTATION

The Ad Hoc Committee on Chemical Weapons decided on 30 June 1989 to establish a Technical Group on Instrumentation and appointed Dr. Marjatta Rautio of Finland as the chairman of this expert group. The group held meetings on 17 July, from 7 to 9 August and from 4 to 15 December 1989.

The group discussed extensively issues related to
- analytical instrumentation
- process monitoring equipment
- seals, surveillance, containment
- sampling, sample custody and transport of samples
- databases and datatransmission.

Background papers were submitted by the delegations of the Netherlands, Switzerland, the Union of Soviet Socialist Republics, the United Kingdom and the United States. A list of all background papers is included as an annex to this report.

The results of the discussions are presented in this report. The report is divided into three parts. The first part discusses the analytical tasks of the Chemical Weapons Convention and the instruments required to perform these tasks. The second part of the report consists of a technical reading of the current rolling text (CD/952) identifying the verification methods required by the provisions of the rolling text in various sites and discussing the technical aspects of these requirements. The third part is a summary of the conclusions and recommendations as well as the views on the needs for further development of instrumentation.

The first and second parts of the report were approved in the closing session of the group's meetings on 15 December 1989. The third part has been compiled by the chairman of the group.

GE.90-60033

PART I. Analytical Tasks and Instruments

A. Analytical Tasks

The analytical tasks required for the verification of the Chemical Weapons Convention are the following:

- Monitoring of known compounds (compounds included in the schedules 1 and 2 and included in the databases).

- Monitoring of compounds for structure elucidation (compounds not included in the data base)

- Unambiguous identification of compounds (known compounds).

- Structure elucidation (detailed analysis of unknown chemicals).

- Semiquantification.

These tasks can invariably be performed with several types of instruments. The choice of a particular type of instrument in a given situation will depend on a number of factors like requirements for sensitivity and reliability and portability. The suitability of the following instruments for the required analytical tasks was considered in the Group:

- GC = gas chromatograph
- HPLC = high performance liquid chromatograph
- MS = mass spectrometer
- LRMS = low resolution mass spectrometer
- HRMS = high resolution mass spectrometer
- MS/MS = tandem mass spectrometer (any combination of LRMS and HRMS)
- IR = infrared spectrometer
- FTIR = Fourier transform infrared spectrometer
- NMR = nuclear magnetic resonance spectrometer
- GC-MS, GC-FTIR = combinations of instruments

A short description of each type of instruments is included as an annex to this report.

As an illustration of the general suitability and for ease of reference the results of the discussion are also presented in the form of a table (Table 1, page 31).

1. Monitoring of known compounds

This task can be performed with all instruments under consideration. The main requirement is previously recorded identification data on each compound to be monitored under the Convention. The task can be performed both in a mobile laboratory and in an off-site laboratory. At present the high resolution MS, MS/MS and NMR instruments are not available for mobile use.

The aim of the analysis is to identify samples for further confirmatory analysis with sophisticated techniques. Accordingly the positive results of the analysis have to be confirmed.

Possible applications in a mobile laboratory are to

a) reduce the number of samples collected in a theatre of alleged use of CW, or to reduce the number of samples collected during challenge inspections,

b) monitor the absence of Schedule 1 compounds when verifying their non-production in commercial facilities,

c) identify declared compounds in a single small-scale facility.

The most appropriate techniques in a mobile laboratory are:
- low resolution MS, e.g. mobile mass spectrometer
- two-channel gas chromatography with Retention Index Monitoring (RIM)
- HPLC combined with enzymatic analysis for detection of nerve agents (incl. unknown ones) and element specific detection.

In an off-site laboratory monitoring of known compounds can be used for screening analyses if previous screening was not performed on-site, to obtain data to help the choice of the sophisticated techniques. For example, ^{31}P NMR can be used for screening of water samples. MS/MS or HRMS can be used directly

without previous screening of the sample when the sample is expected to be very dilute.

2. Monitoring of compounds for structure elucidation

This task is needed especially in a single small-scale facility to detect Schedule 1 compounds which are not included in the database. It can be applied also in the case of alleged use.

This task can be performed on-site with a gas chromatograph equipped with element specific detectors, like atomic emission detector, which can identify compounds including e.g. phosphorus and fluorine simultaneously. In a designated laboratory this type of analysis can be done with a high resolution mass spectrometer giving the elements included in the molecule. This, of course, may reveal confidential information as is the case with NMR and IR spectra. HPLC with enzymatic detector can be used to identify enzyme inhibitors irrespective of their detailed structure.

The identity of suspicious samples are always confirmed in a designated laboratory.

3. Unambiguous identification of agents

This analytical task can be performed with spectrometric techniques but often a combination including chromatographic techniques (e.g. GC-MS) is needed for sample introduction and separation of components in the sample. Two independent methods giving positive identifications are required.

In this task two different cases are distinguished:

a) Unambiguous identification of compounds for the verification of declared activities such as declarations of stockpiles and declarations of the destruction of them as well as declarations of the production in single small-scale facilities.

When there is plenty of material available the unambiguous identification can be performed in a mobile laboratory, e.g. in stockpiles or in destruction facilities.

A combination of a gas chromatograph used with RIM-capability and coupled either to a mass spectrometer or to an infrared spectrometer was considered sufficiently reliable. If the retention behaviour and either a mass spectrum or an infrared spectrum corresponds to that of a declared compound, the compound is considered as identified. The comparison of retention indexes and spectra with those in the database is satisfactory. If either of the two parameters gives negative result, the sample could be subjected to a detailed analysis in a designated laboratory.

b) Unambiguous identification of compounds for the verification of undeclared activities such as alleged use and challenge inspection situations.

Unambiguous identification of compounds for the verification of undeclared activities requires always confirmatory analyses to be done in a designated laboratory and positive results should be obtained with at least two sophisticated instruments before the chemical is considered identified. The concentration level of the samples would determine the choice of the identification technique. For rather concentrated samples (10μ g/ml) either LREI/CIMS + GC-FTIR and NMR 1H, 13C, 31P and 19F can be used. For diluted samples MS/MS or HRMS and GC-MI-FTIR must be applied.

4. Structure elucidation of unknown compounds

Combined use of all spectrometric and chromatographic techniques as well as use of instrumental databases are required. Structure elucidation must always be carried out in an off-site laboratory.

5. Semiquantification

In verification activities semiquantification is needed to tell only the percentage of the compound in the sample. Various techniques can be used for these determinations.

The best suited techniques are gas and liquid chromatography in relatively pure sample matrices. If there is background, MS coupled to a GC is required. In complex background cases either the GC is used in a two-stage mode or the MS has to be HRMS or MS/MS. 13C NMR and 31 P NMR are suitable for concentrated formulates of agents.

B. Specific requirements of the analytical instruments

The specific requirements depend on the analytical tasks and on the concentrations of compounds in the samples. It was felt that there is no need to make a detailed study of the general or specific requirements for following reasons:

- at present the available analytical instrumentation offers to the inspectors a variety of options with which all the analytical tasks can be fulfilled,

- the instruments are being developed at a rapid pace which will automatically lead to enhanced performance, ease of operation and smaller size (portability/transportability).

Often the most important aspect is not the instrument itself but the combination of instruments available and the ways they are used. This emphasizes the importance of agreed standard operating procedures.

The standard operating procedures must be based on interlaboratory comparison tests. These tests can also be used by the Technical Secretariat for the selection of designated laboratories which will be entrusted to perform off-site analyses and other tasks given by the Technical Secretariat and under its supervision and quality control.

Sensitivity is necessary when non-production (Schedule 1), undeclared activities, or alleged use, are being investigated. Environmental samples require often high sensitivity. In these cases it is important to use the most sensitive techniques. Of these MS/MS, HRMS with specific ionization modes and GC-MI-FTIR can be used only in off-site laboratories.

Sensitivity is less important in the verification of declared activities since there is normally sufficient quantities of the compound available. Universal detectors in GC and HPLC suffice and all spectrometric techniques including NMR are applicable.

Reliability is always important. But again, specific requirements differ depending on the task, whether the task is to verify declared or undeclared activity.

For instruments to be used on-site portability/transportability is a very important requirement. The set-up time and ease of calibration after transportation also become important.

Structure elucidation requires powerful instruments to enable speedy results. HRMS, IR an high field NMR are the most important instruments for this task. Instruments required for structure elucidation are also suitable for research purposes, e.g. preparation of databases.

C. Reference Standards

In order to secure the general uniformity and reliability of the analyses performed by the inspectors the need to have internationally agreed and validated operating procedures, data bases and reference standards was stressed.

1. Standards used for basic tuning of the instruments

These standards are normally provided by the manufacturers of the instruments e.g. perfluorokerosene for MS, ethylbenzene for NMR and polystyrene for dispersive IR.

2. Sensitivity tests

Sensitivity tests with spectrometric techniques are part of the normal basic tuning procedures. For chromatographic techniques they have to be performed for each detector type by including a specific compound for each detector type in the sensitivity test mixture.

3. Testing of instruments after basic tuning (calibration)

The testing can be performed with non-toxic calibration standards which resemble CW agents. The test mixture should reflect the difficulties each technique has with certain agents e.g. VX. When a combination of GC and spectrometric techniques are used the combination of instrumentation as a whole should be tested with the same test mixture. [1)]

1) Calibration of instruments is a technically critical issue which should be done by the inspectors themselves.

4. Chemical warfare agents

The chemical warfare agents are needed as reference compounds to ascertain identifications in cases when reference spectra in the database are not considered reliable enough. Thus, authentic compounds certified by the Technical Secretariat should be available for the inspection teams and laboratories. [1) 2)]

Main use of agents is as reference standards to ascertain the analyses when there is obvious need for such analysis, e.g. ion intensity variations in mass spectra recorded in tandem mode. On the other hand, use of the analytical database as a reference should be enough in case of spectrometric verification of declared activities.[3)]

5. Standards for semiquantification

Quantitative analyses on-site during inspection seldom require accurate quantification. Accordingly, agents can be quantified against accurately diluted calibration standards and e.g. using phosphorus-containing compounds as references for nerve agents. Gas chromatographic quantifications should be done with FI-detector.

6. Validated spectra in the database

The spectra included in the database should be obtained by using internationally agreed and validated standard operating procedures using validated authentic compounds. The validations should be done by the Technical Secretariat.

7. Reference laboratory

The preparation of the reference compounds (calibration compounds and authentic agents and databases) to be used by the inspectors and off-site laboratories is a critical issue which will affect the universal confidence on the results obtained. Thus this activity should be controlled by the Technical Secretariat. This can be achieved by concentrating these tasks to a laboratory owned by the TS or to laboratories designated and supervised by the TS.[2)]

1) Toxin standards may pose difficulties as they often are mixtures of closely related compounds especially macromolecular toxins.

2) At present the rolling text does not include a provision which allows the synthesis and transfers of CW agents for reference purposes by the TS or by a designated laboratory.

3) Toxins may require other analytical techniques than those referred to in this paper.

D. Non-destructive interrogative characterization of munitions

The aim of this technique is to characterize munitions into subgroups by providing interrogative information of the internal structure of the munition and the type of their fill. This grouping is used to diminish the number of samples to be analyzed on-site in the storages for the verification of the initial declarations.

Non-destructive methods for determining interior features of chemical weapons fall in three categories, radiographic imaging, neutron activation and ultrasonics.

For radiographic imaging, radiation sources are energetic x-rays and gamma-rays and imaging techniques range from film to high resolution reuseable matrices. The methods are established and reveal interior structure.

Neutron activation of chemical components within a round results in the emission of prompt and delayed radiation that provides a variety of signatures for atomic species in the fill. One method focuses on gamma-rays emitted at the moment of neutron capture rather than at a later time during radioactive decay of daughter nuclei. It has certain advantages over conventional analysis in efficient utilization of neutrons and greater suitability for in situ measurements in uncertain geometries. Some imaging capability also can be realized since low and intermediate Z elements produce distinct gamma ray emission signatures when promptly activated by 14 MeV neutrons. Identification and quantitation are obtained by measuring neutron time of flight and 3D images can be obtained even under conditions of one-sided access. Also, the elements in chemical weapons have absorption signatures in the energy range from 0.1 to 10.0 MeV.

There are two promising methods for ultra sonic interrogation of chemical munitions. Pulse-echo techniques are highly directional and require both optimum placement and acoustic coupling of transducers to indicate the physical state of the contents of a chemical round. Resonance ultrasound spectroscopy measures all elastic modulii of a solid body from a single swept frequency determination. The unique acoustic signature of an object is useful in assessing the similarity of objects and is four to six orders of magnitude better than state of the art measurements of structure and composition. Given an appropriate data base from munition types verified by chemical analysis, all subsequent measurements could be performed rapidly and non-destructively with minimum hazard.

None of the non-destructive methods have been qualified for chemical weapon verification and development is required. However, the advantages of non-destructive methods in reducing hazard and possibly accelerating the verification process, make a development effort important. Issues to be explored include tradeoffs of cost, chemical hazard, speed and convenience of measurement, the possibility of inducing detonation of rounds, portability and accuracy.

E. Need for and use of mobile laboratory facilities

The concept of a mobile laboratory may be replaced by a concept based on a series of separate instrumental modules, individually portable or transportable, from which the inspection team can select that combination of modules which is appropriate to the specific requirements of each individual inspection. The modules could also include a sampling/sample packaging module and protection equipment. The increasing miniaturization of analytical instrumentation also supports this concept of modular instrumentation for on-site inspections. Thus the concept of a mobile laboratory may now be redundant, or become redundant in the very near future. The maximum combination of modules required to support any on-site inspection is very likely to be more readily transportable than a fully equipped, general purpose mobile laboratory.

Examples of available instruments for different targets.

1) For the inspection of declared stockpiles the analytical equipment must allow unambiguous identification of Schedule 1 compounds: either GC-MS or GC-FTIR.

2) For single small-scale facilities the equipment may include a two-channel GC equipped with element-specific detector and used in combination with enzymatic detection.

3) GC-MS or GC-FTIR, or both, may be needed in the CW destruction facility in case the instrumentation at the facility does not meet the requirements of the inspectors. These instruments may also be installed at the facility for the whole period of the destruction.

4) Two possibilities are envisaged in the verification of alleged use:

a) The minimum requirement is to have equipment for sample collection and detection of the best places to collect the samples (military type detection equipment [1]).

b) If feasible, analytical equipment could be brought on-site for preliminary identification of the schedule 1 chemicals to facilitate selection of laboratories for unambiguous identification and transportation of samples. This equipment would require own electricity supply unless the base camp can be established at a site where electricity is available.

5) In ad hoc verification activities an instrument capable of quick identification of schedule 1 compounds would be required. Here a mobile mass spectrometer used in ion monitoring mode but allowing immediate scanning of a spectrum would be the best alternative.

6) In challenge inspections the instruments should be as sensitive and reliable as possible. The future development of mass spectrometry (ion trap detector) may lead to mobile MS/MS. This development trend is promising. Further development should be stimulated, especially the miniaturization of the instruments.

F. Process monitoring

The purpose of process monitoring in chemical industry is to have good control over the process to allow the industry to operate optimally, to provide quality control of the products and to protect the environment.

The physical variables such as temperature, pressure, weight and flow can be controlled very accurately. Chemical variables include e.g. raw materials. These variables have to be tightly controlled to ensure that the desired product is effectively produced in a required quantity. This requires also adjustment of process parameters if needed during production.

1) Military detection equipment will also be necessary for the safety reasons of the inspectors

The objective of process monitoring for verification purposes differs from that of production. In verification the objective is to provide confidence that prohibited activities are not undertaken. The aim e.g. in permitted schedule 2 e production is to verify that quantities produced are consistent with the needs not prohibited by the Convention, that no Schedule 2 chemicals are being diverted to illegal purposes, and that no Schedule 1 chemicals are being produced.

From the process monitoring side information for verification of the production quantity may be obtained by monitoring flow or weight. Accurate instruments for those purposes are available, but they may not suffice alone for verification.

Verification of non-production of prohibited chemicals can be achieved in two ways. First, by monitoring many physical variables simultaneously to get a signature of the process, or by incorporating composition indicating instruments in-line with the production equipment.At present near infrared (NIR) spectrometry with fiber-optics seems to be the one of the promising in-line analyzers. It gives a fingerprint on every chemical. The drawback is the need for frequent maintenance, lack of library spectra and tools for data evaluation. On-line analyzers, e.g. those based on chromatography are too prone to malfunctions in the absence of maintenance personnel. The greatest problem with this type of process monitoring is the potential loss of confidential business information, unless the instruments are specially designed to limit the information extracted from this type of monitoring.

Another approach to the verification of non-production is continuous sampling and analysis of the samples later during on-site inspections. This method could be combined with continuous monitoring of flow for quantity determination. To be reliable, continuous sampling requires stability of components from the time of sampletaking up to analysis. This requirement has been shown to be fulfilled with a prototype of a sampling equipment where the sample is inserted onto a magnetic tape. During inspection, the sample can be desorbed by heating the tape and the vaporized chemicals analyzed with a mass spectrometer.

This technique preserves the confidentiality, if the memory of the mass spectrometer includes only those chemicals under the Convention, as it does not identify other production, thus protecting confidential business information.

All these techniques need further research, development and testing to develop the proper combination of instruments and inspectors for effective verification.

The objective of monitoring of the process of chemical agents' destruction is to verify that chemical weapons really are being destroyed. It is one of the key issues of the CWC. Use of monitoring instruments is easier since continuous presence of inspectors is envisaged during the whole active destruction phase. Accordingly, process gas chromatographs can be applied to process monitoring.

The quantities can be verified by counting and weighing the munitions and storage tanks before and after draining. The identity can be verified by the chromatographic and spectrometric methods. The readings from the monitoring equipment may be certified by taking samples and analyzing them with a mass spectrometer or an infrared spectrometer.

G. Seals, surveillance and containment

Tags, seals, containment and surveillance techniques supporting the requirements of the international atomic energy agency (IAEA) have been developed and tested by a number of laboratories as a component of their IAEA support programs. Because the IAEA requirements that encouraged system development are similar to those of the chemical weapons convention (CW) but have technical differences, adaptation will be required. In some cases expense and the enormous size and dispersion of the collective chemical stockpiles may make the systems impractical for CWC requirements. Nonetheless, they provide point of departure for development of tags, seals, containment and surveillance equipment crucial for a verification of chemical weapons disarmament. These systems have been exhaustively tested, rigorously challenged for counterfeiting and spoofability, reliability over protracted, unattended periods and have been turned over to commercial interests for manufacture and supply in quantity. Thus their adaptation to CWC needs can be accomplished at substantial savings in development costs to the Technical Secretariat and/or cooperating states parties.

The unequivocal permanent identification of declared chemical weapons stockpiles and production facilities is a critical first step in verification of the eventual destruction of chemical munitions and manufacturing capability. On-site inspection requires tagging of declared items either as individual units or groups of items as appropriate. The identity of the units and the groups must be

preserved. Furthermore, sealing of storage and production facilities and preservation of identity during transportation from storage to destruction is needed.

Tags preserve the verified identity of declared items for authentication from application when the treaty goes into effect through until destruction. Even the simplest tags require time to apply, are manpower intensive and because of the size of the stockpiles, require an enormous data base. A candidate system employs a paint with reflective particles in random orientation that can be uniquely identified by an inexpensive reader. The tag is sufficiently difficult to characterize and a counterfeiting methods are understood well enough to ensure integrity. The statistical strategy for stockpile tagging may be accomplished by either passive or active electronic identification. Even after tagging a substantial effort would be required to construct and implement an accounting and inventory control system for maintaining an updated databasis. These methods also indicate tampering and in the case of the active systems can communicate intrusion attempts in real time to a remote location.

Seals, containment and surveillance measures exploit natural boundaries such as walls or pipes, and afford continuity of knowledge by optical surveillance or motion detection either with or without communication. The principal applications are to provide unattended assurance of stockpile integrity by recording movement and by insuring the integrity of other analytical systems of the inspectorate. Closed circuit video systems are capable either of operating unattended for protracted periods with subsequent review of recorded "snapshots" of a protected scene or of remote image transmission. Portable units with similar but shorter operation capabilities, fiberoptic seals and data authentication systems also are available for the protection of aggregate stockpile or production units.

H. Sampling and transportation of samples

Different views were expressed on the desirability of the inspectors performing sampling. General agreement, however, prevailed that in cases of alleged use environmental samples have to be collected by the inspectors.

Detailed instructions concerning the packaging of the samples whenever they are transported should be given by the Technical Secretariat.

Samples taken to designated laboratories should be carefully coded for doubleblind analysis.

Transportation of samples is a serious problem and should be address at an early stage. ICAO and civil airlines are applying stringent rules on transportation of potentially hazardous chemicals. Crashproof containers will have to be developed and tested before they are approved for air transportation. It is certain that the required standards will be very high indeed. Preliminary high level contacts between CD, UN Dangerous Goods Panel and ICAO could prove advantageous already at present.

Unbroken chain of custody during sample transportation should be maintained.

I. Training

The sophisticated instrumentation and other technical aspects of the verification of CWC require highly qualified inspectors and other personnel. The specialization needed can only be achieved through extensive training schemes matched to meet the professional qualifications which are still to be defined.

J. Data Bases and Information Systems

The Chemical Weapons Convention will require the collection, processing and evaluation of large amounts of information. Data need not only be collected and assessed by the Technical Secretariat but they must also be available for use by the inspectors. The verification process will continue throughout the lifetime of the Convention and will require the establishment and operation of a complex information system with an extensive data base.

Data will be generated during the declaration phase of the Convention as well as during the confirmation stage and the lifetime of the Convention. Examples of sources of data are the state parties, the facility operators, the inspectors, the analytical instruments, the process monitoring equipment, and the containment and surveillance devices. The forms of data would range from photographs and schematic diagrams to images, accounting information, process control variables, spectral information and outputs of analytical instruments.

These data must be collected, validated, recorded, processed and analyzed. Therefore, there is a need for developing systems which integrate data sources,

communications and computers into a complete information processing system. Part of this information processing system must be operational at the time or soon after the Convention enters into force, because the current rolling text envisions that confirmation of declarations must be done within a relatively short time from the time of the declaration. Therefore, a reliable information processing system must be in place well before the entry into force of the Convention.

Once the Convention is established there will be a need for the Technical Secretariat to have access to information generated at the declared facilities and to deliver information to the facilities from the central data base of the Technical Secretariat. Information at the facilities may be generated by the inspectors, the facility operators or the sensors located at these facilities. Information to the facilities may be transmitted during the inspection or during the operation of an automated monitoring system. There might be circumstances requiring the transmission and processing of information within short periods of time such as minutes or hours. Examples are the request by inspectors during inspection for particular spectral characteristics, or the remote surveillance of an unusual activity in a storage facility. In cases involving the examination and analysis of schematic diagrams the time intervals involved may be measured in the order of weeks or months. Therefore, the information processing system must not only link the declared facilities with the Technical Secretariat but it must also have adequate communications and computational capabilities to serve the needs of the verification system.

At this time detailed characteristics of the information processing system cannot be established. These characteristics depend on the number, type and geographical distribution of the declared facilities, and on the verification procedures adopted for these facilities and for any other activities in the domain of the Convention. However, some general specifications may be identified. The system should have a hierachical structure with a computational capability distributed between the locations of the Technical Secretariat and declared facilities. The sensors, analytical instruments, communications equipment and computers should be tamper-indicating to ensure the security and reliability of the information. The confidentiality requirements should be taken into account. Depending on the timeliness requirements of the verification procedures the information processing system might utilize couriers, mail, data networks, telephone links or satellite channels.

There is still the unanswered question of the mixture of and interplay with the inspectors and the instrumented component of the monitoring system. This question involves not only the technical specifications of the information processing system but also the optimization of the combination of inspectors and instruments to maximize the effectiveness of the verification system.

At this time the information processing technology is at a high state of development. However, it is unclear how this technology can best be utilized in verifying a chemical weapons Convention. Since a component of the information processing system must have been designed and functioning when the Convention enters into force and since the specifications of the system depend on the verification procedures, there is a need for research and development programs to develop illustrative verification procedures applicable to different classes of facilities and activities and also to begin investigating the structure and operational characteristics of the information processing system as well as the size, content and structure of the date base associated with such a system.

PART II TREATY REQUIREMENTS AND OPTIONS AVAILABLE AT DIFFERENT TARGETS

The contents of this chapter are summarized in the Table 2 on page 32.

A. Declared storage facilities

The purpose of the verification in storage facilities is "to confirm ... the accuracy of the declarations made (by States Parties)". The inspectors "shall verify the quantity and identity of chemicals ...". (CD/952, page 76)

1. Sampling and analysis

(i) Sampling

The main problem in the verification of the accuracy of the declarations concerning the stocks stems from the fact that the number of munitions is very large.

The problems connected with sampling can be reduced by using non-destructive non-intrusive instrumental techniques (so called interrogation techniques). This will, however, also reduce the level of assurance. The extent of this reduction would depend on the combination of sampling and interrogation that is applied. Mathematically sound and statistically valid methods can be used for calculation of confidence levels achieved by different numbers of ramdomly selected munitions taken for sampling.

To illustrate the options available the following five possibilities can be presented:

1) Sampling of every munition
2) Sampling of statistically determined representative number of each type of munitions
3) Combination of non-destructive interrogation techniques and sampling of fewer statistically determined number of munitions of each type
4) Relying entirely on non-destructive interrogation techniques
5) Identifying the agent only by looking at and counting the munitions without any sampling.

The confidence levels attained by these options vary as does the complexity and sophistication of the associated technical requirements. The technical demands and confidence level of option 1 would be the highest whilst those of option 5 would be the lowest.

At present there are several interrogation techniques in the developmental phase and their potential remains to be proved. The most adequate techniques have to be tested singly and in combinations to find the most reliable and cost-effective way of using them. Testing should be combined with analytical method development of the same munitions to demonstrate good collaboration between the two types of techniques. Also, the miniaturization of these instruments is required to allow their use in a mobile laboratory.

If CW agents are in bulk containers the problems described above are reduced.

(ii) Monitoring of known compounds

The monitoring of known compounds is performed to identify the declared chemicals in the storage facilities. The analytical techniques used for this purpose are GC-IR or GC-MS. The IR could be used without preseparation of compounds with GC if background information were collected and a multivariate analysis were established and validated allowing the identification of agents in mixtures.

(iii) Unambiguous identification

GC-IR, GC-LRMS instruments or IR with multivariate analysis can be used for unambiguous identification by comparing the spectra with authenticated spectra in the database of the instrument. The choice of the technique will be made on the basis of the declared chemicals.

(iv) Semiquantification

Semiquantification is obtained using the instruments mentioned in paras (ii) and (iii). For quantitative reference standards, authenticated standards other than chemical agents could be used (see reference standards above) to reduce the need to transport agent standards.

In addition to analytical methods: surveillance and containment (S/C), data reporting (DR) and presence (PR) of inspectors is foreseen between the initial visit and activation of the S/C equipment.

2. Seals, surveillance and containment

The required equipment - tamper indicating seals, tags, videosystems, sensors and data authentication means - exist. Some adaptation for the purposes of the CWC may be needed. However, systems for particular storage facilities can only be planned and built when detailed information is available on the sites concerned.

The large number of individual items in a storage facility may cause a time related problem if individual marking of each item will be required.

At present systems allowing rapid transmission of data and images as well as for query and response system are commercially available. However, they have not been used for verification purposes and thus require further studies for this application. These systems use either terrestrial or satellite networks.

3. Hardware (non-chemical parts for chemical munitions or specialized equipment for CW employment).

Initial declarations of the hardware will be verified by S/C methods (see above) and data reporting.

B. Declared CW-production facilities (art. V)

The rolling text foresees (CD 952. p. 95) verification of declared production facilities by

- on-site inspections
- seals and other S/C equipment
- data reporting and
- presence of inspectors between initial visits and activation of S/C equipment and whenever continuous monitoring with instruments is not feasible.

The purpose of the on-site visits is: "to confirm that all activity has ceased" and "to confirm the accuracy of the declarations".

1. Sampling and analysis

At present there are two different views on the necessity to verify the declarations by sampling and analysis:

1. Sampling and analysis is not necessary since the results of the analysis do not change anything; the facility will be destroyed in all cases. Difficult situation might arise if no signs of former production, ceased e.g. 20 years ago, could be found. The declarations may thus remain unverified.

2. Verification of the declarations can only be done by analytical methods including unambiguous identification of the compounds.

If sampling and analysis would be considered necessary, monitoring of known chemicals could be used to detect the chemicals, and unambiguous identification would be required. If undeclared chemicals were to be found, their structures have to be elucidated. Analysis for the degradation products could be feasible even a long time after the production has ceased.

It was felt that the analytical facilities may be poor or non-existent at the facility. A mobile laboratory could be brought on-site for rapid results. On the other hand, production that has ceased long ago may be difficult to unambiguously identify on-site.

The samples might be very diluted and accordingly, analyses should be made in accredited laboratories with the most sophisticated techniques (HRMS, MS/MS, GC-MI-FTIR).

The same diversity of views was expressed on the need for sampling and analysis in the filling facilities which are not directly connected to any production facility.

2. Process monitoring

Although the current rolling test (CD/952 p. 91, para B.2) states that process control equipment should be closed down as part of the cessation of the production process, it might be noted that continued function and recording of some process control instruments in conjunction with any other tamper indicating

process monitoring equipment may contribute useful information to verification that the process has not only been stopped but has not been resumed.

3. Seals, surveillance, containment

Verification of the inactive status of CW production facilities is a key item. This can be done by using both process monitoring instruments and S/C equipment. Detailed planning can be done only when detailed information exists about the facilities and on the methods used for deactivation.

The required S/C equipment - tamper indicating seals, tags, videosystems, sensors and data authentication means - exist. Also systems for rapid data and image transmission as well as for query and response system are commercially available. Further studies on their applicability for CWC verification purposes are needed.

C. Chemical weapons destruction facilities[1]

1. Sampling and analysis

The group considered it very important that the initial declarations are verified at the destruction facilities irrespective of their verification at the storage site. For this purpose the inspectors may use the instruments of the destruction facility or bring with them their own equipment if they deem it necessary. The instruments will be tested and fully validated by the inspectors using Secretariat validated standards.

Monitoring of known chemicals is performed to verify chemicals and mixtures of chemicals in formulates. The most appropriate techniques are GC-MS, GC-FTIR and IR with multivariate software package. The selection of instruments is made on the basis of the initial declarations.

1) The Group noted that some aspects of the current rolling text (p. 84-86) which have technical implications need attention and possibly clarifications. This include i.a. the following:
- the terms "system of verification" (para 3 c, p. 84) and "proposed measures for verification" and their interrelationship,
- the fact that some destruction facilities will already be in operation by the time the Convention enters into force and the implications this may have on the initial declarations and to their operation during the immediate period after coming into force,
- the rolling text states (para 7e, page 86, CD/952) that the inspectors shall "bring with them and use such agreed instruments as may be necessary for the completion of their tasks" and that "samples will be taken and analyzed by

One spectrometric technique is sufficient for unambiguous identification if the result fully corresponds to that in the database spectrum. GC-MS, GC-FTIR or IR with multivariate software package can be used for this purpose.

Semiquantification can also be performed with the same instruments.

The same instruments can be used to analyse any samples collected in the destruction facilities, be they from munitions, destruction process or from destruction products although they may need to be supplemented with other techniques such as ion chromatography.

2. Process monitoring

It is likely that agent destruction method combinations may not be the same in all countries wishing to destroy chemical weapons. Therefore the type and amount of process control information is going to vary from country to country.

Although the inspectors will endeavour to use to maximum effect information available from the process control it is likely that they need to use monitoring instruments.

The foreseen destruction methods are direct incineration and detoxification before incineration. In the latter case incineration of the detoxified agent must also be verified.

Mass balance in the destruction facility could be determined by the number and weigth of the fill of the munitions and the storage tanks and the weight and composition of destruction products. All the munitions are counted and weighed before and after draining.

3. Seals, surveillance and containment

The most important role of the S/C equipment in the destruction facilities is in monitoring the inactive status of the facility (including the possible storage facility connected with it) whenever it is not in active operation.

In addition, it may be necessary to use monitoring devices at some key points of the destruction process such as weighing and counting of munitions and sample taking even when the facility is in use and the inspectors are present.

The required S/C equipment - tamper indicating seals, tags, videosystems, sensors and data authentication means - exist. Also systems for rapid data and image transmission as well as for query and response system are commercially available. Further studies on their applicability for CWC verification purposes are needed.

D. Destruction of CW production facilities

The destruction of CW production facilities will be monitored by S/C equipment, data reporting and continuous presence of inspectors during the destruction phase.

the S/C systems in use during the period between the inactivation and the beginning of the destruction phase can be applied, as necessary (see above p. 22).

E. Permitted Production (art. VI)

1. Single small-scale facility

It was agreed that the problems of inspection at verification of single small scale facilities were very considerable because the range and nature of the activities, together with the multipurpose role of the facilities, would make each facility unique. It was considered therefore, that the inspection regime, including on-site instrumental methods as well as sampling for off-site analysis, should be adapted to the specific features of each facility by the Technical Secretariat as a result of discussions with the State Party during the initial visit of the inspectors, and included in the facility agreement.

The aim of verification (CD/952, p. 106, II/1,4) is "to verify that the quantities of schedule 1 chemicals are correctly declared and, in particular, that their aggregate amount does not exceed one metric tonne". During the initial visit the purpose is "to verify information provided concerning the facility". Sample taking and analysis is envisaged in the model for an agreement relating to single small scale facilities (CD/952, p. 178, 7).

(i) Sampling and analysis

For accurate verification of the declarations all analytical tasks - monitoring of known compounds, monitoring of compounds for structure elucidation, unambiguous identification, structure elucidation and semiquantification - may have to be performed. To achieve this the following instruments can be used:

- two-channel GC with retention index monitoring, GC-MS or GC-FTIR for monitoring of known chemicals,

- GC equipped with element specific detection, e.g. atomic emission spectrometry for monitoring of compounds for structure elucidation,

- GC-MS or GC-FTIR for unambiguous identification,

- HRMS, FTIR and NMR for structure elucidation. This cannot be done on-site.

- Any of the above instruments for semiquantification.

However, the appropriate methods may be determined in the facility agreements according to the tasks involved, including the off-site analysis.

(ii) Process monitoring

The rolling text provides for the possibility for process monitoring. The need to use it should be decided individually for each facility and be agreed in the facility agreement as the nature of the facilities may differ considerably.

Continuous monitoring can also be achieved by controlling variables not directly connected with the process, such as the water supply and electricity, to reveal intensive production.

If there will be 100 litre reactors, continuous monitoring of the reactors may be considered necessary. For the smaller reactors the possibility for frequent rearrangement of the configuration makes process monitoring very complicated and easily circumvented.

(iii) Seals, surveillance and containment

The need for and the details of the use of seals, surveillance and containment equipment should also be decided on the basis of the initial visit. Especially in the cases where the facility has no reactors larger than 10 litres the surveillance and containment methods seem to be of limited use. Instead the inspectors might be present during the synthesis of agents.

2. Facilities producing schedule 1 chemicals in aggregate amounts less than 10 kg

The verification aim is to verify that "the facility is not used to produce any chemical listed in schedule 1, except for the declared chemical", that "the quantities of the chemical... produced, processed or consumed are correctly declared and consistent with the needs for the declared purpose" and that "the chemical... is not diverted or used for other purposes". (CD/952, page 108, II).

For reasons mentioned in connection with the single small scale facility the details of the inspection activities should be developed by the Technical Secretariat after the initial visit individually for each facility.

The analytical tasks and instrumentation needed is identical with the single small scale facilities.

Also the issues related to process monitoring and the use of seals, surveillance and containment equipment are identical with those in the single small scale facilities.

3. Schedule 2 A and B production

The verification aim in Schedule 2 facilities is to verify that Schedule 1 compounds are not produced, that the quantities of Schedule 2 compounds produced, processed or consumed are consistent with needs for purposes not prohibited and that Schedule 2 compounds are not diverted or used for prohibited purposes (CD/952, page 113, para 4).

(i) Sampling and analysis

Schedule 2 chemicals will be declared and the declared facilities will be monitored for the absence of those chemicals which can be produced from the Schedule 2 chemicals produced in the facility.

Identification data of Schedule 2 compounds will be added to the analytical data base which will also include data from the corresponding Schedule 1 compounds.

The analytical task will be to monitor known compounds. This can be performed with two-channel gas chromatography equipped with retention index monitoring capability. Gas chromatography with selective detectors may detect also compounds which are not in the database but whose presence might need clarification from the facility representatives. Enzymatic detection could be used in combination to detect the presence of enzyme inhibitors, also of unknown structure. A mobile mass spectrometer could also be used whose database whould contain the spectra of only those compounds under the Convention. These methods are used to find out these samples which require further analysis in accredited laboratories. On-site analysis is the principal choice. Only when necessary the samples are transferred off-site. Those samples are analyzed in a designated laboratory with at least two different sophisticated techniques which will be chosen on the basis of the concentration of the samples.

There may be a role for the detection equipment to be used in the verification of non-production. Further development is, however, needed.

(ii) Process monitoring

Combination of process monitoring instruments and in-line analytical instruments such as fibre-optic near infrared or on-line sampling instruments might be applicable in an automatic process monitoring system. Further studies are needed to show the feasibility of using automated process monitoring systems for verification purposes.

At present stage of development of process monitoring instruments those measuring physical variables are accurate enough to be used for that purpose but may not alone suffice for verification purposes.

Combined use of those techniques gives the fingerprint of the process which is confidential business information that the Technical Secretariat must appropriately protect. This information could be evaluated with the aid of artificial intelligence and pattern recognition techniques.

If the chemical warfare agents could be produced with similar production processes in suboptimal process conditions process monitoring equipment may not be sufficient to detect such production. The facility may also change the production parameters of its processes which further complicates data evaluation. Flow could, however, be monitored and perhaps with the instruments of the facility.

One of suitable techniques for detection of undeclared chemicals is near infrared spectrometry with fibre optics. This simple instrument gives fingerprints of every molecule. It is applicable to gases, liquids and solids. At present its use for verification purposes is restricted by the demand for frequent maintenance, limited library spectra and tools for data evaluation. Of these limiting factors the maintenance is the most difficult to solve.

Continuous sampling and the analysis of the samples during on-site visits is a promising alternative approach. Although it requires further development the time-frame for this development may prove to be sufficient for application when the Convention enters into force. The magnetic tape "sample-now-analyse-later" -system allows for an evaluation at an appropriate and minimized intrusion level. It also seems to be suitable for preserving samples long enough to allow inspections including retrospections once or twice a year. The tamper resistance and suitability for industrial environments must be tested.

4. Schedule 3 production

Only data reporting is envisaged on the rolling test for the verification of the production of Schedule 3 chemicals.

F. Alleged use

The main task on-site is to find the best samples to be brought to designated laboratories for detailed analysis. Military detection equipment can be used for this purpose. If it is possible to bring on-site a mobile laboratory, it could be used to screen the best samples, to preliminarily identify the agents, and evaluate their concentration in the samples to facilitate transport. The analytical methods could be: mobile mass spectrometer and GC-RIM with enzymatic detection. GC-FTIR may not be sensitive enough. If GC with selective detectors is available, compounds can be screened for further analysis and the concentration evaluated and the samples sent immediately to two laboratories capable of performing the analyses.

In the designated laboratories the most reliable spectrometric instruments have to be used. The requirements for the instruments depend on the concentration level in the samples. In trace analysis of environmental samples only HRMS, MS/MS and GC-MI-FTIR are reliable enough.

Quantification is required only if naturally occuring toxins are found in the sample to evaluate whether their existence in the sample is due to natural sources.

Packaging, coding and transport problems described above (pages 14-15) are acute in cases of alleged use. Commercially available portable equipment for sample taking and packaging is applicable but needs further study. The transport procedures may need lengthy negotiations for resolution.

G. Transfers

1. From storage facilities to destruction facilities

Inspectors shall be present when chemical weapons are removed from the storage facility and shall verify that the CW on the inventory are loaded on to the transport vehicles. They will seal the cargo and the seals will be verified at the arrival to the destruction facility.

It remains to be decided whether there is a need to track the cargo at all times during the transport. The technology for constructing such a system is available using satellite technology.

2. Permitted uses

It cannot be excluded that inspectors may be present during the transport of chemicals from single small scale facilities to the site where the chemicals are needed.

In the rolling text the verification of transport of schedule 2 and 3 chemicals is covered by data reporting.

The special case not covered by the rolling text is the foreseen need to transport standard reference samples of chemical agents by the inspectors during on-site inspections and to analytical laboratories.

H. Challenge inspections

The detailed provision for challenge inspections are still under negotiation.

The analytical requirements for challenge inspection cannot be foreseen in detail since they will depend on the specific circumstances. However, it seems to be a fair assumption that the analytical tasks discussed in part one of this report and referred to in table 1, will also cover the needs in connection with the challenge inspections. Similarly, it is likely that the range of instrumental options already available to inspectors will also be adequate for challenge inspection. Sampling is likely to be a primary requirement since the specific circumstances associated with a challenge inspection are highly likely to necessitate the provision of the most rigorous analytical proof practicable. This will also require the use of the most sensitive and reliable instrumentation available both for use on-site and in designated laboratories. The situation is analogous in many respects to the rigorous level of proof required with respect to allegations of use. The continuous development of the instruments and their miniaturization will increase the possiblity to meet the most rigorous requirements.

Analytical and instrumental techniques cannot be relied upon to discover activities which will lead to launching of challenge inspections.

TABLE 1. Analytical tasks and required instruments

Instruments / Tasks	GC	HPLC	MS			IR	NMR
			LR	HR	MS/MS		
Monitoring of known compounds	x	x	x	x	x	x	x
Monitoring of compounds for structure elucidation	x [1]	x[1,2]		x[1]		x	x
Unambiguous identification [3]			x	x	x	x	x
Structure elucidation			x	x	x	x	x
Semiquantification	x	x	x	x	x	x	x
Mobile laboratory	x	x	x			x	
Off-site laboratory	x	x	x	x	x	x	x

[1] element specific detection
[2] enzymatic detector for inhibitors
[3] two of the techniques required

TABLE 2. Treaty requirements, options available for different targets

	Detection	Analysis					PC	S/C	DR	PR
		M1	M2	ID	SE	QU				
Declared stocks										
Agents		x		x		x		x	x	x
Hardware								x	x	
Declared Facilities (Art.V)										
Production		x		x	x		x	x	x	x
Destruction										
Stocks		x		x		x	x	x	x	x
Facilities								x	x	x
Permitted Product (Art. VI)										
Single ssf		x	x	x	x	x	x	x	x	x
less than 10 kg		x	x	x	x	x	x	x	x	x
Schedule 2		x		x			x		x	x
Schedule 3									x	
Alleged use	x	x	x	x	x	x				
Movement										
Destruction[2]								x	x	x
Permitted									x	x

[1] Monitoring of Sch. 1 chemicals

[2] Analysis possible before and after movement

M1 - Monitoring of known compounds

M2 - Monitoring of compounds for structure elucidation

ID - Unambiguous identification

SE - Structure elucidation

QU - Semiquantification

PC - Process control

S/C - Surveillance/containment

DR - Data reporting

PR - Presence of inspectors (permanent or during the process)

Part III

CONCLUSIONS, RECOMMENDATIONS AND NEEDS FOR FURTHER DEVELOPMENT

Analytical instrumentation

There was a general agreement that the stage of development of analytical instrumentation currently available to the inspectors meets the requirements set by the Convention. All analytical tasks, 1) monitoring of known compounds, 2) monitoring of compounds for structure elucidation, 3) unambiguous identification of compounds, 4) structure elucidation of unknown chemicals, and 5) semiquantification, can be fulfilled. At present the most demanding analytical tasks can be performed in an off-site laboratory.

The need for mobile instrumentation was stressed partly because it reduces the need to transfer toxic samples and partly because of the need to preserve confidential information. At present instruments exist that can be used for unambiguous identification of CW agents during on-site inspections to verify declared activities.

Further development is needed in the miniaturization of even the most sophisticated techniques which will facilitate to resolve difficult problems even on-site e.g. during challenge inspections. This development trend is promising and should be stimulated.

Toxins may require other analytical techniques than those discussed during the meeting (see Annex on instruments).

Analytical and instrumental techniques cannot be relied upon to discover activities which will lead to launching of challenge inspections.

Process monitoring

Monitoring of destruction

There was a general agreement that the destruction process has to be monitored with on-site instruments. This is feasible as inspectors are continuoulsy present and can react to instrument malfunction. Information obtained from the process equipment of the facility can be used for verification purposes. This may be supplemented by the instruments of the Inspectorate. Samples may also be taken for spectrometric analysis on-site. Further development of spectrometric techniques not requiring previous separation of components might be advantageous.

Monitoring of Production of Schedule 2A and 2B chemicals

Process monitoring in facilities producing precursor chemicals is difficult due to confidentiality reasons and non-presence of inspectors to maintain the instruments.

Verification of non-production could be achieved by monitoring many physical process variables simultaneously, or by incorporating composition indicating instruments in-line with the production equipment. Accurate instruments for measuring physical variables are available, but they may not alone suffice for verification.

Some instrumental developments can be foreseen. Near infrared spectrometry with fibre optics is one possibility but further development in needed. Research is required to record library spectra of all relevant compounds and to create tools for data evaluation. Extensive research is also required to diminish the need for frequent maintenance of the instrument.

Use of continuous sampling equipment and analysis later during on-site inspections is another approach to verification of non-production. The sampling system based on magnetic tape seems promising but requires further research and testing especially of the tamper-resistance and

reliability, and functioning in an industrial environment. This research should be stimulated as the time-frame for this development may prove sufficient for application when the Convention enters into force.

Further studies are needed to show the feasibility of using automated process monitoring systems for verification purposes.

Seals, surveillance and containment

Tags, seals, containment and surveillance techniques have been developed and rigorously tested to meet e.g. the IAEA requirements. The systems are commercially available but need adaptation to CWC purposes. In some cases expense and the enormous size and dispersion of the collective chemical stockpiles may make the system impractical.

Data transmission systems and system for tracking the cargo at all times are commercially available but have not been used for verification purposes. Further work to establish their applicability is needed.

Sampling, packaging, sample custody, and transport

Commercially available portable equipment for sampletaking and packaging exist but need further study. Samples taken to designated laboratories should be carefully coded for doubleblind analysis. The importance of the chain of custody was clearly expressed. The difficulties in the transport of samples was recognized. The group considered it worthwhile that high level contacts be established with appropriate organizations in the near future.

Interrogation techniques

Non-destructive interrogation techniques were considered worth further studying in order to reduce the number of munitions in the storages which have to be opened for samling. Extensive development is

required. The methods have to be tested together with analytical methods to establish their relevance to the verification.

Reference laboratory and reference samples

The Group identified the need for authentic reference samples of chemical warfare agents to be used by the inspectors and designated verification laboratories. The preparation of the reference compounds is a critical issue which will affect the universal confidence of the results obtained. Thus this activity should be controlled by the Technical Secretariat. This can be achieved by concentrating the task to a laboratory owned by the TS or to laboratories designated and supervised by the TS. The present rolling text does not allow the synthesis and transfers of CW agents for reference purposes. Toxin standards may pose difficulties as they often are mixtures of closely related compounds, especially macromolecular toxins.

Calibration of instruments is a technically critical issue which should be done by the inspectors themselves. This can be performed with non-toxic calibration standards.

In order to secure the general uniformity and reliability of analyses performed by the inspectors the need to also have internationally agreed and validated operating procedures and databases was stressed.

Databases

Database requirements will be varied and numerous. Since a component of the information processing system must have been designed and functioning when the Convention enters into force and since the specifications of the system depend on the verification procedures, there is a need for research and development programs to develop illustrative verification procedures and also to begin investigating the structure and operational characteristics of the information processing system as well as the size, content, and structure of the database associated with such a system.

Validation of the analytical data and standard operating procedures should be done by the Technical Secretariat.

Detection equipment

The use of military detection equipment is important especially in finding the best samples in case of alleged use. Their use will be necessay also for the safety reasons of the inspectors. The use of the equipment in verification of non-production needs further research and development which should be stimulated.

Training

The sophisticated instrumentation and other technical aspects of the verification of CWC require highly qualified inspectors and other personnel. The specialization needed can only be achieved through extensive training schemes matched to meet the professional qualifications which are still to be defined.

ANNEX 1

BACKGROUND PAPERS

The following background papers were presented in the Technical Group on Instrumentation. If the paper has been later on presented as an official working paper of the Conference on Disarmament its reference number is mentioned in brackets.

United Kingdom: Analytical Techniques for a Chemical Weapons Convention (CD/CW/WP.255, 9 August 1989)

The Netherlands: The role of military detection and monitoring equipment during inspections on verification of non-production of CW agents (30 November 1989) (CD/CW/WP.271, January 1990)

The Netherlands: Analytical chemical results of the second trial inspection on verification of non-production of chemical warfare agents in a civil chemical industry in the Netherlands (June 1989)

USSR: Organization of monitoring of chemical weapons destruction facilities (6 December 1989)

United Kingdom: Instrumental approaches to non-intrusive analytical techniques for inspection and verification (November 1989) (CD/CW/WP.269, 12 January 1990)

The United States: Demilitarization and disposal of U.S. chemical warfare agent and munitions (CD/CW/WP.265, 11 December 1989)

The United States: Sample preparation, preservation, security and transportation under the Chemical Weapons Convention (CD/CW/WP.266, 11 December 1989)

The United States: The use of instruments in chemical process monitoring or demilitarization of chemical weapons (CD/CW/WP. 267, 11 December 1989)

The United States: Use of a satellite network for collection of data from facilities (CD/CW/WP. 268, 13 December 1989)

Switzerland: Verification of a treaty on chemical weapons ban - chances and limits of process monitoring (CD/CW/WP.270, January 1990).

ANNEX 2

ANNEX ON INSTRUMENTS

This Annex provides general descriptions of the major instrumental methods of chemical analysis which have been referred to in the main part of the Report. All of these techniques are now available with integrated computer-controlled operation and with dedicated computer-based data storage, data manipulation and information display capabilities. The integration of the basic instrumental methods with microcomputers and advanced information display techniques has increased the utility and versatility of the instrumental techniques very greatly. These comments apply to all the instrumental techniques described in this Annex and will, therefore, not be repeated under each Section.

Gas Chromatography

Gas chromatography (GC) is primarily a method of separating a mixture of volatile compounds into the individual components by partitioning the mixture between a liquid stationary phase and a flowing gas stream, usually at elevated temperatures. The nature of the stationary phase, and the temperature programme used, both of which can be varied, are the major factors which affect the effectiveness of separation of the components of the mixture. A variety of different detectors can be used to detect the individual components as they emerge from the chromatographic column.

Although GC was developed primarily as a means of separating complex mixtures into their individual components, continued development of the technique now enables it to fulfil additional functions. For example, by using detectors which are specific, or relatively specific, for certain atoms, the presence of chemicals containing those atoms can be demonstrated by GC techniques; examples are the atomic emission detector (AED, for individual elements), thermoionic detector (NPD, for phosphorus and nitrogen), flame photometric detectors (FPD, for sulphur and phosphorus), the electron capture detector (ECD, for halogen atoms) and the flame ionization detector (FID, for carbon/hydrogen/oxygen compounds). The detectors now used are very sensitive, detection limits frequently being at the picogram level.

GC is not intrinsically an identification technique but when the same sample is separately analysed under a variety of different chromatographic conditions

(different detectors, different chromatographic columns, different temperature programmes etc.), and samples of authenticated reference compounds are analysed under the identical conditions, then repeated coincidence of chromatographic peaks can be used to give a very high probability of compound identification. This technique, based on retention index monitoring (RIM) is of particular value when the presence of one particular compound out of a limited number of possible compounds is suspected as being present; this might well be the case, for example, in many inspection/verfication situations.

GC can also be used to determine the quantity of any one component present in a mixture. This is achieved by comparing peak areas of individual peaks in the chromatogram with those of authentic reference standards at a range of similar concentrations.

Finally, in this Section, mention must be made of the very powerful analytical methods resulting from the interfacing of GC with such advanced chemical identification techniques as Mass Spectrometry and more recently with Fourier Transform Infra-Red Spectrometry. These combined techniques now comprise the most powerful and most sophisticated instruments available to analytical chemists for the analysis and identification of components in mixtures, for the identification and analysis of a single compound (or relatively few compounds) in a complex matrix and for determining the purity and authenticity of a single compound.

High Performance Liquid Chromatography

High performance liquid chromatography (HPLC), like GC, is primarily a method of separating mixtures of compounds into the individual components. However, since the separations are carried out at ambient temperature using liquid eluents rather than a flowing gas stream, HPLC is particularly well suited to the analysis of thermally labile or non-volatile compounds. The separation is achieved by partition of the mixture between a stationary phase, supported in a column, and a flowing liquid eluent. The nature of the supported phase and of the eluent (which can be varied very widely and may include mixed solvents) control the separation which can be achieved. In contrast to GC only a relatively limited number of detection techniques are available for the detection of the chromatographic peaks as they are eluted from the column; probably the most commonly used detector uses UV/visible spectrometry although other detectors are available. As with GC, this technique is now being

interfaced with mass spectrometry and the combination is a very powerful identification/analytical technique. Detection levels using conventional detectors are at the nanogram level or less but with the mass sepctrometry system much lower levels are achieved. Enzyme inhibitors can be detected at the picogram level with an enzymatic detection system.

Although originally devised as a separation technique the continued development of HPLC now enables it to be used for tests of purity on reference compounds, for quantitative measurements using peak areas as described for GC, for identification of known compounds as for GC (provided an authenticated reference sample of the compound in question is available) and for the analysis of individual compounds in complex matrices. In many respects HPLC has capabilities analogous to those of GC provided the limitations presented by the more limited range of detectors is borne in mind and the fact that it utilises liquid eluents at ambient temperature rather than a gas stream at elevated temperatures.

Mass Spectrometry

Mass spectrometry is a very powerful analytical technique which is used for
a) the elucidation of the structure of unknown compounds;
b) the positive identification of known compounds;
c) the monitoring of known compounds; and
d) the measurement of known compounds at trace levels.

The principle of mass spectrometry relies on the ionisation of the material to be analysed. The sample is introduced, directly or by an appropriate indirect technique such as GC, into the ionisation region of the instrument where it is ionised by any one of a variety of ionisation techniques, such as electron ionization (EI) or chemical ionization (CI); the parent ion fragments in a controlled manner to give a characteristic pattern of fragment ions which travel through the analyzer in which the ions are sorted out on the basis of their mass to charge ratio. The ion current collected for each ion is a measure of the amount of the ion present, and the amount of the parent substance to be measured.

The structure elucidation of unknown compounds almost invariably requires the use of sophisticated high resolution mass spectrometers giving the elemental composition of the ions. Daughter- and parent ion spectra can be obtained by tandem mass spectrometry by collision activation (MS/MS) or by linked scan

techniques. The spectra give information on the fragmentation of molecules, characteristic of the structure.

The identification of known compounds is usually achieved by comparison of the measured spectrum with the spectrum of an authentic fully validated reference sample of the presumed compound, obtained under the same conditions; this comparison of spectra is now normally carried out by computerized search of a data base of stored reference spectra and direct computer-based comparison of the spectra.

The monitoring of known compounds can be carried out by using various techniques, the one selected for any one analysis being dependent on the sensitivity and selectivity required, the particular compound under study, the particular matrix of concern and the possible presence of other compounds. Selected ion monitoring (SIM) is a very selective technique especially when a high resolution instrument is used to monitor the effluent of the chromatograph. In specific reaction monitoring one or several fragmentation reactions of a selected molecule is monitored. Analytical limits can range from the picogram to the femtogram level, depending on the instrumental conditions used, which may include variations in the methods of ionising the sample.

The measurement of trace levels of known compounds can be carried out by the same techniques as used for the monitoring of known compounds.

As mentioned previously, mass spectrometers are now commonly interfaced with GC to give an extremely powerful integrated analytical system referred to as gas chromatography/mass spectrometry (GC-MS) in which the mass spectrum can be separately measured on each of the components separated from a mixture by the GC part of the integrated instrument. Considerable progress is now being made in the simplification of such integrated systems, with reduction in size, weight and cost. This principle of integrating a chromatographic separation technique with mass spectrometry is now being extended to include high performance liquid chromatography to give an integrated liquid chromatography/mass spectrometry (LC-MS) system. Although this has not yet progressed as far as with GC-MS the evolution of integrated LC-MS systems is likely to follow a similar route to GC-MS.

Infra-red Spectroscopy

Infra-red (IR) spectroscopy is based on the principle that the various structural features of a molecule will each absorb infra-red radiation at quite precisely defined frequencies which are characteristic of the particular structural features. In practice the sample (which may be a solid, liquid, solution or vapour) in a suitable form is irradiated with broad-band infra-red radiation and the amount of radiation absorbed at various frequencies (or more usually the derived wavelengths or wavenumbers) is measured. The output is an IR spectrum in which absorbtion is plotted as a function of wavelength (or wavenumber); this IR spectrum is quite characteristic of the compound under investigation and no other compound will have a completely identical spectrum. A recent major advance in IR spectroscopy is the development of Fourier Transform (FT) infra-red spectroscopy, commonly abbreviated FTIR. The Fourier Transform technique is basically a mathematical means of manipulating the signal, which is in the form of an interferogram, so that all the energy recoverable from the sample is actually utilised in the generation of the signal. This has the following two immediate practical advantages:

a) By utilising all of the recoverable energy the time taken to measure a spectrum is greatly reduced, typically from about five minutes on a dispersion instrument down to one second on a FTIR instrument, so the measurement is much more rapid.

b) Utilising the total recoverable energy from the sample also improves the sensitivity compared with a dispersion instrument. This improvement is typically of the order of 50 times for scan times of about one second but can be further improved if longer scan times, involving a larger number of FT accumulations, are used; with scan times of one hour sensitivities, in favourable cases, in the nanogram range can be obtained.

IR spectroscopy (and FTIR) is an excellent technique for confirming the identity of known compounds when either an authenticated reference sample of the same material is available for a comparison spectrum to be measured; alternatively the measured spectrum may be compared directly with an authenticated reference spectrum previously measured on a fully authenticated sample and which may be available for comparison purposes either as hard copy or, more frequently now, on a computerised data base.

IR spectroscopy alone can rarely give unambiguous full structure elucidation on unknown compounds except in very favourable cases, but when used in conjunction with techniques such as Nuclear Magnetic Resonance (NMR) and Mass Spectrometry it can provide very useful structural data particularly on the functional groups present in an unknown compound the structure of which needs to be elucidated.

Due to the very rapid scan times available with FTIR it is now possible, as with mass spectrometry, to integrate FTIR with chromatographic separation techniques such as gas chromatography. Complex mixtures can then be resolved into their individual components by the chromatographic technique and as the separated components emerge as peaks from the chronomatographic column they are scanned by the FTIR to produce an IR spectrum of that particular component free from any interference by the other components of the mixture. Such an integrated GC-FTIR instrument makes use of both of the particular advantages of FTIR namely rapid scan times and increased sensitivity. Further increase in sensitivity is obtained if the eluting peaks can be frozen onto the cold surface enabling extended scan times. High resolution obtained with the matric isolation technique furher lowers the detection limit to picogram level.

Nuclear Magnetig Resonance (NMR) Spectroscopy

NMR spectroscopy is a technique which uses a radio frequency field to interrogate the interactions of a powerful applied magnetic field with the local magnetic environments within molecules containing particular atomic nuclei (for example ^{1}H, ^{31}P, ^{19}F and ^{13}C). The technique yields spectra which, by appropriate skilled interpretation, can yield very detailed information on the way in which the various atoms in the molecule are linked to each other and on their relative dispositions in 3-dimensional space. Although the original continuous wave instruments are being largely displaced by Fourier Transform Instruments (FTNMR) the latter, although having much shorter scan times, still do not by any means have the sensitivity achieved by either mass spectrometry of FTIR techniques.

NMR spectroscopy is well suited to the identification of known compounds; the identifications can be confirmed either by comparison of the measured spectrum with the spectrum, measured under identical conditions, of an authentic sample of the same compound or by comparison of the spectrum with an authenticated reference spectrum either as hard copy or in a computerised data bank of NMR spectra. It is also an important technique for the validation and authentication

of compounds prepared by synthesis but which, prior to NMR analysis, have a presumed and not proven structure.

NMR is one of the two instrumental techniques (the other being mass spectrometry) now universally used for the elucidation of the structures of unknown compounds. Indeed, along with mass spectrometry, it ranks well ahead of any other techniques such as IR for this application.

Although NMR can be used, as can IR, for quantitative analysis its relative lack of sensitivity compared with mass spectrometry or gas chromatography for example, limits its applications in this role and it is not a preferred general method of quantitative analysis except in special circumstances.

Super Critical Fluid Chromatography (SCFC)

This is a chromatographic separation technique, in many respects resembling both GC and HPLC. Is is described as the last item in this Annex because, although it is a rapidly evolving technique, unlike GC and HPLC it is not yet a mature instrumental method. The working fluid is a gas which is used under a pressure sufficiently high to take it past its critical point at the working temperature. As with HPLC the technique has a high resolving power and will readily separate complex mixtures into their individual components; in some respects it is superior to HPLC for separation of some mixtures. However, as with GC, a relatively wide range of detectors can be used with SCFC, thus overcoming one of the disadvantages associated with HPLC. The technique has been integrated into a single system with mass spectrometry, and also with FTIR.

The mature technique will be capable of an identification role when used under a variety of experimental chromatographic conditions with authentic reference samples with the compounds of interest; it will also be capable of quantitiative analysis with high levels of sensitivity being achievable. In act, the mature technique will have many of the characteristics of GC and HPLC, with some specific advantages, and is likely to take its place alongside GC and HPLC as a standard instrumental technique of considerable versatility and utility.

ANNEX 3

Chairman's Preliminary Summary of the Discussions held on 7-8 August 1989

The Technical Group on Instrumentation started its work by considering locations for which verification provisions have been elaborated by discussing the various analytical tasks at these locations. It was suggested that the group work out recommendations for procedures involving instrumental aspects of the verification.

The United Kingdom tabled a background paper (since tabled as WP.255) on analytical/interrogation techniques for a CWC which formed an important pool of information and was partly used as a basis for the discussions.

1. Detection equipment

It was felt that there was only a limited role for military detection equipment in verifying the CWC. Analytical identification methods have to be used for the verification and the role of detection equipment is only complementary. The most important role of detection equipment is to guide sample collection especially during investigations of alleged use. It was suggested that the group could recommend the preferred types of equipment. This requires national information on available techniques.

2. Sampling equipment

It was suggested that the sampling equipment be provided by the inspected facility and be described in the facility attachment. The exceptions will be equipment needed during inspections of alleged use and closed production facilities. The inspectors could use their air sampling systems during various types of inspections. More information will be needed on sampling equipment used at stockpiles and destruction facilities (USA and USSR promised background papers on this item for the next meeting of the group). The group appreciated seeing a videotape on a French sampling equipment which is commercially available. In cases where sampling is too hazardous, the use of non-intrusive (non-destructive) interrogation techniques should be considered.

3. Instrumentation of a mobile laboratory

Mobile laboratories could be used for on-site analyses to verify declarations of stockpiles, destruction at the destruction facilitites, and production in a single small-scale facility. The laboratories could also be used for preliminary screening of Schedule 1 chemicals during inspections to verify non-production and, perhaps, in cases of alleged use, to reduce the number of samples to be transported to an off-site laboratory.

In case a mobile laboratory is used to verify declarations of stockpiles, destruction, and production in a single small-scale facility, the laboratory should be equipped in a manner allowing handling of extremely toxic substances. The analytical task is to unambiguously identify declared compounds.

The following instruments (for unambiguous identification) which could be assembled in a mobile laboratory using the present stage of technology are: a gas chromatograph - mass spectrometer (GC-MS) and a gas chromatograph-Fourier transform infrared spectrometer (GC-FTIR). The gas chromatograph is essential in both combinations to separate the agents from impurities and additives. The instruments or the laboratory must be equipped with a database including all chemicals which have to be identified. Verification of the production in a single small-scale facility needs further consideration.

Use of both the above techniques to verify non-production may cause considerable difficulties to States Parties as confidential information may be revealed. For this purpose it might be appropriate to use techniques which enable only monitoring of compounds listed in Schedules 1, 2, and 3. In case suspect samples are found, the monitoring result must be confirmed in an off-site laboratory. The criteria for suspect samples need further consideration. The possible instruments could be a two-channel gas chromatograph with retention index monitoring capability and a mobile mass spectrometer the database of which includes only those compounds relevant to the Convention.

Views were expressed that the instruments of the inspectors are preferred over those of the State Party (facility).

4. Off-site laboratory

The level of sophistication of instruments in an off-site laboratory depends on the types of samples expected to be analyzed and the analytical task, either routine or research-oriented, identification of known compounds or structure elucidation of unknown compounds. Analysis of samples from strockpiles, destruction facilities and single small-scale facilities does not require highly sophisticated instrumentation because of the high concentration of compounds expected in the samples. Samples collected in cases of alleged use or challenge inspections to other targets may require selectivity and sensitivity achievable only with the most sophisticated instrumentation presently available.

The most important analytical methods will be mass spectrometry (MS), Fourier transform infrared spectrometry (FTIR) and nuclear magentic resonance spectrometry (NMR). Chromatographic techniques such as gas chromatography, liquid chromatography and, for the future, supercritical fluid chromatography, are used for preliminary screening and for on-line separation of agents from matrix compounds. At least two spectrometric techniques, preferably three, are required for unambiguous identification. It is preferred to use a combination of MS and FTIR over MS/MS and high resolution MS.

The experts considered the presently available instrumentation for an off-site laboratory to be of the state of the art for the chemicals listed in Schedules 1, 2, and 3. Novel agents may require new types of instrumentation. The difficulty is to recognize that a chemical is a novel agent.

The analytical instruments were considered to be the same regardless of the type of inspection, whether routine or challenge. The analysis request may be to monitor known compounds, to confirm preliminary identifications, and for structure elucidation of unknown compounds.

The group considered not to be necessary to go into more details of the off-site equipment, e.g. to various instrument types on the market or to more details of the techniques which could be used with each instrument type.

The final proof of the identity is always obtained from the analysis of authentic compounds which highlights the need for fully validated and authenticated reference compounds.

Calibration of the equipment needs further consideration. Transportation of samples to an off-site laboratory requires careful consideration as will clarification of some administrative and legal aspects. It was suggested that the group dealing with hazardous substances could be contacted as well as the legal experts and the experts of IATA to find a solution to air transportation.

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