

CONFIDENTIAL

REPORT OF THE SECOND MEETING OF THE AD HOC
GROUP OF SCIENTIFIC EXPERTS TO CONSIDER
INTERNATIONAL COOPERATIVE MEASURES TO
DETECT AND TO IDENTIFY SEISMIC EVENTS

Geneva, 21-25 February 1977

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INTRODUCTION

This report provides an account of the second meeting of the CCD - sponsored Ad Hoc Group of scientific experts to consider international cooperative measures to detect and identify seismic events, held in Geneva 21-25 February, 1977. The outline of the report follows the agenda of the meeting and is intended to give to the reader a summary of the discussions that took place. Where possible, personal observations are made, particularly on matters that affect Canadian technical contributions to the Ad Hoc Group and any eventual technical implications for Canada should international cooperative measures be put into effect. A discussion of the relevance of statements made in formal meetings of the CCD in recent weeks will not be attempted, as appropriate interpretations are better made by officials of the Department of External Affairs. However, for the information of EMR officials, a copy of the 22 February 1977 USSR Draft CTB Treaty is included among the documents accompanying this report.

Attached to this report is a list of relevant documentation which includes Conference Room Papers from the second meeting, Conference Room Paper No. 4 from the first meeting (August 1976) giving the provisional table of contents to the final report of the Ad Hoc Group, draft chapters and informal working papers reviewed during the second meeting, and some miscellaneous documents which include suggestions for work leading to the third meeting, working papers and the draft USSR CTB treaty.

REVIEW OF DRAFT CHAPTERS

2d. Review of earlier relevant studies

This draft was prepared solely by Varghese (India) with no assistance from the other two in his drafting group, Hjelme (Denmark) and Caputo (Italy). Filson (USA) and Thirlaway (UK) assisted greatly by providing Varghese with copies of the various reports of earlier studies. Varghese was commended on having written an excellent first draft.

The principal comments on the draft were: i) it did not contain summaries of relevant studies made by the Soviet Union; Passetchnik (USSR) will provide some monographs that will be summarized in the next draft; and ii) the section on "Conclusions and Follow-up" did not contain adequate reference to countries to whom the various statements are attributed; specific references will be included in the next draft. A number of other minor corrections will also be made in the next draft.

3a. Data and procedures for detection and location of seismic events by a network of seismological array and single stations

This draft was viewed in Ottawa prior to the meeting as inadequate, and there was general agreement that it should be re-written. Specific suggestions included the following. It should be more explicit on how seismic events are detected and located and it should be more understandable to non-specialists. It should describe how to effectively utilize arrays and small numbers of stations and the contributions that can be made by local stations. It should describe the

value of a good geographical distribution of stations. It should describe how data are gathered and used, and how re-reading can improve the phase detections after a first pass. It should contain a comprehensive treatment of depth estimation. It should describe appropriate Earth models and the value of regional travel-time corrections.

3b. Data and procedures for obtaining identification parameters of seismic events at individual stations

This, combined with section 3c, had the greatest amount of material contributed prior to the meeting, with draft chapters by Filson (USA) and informal working papers by Canada, Finland, Norway, Sweden and the UK, and discussion occupied much of the Monday p.m. and Tuesday p.m. sessions.

The discussion centered around the number of "levels" in the acquisition of identification data at the stations. In detail the discussion moved back and forth between i) there was too much data in "level 1" and many stations would be overloaded with work (expressed, e.g., by Japan) and ii) there was not enough data in "level 1" to allow accumulation of large amounts of identification data at an early stage in the data exchange process (expressed, e.g., by Sweden). Much of the discussion was non-productive because no distinction was being made between the simple acquisition of identification, data, i.e., the different stages at which the data would be extracted at a station, and the levels or stages of its application to the identification of seismic events.

There has not yet been any formal discussion in the Group of section 6c "Procedures to be used at data centres for the detection and location of seismic events, for the collation and reduction of identification parameters and for dissemination of these data". Therefore much of the discussion reflected individual conceptions of how data would be employed at data centres. It was not until Tuesday that intervention by the Chairman and by Filson, convenor of the drafting group for this section, steered the discussion back to identification data that it would be desirable to have, and there was a fairly rapid consensus that all of the data described in the various submissions for this section would be desirable at some stage in the identification process.

As described later in this report, section 6c will be drafted for discussion at the next meeting. There are indications that the Canadian suggestion of a general three step procedure for identification may have the general support of the group. The key item is, of course, the responsibility for final decisions on the nature of a seismic event resting with the national agencies. A Soviet intervention during a later discussion of existing data centres made it quite clear that, should one of the eventual cooperative centres be in the Soviet Union, the process of event identification would be undertaken by "national technical means, taking advantage of additional data made available by international exchange" (my paraphrasing of a poor Russian - English translation). There is no doubt that the

U.S. position will be for purely national decisions on the nature of seismic events. The U.K. position is similar. The Swedes will admit the same in private discussions, but in more formal statements press hard for extensive collection of identification data at cooperative centres. Some of the expressed positions, particularly by Finland and Norway, leave the impression that seismic verification would be achieved by a super data centre undertaking detailed digital analysis with all available data. One has the impression that they have not thought clearly through to the final practicalities of seismic verification.

There was one point raised by the Swedish experts in the meeting, and in more detail in private discussions, that concerns the question of "standard discriminants" and "reference populations" as described in the Canadian submission (letter Basham to Filson, January 4, 1977). There has, as yet, been no discussion of what total geographical areas would be of interest to participants in international cooperation, but the total area could be quite large, e.g., all continental areas except Antarctica. After location and depth screening there would be large numbers of events remaining, most from areas that have no reference populations for standard discriminants. The Swedish procedure is to routinely compute discrimination parameters for all events (with sufficient signal-to-noise ratio) in order to build experience with reference earthquake populations in all regions. Referring to the Canadian submission on earthquake screening, this

would not cause any difficulty for $M_s:m_b$ because the basic magnitude data would be contributed under step 1, and the cooperative centre would presumably be computing appropriate magnitudes which, in themselves, produce the reference populations. With respect to P wave discriminants, however, this would entail computation of, e.g., time domain and spectral parameters for larger numbers of events, but without computation of a discriminant that relates these parameters to reference populations. When, and if, the time comes for Canada to make a commitment to international data exchange for this purpose, we will have to ask ourselves if we are willing to provide routine analysis of only those seismic events that interest us, and for which we have assembled reference populations, or if we are willing to commit resources to the routine computation of parameters of seismic events in areas of general interest to other countries.

3c. Data and procedures for obtaining identification parameters of seismic events from networks of stations.

After the confusion and lengthy discussion of section 3b, it was decided that the network procedures could not be distinguished, at this point in the work of the Group, from the sum of the individual station procedures, and requirements for this section would be discussed after achieving an agreed draft for section 6c.

4a, b. Technical description of existing stations of potential interest for the network; data produced at these stations and present station capabilities

The Canadian delegation was commended for its efforts in compiling the summary tables of station information. Basham briefly introduced the Informal Working Paper containing these tables, which will form the principal part of sections 4a, b. He emphasized that the Ad Hoc Group is still at the stage of accumulating information on a relatively large number of stations of potential interest, and that a global network cannot be selected until a reasonable geographical coverage has been achieved.

Information on United States and Danish stations was available at the beginning of the meeting. Schneider (GDR) opened the discussion by offering for inclusion the description of the Moxa station. Information on this station had been received in response to the request for station information, but the accompanying letter had indicated it was for personal information and not for inclusion, at that time, in the Ad Hoc Group list of stations.

The general concensus that was distilled by English - speaking experts from a number of statements by Passetchnik (U.S.S.R), which suffered from poor Russian - English translation, was the following. The Soviet Union will provide, a list of Soviet stations "by the time of the next meeting" of the Ad Hoc Group. Stations will be selected from the Soviet network that will make the best (in their view) contribution to a global network. The stations may (this was not clear) include

some that can provide digital data for international exchange purposes. If agreement is reached on a CTB, "cooperation will be expanded", which has been interpreted to mean that data from these stations would be provided to cooperative centres.

There was a general discussion of the need to receive information on additional stations, particularly from Africa and South America. The general view was that this might be best achieved by asking for station information from all CCD countries that have not yet contributed. This was officially requested in the Ad Hoc Group progress report to the CCD (Conference Room Paper No. 18).

There was a lengthy discussion of the need to report noise and detection statistics for all stations in a standard way as this information is essential in the next step of selecting the stations of the global network and undertaking a calculation of network detection and location capabilities. The discussion ranged widely from a suggestion by Husebye (Norway) that everyone undertake detailed computer calculations of noise, to a suggestion by Filson (U.S.A.) that everyone send copies of seismograms to Basham who would undertake a series of standard noise measurements. Filson's half-serious suggestion was an attempt to extract some sample seismograms from the U.S.S.R. Unfortunately for Filson, but fortunately for Basham, Passetchnik (U.S.S.R.) suggested that this would be much too great a load to put on Basham.

There was no resolution of this problem of standardization of noise and detection data. It was left that each expert would reconsider the noise and detection data available

for his stations and consider submitting additional information that might be adapted to the standard representation of station capabilities required for the network capability calculations. Husebye (Norway), in private discussion, indicated he would undertake an analysis of detection statistics of all Ad Hoc Group stations on the basis of their P wave reporting to the International Seismological Centre.

The Swedish delegation introduced, and the Group accepted with minor changes, a series of brief guidelines for the selection of a global network based upon existing and planned stations (Conference Room Paper No. 15). What can be expected by the time of the next meeting is described in a later section of this report.

5a. Description of existing data exchange facilities

Submissions prior to the meeting included descriptions of the World Meteorological Organization Global Telecommunications System by Suyehiro (Japan), of the United States ARPANET by Filson (U.S.A.) and of other data exchange systems by Harjes (FRG). There was not a large amount of discussions of these facilities as the draft sections are intended simply as background information on existing facilities. The more significant discussion will come at the next meeting when the Group will review draft section 5c, "Timescale, data format, and data channels to be used for the monitoring network".

The ARPANET is clearly the most sophisticated inter-computer communications network, which will continue to be

used as a research tool within the U.S.A. and as a seismic data link to Norway and the U.K. The U.S.A. cannot, at this time, commit ARPANET to the work of the Ad Hoc Group and any conceivable extension of it to provide truly Global data communications would be out of the question because of the enormous cost.

It is claimed that the WMO GTS has ample space for seismic data (time and amplitude data, but not digital waveforms), and it may be an inexpensive method of transmitting "level 1" seismic data to and from cooperative centres. However, there has as yet been no comparison of the actual space available on GTS, with the actual volume of seismic data that may be required for effective international data exchange; and it is possible that the volume may be underestimated at the present time.

Commercial telex and, perhaps, telecopy are existing systems that could be used more extensively for international exchange. Not included in the report on other data exchange systems, but discussed briefly at the meeting, was the use being made at present, e.g., by Canada, of dialed telephone links to transfer data between computers. Thirlaway (U.K.) noted that with the installation of appropriate modems costing a few thousand dollars, dialed telephone computer links could be extended to an essentially world-wide basis.

6a. Description of existing data centres

Five existing data centres are described in the draft of this section:

ISC International Seismological Centre (U.K.)

NEIS National Earthquake Information Service (U.S.A.)

EMSC European-Mediterranean Seismological Centre (France)

SDAC Seismic Data Analysis Centre (U.S.A.)

BDAC Blacknest Data Analysis Centre (U.K.)

The ISC is the only centre with broad and formal international support, and is financially supported by 33 agencies in 32 countries; the Canadian contribution is from the Department of Energy, Mines and Resources. NEIS and EMSC are national centres with strong international links, providing a fast epicentre service on a world-wide and European-Mediterranean basis, respectively. NEIS is funded entirely by the U.S.A.; E.M.S.C. is funded primarily by France, but does have a subscription minimum that allows other countries to have a voice in its operations (the details are not known to the writer). SDAC and BDAC are examples of national research centres specifically concerned with problems of seismic discrimination and associated data management and analysis techniques.

A number of the members of the ISC Governing Council are representing their countries as experts in the Ad Hoc Group. At least one of these, Hjelme (Denmark), had expressed concern that the apparent "promotion" of the ISC for consideration by the Ad Hoc Group might disrupt the smoothly functioning service that the ISC now provides to the international seismological community. Thirlaway (U.K.) countered this concern by emphasizing that any new role that the ISC might in future undertake would have to be kept separate from its

present function, and would have to be financed separately.

Revision of Drafts

In principle, each of the above-mentioned draft sections, with the exception of 3c, received sufficient discussion to allow the Scientific Secretary to prepare revised versions. He will use suggestions received during discussions and any additional material that might be sent to him. These sections would not be reconsidered by the Group until the entire report is in similar second draft to be considered as a whole at the fifth, and final, meeting of the Group.

REVISED SCHEDULE FOR THE WORK OF THE AD HOC GROUP

The key concern with respect to the schedule of the work of the Ad Hoc Group is to have the final report submitted to the CCD early in 1978 so that it, among other CCD contributions, will be available for the special meeting on disarmament scheduled for May, 1978 in the U.N. Thus the final meeting at which the Ad Hoc Group will complete its report, i.e., make final revisions to second drafts of all sections, is tentatively set for February, 1978. The discussion of the intervening schedule, therefore, centered on the need for one, or for two, meetings between February 1977 and February 1978. Although there were a number of protestations, related primarily to travel costs from distant countries and to the shortness of time to complete work, with regard to two meetings, it was decided by the Group that two more 1977 meetings are essential

to complete the work (see Conference Room Paper No. 19).

The principal reasons for two meetings, the last week of April and the first week of August, are the following:

- i) There are a large number of fairly contentious items for discussion at the next meeting; if this were the only meeting before February 1978, the Group might be going into its last meeting with a number of unresolved issues. Thus, it is expected that issues that are not resolved in April can be resolved in August.
- ii) The possibility of a two-week meeting in August seems to be precluded by the difficulty of the CCD Secretariat finding the extra support services. (Apparently the Secretariat cannot support more than one special meeting, in addition to the CCD itself, at any one time). As it is, an informal meeting of the CCD has decided to extend its Spring session by one week solely to allow the Ad Hoc Group to meet as late as possible in April.
- iii) Among Western and Non-aligned delegates a separate, but important, reason is the availability of information on Soviet Stations. If this information is available "by the time of the next meeting" in April, it can be incorporated into the network capability study by August and the second drafts to be considered in February, 1978 would be relatively complete ones.

The implications of this schedule for the Canadian delegation to the Ad Hoc Group relate to the time and effort by officials within EMR to prepare for and attend three meetings in the next twelve months, and the cost to DEA of travel support of three meetings within the 1977-78 fiscal year.

PREPARATORY WORK FOR THE APRIL MEETING

The shortness of time to the April meeting, approximately six weeks, is of obvious concern with respect to the amount of work that will actually be completed. Nevertheless, an optimistic work load has been set as shown in the revised schedule of work in Conference Room Paper No. 19 (the full titles for the sections are given in Conference Room Paper No. 4). Following is a brief summary of this work load and some comments on expected results.

4c, d, e. - Stations and Network

Basham has been named convenor of the group to provide drafts for these sections, as a continuation of the work assembling information on stations of potential interest in a global network. The principal work will be to assemble information on additional stations that may be provided within the next few weeks, make a tentative selection of a network on the basis of geography and station capabilities, define the detection thresholds of the network stations, and forward this information to the convenor of the group (Filson) under-

taking the calculations of network capabilities. This will need to be done by early in April in order for Filson to have some sample calculations completed for the April meeting. The participants in Basham's group are expected to forward any suggestions they might have on the ways in which these subjects should be dealt with.

It is not expected that these sections will be completed, but the basic concepts and procedures should be set out for consideration at the April meeting. After that meeting, the remaining station information should be available and the drafts can be completed for the August meeting.

8a, b, c - Network Capabilities

Filson (U.S.A.) is the convenor of the drafting group on the network's capability to detect and locate seismic events and to obtain identification parameter. Much of the work on detection and location will likely be undertaken at the Lincoln Laboratory of M.I.T. using computer programs available there and at the Seismic Data Analysis Centre in Alexandria, Virginia. It is expected that the basic programs can be established and some sample network calculations made by the time of the April meeting. If these are acceptable to the Ad Hoc Group in April, the programs can be re-run as more stations are added to the network.

Filson, personally, is not as clear about what will be achieved for section 8c on identification parameters, but material on this subject will no doubt be contributed by Dahlman (Sweden) of Filson's drafting group.

Appendix - Yield Estimation

There were strong views in the August, 1976 meeting of the Ad Hoc Group, particularly from the U.S.A., that this subject should not be treated by the Group; it was consequently relegated to an appendix. The Swedes are apparently writing a book on seismological verification which contains a chapter on yield estimation. Dahlman (Sweden) as convenor of the drafting group will utilize this book chapter as a framework for the draft appendix, and circulate a draft to the additional members of the group (which includes Basham) for comments prior to the April meeting.

5b, c - Data Exchange

These sections will be drafted to describe the exchange of data, its timescale, format, etc., in a manner that conforms with the desirable "data and procedures" described under sections 3a, b, c. (See Suyehiro's instructions to his drafting group among the enclosed documents).

Although there was a general concensus on desirable data, as described in an earlier section of this report, there was certainly no detailed discussion of procedures. Thus, the drafts of these sections, and of sections 6b, c, d, will provide the framework for this important matter of "procedures" of international cooperation for discussion at the April meeting.

6b, c, d - Data Centres

Procedures to be used at data centres are, of course, closely linked to procedures of data exchange and in fact these items cannot be usefully discussed separately. Thirlaway (U.K.), the convenor of the drafting group for these sections, has provided his group with a suggestion (see hand-written page among enclosed documents) in which the data centre is little more than an internationally - supported epicentre determination agency and distribution centre for any other parameters it might receive. This is one step less than the Canadian proposal in which the data centre would undertake preliminary earthquake screening and collate discrimination parameters. Filson (U.S.A.), in private discussions, believes the cooperative system should be more than that described by Thirlaway, perhaps including a number of regional centres to which additional seismological data, including waveforms, might flow and therefore be available to any national group associated with a regional centre.

Clearly, this is the most important topic for discussion in the Ad Hoc Group and it is difficult to prejudge the outcome. If it becomes difficult to achieve a compromise, for example, between the above-noted Thirlaway scheme and the previously-mentioned Scandinavian scheme of a super verification centre, the Group may be left with no choice but to describe in its final report a number of international cooperative data exchange options. It can be noted that in its original terms of reference it was stated that the Group would actively seek

a consensus view of the final report as a whole.

SUMMARY AND IMPLICATIONS

As indicated in some of the above discussion, it is difficult to foresee the outcome of some of the important sections of the Ad Hoc Group report to the CCD. Many of the more contentious items will be discussed at the April meeting and the principle thrusts of the report and the attending implications will be clearer at that time.

The Soviet expert took a fairly active part in discussions at the meeting, although he indicated that the Soviet delegation was not adequately prepared at this meeting to contribute draft material for the Group report. On a number of occasions he indicated the Soviet delegation would be preparing reports addressing a number of topics being considered by the Group. If available by the April meeting, these should give an indication of the type of influence the U.S.S.R. wishes to have on the Group's work and on the contents of its final report.

One interpretation of recent diplomatic activity relating to a CTB might be that Ad Hoc Group's recommendations could have a greater relevance than they were seen to have at the outset. We must, therefore, continue to be aware of any implications for Canada should some or all of the Group's recommendations on international cooperation be put into effect. Canada provided information on 5 seismograph stations for the Ad Hoc Group's consideration as of potential interest in a global network. Because of the large geographical region

covered, all or most of these stations are likely to be retained in the, at this stage hypothetical, network. It is understood in Ad Hoc Group discussions that the offer of stations for consideration carries no commitment to actual participation. (This point was made again in this meeting for the benefit of the Eastern Bloc delegations).

Some of the views being expressed by delegations in the Ad Hoc Group would make the international cooperative effort very extensive in terms of extraction of detailed data at stations and exchange of these data through international cooperative centres. It is expected, however, that the views of delegations, such as Canada, recommending more modest levels of data exchange will prevail. Even at these modest levels the extra resource commitment that would be required for Canadian participation in such a scheme is significant. The present estimate based on anticipated recommendations of the Ad Hoc Group is approximately 2 man-years and \$60K per annum. This estimate will be updated after the April meeting.

ENCLOSED DOCUMENTS

Conference Room Papers

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| No. 12, 21 February | Draft Agenda for the meeting 21-25 February 1977. |
| No. 13, 21 February | Draft chapters and informal working papers on the Final Report received as of 21 February 1977. |
| No. 14, 23 February | List of Scientific Experts and representatives participating in the Second Session of the Ad Hoc Group. |
| No. 15, 24 February | Guideline for the work to specify a global network and to estimate its detection and location capability (as revised by the Scientific Secretary). |
| No. 16, 24 February | Mailing list for Experts and Representatives. |
| No. 17, 24 February | Draft Agenda for the Third Meeting of the Ad Hoc Group. |
| No. 18, 24 February | Second Progress Report to the CCD. |
| No. 19, 24 February | Revised schedule for the work of the Ad Hoc Group. |
| No. 20, 24 February | List of experts preparing draft chapters for discussion at the April Meeting of the Ad Hoc Group. |
| No. 4, 6 August 1976 | Provisional Table of Contents to the Final Report of the Ad Hoc Group. |

Draft Chapters of the Final Report: contributions (including informal working papers) received as of 4 February 1977.

- This material was received by all participants in advance of the second meeting. The enclosed copy has been updated by additional material received at the second meeting, namely:

- a) Section 2d, Review of earlier relevant studies.
- b) Additional material for Sections 4a, 4b:
 - information for Finland stations in Table 3.
 - extensions of Tables 2, 3 and 4 describing United States stations.
 - GSE/GDR/1 describing German Democratic Republic Station Moxa.
 - GSE/DK/1 describing Danish stations.
- c) Section 5a, Appendix 1. Large diagram of WMO communication network, and "Additional Information on WMO Network".

Miscellaneous

1. Suggestions on how to prepare a working paper on 5b and 5c.
2. Informal note from the Scientific Secretary.
3. Informal guidelines for Sections 6b, 6c, 6d.
4. Working Paper by the Finnish Delegation on Data and Procedures for obtaining identification parameters.
5. Working Paper by the Japanese Delegation on Location Capability of a Multi-Array Stations System.
6. CCD/523, 22 February 1977. U.S.S.R. Draft Treaty on the complete and general prohibition of nuclear weapon tests.