Intergovernmental Oceanographic Commission
Reports of Governing and Major Subsidiary Bodies

International Co-ordination Group for the Tsunami Warning System in the Pacific

Fourteenth Session

Tokyo, Japan, 30 August - 3 September 1993

UNESCO

In this Series — *Languages*

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SC-93/CONF.231/LD.1

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1. OPENING AND ARRANGEMENTS FOR THE SESSION

1 The Chairman, Mr. R. Hagemeyer, opened the Fourteenth Session of the IOC International Co-ordination Group for the Tsunami Warning System (ICG/ITSU) in the Pacific at 10.00 on 30 August 1993.

2 In welcoming participants, he recalled that the First Session of the Group was held almost 25 years ago and since that time the Group accomplished many tasks, which have been targeted on strengthening national and regional infrastructures of the tsunami warning system. He emphasized the usefulness of the Group activities for society and the need to make its voice heard in a constructive manner in light of the International Decade for Natural Disaster Reduction (IDNDR) and the United Nations Conference on Environment and Development (UNCED). The Chairman welcomed the Representative of Nicaragua, the newest member of the Group, added in February 1993, to the IOC International Co-ordination Group for ITSU.

3 Dr. Kozo Ninomiya, Director-General of the Japan Meteorological Agency, expressed his great pleasure and extended his heartiest welcome to all the participants of the Session. He stressed that during all its years of existence the Group devoted itself to the improvement of operational services for tsunami warning and emphasized the importance of the Group activities. He drew the attention of the participants to the large tsunami disasters in Indonesia, Japan and Nicaragua which are still vivid in our memory. These tragic disasters reminded us once more of the task to improve the effectiveness of the Pacific Tsunami Warning System and to make it more rapid and accurate.

4 Dr. Ninomiya reminded the participants that the Session will be in recess on 1 September due to the general disaster prevention drills. On 1 September 1923, just 70 years ago, the Great Kanto Earthquake occurred and more than 140,000 people were killed in and around Tokyo. The Disaster Prevention Day was created to memorialize this tragic disaster. Holding the Session on the Disaster Prevention Day in Tokyo makes it more meaningful. He invited participants to take part in the drills and announced that the delegates from Indonesia and Nicaragua were invited on 1 September to deliver lectures to the staff of JMA on the tsunami disasters of 1992 in their countries.

5 Finally, the Director-General expressed a strong belief that the session will provide an excellent opportunity to make proposals of future strategy for further development of the tsunami warning system in Pacific. He wished all the participants a pleasant stay in Japan and an enriching experience both personal and professional.

6 Dr. I. Oliounine, the Technical Secretary of the Session, Senior Assistant Secretary IOC, thanked the Government of Japan for hosting the Meeting and thanked the representatives of Member States and international agencies for the exemplary co-operation which has led to the establishment of the unique operational warning system with its data collection sites, communication links, procedures for warnings dissemination. He said that the Tsunami Warning System is now about to embark on a new phase of its existence, in which it will attempt to anticipate Member States' aspirations, laying special emphasis on the development of regional warning centers, on improving our knowledge on the mechanism of tsunami generations and on increasing awareness of population of tsunami danger. Dr. Oliounine noted that this session is taking place at a very significant moment with less than one year left before the World Conference on Natural Disaster Reduction which will be held in Yokohama, Japan in May 1994. He called on the delegates to provide guidance to the Secretary IOC on the best way to present the IOC tsunami mitigation programme at this international forum.

7 He strongly emphasized the need to take into consideration, not only Pacific wide but also local problems, to ensure that training, education and mutual assistance activities are given high attention, to consider and suggest ways for further improving the bonds of co-operation with the scientific community, and insisted on the need of increased involvement of Member States of the region to accomplish these tasks.

8 On behalf of the Secretary IOC, Dr. G. Kullenberg, Dr. Oliounine wished the participants every possible success and a very good stay in Tokyo.

9 The Chairman of the Group thanked all the speakers for encouraging words and advice, and invited the Group to adopt the Provisional Agenda as circulated dated 10 March 1993. **The Group adopted** the Agenda as presented in Annex I.

10 **The Group accepted** the proposal by Colombia to designate Mr. W. Sites (USA) as Rapporteur for the Session.

11 The Technical Secretary introduced the timetable and the documentation. **The Group adopted** the working procedures, took note of the documentation and accepted the timetable with minor modifications. The List of Participants is given in Annex III. The List of Documents is reproduced hereto as Annex IV.

12 **The Group noted with satisfaction** a very good representation of the IOC Member States of the Pacific at this Session. However, it **expressed** concern that a few Member States of ICG/ITSU including Australia, China, Democratic People's Republic of Korea and Russia have not been represented at the last two Sessions and **requested** its Chairman and the Secretary IOC to find out the reasons for their absence and take the necessary actions in order to bring them to the next Session.

13 Finally, the representative of the local organizing Committee, Mr. Masaro Saiki, informed the participants of the local arrangements.

2. GENERAL REVIEW OF INTERSESSIONAL ACTIVITIES

14 The Chairman presented his report on the intersessional activities (Document IOC/ITSU-XIV/6), noting that he greatly appreciated the assistance, time and guidance of the IOC Secretary and the very co-operative support of the Member States. The Report summarized the Group's activities since ICG/ITSU-XIII (Ensenada, Mexico, 10-13 September 1991) and highlighted the experience gained in carrying out the programme.

15 He noted that the Governing Bodies of IOC expressed satisfaction with the results achieved by the Group and approved the recommendations of ITSU-XIII.

16 By Resolution EC-XXV.5, the Secretary IOC was instructed *"to spare no efforts to help to ensure the necessary financial support for the implementation of the ITSU projects in accordance with the priorities identified in Recommendation ITSU-XIII.4"*

17 The Chairman then referred to the continuous attempts made by him and the IOC Secretariat to resolve the problems relative to the establishment of the Regional Tsunami Warning System for the South Pacific, to the improvement of communicating tsunami watches and warnings to Beijing and Pyongyang and to the provision of funds for the implementation of the TIME project. The Chairman also informed the Group on his participation at the ITSU Officers meeting and the meeting of the ITSU *ad hoc* Group of Experts on Real-Time Telemetry, Seismic and Tsunami Data Exchange. The results of these attempts and the findings of these meetings will be considered under relevant agenda items.

18 **The Group thanked** the Chairman for his efforts, **accepted** the report on the intersessional activities and **requested** the Technical Secretary to include the Action Sheet presented as Annex III of Document IOC/ITSU-XIV/6 after the necessary modifications resulting from the deliberations of other agenda items as Annex V to the Summary Report of this Session.

19 In response to the IOC Circular Letter 1371 of 10 March 1993, national reports on tsunami related activities were received from Australia, Canada, Chile, Colombia, Costa Rica, Fiji, Hong Kong, Indonesia, Japan, Mexico, New Zealand, Nicaragua, Peru, Philippines, Republic of Korea, Russian Federation and the United States of America. All these reports were made available to the participants (Document IOC/ITSU-XIV/7).

20 The Representative of the Republic of Korea provided additional information on national activities, reporting on the 12 July 1993 Hokkaido Nansei-Oki earthquake and its effects on his nation. He noted that the tsunami wave propagated to Korea in approximately 100 minutes which allowed time for a tsunami warning to be issued and preparedness activities to be accomplished in sufficient time to save lives and property. He also expressed his appreciation to JMA and PTWC for the tsunami information and co-operation during the 12 July 1993 earthquake and tsunami.

21 He noted that offshore fishing vessels were surprised to learn of the tsunami after returning to port and this fact presented an opportunity for the national disaster prevention authorities to improve communication of tsunami warnings to ships at sea.

22 The Representative of Japan elaborated on the 12 July 1993 devastating Hokkaido Nansei-Oki earthquake, noting that a large earthquake also occurred in this region in 1983. During this discussion, he presented information on earthquake magnitudes calculated by the Japan Meteorological Agency (JMA) and the United States Geological Survey (USGS); seismicity of the region from January 1990 through July 1993; the after shock frequency and distribution in the area; a comparison to the 1983 earthquake; results of the JMA Field Survey Team and distribution of tide gauges in Japan.

23 He remarked that residents in many localities felt that the tsunami waves were higher than observed by the JMA tide gauges. This difference will be the subject of a future investigation. He also remarked that even though a tsunami warning was issued within 5 minutes of the earthquake origin time, the effects of the subsequent tsunami were felt almost instantly in Okushei Island. It was noted that while promptness of warning issuance is important; awareness, preparedness and evacuation programmes are equally important for the saving of lives.

24 The Representative of Japan noted that the event provided an excellent demonstration of international co-operation. However, he expressed concern that there was no tsunami information from Russia regarding the 12 July 1993 earthquake, such as Russian tsunami warning efforts and dissemination, and related local tsunami effects. Mr. D. Sigrist, Acting Director of ITIC, noted that some informal information on the event was received from Russia via INTERNET (electronic mail).

25 **The Group requested** its Chairman and the IOC to address the subject further and to attempt to enhance communication with Russia.

26 The Representative of Chile provided additional information on the national activities, adding that a new tide gauge was installed at 42° S. The new gauge will help fill in a gap in their sensor network. He also enthusiastically reported that a successful communications test with the Peruvian Navy was completed in early July, and that seismic information was being successfully obtained from Papeete, Tahiti (French Polynesia).

27 The Representative of France made a presentation on their tsunami inundation and propagation numerical modeling efforts. Over the past few years, they have been working on creating tsunami inundation and propagation models for Portugal and the area around San Remo, Italy. An underwater landslide off Nice caused damage along the French coast. He also reported on TREMORS (Tsunami Risk Evaluation through seismic Moment from Real-time System) which is being used to help mitigate the tsunami hazard in French Polynesia. He noted that their earthquake solutions have compared very favourably to those generated by Harvard University. The USGS' National Earthquake Information Center (NEIC) solution differs slightly from French results.

28 The Representative of Canada provided additional information on national activities, noting that there is now compelling evidence that the Cascadia Subduction Zone does generate a mega-thrust earthquake every 350 to 500 years with a magnitude of at least 8.0. An earthquake of this magnitude could certainly generate a Pacific-wide tsunami. He noted that Canada has been concerned with far-field earthquakes, but now must shift their focus to concentrate also on the hazard of near-field events in which response time is measured in minutes not hours. He called on the Group to consider ways in which it could assist Canada in this concern.

29 The Representative of the Philippines expressed concern that his nation needed additional effort in tsunami preparedness and education, and an increase in the number of operational tide gauges. He requested assistance from international organizations and funding agencies in these aspects of tsunami hazard mitigation. In this regard the Technical Secretary noted that the implementation of a long-waited project on the Regional Tsunami Warning System in the South-West Pacific could give a good opportunity to upgrade existing national tide gauge and seismic networks in the region and suggested to defer further discussion on this issue until Agenda Item 6 is discussed.

30 **The Group expressed** its gratitude to the Member States for their informative reports and **recommended** that abstracted texts of the reports be published in the next issue of the Tsunami Newsletter and **requested** the Acting Director of ITIC to pursue the implementation of this decision. Each Member State is requested to provide the abstracted texts to ITIC by 1 October 1993.

31 Mr. D. Sigrist, Acting Director of ITIC, provided his report on intersessional activities highlighting the important accomplishments. He explained that a staffing problem at ITIC impacted the Centre's visibility and effectiveness during the past year. The staffing situation being resolved by the USA with his assignment as Acting Director, will allow the ITIC to resume operation in a number of areas. Mr. Sigrist reported the ITIC Newsletter resumed publication in July with a second issue scheduled for the end of the year. The Visiting Scientists Programme is expected to resume in 1994.

32 Following ITSU-XIII (Ensenada), two visiting experts participated in ITIC's Visiting Scientists Programme for 1991. On 15 October 1991, Dr. Hansjurgen Meyer from Bogota, Colombia and Dr. Im Sang Oh from Seoul, Korea commenced a 4-week visit at ITIC under the auspices of the Visiting Scientists Programme which is sponsored and funded by IOC.

33 In the 1990-1991 time period, it appeared there may have been a candidate for the position of Associate Director, ITIC. Unfortunately, there has not been any further substantial discussion during this intersessional period that would lead to seconding an individual to the position. There has been a long standing request to the IOC and Member States to fill the Associate Director's position.

34 In co-operation with IOC, ITIC oversaw the development and printing of a children's book on Tsunamis that has been made available to IOC (and through ITIC) for distribution; 10,000 copies were printed initially. These materials address the response awareness for both far- and near-field tsunami events.

35 The 12 July 1993, Hokkaido Nansei-Oki earthquake and subsequent tsunami in the Sea of Japan provided an opportunity for the acting ITIC Director to participate in a field survey as part of a collaborative USA-Japan agreement. Run-up measurements on Okushiri and Hokkaido Islands (Japan) provided dramatic evidence of a major region tsunami event causing significant loss of life and property damage. The tsunami also affected the coasts of Russia, the Democratic People's Republic of Korea and the Republic of Korea causing property damage. A summary report on this survey is planned for inclusion in the December 1993 ITIC Newsletter.

3. IMPLEMENTATION OF DECISIONS AND RECOMMENDATIONS OF THE THIRTEENTH SESSION OF THE ICG/ITSU

3.1 REAL-TIME EXCHANGE OF TELEMETRY, SEISMIC AND TSUNAMI DATA

36 Mr. M. Blackford, in his capacity of a member of the *ad hoc* Group of Experts on Real-Time Telemetry, Seismic and Tsunami Data Exchange, presented the Summary Report of the Second Session of the Group for the consideration and adoption by the ICG/ITSU (Document IOC/INF-930). He paid special attention to the strategy document annexed to the report on the implementation of the Pacific Rapid Response System Project.

37 **The Group expressed thanks** to the members of the *ad hoc* body, **adopted** the Summary Report of the Second Session and taking into account the progress achieved in the implementation of Phases 1 and 2 of the project **decided** to change the status of the *ad hoc* Group of Experts to a Task Team with the modified Terms of Reference, as given below:

(i) Meet as a Task Team at regular sessions of the ICG/ITSU and otherwise conduct its business through correspondence during intersessional periods;

(ii) Review, on a continuing basis, both the Project on Pacific Rapid Response System and its Strategy Plan for Phase III Implementation to evaluate implementation progress and needs for improvements;

(iii) Assume responsibility, in consultation with the Chairman ICG/ITSU and the Secretary IOC, for technical visits as specified under Phase III of the Strategy Plan;

(iv) Report on the Task Team activities at regular sessions of the ICG/ITSU.

38 **The Group invited** Mr. Blackford (USA) to chair the Task Team. The Representatives of Chile, France, Indonesia and Japan expressed interest to participate in the Task Team activities. **The Group recommended** that the Task Team focus its main efforts on the real-time tsunami data exchange issues and continue the close co-operation with seismologists in resolving seismological aspects of the problem. Taking into account discussions under this agenda item and comments made by different delegations, **the Group revised** the Project Strategy Plan as presented in Annex VI to the Summary Report.

39 **The Group urged** its Chairman and the Secretary IOC to seek financial support for the implementation of the Project and **noted** the need to identify sources of potential extrabudgetary funding.

3.2 TSUNAMI INUNDATION MODELING EXCHANGE PROJECT (TIME)

40 The Chairman reminded the Group that the TIME Project, as suggested by ITSU-XIII was approved by the Twenty-Fifth Session of the IOC Executive Council in March 1992 for implementation. The project has wide potential to mitigate the tsunami hazards. The Chairman reported that considerable effort had been spent in the attempt to secure funding for the implementation of the TIME Project. Unfortunately, the effort has not yet been successful. However, Dr. Shuto and other Japanese tsunami experts are proceeding with inundation modeling efforts despite the lack of funding and are making progress.

41 A ten minute video, produced by the Tohoku University of Japan and Sung Kyun Kwan University of the Republic of Korea, which visually demonstrated tsunami propagation, was shown to the Group. The Group noted that an accurate propagation model was the first step in the development of an accurate tsunami inundation model. The **Group praised** the efforts of Dr. Shuto and his colleagues, **recognized** the progress made, and **agreed** that these efforts should continue.

42 **The Group strongly supported** the decision of the Seventeenth Session of the IOC Assembly by which *"the Assembly instructed the Secretary IOC, requested the Chairman of the Group and urged Member Stated concerned to continue efforts to obtain financial support ... and TIME Project."* The Group urged its Chairman to implement this request.

43 In this regard, the comment made by the Representative of Mexico about the Japan International Co-operation Agency (JICA) was well taken and **The Group requested** the Chairman and the Representative of Japan to explore the possibilities of securing funding from JICA and to provide guidance to the Secretary IOC.

3.3 USE OF PERSONAL COMPUTERS FOR TSUNAMI TRAVEL TIME CALCULATIONS

44 The Technical Secretary reminded the Group of the decision of ITSU-XIII requesting the IOC Member States to make the necessary contributions to the IOC Trust Fund in order to make arrangements with the Krasnoyarsk Computing Center to transfer to IOC the rights for copying the "Luch" software. "Luch" gives an opportunity to compute tsunami travel times from designated tsunami sources with the use of personal computers.

45 He informed the Group that in 1992 requests for the "Luch" software were received from a few Member States, however, no Trust Fund Contributions have yet been made.

46 **The Group suggested** that interested parties contact the Computing Center directly with requests for the software on the basis of bilateral agreements.

3.4 RECOMMENDATIONS OF COMMUNICATIONS TEST BETWEEN SELECTED CENTERS OF THE NORTH PACIFIC - NEEDS AND WAYS FOR IMPROVEMENT

47 **The Chairman brought the Group up to date on the status of this issue. He noted that he has been working steadily on the resolution of this issue since ITSU-XII.**

48 The Chairman reported that his efforts have determined that the relay of the messages via the WMO Global Telecommunication System (GTS) is working. Washington is relaying to Tokyo which is relaying to Beijing and Kabarovsk. Kabarovsk then relays to Pyongyang. The arrival of the messages at Pyongyang has been confirmed by correspondence but confirmation via GTS has not been accomplished. Correspondence with Beijing continues, through the auspices of the IOC and WMO, in an effort to resolve the problem.

49 The USA Representative was tasked with pursuing a solution of the item. Specifically, he will pass all related correspondence from the past several years to the State Oceanic Administration (SOA) tsunami focal point of the People's Republic of China, so they can attempt to locate and resolve the communication problem.

50 The Director of PTWC stated that monthly communication tests will continue. In the near future, PTWC intends to test receipt of messages by end users in addition to primary disseminators of tsunami watches/warnings /information bulletins. **The Group requested** the Representative of the USA to continue efforts in making the communication system effective and report on the status and achievements at ITSU-XV.

51 **The Group noted** that the tsunami warning system should take advantage of the latest and most cost effective communication technologies. While the progress was made in communications, this activity must be continued especially in the area of exploration of new and improved methods for distribution of warnings, and collection and exchange of data.

4. RECOMMENDATIONS OF THE IUGG-IOC TSUNAMI '93 SYMPOSIUM AND ACTIONS REQUIRED FROM THE ICG-ITSU

52 The IUGG/IOC International Tsunami 93 Symposium was held in Wakayama, Japan from 23-27 August. Many scientists took part in this event. The Chairman summarized the findings of the joint Symposium. More than 70 papers were presented covering a wide scope of tsunami research and mitigation; tsunami generation, propagation and seismic focus; tsunami prediction and simulation; instrumentation, observation and tsunami database; tsunami disasters and mitigation; tsunami warning systems and plans for improvement. More than one hundred papers were published in the Proceedings of Tsunami, 93. **The Group stressed** that this type of joint activity with the scientific community should be continued and expanded.

53 The Representative of the WDC-A for Solid Earth Geophysics, Mr. J. Lander, joined the Chairman in expressing the need to have co-operation between tsunami scientific and operational communities on a more regular basis, as the joint meetings give a unique opportunity to exchange views, arrange fruitful discussions and come to valuable decisions for the benefit of all Member States. He recommended that there be an IOC presence at the Tsunami Commission Meeting planned in conjunction with the IUGG General Assembly for 1995 in Boulder, Colorado, USA.

54 **The Group fully supported** the views and **recommended** that the Secretary IOC arrange for the participation of ICG/ITSU experts at the Boulder Meeting.

55 **The Group noted** the Recommendation of the Tsunami 93, Symposium to develop standards for tsunami survey measurements of tsunami run up and damage.

56 The Acting Director of ITIC recommended that the Group consider developing standard markings for positions to identify both the maximum horizontal and vertical run up. The Global Positioning System (GPS) positioning equipment, with reported 5 cm accuracy in both the maximum horizontal and vertical axes, was suggested as an excellent option for positioning equipment.

57 The Representative of Mexico recommended that a standard measurement questionnaire be developed as a means to maintain standards, transfer technology, and help future disaster survey participants use the same set of parameters.

58 **The Group decided** to form an *ad hoc* working group, chaired by the Director of ITIC, and with assistance from the Representatives of Canada and Mexico, to complete these tasks during the intersessional period.

5. IMPLEMENTATION OF THE PROVISIONS OF THE ITSU MASTER PLAN IN LIGHT OF UNCED AND IDNDR

59 In response to the decisions of ITSU-XIII, the ITIC Acting Director presented Document IOC/ITSU-XIV/9 which contained a comparison of accomplishments of the ICG/ITSU Member States versus the proposed actions specified by the Master Plan. Unfortunately, due to ITIC staffing problems and time constraints there was no possibility to distribute this document well in advance of ITSU-XIV as it was originally planned.

60 The Group then discussed at length sections of Chapter 6 of the ITSU Master Plan with recommendations on future actions. After a thorough review, **the Group agreed** that the actions as outlined in the Chapter were indeed worthy of further pursuit. **The Group noted** that much progress had been made in technology development and scientific research since the Master Plan was written in 1987, e.g., communication techniques had improved significantly since 1987 with the advent of satellite communications, telephone facsimile technology and electronic mail such as INTERNET. INMARSAT-C satellite communications for delivery of alphanumeric information was also mentioned as a possible new method of communications to be investigated.

61 The Group then discussed whether or not the ITSU Master Plan remained a relevant document and whether or not it should be updated. **The Group agreed** that the Master Plan continues to be a relevant document, provides a good framework for operation and improvement of the Tsunami Warning System in the Pacific, and that it is sufficiently flexible/general to have lasting value and allow for improvements in technology.

62 **The Group recognized** that some updating is desired and **recommended** that Mr. Sigrist chair a Task Group to create an addendum of additions and corrections to the ITSU Master Plan. The representatives of France and Mexico volunteered to assist in this effort. This Task Group will complete an addendum to the Master Plan for discussion at ITSU-XV.

6. ESTABLISHMENT OF REGIONAL TSUNAMI WARNING SYSTEMS AND THE LESSON OF TSUNAMIS '92 IN NICARAGUA AND INDONESIA AND TSUNAMI '93 IN JAPAN

63 The Technical Secretary informed the Group of the efforts made by the Chairman and the Secretary IOC in their search for financial support for the project proposal "*Tsunami Warning System in South-West Pacific*" which has been in the pipeline of the UNDP project proposals since 1989. At the meetings of the IOC Governing Bodies and different international scientific meetings numerous concerns were expressed with the delay of the adoption of the project for funding.

64 Unfortunately, one of the reasons for the delay was the lack of support from the Member States who would benefit directly from the implementation of the project. Only the representative of Indonesia to UNDP was instructed in 1993 to express his country's support to the project. The Technical Secretary noted that UNDP is not likely to consider supporting the project unless encouragement is received from the concerned Member States including the Fiji, Papua-New Guinea, Philippines, Solomon Islands, Tonga and VietNam.

65 Recent deadly and damaging tsunamis in Indonesia, Nicaragua and Japan have triggered a new wave of interest in the project and may increase the priority for the establishment of a Regional Tsunami Warning System in the Southwest Pacific if actions are taken now by the concerned Member States indicated above.

66 **The Group recommended** that this item continue to be pursued. The representatives of the Philippines and France requested the opportunity to communicate with the other Member States involved and to attempt to galvanize this effort and show support by writing to the regional UNDP representative.

67 Finally, it was agreed that the IOC Secretary and the Chairman ICG/ITSU will again correspond with the concerned Member States to inform them that if letters of support are not received by UNDP soon, funding for establishment of the Regional Tsunami Warning System in the Southwest Pacific will not likely be obtained.

68 The Representative of Mexico stated that they desired to start working with other Member States in Central America to begin discussions which may eventually result in the formulation of a design for a regional tsunami warning system in Central America. **The Group was in general agreement** that Mexico should pursue this activity and **encouraged** them to do so.

69 The Acting Director ITIC, in response to the request of Mexico, will include an updated list of all ITSU national contacts in the December ITIC Newsletter to assist Member States in maintaining contact with each other.

70 The representatives of Indonesia and Nicaragua made, respectively, presentations to the Group on the 12 December 1992 and 1 September 1992 devastating tsunamis. Copies of their reports - "*Report of the Flores Earthquake - Tsunami of 12 December 1992*" and "*Actions Taken by Nicaragua to Mitigate the Effects of Future Tsunamis*", were provided to all participants and **the Group expressed appreciation** for these informative reports. **The Group paid** a special tribute to Nicaragua for the considerable work completed by the country to mitigate the tsunami hazard since the September 1992 event.

71 **The Group also considered** the Recommendations formulated by the Canada-USA Survey Mission to Nicaragua supported by IOC, as they were presented in the mission report "*Post Tsunami Survey (2-7 November 1992) of Run-up and Inundation in the Coast of Nicaragua*". This Document received a wide distribution of the IOC Member States as an information document of ITSU-XIV. **The Group supported** the idea of setting up an international team of experts on different aspects of coastal earthquakes and tsunamis that will be technically and financially prepared to survey the affected area within a few days of any major tsunami and again a couple of months after the tsunami. **The Group requested** its Chairman to recommend the composition of such a team in consultation with the officers of the Tsunami Commission and Tsunami Society. **The Group also recommended** returning to the practice of allocating a certain amount of funds to support the team financially in cases of emergency. **The Group noted** the need to develop inundation maps and emergency plans for countries with limited technical capabilities such as Indonesia and Nicaragua and **requested** the Director ITIC in consultation with the ICG/ITSU Officers to propose a plan for the implementation of the recommendations included in the report of the survey mission.

7. SUPPORT TO ITIC

72 **The Group noted** a comprehensive and ambitious mandate which is attainable only to the extent that resources are available. The bulk of funding is provided by the United States National Weather Service and IOC which is largely used for the Visiting Scientists Programme, publication of the Newsletter and travel for the Director. **The Group acknowledged** with thanks the interest of the USA to support the ITIC activities and **invited** the Secretary IOC to consider ways of increasing support to ITIC in the coming years, bearing in mind the variety of activities which the Group assigned to ITIC at this Session.

73 The Technical Secretary commented on the recent efforts to fill the position of the ITIC Associate Director. In the 1991-1992 time period, it appeared there may have been a candidate for the position. Unfortunately, there has not been any further substantial discussion during this intersessional period that would lead to seconding an individual to the position. **The Group noted with satisfaction** Resolutions of the IOC Governing Bodies urging the IOC Member States to fill the position and **requested** its Chairman to continue these efforts.

74 A few delegates expressed an interest in getting the description of the Associate Director post and conditions under which he is hired and functions. **The Group requested** IOC to provide Member States with the necessary documentation and **encouraged** Member States to consider financial support for this post.

8. TRAINING, EDUCATION AND MUTUAL ASSISTANCE IN REGARD TO THE ITSU PROGRAMME

8.1 RECOMMENDATION ITSU-XIII.3 ON TSUNAMI PUBLIC EDUCATION AND AWARENESS

75 The Chairman of the *ad hoc* Working Group, Mr. H. Gorziglia (Chile), presented a detailed overview of the proposal and progress to date in regard to the development of earthquake and tsunami text books, and methodological instructions for teachers. Teaching with the help of these books have already been implemented on a trial basis in 30 schools in Chile. The results were most encouraging. Mr. E. Lorca (Chile), demonstrated a video film showing this educational process. The Group noted that due to time and funding constraints the work which was accomplished was done in its entirety by the Chairman of the Working Group and a group of Chilean specialists. The Group expressed its appreciation to Mr. Gorziglia and his group of specialists for their outstanding efforts and **recommended** that these activities continue.

76 **The Group agreed** that the high-quality publication of these books will be a valuable contribution to the objectives of the World Conference on Natural Disaster Reduction. It was decided to publish the text books in various languages. The possibility of adopting the original text for improved comprehension was discussed at length.

77 **The Group invited** the representative of Chile to provide a Master Copy of a Spanish version of the books by the end of 1993 and **requested** its Chairman and the Secretary IOC to secure funds for its publication. At the same time, it was **recommended** that efforts should continue in publishing English texts and developing English versions ready for publication.

78 **The Group decided** to continue activities of the Working Group for public education and awareness with revised terms of reference and **invited** Mr. H. Gorziglia (Chile) to continue chairing this Group. The representatives of Canada, Japan, New Zealand and the USA agreed to serve as members of the Working Group. **The Group adopted Recommendation ITSU-XIV.1.**

79 It was noted that the education strategy document had not been prepared as originally planned and that efforts should be focused on the implementation of this decision of ITSU-XIII.

80 Under the same agenda item, the Group discussed at length the various media which could be used to present educational materials to people including pictures, posters, slide shows, videos, pamphlets, brochures, CD-ROM and television informational spots. **The Group was in general agreement** that whatever medium was chosen, it must have the capability to reach a wide cross-section of people, taking into account cultural, financial and technological differences, funding limitations and the need for flexibility.

81 **The Group requested** that tsunami television and radio spot announcements which may be available in Member States, be sent to the ITIC which can then act as a reference source for other interested ITSU Member States.

8.2 VISITING EXPERTS PROGRAMME

82 The Chairman advised the Group of the circumstances that resulted in the suspension of the Visiting Experts Programme. He indicated that the resumption of this programme has a very high priority in the ITIC plans for the future. Current plans are to hold a session of the Visiting Experts Programme in Honolulu during October 1994 and, if funds are available, a second session in October 1995.

83 **The Group agreed** that the programme should be resumed, **considered** that the schedules for October 1994 and 1995 were acceptable and **requested** the Secretary IOC to advise all Member States of these plans.

9. NATIONAL PROPOSALS FOR FUTURE PROJECTS

84 The Representative of France provided a briefing on France's Proposal for the Establishment of National Tsunami Warning Centers in the Southwest Pacific. A complete text of this proposal is presented in Annex VII to the Summary Report.

85 The Group considered the French proposal and **agreed** that it had significant merit, and that the proposal and its equipment methodology are complementary to the equipment portion of the proposal for the Tsunami Warning System in Southwest Pacific now before the UNDP. **The Group decided**, taking into account the benefits of the French proposal, that the equipment portion should be reviewed at the time funding for the Tsunami Warning System in the Southwest Pacific is approved.

86 The Group discussed the Russian proposals on the Expert Tsunami Database for the Pacific (ETDP), Integrated Tsunami Research and Information System (ITRIS), and the Investigation of Geological Traces of Paleotsunamis in the Kuril-Kamchatka Region. **The Group regretted** that representatives of Russia could not be in attendance to present their proposals.

87 After consideration of the ITRIS proposal, **the Group noted** with interest the achievements of the Novosibirsk Computing Center, **noted** the similarities of this proposal to the TIME project, **encouraged** its continued development, and very much **looked** forward to a demonstration of its capabilities at ITSU-XV.

88 **The Group considered** the ETDP proposal and **was in general agreement** that its pursuit and eventual implementation would be of great benefit to the ITSU Member States, and would complement the database of ITIC. However, concerns were expressed that the programme should be reviewed further before making it available internationally and providing financial support. After a long discussion, it was decided that this proposal would be accepted and financially supported. **The Group urged** the Secretary to make it clear to our Russian colleagues that, after completion of the project the software would be available to the ICG/ITSU Member States at no cost. A complete text of this proposal is presented in Annex VIII.

89 **The Group considered** the third Russian proposal with interest, but noted that the bilateral agreement between Russia and the USA exists which addresses the issue in an appropriate manner. **The group recommended** that this effort be continued in its present form.

90 The Representative of Korea proposed the establishment of the Far East Tsunami Warning Center. One of the possible locations for the Center could be at the Japan Meteorological Agency. The Representative of Japan informed the Group that much discussion and consensus among the Member States concerned would be necessary to establish the Centre and obtain additional tide and seismic data from and improve communications with the concerned countries in the area of the Japan, Yellow and East China Seas for the tsunami warning service.

91 After a discussion in which many Member States participated, **the Group agreed** that it would be desirable for the Member States bordering on these Seas to discuss the possibility of establishing a Far East Tsunami Warning Center. Japan was requested to advise the Secretary of the results of any discussions, so that, if appropriate, the issue can be included as an Agenda Item at ITSU-XV.

10. WORLD CONFERENCE ON NATURAL DISASTER REDUCTION

92 The Representative of the IDNDR Secretariat, Mr. A. Takeda, presented an overview of the IDNDR objectives and focused the attention of the Group on the World Conference programme. This Conference will be held in Yokohama in May 1994 and is considered to be similar in importance to the 1992 United Nations Conference on Environment and Development. The aims of the Conference are to:

(i) review IDNDR accomplishments at national, regional and international levels;
(ii) chart an action programme for the future;
(iii) exchange information on the implementation of IDNDR programmes and policies;
(iv) increase awareness of the importance of the progress of disaster reduction policies.

93 Mr. Takeda encouraged the Group to participate in the World Conference through contributions to national reports and to topical and poster sessions.

94 The Technical Secretary echoed this encouragement. He called on Member States to ensure an adequate contribution to the Conference. He stressed that this Conference gives a unique opportunity to make different groups of society acquainted with the IOC and other international agencies activities in the field of tsunami research, mitigation and preparedness. It is vital that the IOC contribution to the Agenda

of the Conference be appropriate, substantial and timely. He called on Member States to provide IOC and UNESCO with the necessary guidance and advice.

95 **The Group shared** the view on the importance of the Conference and **agreed** to provide the Secretary IOC with concrete ideas and proposals on IOC participation at the Conference by 20 September 1993. These proposals will include descriptions of the content of posters, themes of video films and slide shows which can be demonstrated during the Conference. Information on potential exhibitors from the private sector who are involved in the development and application of tsunami research, observation and mitigation technology should also be provided to the IOC.

11. PUBLICATIONS

96 The Technical Secretary noted a number of publication activities which have taken place during the intersessional period, highlighted the catalogue of Tsunamis on the West Coast of Mexico (jointly in Spanish and English published by the WDC-A for Solid Earth Geophysics), the Children's Book on Tsunamis (in English), and the resumption of the ITIC Tsunami Newsletters.

97 The Group then discussed the possibility of publishing the Children's Book in other languages. After an extensive discussion, it was agreed that the most effective way to do this would be to make the master illustrations and text available to those Members States who wish to publish the Book in a language other than English. The Director ITIC, was assigned the task to develop the procedures by which this could be accomplished and to provide this information to the Member States.

98 Mexico's translation of the ITIC Brochure into Spanish was acknowledged with appreciation, and France indicated that it would look into preparing a French translation. **The Group confirmed** its opinion that the IOC should publish the Brochure in Spanish and French.

99 The next edition of the Tsunami Newsletter will be published in December 1993 and will contain condensed versions of the National Reports presented at the Session. The Director ITIC requested the Member States to provide him with the condensed version of their reports by 1 October 1993. The December edition will also include the most current list of the ICG/ITSU Member States and their national contacts.

12. ELECTION OF THE CHAIRMAN AND VICE-CHAIRMAN OF THE ICG/ITSU

100 The Technical Secretary introduced procedures for the election of the Chairman and Vice-Chairman of the IOC main Subsidiary bodies as they are presented in the IOC Manual Part I, March 1989 and invited the delegates to make proposals.

101 The Delegate from New Zealand reminded the Group of the increasingly strong role of Chile in the implementation of the IOC tsunami programme and therefore proposed Mr. H. Gorziglia as the Chairman of the Group for the next intersessional period and next session.

102 The delegates of Canada, Mexico and Nicaragua seconded this proposal.

103 There being no other candidate, the Group elected Mr. H. Gorziglia Chairman, unanimously.

104 The Group re-elected the Vice-Chairman, Mr. H. Uchiike by acclamation.

Mr. H. Gorziglia thanked the Group for its expression of confidence and stressed that he needed the co-operation and support of all ICG/ITSU Member States in this task.

105 In recognition of Mr. Richard Hagemeyer's outstanding contributions as the Chairman of the ICG/ITSU for the past 6 years, **the Group honored** him with a token of their sincere appreciation. The Technical Secretary, on behalf of the Secretary IOC, expressed praise for Mr. Hagemeyer's work as Chairman and presented him with a certificate of recognition. Mr. Hagemeyer expressed his heart-felt

gratitude to the representatives of ICG/ITSU Member States, the Secretariat and the Secretary IOC for their support and hard work during his tenure as Chairman.

106 **The Group also acknowledged** the many contributions made by Dr. G. Pararas-Carayannis during almost 30 years, to the development of the tsunami warning system in the Pacific. **The Group highly appraised** his experience, knowledge and energy which were devoted to ITIC activities. The Technical Secretary presented Dr. G. Pararas-Carayannis, on behalf of the Secretary IOC, with a certificate of recognition for his invaluable efforts, and **the Group requested** the Chairman to pass the certificate to Dr. Pararas-Carayannis with the words of thanks.

13. PROGRAMME AND BUDGET FOR 1994 - 1995

107 On the basis of requirements and actions proposed under previous agenda items, the Group formulated the programme for 1994-1995 as it is presented in Recommendation ITSU-XIV.2. The action items of the programme are arranged in order of priority.

108 **The Group** briefly **reviewed** the Medium-Term Plan of IOC and **noted with concern** that in spite of the high priority given to the IOC Tsunami Programme by the IOC Governing Bodies, the level of financial support to the programme is very low and may put the implementation of the whole effort into jeopardy.

14. DATES AND PLACE OF THE NEXT SESSION

109 The Delegate of France reiterated his country's offer to host the Fifteenth Session of the Group in Papeete, French Polynesia. **The Group acknowledged** this offer with appreciation and **accepted** it. The Technical Secretary briefly explained the constraints the Secretariat now faces in scheduling main subsidiary bodies meetings and called on Member States to consider the possibility of extending the intersessional period. **The Group thought** that the extension of the time between two sessions would be most undesirable as it will hamper the implementation of many activities. **The Group decided** that it would be most appropriate to have the next session in the fall of 1995 and **invited** the Secretary IOC to positively consider these dates.

110 The delegates of Peru and the USA invited the Group to consider the possibility of having its Sixteenth Session in one of those countries. **The Group thanked** the Member States for this kind offer and **requested** its Chairman to negotiate with these countries and bring the results of the negotiations for the consideration of ITSU-XV.

111 **The Group stressed importance** of the ITSU officers meeting for the continuous review of the programme implementation and for the successful preparation for the ICG/ITSU sessions. **The Group recommended** having the meeting not later than a year prior to ITSU-XV.

15. ADOPTION OF SUMMARY REPORT AND RECOMMENDATIONS

112 **The Group adopted** the Summary Report and Recommendations of the Fourteenth Session, as reviewed during this Agenda Item. **The Group requested** the Technical Secretary to undertake the necessary editing to ensure accuracy and correctness.

16. CLOSURE

113 The Chairman closed the Session at 15.00 on 3 September 1993.

ANNEX I

AGENDA

1. OPENING AND ARRANGEMENTS FOR THE SESSION

2. GENERAL REVIEW OF INTERSESSIONAL ACTIVITIES

3. IMPLEMENTATION OF DECISIONS AND RECOMMENDATIONS OF ITSU-XIII

   3.1 REAL-TIME EXCHANGE OF TELEMETRY, SEISMIC AND TSUNAMI DATA
   3.2 TSUNAMI INUNDATION MODELING EXCHANGE PROJECT (TIME)
   3.3 USE OF PERSONAL COMPUTERS FOR TSUNAMI TRAVEL TIME CALCULATIONS
   3.4 RESULTS OF COMMUNICATIONS TESTS BETWEEN SELECTED CENTRES OF THE NORTH PACIFIC - NEEDS AND WAYS FOR IMPROVEMENT

4. RECOMMENDATIONS OF THE IUGG-IOC INTERNATIONAL SYMPOSIUM, TSUNAMI-93 AND ACTIONS REQUIRED FROM THE ICG/ITSU

5. IMPLEMENTATION OF THE PROVISIONS OF THE ITSU MASTER PLAN IN LIGHT OF UNCED AND IDNDR

6. PROJECTS FOR THE ESTABLISHMENT OF NEW REGIONAL TSUNAMI WARNING SYSTEMS IN THE PACIFIC AND THE LESSON OF TSUNAMIS 92 IN NICARAGUA AND INDONESIA

7. SUPPORT TO ITIC

8. TRAINING, EDUCATION AND MUTUAL ASSISTANCE IN REGARD TO THE ITSU PROGRAMME

   8.1 RECOMMENDATION ITSU-XIII.3 ON TSUNAMI PUBLIC EDUCATION AND AWARENESS
   8.2 VISITING EXPERTS PROGRAMME

9. NATIONAL PROPOSALS FOR FUTURE PROJECTS AND OTHER BUSINESS

10. PUBLICATIONS

11. ELECTION OF THE CHAIRMAN AND VICE-CHAIRMAN OF THE ICG/ITSU

12. PROGRAMME AND BUDGET FOR 1994-1995

13. DATE AND PLACE OF THE NEXT SESSION

14. ADOPTION OF THE SUMMARY REPORT

15. CLOSURE

ANNEX II

LIST OF ADOPTED RECOMMENDATIONS

Recommendation ITSU.XIV.1

PROGRAMMES FOR PUBLIC EDUCATION AND AWARENESS

The International Co-ordination Group for the Tsunami Warning System in the Pacific,

Acknowledging the outstanding efforts of the Chairman of the Working Group for Tsunami Public Education and Awareness and the Chilean experts in 1991-1993 in the development of tsunami educational programmes for primary and high schools,

Recognizing the growing need of developing education and awareness programmes which will help populations of Member States to increase knowledge and understanding of seismic and tsunami phenomenon and to attain a favourable and rational attitude in case of earthquakes and tsunamis,

Noting that the objectives of this project correspond fully to the IDNDR objectives relevant to training and education, and to those of the Master Plan for the Tsunami Warning System in the Pacific,

Recommends that the activities of the Working Group should be continued with the revised Terms of Reference to :

- define and develop a general public education strategy;
- facilitate in the production of a Spanish Edition of the Earthquake and Tsunami text books and instructions for teachers (8 books);
- prepare for publication a revised English version of the Earthquake and Tsunami text books;
- report on the activities of the Working Group to the Fifteenth Session of ICG/ITSU,

Recommends that the Secretary IOC anticipate and secure funds to support the printing of a Spanish Edition of the Earthquake and Tsunami education books;

Urges all IOC Member States to contribute financial support for the printing of an *English* Edition using the IOC Trust Fund or other extra-budgetary mechanisms.

Recommendation ITSU.XIV.2

PROGRAMME OF WORK AND PRIORITIES FOR 1994 - 1995

The International Co-ordination Group for the Tsunami Warning System in the Pacific,

Appreciating the view of the IOC Governing Bodies on the IOC Tsunami Programme as the programme of high priority and the most successful regional one,

Being aware of the need to fulfill efficiently and effectively the responsibilities assigned to the Group by IOC Member States and to maintain the momentum of the programmes that contribute to the IDNDR,

Being informed of the IOC Programme and Budget for 1994-1995, adopted by the Seventeenth Session of the IOC Assembly,

Noting that additional resources would be required for sustained satisfactory implementation for all projects proposed by the Fourteenth Session of the Group,

Noting further the need for additional resources which can be acquired through voluntary contributions of Member States to the IOC Trust Fund, secondment of staff and in-kind support,

Urges the Secretary IOC to assign a high budgetary priority to the IOC Tsunami Programme and to make additional funds available to meet the demands of the IOC Member States for enhancement of their capabilities to combat tsunami,

Calls on Member States of the ICG/ITSU to increase their efforts to provide adequate funding for the support of the IOC Tsunami Programme,

Adopts the ICG/ITSU work programme for 1994-1995 with the following order of priority:

1. Provision of increased assistance for the continuing activities of the International Tsunami Information Centre (ITIC).

2. Visiting Experts Programme (4-6 trainees).

3. Provision of assistance to member States for the implementation of the actions of the Master Plan for the Tsunami Warning System in the Pacific.

4. Provision of funds for the organization of meetings of the Group (e.g., ITSU-XV, ITSU Officers Meeting); for implementation of project proposals, and hiring consultants as recommended at ITSU-XIV.

5. Provision of funds for the assessment of tsunami damage and inundation.

6. Support for publication of tsunami research and mitigation documents (ITIC brochure in French, Spanish and Russian, text books proposed by the *ad hoc* Working Group on Education and Public Awareness, *errata* sheet for the Tsunami Glossary, etc.).

7. Provision of funds for participation of ITSU Officers/Experts in the meetings of other organizations dealing with tsunami problems, and of the ICG/ITSU Chairman at the meetings of the IOC Governing Bodies.

8. Co-sponsoring scientific conferences and symposia of other international bodies related to the IOC Tsunami Programme by providing support for participation of experts from developing countries.

9. Provision of living allowance and travel for the Associate Director, ITIC.

ANNEX III

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ANNEX IV

LIST OF WORKING DOCUMENTS [1]

Document Code	Title
IOC/ITSU-XIV/1	Agenda
IOC/ITSU-XIV/1 add.	Timetable
IOC/ITSU-XIV/2	Annotated Agenda
IOC/ITSU-XIV/3	Summary Report
IOC/ITSU-XIV/4	List of Documents
IOC/ITSU-XIV/5	List of Participants
IOC/ITSU-XIV/6	Report of the Chairman of the ICG/ITSU on Intersessional Activities
IOC/ITSU-XIV/7	National Reports on Tsunami Related Activities
IOC/ITSU-XIV/9	Evaluation of Progress, through 1992 in the Implementation of the Master Plan for the Tsunami Warning System in the Pacific
IOC/ITSU-XIV/10	Draft Textbooks for Tsunami Education and Awareness (set of 8 books)
IOC/ITSU-XIV/10 Add.1	Compilation of Comments on Draft Textbooks
IOC/ITSU-XIV/11	National Proposals for Future Projects

[1] *This list is for reference only. No stocks of these documents are maintained, except for the Summary Report.*

ANNEX V

ACTION SHEET

Implementation of Decisions and Recommendations of ITSU-XIII

Para of ITSU-XIII Summary Report	Action (Responsible Person)	Status of Implementation
14	Publication of national reports in Tsunami Newsletter (Dir. ITIC)	Done
17	To report to IOC Governing Bodies on progress achieved by ICG/ITSU (Chairman, ICG/ITSU)	Done
29	Continuation of work on interactive software for seismic network analysis on personal computers (Novosibirsk Computing Centre)	Done See project proposal in Doc. ITSU-XIV/11
36	Inclusion of text of project on Rapid Seismic Response as an Annex to Summary Report of ITSU-XIII (Assistant Secretary IOC)	Done
38	Working Group on Tsunami Public Education and Awareness Programme. New membership of Group (Chairman ICG/ITSU; Chairman of Working Group)	Done
39	Development of education programmes for primary and high schools (Consultants; Chairman of Working Group)	Done
39	Definition and development of draft of general public education strategy (Consultants; Chairman of Working Group)	Under preparation
39	Distribution of programmes and strategy for comments (Chairman of Working Group; Assistant Secretary IOC)	Done
39	Meeting of Working Group (Chairman ICG/ITSU; Chairman of Working Group; Assistant Secretary IOC)	There was no meeting due to lack of funds
39	Submission of documents to ITSU-XIV for adoption (Chairman of Working Group)	Done
42	To invite consultants to draft education programmes and strategy (Secretary IOC)	Done
48	To give wide publicity to automatic system of real-time measurements of seismic moment and estimation of tsunami risk, developed at Polynesian Tsunami Warning Centre and solicit comments from the field (Chairman ICG/ITSU; Assistant Secretary IOC)	See IOC letter to Member States of the Pacific; no comments received
49	To provide support and implement software, hardware and training for Mm determination to Mexico (National Co-ordinators of France and Mexico)	Done

Para of ITSU-XIII Summary Report	Action (Responsible Person)	Status of Implementation
51	To inform Member States concerned, on results of communication test (Chairman ICG/ITSU; Assistant Secretary IOC)	Done
54	To request ITSU Member States to continue efforts on historical tsunami data collection on regional basis (Director ITIC; Assistant Secretary IOC)	Not done
55	To make software for database format available upon request (requests came from Chile and Mexico) (Director ITIC)	Not done yet because of ITIC problems. Will provide format to Chile and Mexico in 1994
55	To use most updated version of d-Base-IV for tsunami database format (Director ITIC)	Not done due to staffing problems
62	To make contact with Krasnoyarsk Computing centre for transfer of rights on "*Luch*" software, based on contributions of Member States to IOC Trust Fund (Assistant Secretary IOC; National Co-ordinator of Russia)	Contract was not signed, there were no contributions from IOC Member States to Trust Fund
68	To collaborate in establishing GOOS and inform First Session of GOOS Committee on ITSU-XIII decisions relevant to GOOS/ITSU joint activities (Chairman ICG/ITSU; Assistant Secretary IOC)	Done
72	To establish direct contact with ASCWP (Chairman ICG/ITSU; Chairman of Group of Experts on RTSDE)	Not done
74	To prepare status report on implementation of actions specified in ITSU Master Plan and distribute it to ITSU Member States prior to ITSU-XIV (Chairman; Vive-Chairman ICG/ITSU; Director ITIC)	Done
79	To bring to the attention of SOPAC meeting (Sept. '91) concerns of the Group related to development of UNDP support to the project of Regional Tsunami Warning System for Southwest Pacific (National Co-ordinator of France)	Done Dr. Talandier drew attention of SOPAC meeting to the problem we face in implementing the regional proposal for Southwest Pacific
79	To continue efforts in order to solicit UNDP Support to the project (Secretary IOC; Chairman ICG/ITSU)	Continuous
85	To inform EGSWG on decisions of ITSU-XIII relevant to expansion of ICG/ITSU activities to other tsunami-prone areas (Chairman ICG/ITSU; Assistant Secretary IOC)	Done
91	To invite Member States to give names of candidates for post of Associate Director ITIC (Secretary IOC; Chairman ICG/ITSU)	See Resolution IOC-XIII.9 of IOC Assembly
92	To continue financial support to ITIC activities (Assistant Secretary IOC; Chairman ICG/ITSU; Director ITIC)	Continuous

Para of ITSU-XIII Summary Report	Action (Responsible Person)	Status of Implementation
97	To arrange ITIC visiting experts training activities in 1991-1992 for 4-5 experts from countries of the region (Director ITIC; Assistant Secretary IOC)	Done in 1991 (2 experts were trained). There was no training course in 1992 due to staffing problems in ITIC
101	To continue work on interactive tsunami modelling system and report on the progress to ITSU-XIV (National Co-ordinator of Russia)	Done
103	Publication of Children's Book on Tsunamis (Director ITIC; Assistant Secretary IOC)	Done
103	To request Member States and organizations to provide comments on Tsunami Glossary and publish regularly errata pages (Director ITIC; Assistant Secretary IOC)	Done No comments received
104	Publication of ITIC brochure in Spanish, French and Russian (National Co-ordinators of Mexico and France; Assistant Secretary IOC, Director ITIC)	Spanish version was prepared in Mexico. It was not published due to lack of funds. Negotiations with France and Russia will continue
105	To investigate possibility of publishing Catalogue of Tsunami on Western Coast of Mexico in WDC-A for Solid Earth Geophysics (Assistant Secretary IOC; National Co-ordinator of Mexico)	Done
116	To make arrangements for 1993 Tsunami Workshop in conjunction with IUGG Symposium on Tsunami, taking into account ITSU-XII recommendations (Chairman and Vice-Chairman ICG/ITSU; Director ITIC; Assistant Secretary IOC)	Done
118	To finalize with Japan place and date of ITSU-XIV (Chairman and Vice-Chairman ICG/ITSU; Assistant Secretary IOC)	Done
	Recommendation ITSU-XIII.1 (TIME) To urge Member States at EC-XXV to give high priority to this project (Chairman ICG/ITSU; Secretary IOC) To invite Member States to consider financial support for the project using extra-budgetary mechanisms of funding (Secretary IOC; Chairman ICG/ITSU)	Done See Resolution EC-XXV.5. Resolution IOC-XVII.9 and para. 155 of EC-XXV and para. 247 of IOC-XVII
	Recommendation ITSU-XIII.2 (Pacific Rapid Response System) To encourage Member States to provide financial support for implementation of elements of Phase-II (Chairman ICG/ITSU; Secretary IOC) To organize meeting of Group of experts during latter half of 1992/early 1993 (Secretary IOC; Chairman of Group of Experts)	Done See Resolution IOC-XVII.9 Done See Summary Report Doc. IOC/INF-930

Para of ITSU-XIII Summary Report	Action (Responsible Person)	Status of Implementation
	Recommendation ITSU.XIII.3 (Public Education and Awareness (see actions and their implementation under paras.32,38,39)	
	Recommendation ITSU.XIII.4 (Programme and Budget) To provide funds for organization of ITSU-XIV, Workshop, Officers Meeting (Secretary IOC; Chairman ICG)	Done
	To provide funds for participation of ITSU Officers/Experts in relevant meetings of other organizations (Secretary IOC)	Done
	To implement TIME Project (Chairman ICG/ITSU; President IUGG Tsunami Commission; Secretary IOC)	Implementation is going on, due to support provided by Japan and USA. No support from IOC and other international organizations has been received yet.
	To co-sponsor scientific conferences and symposia related to tsunami programme (Secretary IOC; Chairman ICG/ITSU)	Done
	(See also actions under paras. 39, 42, 74, 91, 92, 97, 103, 104)	

ANNEX VI

STRATEGY FOR A RAPID RESPONSE SYSTEM
(Revised Version)

PROJECT STRATEGY PLAN

This project has as its objective the mitigation of hazards created by tsunamis and destructive earthquakes within the Pacific region through the real-time telemetry of geophysical data. The entire Pacific region is surrounded by the most seismically active zones in the world. Destructive earthquakes are common in these zones, and there is a long history of death and destruction caused by these earthquakes and the tsunami they generate.

The very nature of the effort necessary to improve our capability to mitigate these earthquake-related hazards makes this project international in scope and character. Consequently, to be completely successful, this project will require good international co-operation and the active support of all countries in the Pacific region and international organizations.

A primary goal of this project is to co-ordinate the individual efforts of many countries and to provide any necessary technical assistance. This project is structured to have 3 phases as will now be summarized.

Phase 1

Included in Phase 1 are all of the national and international co-operative arrangements which have been made and were in effect as of a few years ago. These co-operative arrangements have all continued or improved over the last two years. Routine exchanges of alphanumeric data for the larger Pacific region earthquakes have been extended to a number of countries. The largest increase in data sources is in the number of tidal stations available via satellite telemetry (from 68 to 80). Phase 1 continues to be very successful.

Phase 2

The second phase of this project consists of those efforts which have been underway for the last few years to improve the existing monitoring system through the transmission in real-time of high quality digital data. Many of these efforts include the deployment of new broadband seismic stations and the real-time transmission by satellite of seismic and other geophysical data. Progress in this phase over the last two years has been remarkable. For example, broadband seismic stations transmitting high quality data in real-time now exist and are operating in many places in Australia, Canada, China, French Polynesia, Japan, Mexico, and the United States. A number of similar stations will soon be operating in South America and plans have been prepared for the development of real-time networks that will span all of Central and South America. International programmes such as IRIS, GEOSCOPE, GTSN, GDSN are developing near real-time full wave satellite transmission. Because such wave form might be of interest, ITSU should keep close contact with these programmes. However, within the scope of ITSU, the first objective should be focused on early warning. Real-time transmission of processed data such as P arrival, amplitudes, seismic moment, etc. is of the foremost importance, particularly in the context of independent national tsunami warning centers.

Phase 3

The third and motivating phase of this project is just beginning. This phase consists of all those actions that must be undertaken to complete the real-time system for the Pacific. These actions may be technical (involving technical assistance) or political (encouraging co-operation). The activities of Phase 3 of this project are designed to support the objectives of the International Decade of Natural Hazard Reduction. Phase 3 will continue throughout the time period of the Decade. At end of this time, a complete tsunami and earthquake monitoring system should be in place throughout the Pacific region to safeguard life and property against these natural hazards. A strategy plan for the implementation of Phase 3 is presented below.

Implementation of Phase 3

(I) General Approach

Experience gained both in the execution of a number of international geophysical programmes and in the planning, development and deployment of real-time networks in North, Central, South America and Indonesia has demonstrated that a highly effective method of encouraging the international co-operation necessary to a project is a series of visits by technical personnel to those countries and institutions who must play a primary role in the project. For this project, these visits will provide the important opportunity to make technical presentations that detail the nature and many advantages of real-time systems and formulate national and regional technical funding and management plans.

(II) Specific Projects

In addition to the general approach described above, there are a number of specific projects which appear to merit immediate consideration:

(a) One such project which should be given a very high priority involves the use of the worldwide Internet computer telecommunications network. Initial efforts would emphasize the exchange of parametric, processed data from regional network nodes using TCP/IP ftp (file transfer)/telnet (remote login) utilities over the Internet computer telecommunications system. Also important will be the development of automated digital acquisition systems capable of providing segmented seismic and tsunami waveform data streams in near real-time for automatic data exchange via Internet.

(b) A very important project that should be implemented now in various countries throughout the Pacific Region is the installation of PC-based automatic earthquake detection and location systems (such as the IASPEI system) in areas where local telemetered seismic networks already exist. Event data from these systems would augment data now being collected by tsunami warning centers and may provide the necessary information to determine if a particular earthquake has created a tsunami.

(c) An alternate project would be the establishment of a single station warning system. Much of the damage and loss of life resulting from earthquakes and tsunamis in the Pacific region occurs within regional distances from the epicentre (i.e., Nicaragua, 1992 and Indonesia, 1992). The time delay before triggering of an alarm is therefore a critical parameter. A single station warning device may provide an adequate answer to the problem of early warning. Such a device exists (the Tremors system) and has been successfully tested for many years in French Polynesia. This system consists of a 3-component broadband seismic station linked to a PC computer. Its concept is based on the real-time evaluation of the seismic moment of the event, a parameter which is known as a good indicator of the height of the tsunami on the high sea. The single station warning system can trigger an alarm in less than 5 minutes after receiving the P waves from a regional event. The system such as Tremors should be implemented on existing strategic broadband seismic stations located in the Pacific States and the parametric data should be made remotely accessible through Internet, described above, or by other means.

(d) Another project would be to encourage the telemetry and digitization of local water level data. Much of the hardware necessary to support automated earthquake detection systems can also be used to collect water level data in a digital format. Tsunami data collected in this manner would supplement data telemetered via satellite or accessible via telephone dial-up.

(e) Finally, an important project which can yield immediately a large amount of high quality data in near real-time is to obtain access to data from stations originally installed for nuclear treaty monitoring purposes. Access to these data requires only the approval of the countries that installed the stations.

Recommendation

It is the strong recommendation of the Group that the implementation plan for Phase 3 detailed above be approved and executed. The Group considers the on-site visits of technical experts to be of particular importance for the implementation of the following recommendations and notes that the benefit of such visits can be extremely large, while the cost will be very small (US$ 20,000/year).

It is recommended:

(i) that every effort necessary be taken by the IOC to support the establishment of a wide-area informational exchange network among the ICG/ITSU Member States for the purpose of providing immediate access to most recently processed earthquake and tsunami data and ultimately to event waveform data using a worldwide telecommunications system such as Internet;

(ii) that the IOC Assembly consider ways of support for the installation of PC-based earthquake detection and location systems and making a system similar to Tremors systems available throughout the Pacific; and

(iii) that IOC Member States make real-time seismic and tsunami data such as P arrivals, amplitudes, seismic moment, etc., collected by nuclear treaty monitoring facilities available for international exchange as needed.

ANNEX VII

PROJECT PROPOSAL OF FRANCE ADOPTED BY ITSU-XIV

1. INTRODUCTION

1.1 HISTORICAL BACKGROUND

After the recommendation from the General Conference of UNESCO in 1966, to improve the capabilities of a Tsunami Warning System in the Pacific, it has been agreed that the already existing US facilities in Honolulu are to be expanded to become the International Tsunami Information Centre (ITIC) for the Pacific area. The co-operation between countries of the Pacific region has been put into effect with the actual establishment in 1968 of an International Co-ordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU). At its Sixth Session, held in Manila in 1978, ITSU recognized the need for the development of Regional Tsunami Warning System in regions where tsunami warnings cannot be provided in good time by the current system, which acts on behalf of the international community (PTWC). This need has been strongly emphasized by ITSU Members in several of its sessions. Following an ICG/ITSU recommendation (Suva, 1982), IOC organized, with the financial assistance of Japan, a feasibility study mission (in 1984) to some countries of the Southwest Pacific region (Indonesia, the Philippines and Papua-New Guinea) which are strongly concerned by tsunami hazards mitigation. A project proposal, well accepted in the Group, was submitted to UNDP for consideration and funding. On request of the UNDP, a survey of the needs of the concerned countries (including the Solomon Islands) has been made by IOC and a Group of Experts (May, 1989), and a project draft was finalized. It is the "*Five Year Master Plan for the Development of a Regional Tsunami Warning System in the Southwest Pacific*", prepared by G. Pararas-Carayannis (ITIC). The Senior Assistant Secretary IOC reported on the implementation of the proposed actions during the Thirteenth Session, held in Ensenada, 1991. After an intensive discussion, the ITSU Group urged all Member States involved in the implementation of the project, to ask their representatives to UNDP to express their full support to the project.

In addition to the need for the development of Regional Tsunami Warning Centres, the ITSU Group decided during its Twelfth Session (Novosibirsk, 1989) to study various possibilities, such as real-time telemetry and seismic and tsunami data exchange between national centres in the Pacific. An *ad hoc* Group of Experts was formed, with members nominated by France, Japan, USA and USSR. The First Session took place in Honolulu, Hawaii, January 1991 and has been reported at the ITSU Thirteenth Session (Project on Rapid Seismic Response IOC/ITSU-XIII/3 Annex VI, 1991). Some project components, as defined by the *ad hoc* Group, are the following:

- installation of broad-band instrumentation throughout the Pacific basin, since this kind of equipment is the only one able to deliver a good estimation of the seismic moment.

- development of real-time data acquisition telemetry system for these seismic installations.

- installation of tsunami gauges in tsunami source regions and at specific locations to rapidly detect and monitor the progress of a tidal wave across the Pacific; development of real-time communications for these tide gauges.

- development of a real-time communication network linking national tsunami warning centres.

Following the Recommendation ITSU-XIII.2, a Second Session of the *ad hoc* Group of Experts was held in Honolulu, Hawaii, in January 1993.

1.2 SEISMICITY AND HISTORICAL TSUNAMIS OF THE SOUTHWEST PACIFIC REGION

The geologic and tectonic settings of most of the countries of the Southwest Pacific Region, cause them to be prone to two major hazards: volcanic eruptions and destructive earthquakes with their side effects. Most of the coastal areas are vulnerable to tsunamis, triggered by distant or regional earthquakes and also

by local submarine landslides. The effects of these disasters are strongly amplified by the habits of the inhabitants who usually live along the coast.

It may be noticed that, for more than 50 years, only 3 tsunamis induced a lot of damage and death in countries located very far away from the earthquake epicenter (Aleutian Islands, 1946, 1957 - Chile, 1960). On the other hand, it is clear that a lot of people have died or have been injured because of tsunamis initiated by earthquakes occurring at regional or local distances. Among the most important ones, and in the last two decades only, we can mention: the Philippines (August 1976), Indonesia (July 1979), Colombia (December 1979) Japan (May 1983), Nicaragua (September 1992) and Indonesia (December 1992. Each of these events caused a lot of damage, some hundreds of casualties (thousands for the Philippines and Indonesia - 1992 earthquakes) and thousands were injured. In each case it appears that the Pacific Warning System was not able to provide information to the concerned countries in time. The main reason why PTWC was unable to issue an alarm in time is that the tsunamis were triggered by regional earthquakes occurring in inland seas close to the coast, or on the island itself, or the continent, very close to the coastline (Flores, Indonesian earthquake, 1992). The appropriate response to such a hazard can only be given by national warning centres able to estimate by themselves, and in real-time, the magnitude and seismic moment of any large earthquake, to assess the tsunami risk and to broadcast warnings in less than 15 to 30 minutes. This seems to be made possible by the use of modern technology (broadband seismometers, tidal sensors, acquisition systems linked in real-time to computers) and of a single station concept for the measurement of the seismic moment of an event, and the following evaluation of the tsunami risk. The method to be used to achieve this aim is discussed hereafter.

2. CONCEPT FOR A NATIONAL TSUNAMI WARNING CENTRE: THE TREMORS SYSTEM

The final goal of this proposal is to create seismic warning centres, in each country of the Southwest Pacific region, dealing with earthquakes and related tsunami hazards. These centres would be able to issue warnings within an adequate time-frame following a large earthquake. Each national centre would be responsible for the tsunami risk evaluation for its own country. Hence, it would have to be connected to the other national centres of the region in order to exchange, as quickly as possible, all the information related to the triggering earthquake. The possibility of a regional warning centre which would concentrate all the data may be considered as an improvement to the system, giving a bigger safety margin in case of failure of a national centre. This regional centre could be linked in near real-time to other warning centres in the Pacific basin and particularly to the PTWC. Then, it would bring a major contribution to a comprehensive Pacific-wide seismic monitoring network. However, priority must be given to the delivery of an early alarm, and thus, in the first place, the national centres have to be provided with equipment allowing them to be self sufficient.

2.1 THE TREMORS SYSTEM

TREMORS is an integrated automated system, based on a 3-component broadband seismic station, used in French Polynesia by the Laboratoire de Géophysique, CEA. Developed and installed at the CPPT (French Polynesian Tsunami Warning Centre in Tahiti), it computes in real-time the earthquake source parameters (location, mantle magnitude Mm, seismic moment Mo), and provides a quantitative estimate of the tsunami risk for French Polynesia. The broadband sensors, featuring a high dynamic range, are connected to a 486 IBM-compatible computer, running a specific software. This system, which has been developed on both an experimental and a theoretical basis, has been working in Tahiti since 1987. Numerous reports have been published (Okal, Talandier, Reymond, Hyvernaud) and several communications made during the last ITSU sessions. The most important points are just summarized thereafter.

The event detection is performed using the classical STA/LTA criterion, applied on the envelope of the vertical seismic signal. While the corresponding algorithm is running continuously, instantaneous azimuth and incidence angles are computed over a moving window, giving a rough estimate of the epicenter location.

The system starts looking for S waves and surface waves (Rayleigh and Love waves). The final analysis involves an automatic phase picker working on a characteristic function of the signal. The polarization planes of the seismic wave are determined and the final location calculated from the S-P time interval, using the Jeffrey-Bullen tables. Earthquakes received as PKP, with epicentral distances greater than 130° are also located automatically.

The seismic moment evaluation process starts immediately after completion of the epicenter location. This measure, based on the Mantle Rayleigh wave and Love wave, uses the mantle magnitude Mm as an intermediate parameter. Computed in the frequency domain in the full range of surface wave periods from 50 to 300 s, this magnitude has several advantages: unlike the usual magnitudes (mb, Ms) it doesn't saturate and it is valid therefore for large earthquakes. Moreover, it is in particular directly connected to the seismic moment Mo.

TREMORS has been used to compute more than 600 seismic moments in the range from 10^{16} to 4.10^{21} N.m. When later compared to the moment values obtained from Centroid Moment Tensor inversion, the standard deviation of the residual is less than 0.2 unit of magnitude, which is comparable with the scatter between individual CMT solutions for the same event. This is an experimental proof of a theoretical work by E. Okal (1988).

More recently, this procedure, first introduced for teleseismic events, has bene extended to the case of regional distances ($1.5° < \text{delta} < 15°$). The results obtained indicate that the mantle magnitude Mm can be used, in the case of the regional field, without losing its performance. The particular case of regional field warning has then been investigated and the TREMORS system modified, to take into account the necessity to minimize the time delay before triggering the alarm. Based on the seismic moment computation - through a growing window which increases by 50 seconds steps - the method allows to trigger the alarms in less than 5 minutes after receiving the P waves. The analysis performed by Talandier and Okal (1992), on more than 140 events recorded by the Geoscope network, shows the quality of the seismic moment estimate, and also the accuracy of the Mm magnitude in the case of the regional field. Talandier and Okal showed that there is a threshold in terms of seismic moment above which earthquakes might be tsunamigenic. This seems to hold also for the most recent events. Moreover, in French Polynesia, there is a relation between seismic moment and tsunami height. However, each region has a specific geological context which should be carefully studied before the Tahitian quantitative relationship is strictly applied. Sufficient seismic data, through the TREMORS system, and bathymetric data should be gathered for each specific site. Proper consideration should be given to coastal slope stability, resonance of coastal bays and harbours, and run up. It therefore seems that the TREMORS system is a major improvement for tsunami warning applications, as we think that once installed in a national or regional warning centre, it would be self sufficient to give an adequate seismic alarm for the regional field. It would also allow gathering of data for quantitative relationship between local tsunami height and seismic moment. As it does not need any complicated satellite link, it will work faster than any system based upon computation of the source parameters (location, focal mechanism), that would use data transmitted in real-time from a large network of seismic stations.

2.2 PROPOSED TSUNAMI WARNING NATIONAL CENTRES FOR THE SOUTHWEST PACIFIC

Following the recommendations of the ITSU Group, the countries selected to participate in a Regional Tsunami Warning System are those chosen in the Five Year Master Plan, namely: Indonesia, Papua-New Guinea, the Philippines and the Solomon Islands.

The installation of tide-gauge sensors are not taken into account in this report but the conclusions of the Five Year Master Plan are still valid.

2.2.1 The Philippines

A broadband station should be installed in the southern part of the archipelago, for example, in Cebu or in Mindanao. Data processing will be performed in this station if it can play the role of the national warning centre. Otherwise, it will be necessary to connect the seismic station to the warning centre in real-time, using a hard line radio telemetry or a satellite link.

2.2.2 Indonesia

A broadband station has been set up at Tretes, East Java in the frame of a bilateral French-Indonesian programme. This station is expected to be equipped with the TREMORS system by the end of 1994, the data being also processed at BMG (Meteorological and Geophysical Agency, Jakarta) which is in charge of earthquake monitoring and seismic warning. BMG is therefore in a very good position to issue initial watches or warnings.

A second station should be installed at Manado, Northern Sulawesi, which is located close to a very seismically active area. The TREMORS system could be set up at Manado, if there are existing facilities to issue warnings there, or at Ujung Pandang which can be linked to Manado by telemetry.

2.2.3 Papua-New Guinea

We noted that a new digital seismic network has been installed there with the support of Germany. However, it seems that no broadband station has been planned. Therefore, a station should be set up near Port Moresby, where the Geophysics Laboratory is located. The distance from the north coast, about 5°, is compatible with an early warning. As indicated in the Five Year Master Plan, it will be necessary to establish an around the clock capability to issue watches and warnings, even though the whole TREMORS process is automatic.

2.2.4 The Solomon Islands

Since there is no modern seismic station yet in the Solomon Islands, the exact location of the broadband station to be installed will depend on the existence of facilities. It could be in Honiara, on the island of Guadalcanal.

2.2.5 Other Countries

Except for some sophisticated links that might be needed, the most expensive part of the TREMORS system, is clearly the one concerning the broadband sensors. This is the reason why, LDG and INSU/IPGP (INSU being the French organization which is running the worldwide Geoscope network) agreed to study the possibility of implementing the TREMORS system on Geoscope stations. The Geoscope seismic stations which could be concerned by this programme are located in New Caledonia and at Inuyama, in Japan. Carrying on the same idea since 1991, LDG and ORSTOM - which participate with the Geoscope network - are looking for an opportunity to implement some broadband seismic stations in the Vanuatu Islands. If realized, these implementations would increase, at a cheap cost, the monitoring capabilities of the warning centres.

It is obviously possible to extend this programme to other countries of the Southwest Pacific region, located on both sides of the considered area, which are also concerned by seismic and tsunami hazards mitigation. This applies, for example, to Fiji, Samoa, Tonga on the eastern part, Malaysia and Vietnam on the western part. If these countries are already equipped with broadband seismic stations (or if it is expected that they will be equipped in the near future) the possibility of implementing the TREMORS system could be considered at a rather moderate cost.

In any case, it would be important for these countries to receive, in near real-time, warning issues from national centres as Indonesia or the Philippines for the Western area, Vanuatu or New Caledonia for the eastern area.

3. CONTRIBUTION OF THE TREMORS SYSTEM TO A COMPREHENSIVE PACIFIC-WIDE TSUNAMI MONITORING NETWORK

In the previous section, the contribution (in terms of regional seismic and tsunami warnings) which the TREMORS system could bring to national centres of the Southwest Pacific countries, have been described. Moreover, this single station concept can be extended to other countries located all around the Pacific basin (i.e., Central and South America) where 3-component broadband seismic stations have already been installed. These stations, equipped with the TREMORS system, could also participate in a comprehensive Pacific-wide monitoring network and contribute to the far field global alarm (i.e., French Polynesia, Hawaii, California).

It is proposed to implement TREMORS on the following broadband stations of the world-wide Geoscope seismic network.

- in Mexico (Mexico City University, already working);
- in Chile (planned section) for which the funding has to be found;
- in Hawaii, Oahu (existing station;
- in the USA, Santa Cruz, California (already working) which could be funded on national grants.

In this context, the Laboratoire de Géophysique at Tahiti, French Polynesia has been running a TREMORS station for more than 6 years. It is planned to implement TREMORS within one year in 3 other stations located in the Rangiroa atoll (Tuamotu archipelago), in Rikitea (Mangareva Island, Gambier archipelago) and in Tubuai (Australes Islands). This programme is already funded.

Data from each national centre of the Southwest Pacific countries will have to be checked, during a period of approximately two years following implementation, against CPPT data in Tahiti. To achieve this monitoring, the main earthquake parameters determined by the TREMORS system (i.e., arrival times of the different phases, azimuth and incidence angles, location, mantle magnitude Mm, seismic moment Mo) will be transmitted in real-time to the CPPT. Because the seismograms are processed on each site by the TREMORS system, this involves a rather low amount of data, roughly estimated to 8 kBytes per day (on the basis of 250 Bytes/event, 4 events/day and 8 seismic stations). It is planned to use a DCP connected to the TREMORS system and a satellite link. One possible implementation would be: the INMARSAT C satellite, X25 links between the earth stations (Perth in Australia and Santa Paula in the USA) and Tahiti. Other solutions should be investigated, such as using, even partially, the PEACESAT satellite. With such a possibility, the CPPT would collect, for the whole duration of the project, the parameters of numerous earthquakes recorded by the national centres of the regions of interest. Thus, it would allow a calibration of the TREMORS system and it would be a great opportunity for the personnel involved in tsunami warning to get some training before the beginning of the operational phase in their respective national centre.

After a probation period, these data-collecting capabilities could be transferred to one of the national centres, chosen to play the role of a regional centre.

4. TRAINING AND EDUCATION

A training programme has to be set up for the personnel of different national centres in charge of maintenance and operation of the equipment: broadband seismic sensors, data acquisition and transmission systems and data processing systems.

A total of 6 technical training workshops would be organized over the period of the project implementation: one for each of the 4 Southwest Pacific countries, originally members of the plan - one for New Caledonia and Vanuatu - one for Mexico and Chile.

These workshops might take place in Tahiti, in order to use the advantages of the TREMORS system already installed in French Polynesia and to benefit from the experience accumulated for many years in this field, of the CPPT. It could prove useful to add to these workshops, a one- to two-week training period, in each of these countries, on the definitely installed equipment. This would be the last step before the transfer of responsibility to national authorities.

Furthermore, one or several workshops aimed at the official organizations responsible for carrying out the actions necessary to alert the population, to prepare evacuation plans and to send rescue teams on the field, have also to be planned. This component of the educational plan has not been evaluated in this document.

5. PROJECT FUNDING

The financial estimate, given hereafter, is based on the following assumptions:

- Installation of 4 three-component broadband seismic stations equipped with the TREMORS system and a DCP allowing transmission of earthquake parameters by satellite telemetry. These stations will be set up in the Philippines (Cebu or Mindanao), in Indonesia (Manado), in Papua-New Guinea (Port Moresby) and in the Solomon Islands (Honiara).

- Implementation of 4 TREMORS system, with DCP, on Geoscope stations. We propose to select the existing stations located in New Caledonia and Mexico, and those which are planned in Chile and Vanuatu.

- Six technical training workshops for geophysicists and maintenance personnel of the 8 participating countries. These workshops would be held in Tahiti (CPPT - Papeete) over a period of one year, with groups consisting of mostly 4 people. The sessions may last two weeks.

- Eight training courses to be held in each national centre of the participating countries, before the transfer of responsibility for the warning system to national authorities.

- Post-installation maintenance: one technical visit per seismic station and per year during a two-year period. One lot of spare parts for each station.

- Miscellaneous: consumables, satellite communication costs over the 3-year period.

5.1 PROJECT PERSONNEL COMPONENT

It is considered that the project will require the full-time services of a project co-ordinator, the services of an administrative support and occasionally of experts or consultants. This component includes travel to participating countries, performed for the purpose of co-ordination and supervision of field installations; with travel and per diem, it is estimated at US$ 300,000.

5.2 TRAINING COMPONENT

The training programme in Tahiti will include 6 workshops; each of them will be held for 4 people over a 2-week period. The expenses, covering travel and per diem are estimated at US$ 100,00.

The technical visits planned in each participating country before the transfer of responsibility to national authorities will provide a second opportunity of training for personnel in charge of the warning centre. The costs of these visits including travel and per diem, should be US$ 40,000.

5.3 EQUIPMENT COMPONENT

The cost for a 3-component broadband instrumentation including telemetry and a provisional sum for a seismic vault should be approximately US$ 100,000. The cost of the TREMORS system and the DCP associated to a satellite link is estimated at US$ 35,000.

A new 3-component broadband seismic station including the TREMORS system, telemetry and a DCP will cost approximately US$ 135,000. For 4 stations of the Southwest Pacific countries, the total amount will be US$ 540,000.

When the TREMORS system is implemented on a Geoscope station, we must add US$ 15,000 for digital telemetry between the existing seismic station and the computer.

The cost of the TREMORS system with telemetry and a DCP implemented on an existing broadband station is estimated at US$ 50,000. For two stations in the Southwest Pacific area, one station in Mexico and one in Chile, the total amount will be US$ 200,000.

5.4 INSTALLATION COMPONENT

Initial installation of a new broadband seismic station equipped with the TREMORS system will require the services of at least two people, at a cost of approximately US$ 17,000. Travel and per diem are estimated at US$ 10,000. Considering the 4 new stations in the Southwest Pacific region, the funding requirement should be US$ 108,000.

Implementation of the TREMORS system on an existing station will require the services of two people at a cost of US$ 10,000. Travel and per diem are estimated at US$ 8,000. It results that the implementation of TREMORS on 4 stations will cost US$ 72,000.

It is supposed that local labour will be hired in each country at an approximate cost of US$ 20,000 for a new station and US$ 5,000 for an existing station.

5.5 MAINTENANCE COMPONENT

The post-installation maintenance, not including travel, is estimated to average about US$ 6,500 per station per year. For 8 stations, and a 2-year period, this maintenance will cost approximately US$ 100,000. Travel for the same 2-year period, is estimated at US$ 50,000.

It is expected that spare parts will be covered approximately by a provision of US$ 7,000 per each new broadband station and US$ 3,000 per each TREMORS system which will be implemented on an existing station. The total amount for spare parts should be US$ 40,000.

5.6 CONSUMABLES, SATELLITE COMMUNICATION AND MISCELLANEOUS

It is supposed that miscellaneous expenses of US$ 50,000 will be engaged over a 3-year period to cover consumable costs, satellite communication costs and office supplies related to administration.

5.7 SUMMARY OF COSTS

Project personnel	US$ 300,000
Training programme.	US$ 140,000
Training workshops in Tahiti (6)	US$ 100,000
Visits (and training) to national centres (8)	US$ 40,000
Equipment	US$ 740,000
New broadband stations with TREMORS (4)	US$ 540,000
TREMORS implemented on existing stations (4)	US$ 200,000
Installation	US$ 280,000
New stations (4)	US$ 188,000
TREMORS and existing stations (4)	US$ 92,000
Maintenance	US$ 190,000
One visit/station/year over 2 years (8)	US$ 150,000
Spare parts (8)	US$ 40,000
Miscellaneous	US$ 50,000
Grand Total	US$ 1,700,000

6. WORKPLAN AND SCHEDULE OF ACTIVITIES

Upon approval of the project and assuming funding at D0, the project could be implemented in the following order:

D0	The final project is accepted and funded by international agencies.
D0 + 3	Section of project co-ordinator. A Technical Advisory Committee is established. Contracts for procurement of instrumentation are issued.
D0 + 12	All instrumentation manufactured. FOB.
D0 + 15	Shipment
D0 + 21	Completion of installations. Testing and calibrations in the Philippines, Indonesia, Papua-New Guinea and the Solomon Islands.
D0 + 24	Completion of installations. Testing and calibration in Mexico and Chile.
D0 + 27	Completion of installations. Testing and calibration in New Caledonia and Vanuatu.

D0 + 18 to D0 + 27 — Training courses on technical aspects, in Tahiti.

D0 + 30 — Second training in each national centre, before starting of official operation.

D0 + 21 to D0 + 36 — Earthquake parameters determined by TREMORS are transmitted from each national centre to CPPT. System calibration for each participating country.

D0 + 36 — Final acceptance and inspection of the seismic stations and national centres by experts of participating countries and by the staff of the project co-ordinator.

D0 + 39 — Total responsibility for national warning system transferred to participating country authorities. Transfer of communication facilities from CPPT to a Regional Warning Centre.

ANNEX VIII

PROJECT PROPOSAL OF RUSSIA ADOPTED BY ITSU-XUV

EXPERT TSUNAMI DATABASE FOR THE PACIFIC

The objective of the proposed project is the development of a comprehensive expert database on tsunamis and related geophysical phenomena on regional and Pacific-wide basis for further application in tsunami warning, risk assessment and mitigation.

The compilation of historical data on tsunami occurrence and coastal manifestation is an important part of the investigation of the tsunami problem for any tsunamigenic region of the Pacific and elsewhere. Traditionally, historical data has been compiled and published in the form of tsunami catalogues for the whole Pacific, as well as for its particular regions. However, the data in the paper catalogues become obsolete rather quickly. Besides, they have a fixed pre-determined format that makes the data retrieval and handling rather complicated and a time-consuming process. Modern information technology demands the organization of data in the form of databases, where the data are in active form and their handling can be interactively made in a fast and efficient manner.

Recent achievements in the developments of PC-based DBMS software along with the declining prices of personal computers provide an excellent opportunity to bring all observational tsunami data to the desk of a researcher who wishes to have all available information at hand. It is highly desirable to make all regional and Pacific-wide tsunami catalogues available to individual researchers and provide them with a specialized PC-based software which can be easily used to manipulate this type of data. Direct access to historical tsunami databases in a standardized format along with some mathematical models and efficient processing tools will open new possibilities for investigations related to many aspects of the tsunami problem.

As a result of a feasibility study, a concept of the Expert Tsunami Database (ETDB) was developed at the Tsunami Laboratory of the Novosibirsk Computing Centre, Russian Academy of Sciences. The ETDB will contain in digital form all available earthquake and tsunami information for a particular region (source parameters, observed heights, original historical descriptions, etc.) as well as basic reference information on regional seismic and mareograph networks, regional geography, geology and tectonics. Additionally, it will include blocks for tsunami modelling (e.g., calculation of travel-time charts) and some standardized tools for data processing and plotting. The specially developed graphic shell will provide the possibility to manipulate maps, models and data in a convenient and efficient manner.

In elaborating the ETDB we are to meet the following basic requirements:

1. the system should have a module structure allowing flexibility and adjustment to particular application, as well as to be an open system providing the potential for growth to keep abreast of research advancement;

2. it should have a built-in computer mapping subsystem providing the ability to display the data on actual geographical bases;

3. the system should have a built-in glossary of tsunami-related terms accessible in sequential and browsing mode;

4. the system should have some standardized tools for data processing and visualization;

5. the system should have a user-friendly interface based on a menu driven approach.

It is proposed to build the ETDB on the basis of the Hypertext conception which allows the integration within one software system of all kinds of data: numerals, text, graphics, source codes (e.g., mathematical models), even audio and video information. The ultimate goal of the ETDB Project is to develop the comprehensive database on tsunami and related geophysical phenomena, which contains the complete set of original, un-interpreted information available to anyone who wishes to revise estimates, to make his own

interpretation, to raise questions or to propose improvements. The final product could be used, not only as a comprehensive tsunami database, but also as a convenient electronic textbook and reference book on tsunamis, as well as a computer-aided device for investigation of different aspects of the tsunami problem.

The Expert Tsunami Database should exist in 2 forms which can be called "parents form" and "users form". The database in its parent form should exist at a regional warning centre or specialized data centre on some dedicated hardware and be provided with some continuing qualified maintenance, i.e., to have the database administrator who is authorized and responsible for routine updating, editing and refinement of data.

In its users form, the ETDB exists as an automated tsunami catalogue embedded inside a specialized graphic shell that is an users interface and provides possibilities for fast and convenient retrieval, visualization and handling of data. As such, the users database represents an electronic analog of conventional tsunami catalogues, however, considerably surpasses them in its efficiency and convenience. The users database is also provided with some tools for data editing and further data compiling that makes it possible to use it as a base for the development of a personal database containing all the meaningful information related to the needs of individual researcher.

The potential application of the ETDB can be 3-fold:

1. Facilitating the decision-making process at regional Tsunami Warning Centres;

2. In-depth education and orientation of officials and the public, demonstrations and prevent emergency planning;

3. It can be used as the basis for the development of a personal database for scientists involved in tsunami research and investigation.

The software developed under the ETDB Project will be the Database Management System (DBMS), menu-driven graphic shell for data retrieval and handling, and the supporting mapping software. It will run on 286 or 386 PC under MS-DOS.

The demonstration version of the ETDB has been developed at the Tsunami Laboratory of Novosibirsk Computing Centre on the basis of the historical tsunami database for the Kuril-Kamchatka region. It covers the area within 41° to 64° N and 130° to 168° E and consists of 4 main parts: earthquake database, tsunami database, geographical mapping and data processing subsystems. Two additional databases contain some basic reference information of the existing regional seismic and mareograph networks.

Currently, the earthquake database contains the source data of almost 8,000 events occurring within the region from 1737 to 1990. Source information includes date, time, co-ordinates of epicenter, depth, magnitude (basically Ms) and seismic intensity followed by indexing to data sources. All data can be cross-correlated and retrieved by geographical area, date, depth and magnitude.

The tsunami database covers the same period and contains 124 events with 109 of them having regional and 15 distant sources. Among 109 regional tsunamis, 96 have tectonic, 6 volcanic and 4 unknown sources. The tsunami dataset consists of 3 main blocks: detailed source data, observations of tsunami wave heights on the coast and original descriptions of tsunamis. Source data of tsunamigenic effects are cross-referenced to the earthquake database but contain the extended set of magnitudes including moment-magnitude Mw, tsunami-magnitude Mt, seismic moment, moment-tensor 7 source mechanism (where available), tsunami intensity, maximum run-up height, position of tsunami source, validity of event, warning status and some other complementary information. The tsunami data can be retrieved by area, data, source magnitude and tsunami intensity. The information can be had in summary (condensed) or detailed (expanded) form. The latter includes all available observations of tsunami heights, periods, direction of the first motion, observed and calculated arrival time (where available).

The third part of the tsunami database, which is still in the process of compilation, contains comments, bibliographic data and the primary tsunami descriptions collected from original publications. Its main target is to bring to a researcher the full initial descriptions of old events. Some of them can be re-interpreted from a contemporary point of view.

Though the ETDB is developed first for the Kuril-Kamchatka region, it could be applicable and easily adapted to any other tsunamigenic region of the Pacific like Alaska, Hawaii, the Philippines, Indonesia, the South Pacific region, Chile, Peru, Ecuador and Mexico. The final ETDB product can be made available to the International Tsunami Information Centre (Honolulu, USA) from where it can be distributed to the ICG/ITSU Member States as a standard DBMS for regional and Pacific-wide electronic tsunami catalogues. At a minimum cost it may be customized to a particular region of the Pacific and elsewhere (mainly, by extension of the geographical database). After that, the actual data compiling from the existing regional tsunami catalogues and other sources of data can be received in a relatively short time-frame. A wealth of such data already exists but they are not properly organized, are not uniformly collected and are not readily available. Therefore, standards must be established for the collection of data. Tsunami databases must be organized on a regional scale initially and shared on the Pacific-wide scale later. After the integration of all this knowledge into the expert database it will be widely used for real-time operations in event mode and for tsunami risk assessment and mitigation in pre- and post-event mode.

It is proposed that the work on the development of the ETDB prototype will be done at the Tsunami Laboratory of Novosibirsk Computing Centre. The staff of the laboratory includes 6 members, among them 2 geophysicists, 2 applied mathematicians and 2 programmers. The prototype of the system can be developed within 18 months after receiving financial support for the project.

On the basis of the agreement between IOC, ITIC, the Computing Centre and an interested national agency, it can be customized to any other tsunamigenic region of the Pacific and elsewhere; after that, the actual data compilation from the existing catalogues can be made in a relatively short time.

The close co-operation collaboration during the project implementation is supposed with ITIC, PTWC (Honolulu, Hawaii), ATWC (Palmer, Alaska), NGDC (Boulder, Colorado) and interested institutions and government agencies in the Member States.

The proposed duration of the ETDB Project - 1.5 years (1994-1995)
Requested amount of funds - US$ 5,000

ANNEX IX

LIST OF ACRONYMS

ASCWP	Association for Seismological Co-operation in the Western Pacific and Southeast Asia
ATWC	Alaska Tsunami Warning Centre
BMG	Meteorological and Geophysical Agency (Indonesia)
CICESE	Centro de Investigación Científica y de Educación Superior de Ensenada (Mexico)
CMT	Centroid Moment Tensor
CPPT	Polynesian Tsunami Warning Centre
DBMS	Data Base Management System
DCP	Data Collection Platform
EC	IOC Executive Council
EGSWG	European Geophysical Society Working Group on Tsunamis
ETDB	Expert Tsunami Data Base
ETDP	Expert Tsunami Database for the Pacific
GDSN	Global Digital Seismic Network
GOOS	Global Ocean Observing System
GPS	Global Positioning System
GTS	Global Telecommunication System
GTSN	Global Telemetered Seismic Network
IASPEI	International Association of seismology and Physics of the Earth's Interior
ICG	International Co-ordination Group
IDNDR	International Decade for Natural Disaster Reduction
INETER	Instituto Nicaraguense de Estudios Territoriales (Nicaragua)
INMARSAT	International Marine Satellite
INSU	Institute National des Sciences de l'Univers
INF	Information Document (IOC)
IOC	Intergovernmental Oceanographic Commission
IPGP	Institut de Physique du Globe de Paris
ITIC	International Tsunami Information Centre
ITRIS	Integrated Tsunami Research and Information System
ITSU	International Tsunami Warning System in the Pacific
IUGG	International Union of Geodesy and Geophysics
JICA	Japan International Co-operation Agency
JMA	Japan Meteorological Agency
NEIC	National Earthquake Information Center
NGDC	National Geophysical Data Centre
NOAA	National Oceanic and Atmospheric Administration (USA)

NWS	National Weather Service (USA)
ORSTOM	Office de la recherche scientifique et technique outre-mer (France)
PKP	Seismic Wave Passing Through the Core of the Earth
PMEL	Pacific Marine Environmental Laboratory
PTWC	Pacific Tsunami Warning Centre
RTSDE	Rapid Tsunami and Seismic Data Exchange (Group of Experts)
SOA	State Oceanic Administration (China)
SOPAC	South Pacific Applied Geoscience Commission
STA/LTA	Short-Term Average/Long-Term Average
TIME	Tsunami Inundation Modeling Exchange Project
TCP/IP	Transmission Control Protocol/Internet Protocol
TREMORS	Tsunami Risk Evaluation through seismic Moment from Real-Time System
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USGS	United States Geological Survey
WDC	World Data Centre
WMO	World Meteorological Organization