Intergovernmental
Oceanographic
Commission

Manuals and guides **6**

WAVE REPORTING PROCEDURES FOR TIDE OBSERVERS IN THE TSUNAMI WARNING SYSTEM

REVISED EDITION

1988 Unesco

FOREWORD

The Tsunami Warning System in the Pacific has the function of detecting and locating major earthquakes in the Pacific region, determining whether they have generated tsunamis, and providing timely and effective tsunami information and warnings to the populations of the countries bordering the Pacific in order to minimize the hazards of tsunamis, especially those to life and property. Watch and warning information is disseminated to countries and territories throughout the Pacific basin by the Pacific Tsunami Warning Centre (PTWC) on behalf of the Intergovernmental Oceanographic Commission (IOC). The Pacific Tsunami Warning Centre is operated by the National Weather Service of the United States of America and serves as the operational headquarters for the Tsunami Warning System. The IOC, with the support of the United States, maintains the International Tsunami Information Centre (ITIC) in Honolulu in accordance with an international agreement (IOC Resolution IV-1, November 1965).

The Tsunami Warning System in the Pacific is an international system which makes use of more than 67 seismic stations, 67 tide stations and 51 dissemination points scattered throughout the Pacific basin. These facilities are under the varying control of the many Member States of IOC, with general guidance provided by the IOC through its International Co-ordination Group for the Tsunami Warning System in the Pacific (ICG-ITSU) and the International Tsunami Information Centre. Information from the network of stations is transmitted to the Pacific Tsunami Warning Centre where it is analysed and relayed as tsunami watches and warnings to civil defence organizations, meteorological and other local governmental offices that have been designated to receive the information by the participating countries, territories, and administrative areas throughout the Pacific. Effectiveness of the system results in a large measure from the prompt and accurate reports of the observers who staff the tide and seismic stations of the network.

The purpose of this publication is to provide general information and specific instructions to aid tide observers in reporting tsunamis. Both regular tide observers and alternate or substitute observers at participating tide stations should be familiar with the procedures outlined herein which have been approved for international use by the Intergovernmental Oceanographic Commission (Resolution EC-IV.6, June 1974).

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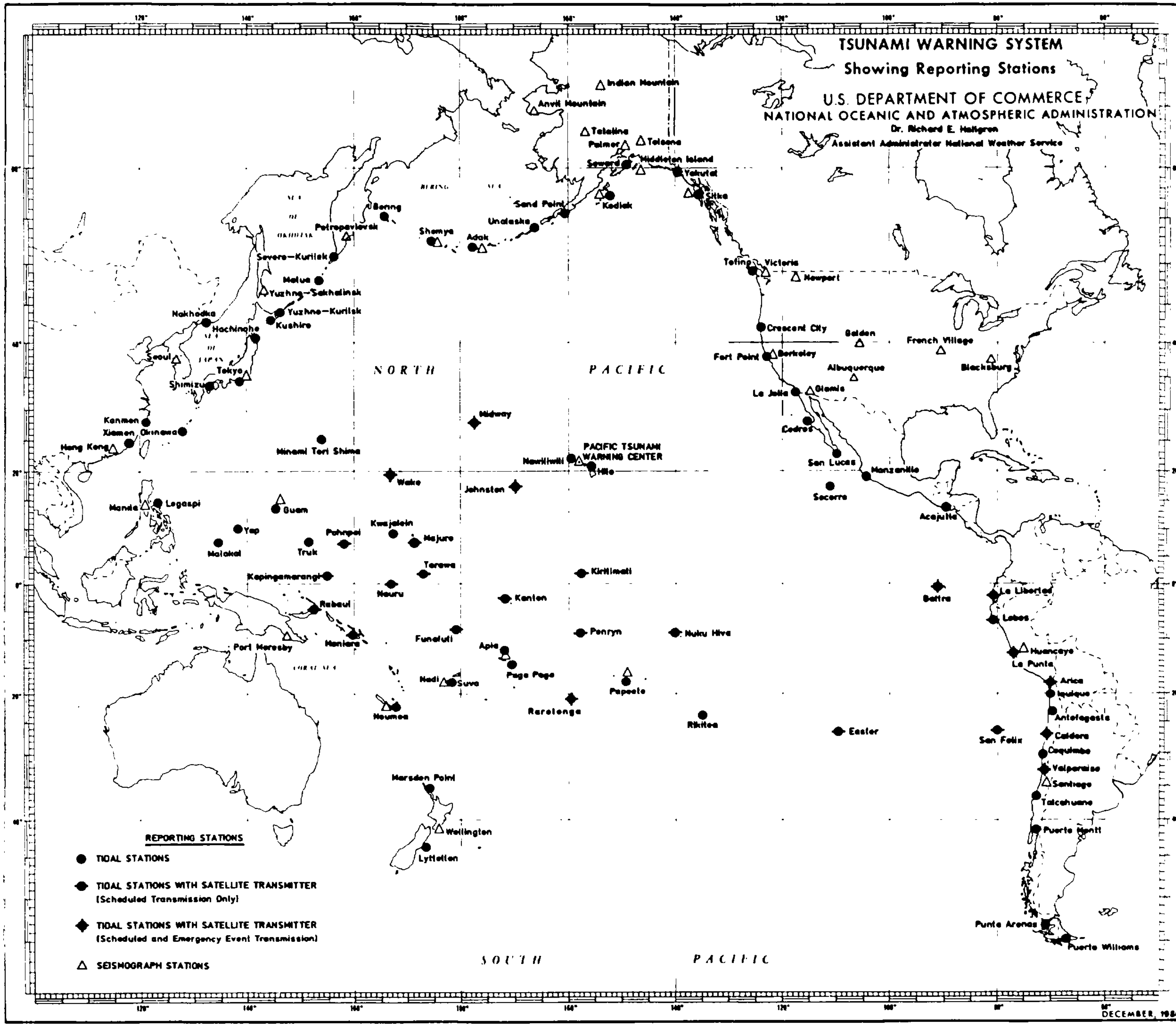
TSUNAMI WARNING SYSTEM
Showing Reporting Stations
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Dr. Richard E. Hallgren
Assistant Administrator National Weather Service
NORTH
PACIFIC
SOUTH
PACIFIC
PACIFIC TSUNAMI WARNING CENTER
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Talcahuano
Puerto Montt
Punta Arenas
Puerto Williams
DECEMBER, 1986

Figure 1

Section 1 - GENERAL INFORMATION

1.1 Nature and description of tsunamis

Tsunamis (or seismic sea waves) are true gravity waves of extremely long wave length and period that travel in series across the ocean. At sea the wave heights are low, but in coastal areas the wave heights are increased by shoaling of the sea floor. In this way vast expanses of lowlands are sometimes inundated by sudden rises in sea level with the arrival of the larger waves. The waves are set in motion by underwater disturbances, usually associated with large earthquakes in the underlying sea floor or coastal areas. The first tsunami wave may be the largest near the place of earthquake origin; but at greater distances from the earthquake, the largest tsunami wave may be one of several successive waves. Not all submarine earthquakes produce tsunamis, and not all tsunamis are large enough to cause damage; however, occasional large tsunami waves have caused great destruction and loss of life in coastal areas. Earthquakes can be detected from seismograph records soon after they occur; but at present, there is no way to determine from the seismic records if an earthquake has generated tsunami waves. It is necessary to detect the occurrence of the earthquake, locate its geographic position, and then to watch for the arrival of the characteristic tsunami waves at a network of tide stations.

1.2 The Tsunami Warning System

The Tsunami Warning System in the Pacific is an international cooperative undertaking of the Member States of the Intergovernmental Oceanographic Commission (IOC). International aspects of the Tsunami Warning System in the Pacific are coordinated through the IOC's International Tsunami Information Centre (ITIC), located in Honolulu; and also through the IOC's International Co-ordination Group for the Tsunami Warning System in the Pacific (ICG-ITSU) which is open to all Member States of IOC. The Pacific Tsunami Warning Centre (PTWC), located in Honolulu, is the operational centre of the Tsunami Warning System in the Pacific. PTWC is operated, maintained and administered by the National Weather Service of the United States of America in cooperation with the IOC. The system is designed to rapidly detect large earthquakes in the Pacific basin, verify the existence or non-existence of tsunami waves by interrogating tide observers, and then disseminate appropriate information or warnings to participants throughout the Pacific basin. Seismograph and tide stations participating in the system are shown in figure 1. Each tide observer's participation, particularly those located near the epicentre of any reported earthquake, is of fundamental importance to the Tsunami Warning System. Sea level data provide the only confirmation of the generation of a tsunami as well as an evaluation of its destructive potential. Of equal importance is the accurate and timely confirmation that no tsunami was generated, thereby avoiding the danger of false warnings.

1.3 The Communication Plan

Arrangements have been made with foreign and domestic government agencies to handle the message traffic essential to the success of the Tsunami Warning System. The arrangements provide for the transmission of the messages on a high priority basis, commensurate with the need for rapid communications and the regulations of the various communication agencies. The Communication Plan for the Tsunami Warning System outlines communication channels between the Pacific Tsunami Warning Centre and each seismic station, tide station and dissemination agency in the system. Every participant in the system and all communication agencies handling Tsunami Warning System messages should maintain an up-to-date copy of this Communication Plan. Information in this Wave Reporting Procedures Manual which was extracted from the Communication Plan is correct for the date of its publication, but future changes in the Communication Plan may invalidate portions of this Wave Reporting Procedures Manual. In such a case, the latest instructions in the

Communication Plan must be followed. The Communication Plan also provides information on tsunamis, a history of the Tsunami Warning System, and a description of the duties and responsibilities of system participants. Copies of the Communication Plan are available from the: Pacific Tsunami Warning Centre, 91-270 Fort Weaver Road, Ewa Beach, Hawaii 96706, U.S.A.

Section 2 - DUTIES OF TIDE OBSERVERS

2.1 Responsibilities

It is essential that a capable tide observer be available at all hours to report the occurrence of tsunamis. Substitute observers should be designated as necessary, and each should be made thoroughly familiar with the recording instruments and the reporting procedures of the Tsunami Warning System.

2.2 Duties

2.2.1 Keep the tide gauge in operation at all times.

2.2.2 Keep the tide transmitters and remote recorders (if available) functioning properly at all times.

2.2.3 Report immediately the occurrence of any tsunami to the appropriate authorities even though the station has not been alerted and interrogated by the Pacific Tsunami Warning Centre (see Section 5).

2.2.4 Watch the tide record for evidence of tsunamis when alerted and interrogated by the Pacific Tsunami Warning Centre. Report back to PTWC in accordance with instructions in this publication, following any special instructions in messages from PTWC (see Section 5).

2.2.5 Reply promptly upon receipt of all test messages from PTWC (see Section 4).

2.2.6 At those tide stations where water heights are telemetered from the gauge location to a remote recorder at another location, the individual on duty at the remote recorder is reponsible for reporting to PTWC during a communication test (Tsunami Dummy) or an actual tsunami emergency. During an emergency, the person responsible for checking the tide gauge daily should first check the gauge and then make himself available to the observer on duty at the remote recorder.

2.2.7 Report any change of the observer's address, telephone, teletype number or teletype designator to local communication stations through which messages are sent and received. The same information should be sent by letter to the Pacific Tsunami Warning Centre, 91-270 Fort Weaver Road, Ewa Beach, Hawaii 96706, United States of America.

2.2.8 Whenever the tide gauge is out of operation, notify PTWC of that fact. If possible, include an estimate of when the gauge will return to operation. Finally, notify PTWC when the tide gauge does return to operation.

2.3 Safety measures

Although tide records must be examined for evidence of tsunamis, the observer is not expected to take needless risks to reach the tide gauge when dangerous waves are approaching. At such times, visual sightings of tsunami waves should be reported to the Pacific Tsunami Warning Centre without visiting the gauge. Since requests for wave reports are usually made only when there is a good chance that a tsunami has been generated, persons in charge of tide stations should take every precaution to avoid endangering personnel at the station.

Section 3 - TSUNAMI WARNING SYSTEM MESSAGES

3.1 Communication facilities

Instructions for handling Tsunami Warning System messages are given in the Communication Plan for the Tsunami Warning System. The instructions repeated in this section are in compliance with the Communication Plan, as revised to February 1984. In the event of future conflict due to publication of a new revision of the Communication Plan, the instructions in the Communication Plan are to be followed as they are the most current regarding communication matters.

To ensure the timely and effective operation of the Tsunami Warning System, communication facilities must be capable of rapidly handling the data requests from the PTWC, the seismic and tidal reports to the PTWC, and watch and warning messages. Since such traffic is relatively infrequent, existing communication channels are used with some supplementation where absolutely necessary, instead of establishing a separate communication system that would, to a large extent, duplicate existing channels. Hence, the communication channels under the management and control of the Defense Communications Agency (DCA), Federal Aviation Administration (FAA), National Aeronautics and Space Administration (NASA), National Weather Service (NWS), the Army, Navy, Air Force, Coast Guard, various international agencies, and private companies, as outlined herein, will be used to handle the message traffic involved between the PTWC and the seismological and tidal stations and dissemination agencies participating in the Tsunami Warning System.

The PTWC presently maintains teletype terminals for the Hawaii Marine Circuit (HMC), the Aeronautical Fixed Telecommunication Network (AFTN) or FAA circuit, the Defense Communications System (DCS) AUTODIN circuit, and commercial Telex. The HMC is maintained by the NWS and connects to the National Meteorological Centre (NMC) for relay to the Automation of Field Operations and Services (AFOS), the West Coast Marine Circuit (WCMC), and the World Meteorological Organization (WMO) Global Telecommunication System (GTS). The AUTODIN circuit connects to the Goddard Space Flight Centre at Greenbelt, Maryland, for access to the NASA communication network.

3.2 Message format

Correct message formats are essential to ensure message transmission and relay to proper circuits. Different circuits and varying teletype hardware may require specific message formats. The user should refer to his immediate communications supervisor or to the appropriate communications manuals for correct message formatting of headers, precedence designation or priority indicator, date-time group, originator designation, addressee, and text content.

The word "TSUNAMI" should be entered as the first word of the text for all messages involving actual data requests or transmissions, i.e., requests from the PTWC to tidal stations for data, and tidal reports to the PTWC from tidal stations.

The words "TSUNAMI DUMMY" should be entered as the first words of text for all messages involving testing of communications, i.e., monthly messages from the PTWC to test circuit dissemination times, and replies from tidal stations to monthly station tests. Section 4 provides further discussion of communication tests.

3.3 Priority or precedence

A priority indicator or precedence designator, as established by the appropriate communication authority of each country, is to be assigned to each message as appropriate. A precedence designation as used by some government agencies is essentially equivalent to a priority indicator as used by the

International Civil Aviation Organization's (ICAO) Aeronautical Fixed Telecommunications Network (AFTN). Both indicate the relative order in which a message is to be handled or processed with respect to other messages. Precedence designations and priority indicators are assigned to the message by the originator. They indicate: to the originator - the required or desired speed of delivering the message; to communication personnel - the relative order of processing, transmitting, and delivering the message; and, to the addressee - the relative order of importance or significance assigned to the message. Messages of the Tsunami Warning System will usually be assigned an AFTN priority of SS or an AUTODIN precedence of O or higher level as determined by appropriate communication authority.

3.3.1 Precedence or priority of live messages. Live messages contain factual information about the occurrence of natural phenomena that have caused, or that might cause, a disaster. Messages in this group include requests to tide stations for information, replies by tide stations providing requested information, and tide reports. Live messages normally are assigned an AFTN priority of SS or an AUTODIN precedence of O.

3.3.2 Precedence or priority of test messages. Test or dummy messages contain the words TSUNAMI DUMMY (see Section 4). The precedence or priority assigned to test messages is generally the same as for live messages.

3.3.3 Precedence or priority of routine messages. Message requests for reports of instrument status, general information and instructions normally are assigned an AFTN priority of GG or AUTODIN precedence of R.

3.4 Date-time group

The date-time group establishes the time of message transmission and therefore uniquely identifies the message. The date-time group is a 6 digit number representing the day of the month and the hour and minute of the day, in Greenwich Mean Time. The first two digits indicate the day (01-31), the third and fourth digits indicate the hour (00-23), and the fifth and sixth digits indicate the minute (00-59). Thus 2:42 p.m. on 5 March, Greenwich Mean Time, is represented as 051442.

3.5 Greenwich Mean Time

Greenwich Mean Time, sometimes identified by the letter Z, is used for all messages to and from the tide stations. To convert standard time at Pacific tide stations to Greenwich Mean Time, use the accompanying conversion table. Enter the table on the line designating the standard time zone for the station. Standard time zones are designated by their central meridian in column 1 and by letter designator in column 2. To the station's standard time, add or subtract (as indicated) the number of hours in column 3 of the table. This gives Greenwich Mean Time. Be careful to change the date when the difference changes the Greenwich Mean Time to the following or preceding day. To change Greenwich Mean Time of a message to the standard time of the tide station, enter the table on the line designating the standard time zone of the station and add or subtract (as indicated) the number of hours in column 4 of the table. Special note: the 12th zone of the standard time system is divided by the 180th meridian. The half with West longitudes (180 degrees to 172 degrees 30 minutes West) is designated zone Y and is numbered plus 12. The half with East longitudes (180 degrees to 172 degrees 30 minutes East) is designated zone M and is numbered minus 12.

Conversion Table for Greenwich Mean Time

Standard time zone of tide station		Greenwich mean time (Z)	
Central meridian	Letter designator	To convert local time to Z	To convert Z to local time
		(*hours*)	(*hours*)
60°W.	Q	+ 4	− 4
75°W.	R	+ 5	− 5
90°W.	S	+ 6	− 6
105°W.	T	+ 7	− 7
120°W.	U	+ 8	− 8
135°W.	V	+ 9	− 9
150°W.	W	+10	−10
165°W.	X	+11	−11
180°			
W.[1]	Y	+12	−12
E.[2]	M	−12	+12
165° E.	L	−11	+11
150° E.	K	−10	+10
135° E.	I	− 9	+ 9
120° E.	H	− 8	+ 8

[1] 180° to 172°30′ W.
[2] 180° to 172°30′ E.

3.6 Station designator

Each participant in the Tsunami Warning System network - seismic station, tide station, and dissemination agency - is assigned a station designator that is listed in the Communication Plan. These designators shall be used in all messages in accordance with instructions contained in the Communication Plan.

3.7 Classification designator

The designator UNCLAS (unclassified) must be included at the beginning of the text of messages prepared for United States Military channels (AUTODIN). The UNCLAS designator is not required for messages sent by AFTN channels.

3.8 Message identification

The first word of the text identifies the message as a live message or test message. Live messages begin with the word TSUNAMI. Test messages begin with the words TSUNAMI DUMMY.

3.9 Sample messages

Examples follow showing the form and order of items for messages as they should be given to the communication station by the tide observer.

3.9.1 Message prepared for military communication channels (AUTODIN).

Example:

```
O 150930Z SEP 86
FROM ACAJUTLA TIDE OBSERVER
TO RUHHAJA/PACIFIC TSUNAMI WARNING CENTER
UNCLAS
TSUNAMI.  WAVE BEGAN 0920Z.  TIDE RECORD SHOWS WATER ROSE 0060 CM
IN 7 MINUTES.  STILL RISING 0928Z.  WILL REPORT FURTHER.
```

3.9.2 Message prepared for AFTN communication channels.

Example:

SS PHNLYMHO
172014Z RPMPYF`````
FROM LEGASPI TIDE OBSERVER
TSUNAMI. WAVE BEGAN 2050Z. TIDE RECORD SHOWS WATER ROSE
1202 CM IN 9 MINUTES. NOW FALLING. WILL REPORT FURTHER.

Section 4 - COMMUNICATION TESTS

4.1 Test messages

It is important that the Tsunami Warning System function efficiently in time of emergency. Therefore, test messages are sent to tide observers each month at unannounced times to determine the transmission times of messages, to keep communication personnel familiar with procedures for handling Tsunami Warning System messages, and to help maintain contact between tide observers and personnel at local communication stations. Test messages are identified by the words TSUNAMI DUMMY at the beginning of the text and are assigned precedence or priority as indicated in paragraph 3.3.2. The observer should follow any special instructions in the message text.

4.2 Test message from the Pacific Tsunami Warning Centre

SS SPIMYY
081805 PHNLYMHO`````
TO LA PUNTA TIDE OBSERVER
TSUNAMI DUMMY. REPORT TIME OF RECEIPT OF THIS MESSAGE.
MARK AND LABEL TIDE RECORD. REPORT WATER HEIGHT AND TIME AT MARK.

4.3 Procedure at the tide station during a test

During a test, observers at tide stations should either follow the same procedures used during the normal daily inspection of the gauge or the procedures outlined below.

4.3.1 Standard tide gauge. Rotate the float drum to make a vertical line on the tide record, as is done during the normal daily inspection of the gauge. Label the vertical line on the tide record with the words: Tsunami Dummy Test. Next to these words enter the Greenwich Mean Time. Finally, use the plastic tsunami wave scale to measure the water height indicated by the tide recorder at the time the vertical line is made; and write this value on the recorder near the vertical line. (see figure 2).

4.3.2 Gas-purging pressure tide gauge (bubbler gauge). On the strip-chart recorder of the gas-purging pressure tide gauge move the recording pen to the right a small amount. Label the line made by this movement as in 4.3.1 above with: Tsunami Dummy Test, the Greenwich Mean Time, and the height of the water indicated by the tide recorder at that time. Caution: DO NOT MOVE THE PEN TO THE LEFT, as this can damage the recording mechanism.

4.3.3 All remote recorders. Draw an arrow on the recorder to the tide curve to indicate the position of the recording pen at time the message is received (see figure 3). Label the arrow with the words Tsunami Dummy Test, Greenwich Mean Time, and indicate the height of the water on the record at the marked point. DO NOT MOVE THE PEN.

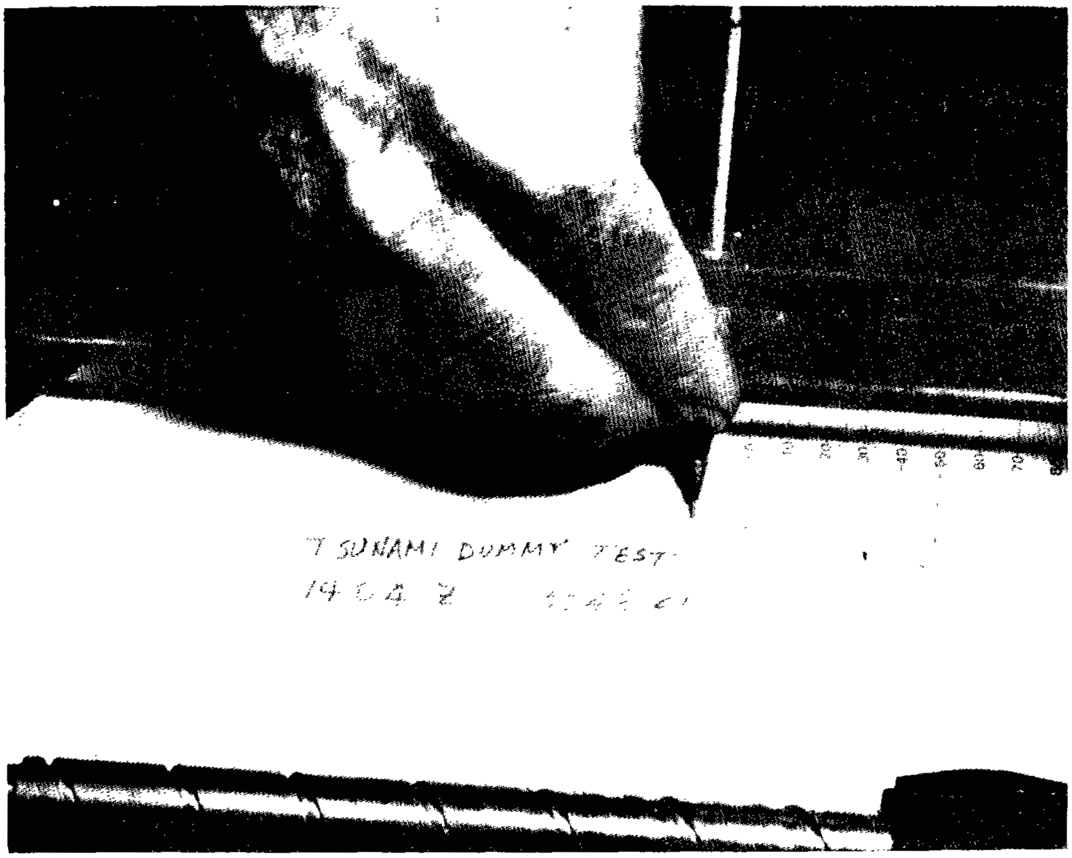


Figure 2. - Tsunami dummy test note on standard tide gauge record.

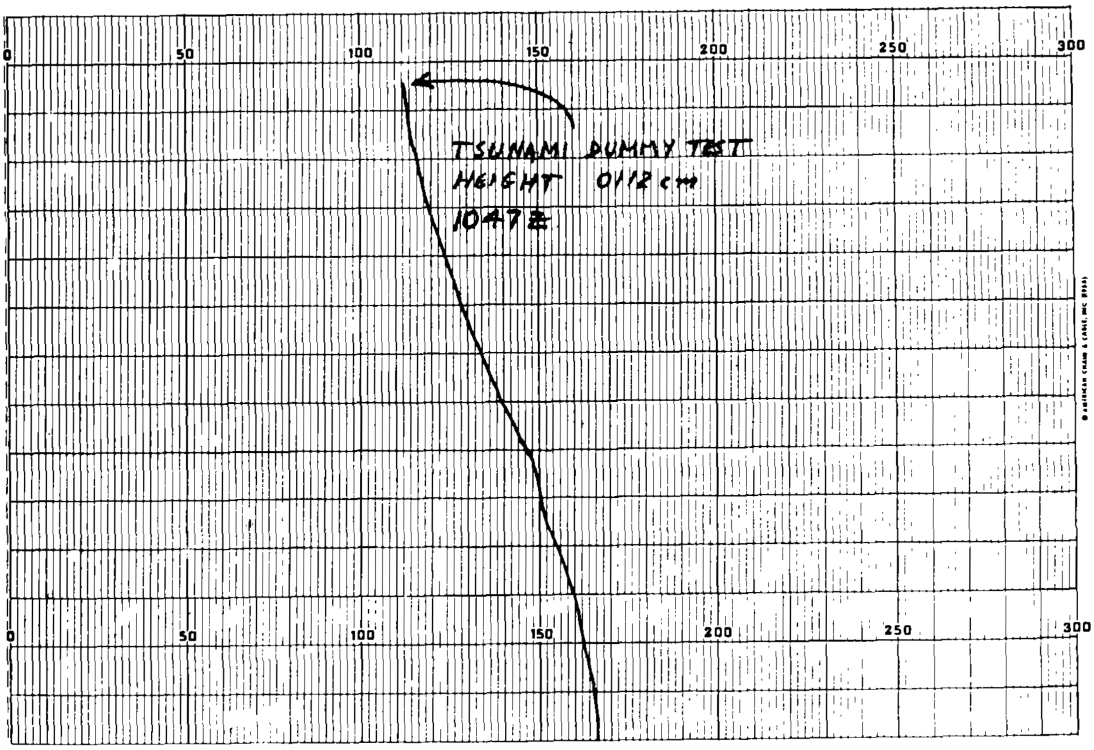


Figure 3. - Tsunami dummy test note on remote tide recorder record.

4.4 Reply by tide observer

The tide observer should reply to test messages as soon as he can provide the requested information. The following is an example of a reply to the test message in paragraph 4.2.

```
SS PHNLYMHO
081820 SPIMYY`````
FROM LA PUNTA TIDE OBSERVER
TSUNAMI DUMMY.  YOUR 081805Z RECEIVED 081812Z.
WATER HEIGHT IS 0075 CM AT 081815Z.
```

Section 5 - REPORTING WAVES TO THE PACIFIC TSUNAMI WARNING CENTRE (PTWC)

5.1 Reporting when not alerted by an interrogation message from PTWC

Whenever an observer believes a tsunami exists at his station or in his area of responsibility, he should send a message to the Pacific Tsunami Warning Centre. Evidence of a tsunami may be based upon visual observations, apparently reliable reports, or alarm signals of a tsunami detector.

5.1.1 Procedure when not alerted. The message to PTWC should tell as much as is known about the wave - its time of arrival, its size, and the source or basis of the information. When possible, verify reports and alarm signals before sending the message. This procedure, however, should not unduly delay sending of the message. Alarms that are obviously false should not be reported. If the tide gauge cannot be visited prior to sending the message, first send the message and then go immediately to the tide gauge to verify existence of the tsunami and to obtain information about it. Send this information to PTWC as soon as possible. Continue to watch the tide record and send any additional information to PTWC.

5.1.2 Precedence or priority of message when not alerted. The precedence or priority for live messages (see paragraph 3.3.1) is assigned to all reported occurrences of tsunamis. After alerting PTWC, all subsequent messages pertaining to the alert, including any notification of a false alarm, are assigned the same high precedence or priority.

5.2 Reporting when alerted by an interrogation message from PTWC

After determining the location of a large earthquake in the Pacific, PTWC alerts those tide stations which are likely to record a tsunami if generated. Personnel at PTWC, by means of travel-time charts constructed for each tide station, can determine approximately when the waves of any generated tsunami will reach a given tide station. In predicting the arrival time of tsunamis, allowance is made for uncertainties about the rate of wave travel across inadequately surveyed areas of the ocean, and for uncertainties about the precise location of the earthquake. Consequently, messages to tide stations usually instruct tide observers to examine the tide record for any unusual disturbance during a period of one hour.

5.2.1 Procedure when alerted. The following is an example of an interrogation message from PTWC alerting the tide observer to monitor his tide recorder and tide gauge.

```
SS KLAXYM
280610 PHNLYMHO`````
TO SANTA MONICA TIDE OBSERVER
TSUNAMI.  EARTHQUAKE OCCURRED AT 0336Z.  LAT 61.1N LONG 147.6W
OBSERVE TIDE RECORD FROM 0850Z TO 0950Z.  REPORT ANY UNUSUAL
ACTIVITY IMMEDIATELY OR REPLY NEGATIVE AT 0950Z.
ACKNOWLEDGE RECEIPT OF THIS MESSAGE IMMEDIATELY.
OBSERVE SAFETY GUIDELINES IN YOUR WAVE REPORTING PROCEDURES MANUAL.
```

When the observer is requested to watch the tide record for unusual disturbances during an alert period, he should proceed as follows. First, promptly acknowledge receipt of the interrogation message. An example of the acknowledgement message text follows:

TSUNAMI. YOUR 280610Z RECEIVED 280615Z. WILL COMPLY.

Next, examine the tide record and instrumentation. Continue to watch the record as requested. Examine past tide records to familiarize yourself with the character of past tsunamis originating from earthquakes in the same area as the earthquake of this current alert. It is important to transmit preliminary data to PTWC promptly. Provide additional detail in later messages.

5.2.2 Precedence for messages when alerted. All messages pertaining to a tsunami alert are assigned live message precedence, or priority, as specified in paragraph 3.3.1.

5.3 Tsunami reporting procedures

If a tsunami or suspected tsunami begins while the observer is checking the record, he should report the time at which the disturbance begins and the change (rise or fall) in water level up to the time the observer makes his report. For example (see figure 6), if an observer arrived at his gauge at 0915Z and was watching as a tsunami began at 0918Z, he would send a message such as the following at 0925Z:

TSUNAMI. WAVE BEGAN AT 0918Z AND ROSE 0015 CM IN 7 MIN.
STILL RISING AT 0925Z.

The amplitude of the first rise or fall and its beginning and ending times should be included in the first message sent after the rise or fall is completed.

If the record indicates that a tsunami has already begun when the observer reaches his tide gauge, the observer should immediatley report to PTWC the time of its beginning, the ending time of the reporting period, the amplitude of the first rise or fall if it has been completed, and the maximum wave height, trough to crest or crest to trough, that has been recorded by the time the tide gauge is inspected. For example (see figure 7), if the observer arrived at his gauge at 0958Z and found that a tsunami had begun recording at 0918Z, he would immediately send a message such as the following:

TSUNAMI. WAVE BEGAN AT 0918Z. ROSE 0074 CM BY 0935Z. MAXIMUM HEIGHT OBSERVED BY 0958Z IS 0142 CM.

Once the initial report of a tsunami has been submitted, additional messages should be filed at regular intervals for at least the first two hours of the tsunami. The intervals usually should not exceed 30 minutes; however, reports may be delayed for a few minutes, if necessary to record complete waves. Data to be given in these messages include the maximum wave height, measured from trough to crest or crest to trough, recorded since the previous message and the beginning and ending times of the reporting interval. For example (see figure 8), the observer who sent the first message above might submit the following message at 0958Z.

TSUNAMI. REPORTING PERIOD 0918Z TO 0958Z. DISTURBANCE BEGAN AT 0918Z.
ROSE 0074 CM BY 0935Z. MAXIMUM WAVE HEIGHT OBSERVED IS 0142 CM.

All measurements should be made with centimetre scales, and all wave heights should be reported in centimetres to PTWC. To reduce transmission errors, all wave heights should be reported in four figures. For example, a wave height of 5 centimetres would be reported as 0005 cm; one of 46 centimetres would be reported at 0046 cm; 293 centimetres would be reported as 0293 cm; etc.

If damaging waves are still occurring after two hours, or if the wave size is still increasing, the tide observer must continue reporting to PTWC at regular intervals, until such time as the damaging waves cease or the size begins decreasing. When the observer sends his last message, he should tell PTWC that he will not report again.

If the size of the waves begins to increase significantly after the observer has stopped reporting, he should resume reporting, giving the maximum wave height recorded since his previous message. The observer should continue reporting at regular intervals until the height of waves again decreases.

5.4 Reporting when tsunami does not occur

If a tsunami does not occur during an alert period as specified in the Pacific Tsunami Warning Centre (PTWC) interrogation message, the observer should so inform PTWC at the end of the period.

Example:

TSUNAMI. NO TSUNAMI RECORDED 0850Z TO 0950Z.

Section 6 - ILLUSTRATIVE EXAMPLES

To aid observers in interpreting tide records and to provide guidelines in preparing messages, samples of tide records and of messages relating thereto are presented in this section. The tide records are selected to illustrate various wave conditions, without regard to date and source. The sample messages simulate those which might be sent during the sequence of events depicted by the tide records.

Figures 4 and 5 show normal tide records with varying wave action produced by winds. Figure 5 also shows seiche oscillations. Figures 6 through 12 show simulated messages relating to the observed conditions that might have been sent to the Pacific Tsunami Warning Centre by a tide observer during the course of a tsunami. Only the texts of the messages are given in the examples. For samples of complete messages, including precedence or priority indicator, date-time group, station designators, security classification, and type-of-message identification, see paragraph 3.9. In figures 13 through 20, additional samples of tsunamis are shown without messages.

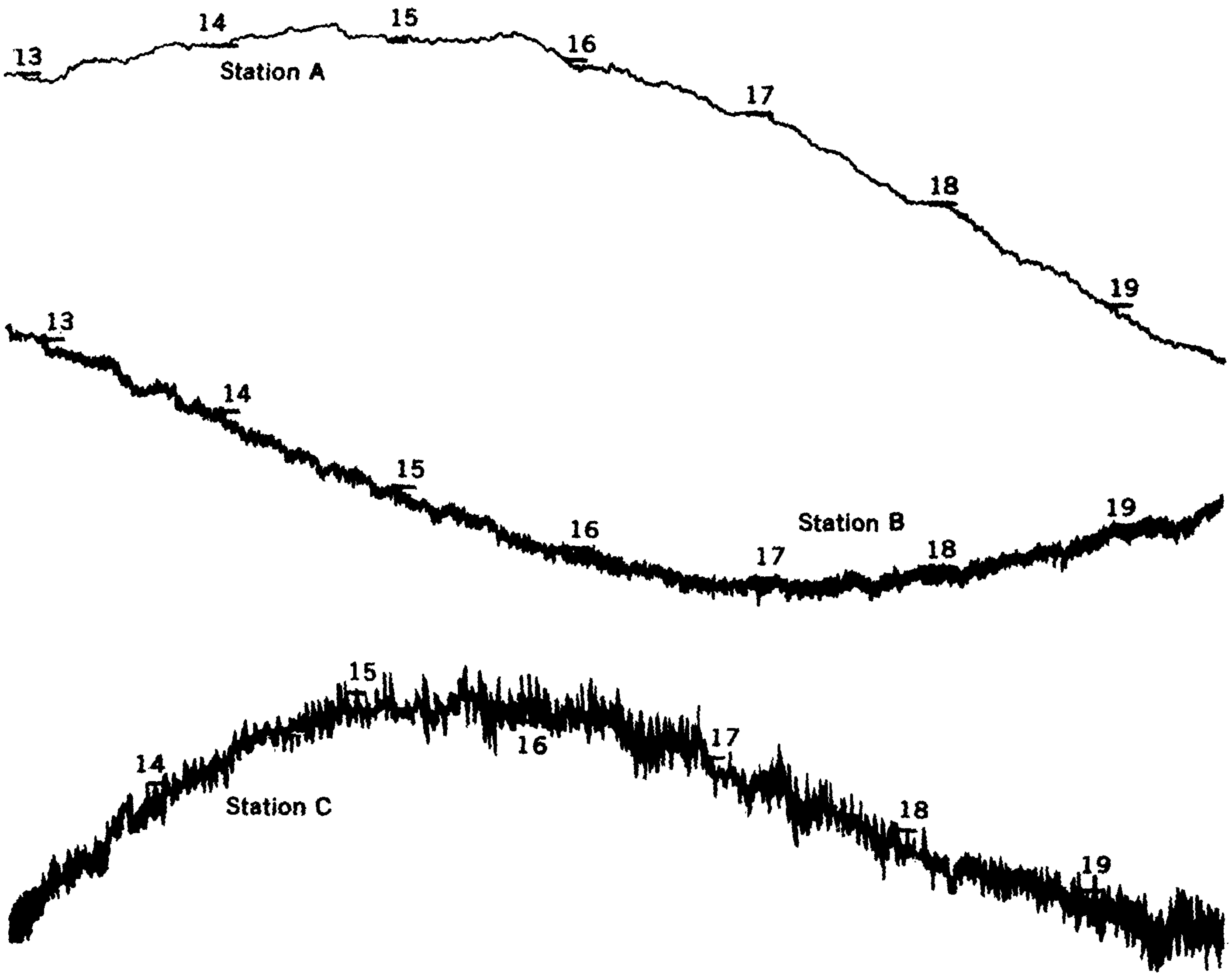


Figure 4. - Normal tide records showing wind waves. Numbered horizontal trace deflections on this figure and following figures indicate hours.

Tide records for the three stations show varying amounts of trace motion caused by differences in gauge exposures and in size of intake openings in still wells.

Stations A, B, and C might have received the following message from Honolulu Observatory:

TSUNAMI. EARTHQUAKE OCCURRED ... Z. LAT ... LONG ... OBSERVE TIDE RECORD 1600Z TO 1800Z. REPORT ANY UNUSUAL ACTIVITY IMMEDIATELY OR REPLY NEGATIVE AT 1800Z. ACKNOWLEDGE RECEIPT OF THIS MESSAGE IMMEDIATELY.

Each station, after acknowledging the message immediately, might reply as follows at 1800Z:

TSUNAMI. NO TSUNAMI RECORDED BETWEEN 1600Z AND 1800Z.

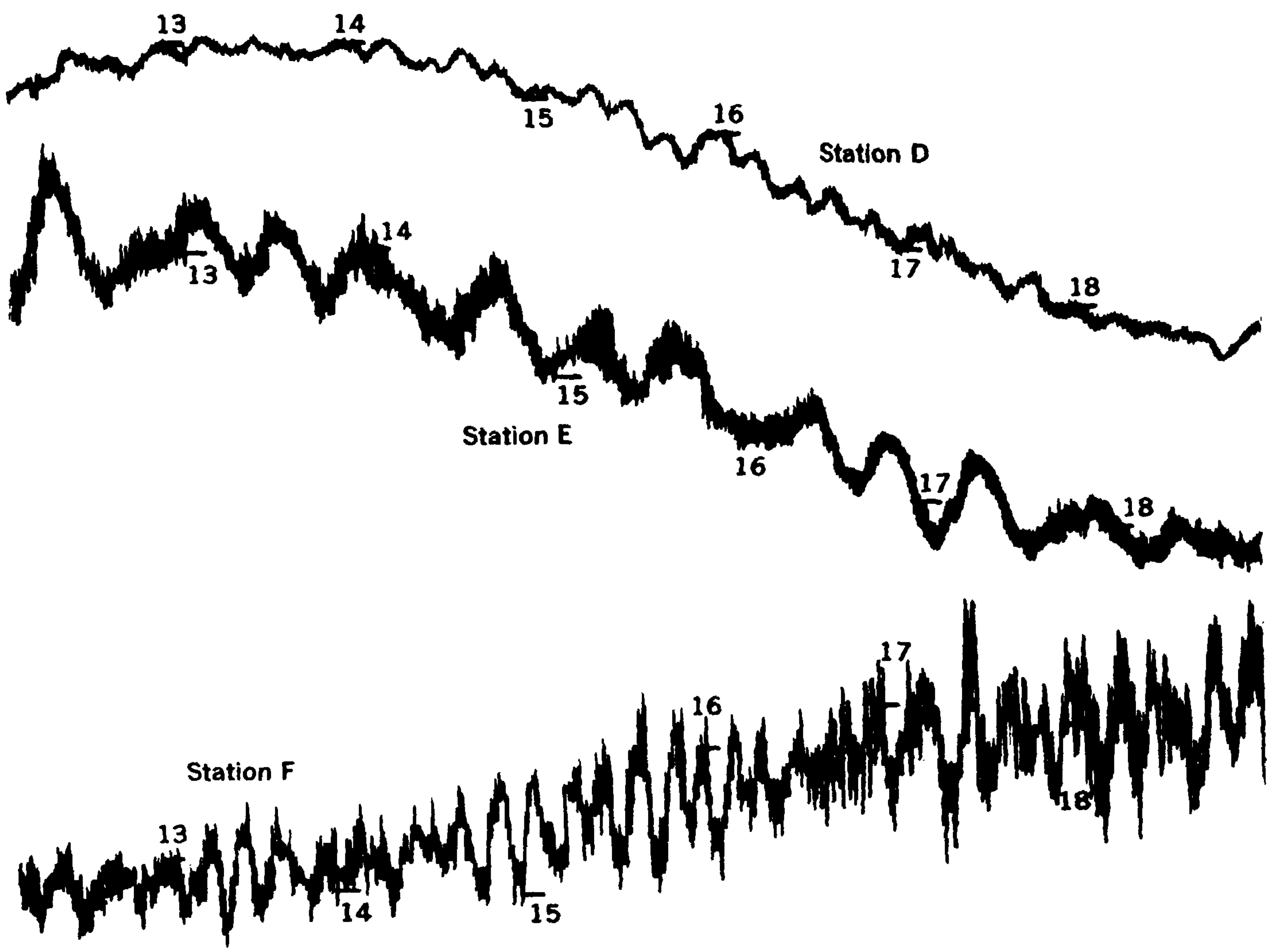


Figure 5. - Tide records showing wind waves and seiche oscillations.

It is difficult sometimes to distinguish seiche oscillations from small tsunamis. Both types of waves can have the same period--the time between successive crests at a given point. At Stations D and F, the seiche oscillations have a period of about 12 to 15 minutes; at Station E, the period is about 30 minutes. Seiche action usually is caused by meteorological conditions and is intensified by the resonance characteristics of the harbour.

An identifying feature of seiches is their gradual growth in size over a period of hours, whereas the onset of a tsunami is identified by a sudden change in wave pattern on the tide record. In figures 20 and 24, seiche oscillations precede the tsunamis.

Any query relative to unusual activity on the tide records for Stations D, E, and F, between 1600Z and 1800Z, might have been answered as follows:

TSUNAMI. NO TSUNAMI RECORDED BETWEEN 1600Z AND 1800Z. SEICHE OF ... CM HAS BEEN ACTIVE FOR ... HOURS OR MORE.

Figure 6, and figures 8 through 12 illustrate a series of messages that might have been sent to the Pacific Tsunami Warning Centre by the tide observer at the Santa Monica tide station during the tsunami generated by the Prince William Sound, Alaska earthquake of 0336Z, 28 March 1964. Figure 7, and figures 9 through 12 illustrate a second such series where the reporting begins after the tsunami has been recorded for some time.

Hours indicated on the curves are 120 degrees West meridian (+8 hours) times. A centimetre scale is superimposed over the wave, or portion thereof, to be measured and reported. Arrows indicate the beginning and ending of reporting period.

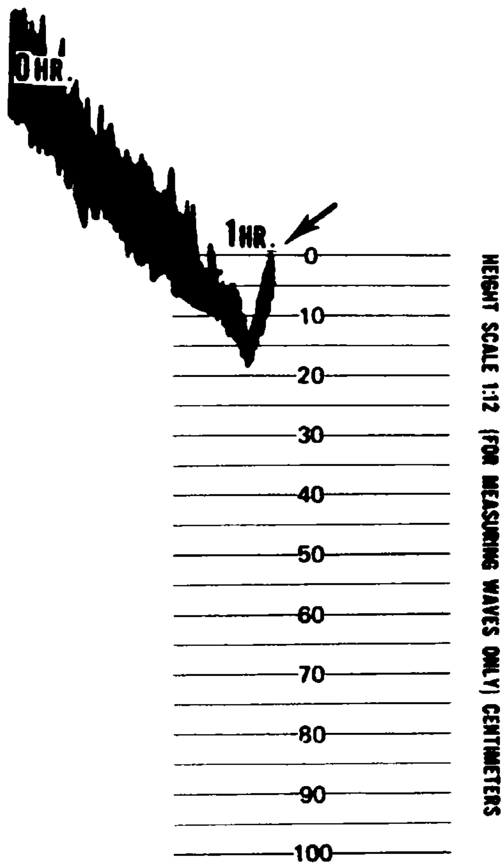


Figure 6. - Santa Monica tide record 0000H to 0125H (local time).

After watching the start of the tsunami at 0118H local time (0918Z), the observer would send a message such as the following at 0925Z:

TSUNAMI. WAVE BEGAN AT 0918Z AND ROSE 0015 CM IN 7 MINUTES.
STILL RISING AT 0925Z.

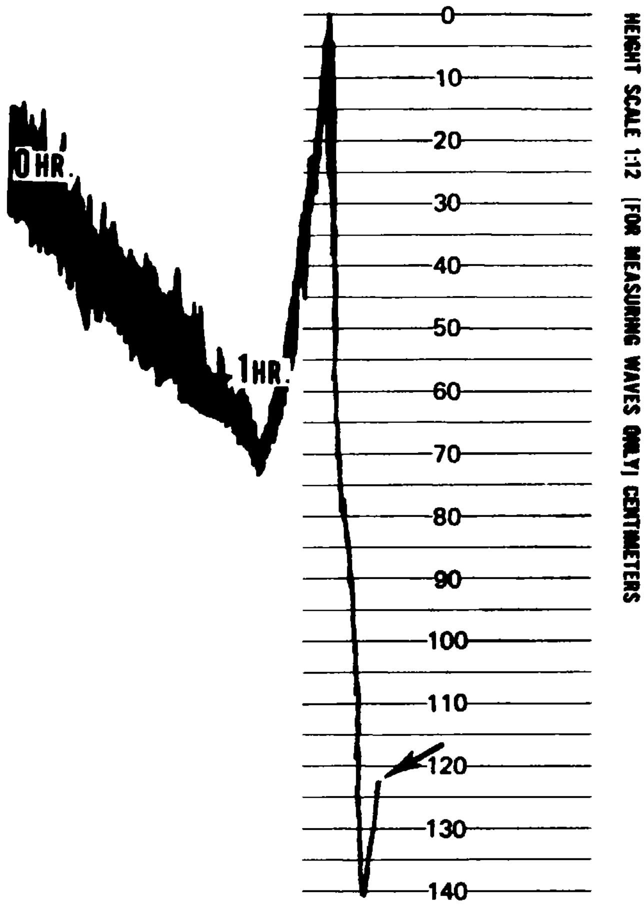


Figure 7. - Santa Monica tide record 0000H to 0158H (local time).

If the Santa Monica observer arrived at his gauge at 0158H local time (0958Z) and found the tsunami recording shown above, he would send a message similar to the following to the Pacific Tsunami Warning Centre:

TSUNAMI. WAVE BEGAN AT 0918Z. ROSE 0074 CM BY 0935Z.
MAXIMUM HEIGHT OBSERVED BY 0958Z IS 0142 CM.

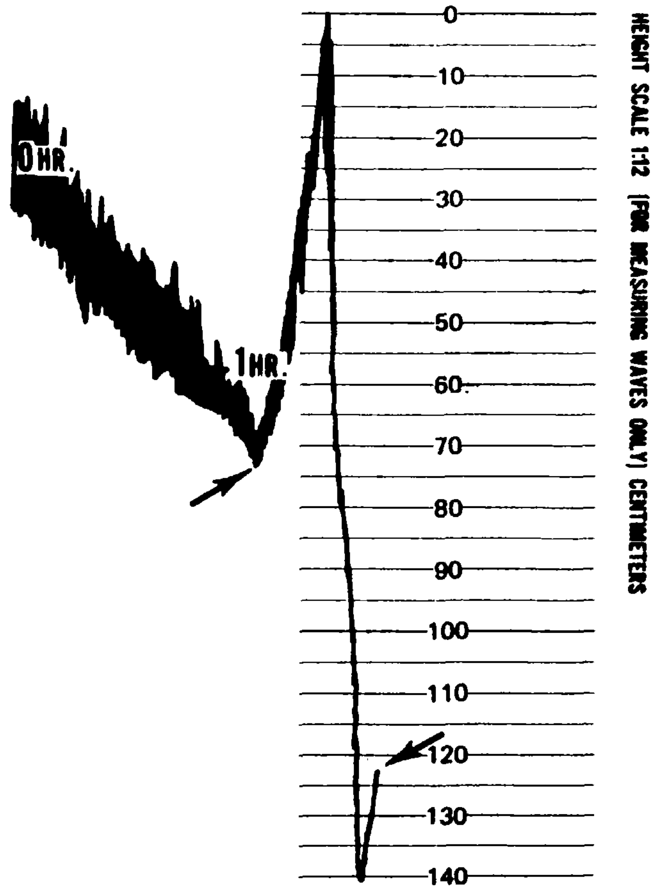


Figure 8. - Santa Monica tide record 0000H to 0158H (local time).

At 0158H local time (0958Z), the Santa Monica tide observer, who sent the message in figure 6, would send the following message:

TSUNAMI. REPORTING PERIOD 0918Z TO 0958Z. DISTURBANCE BEGAN AT 0918Z. ROSE 0074 CM BY 0935Z. MAXIMUM WAVE HEIGHT OBSERVED IS 0142 CM.

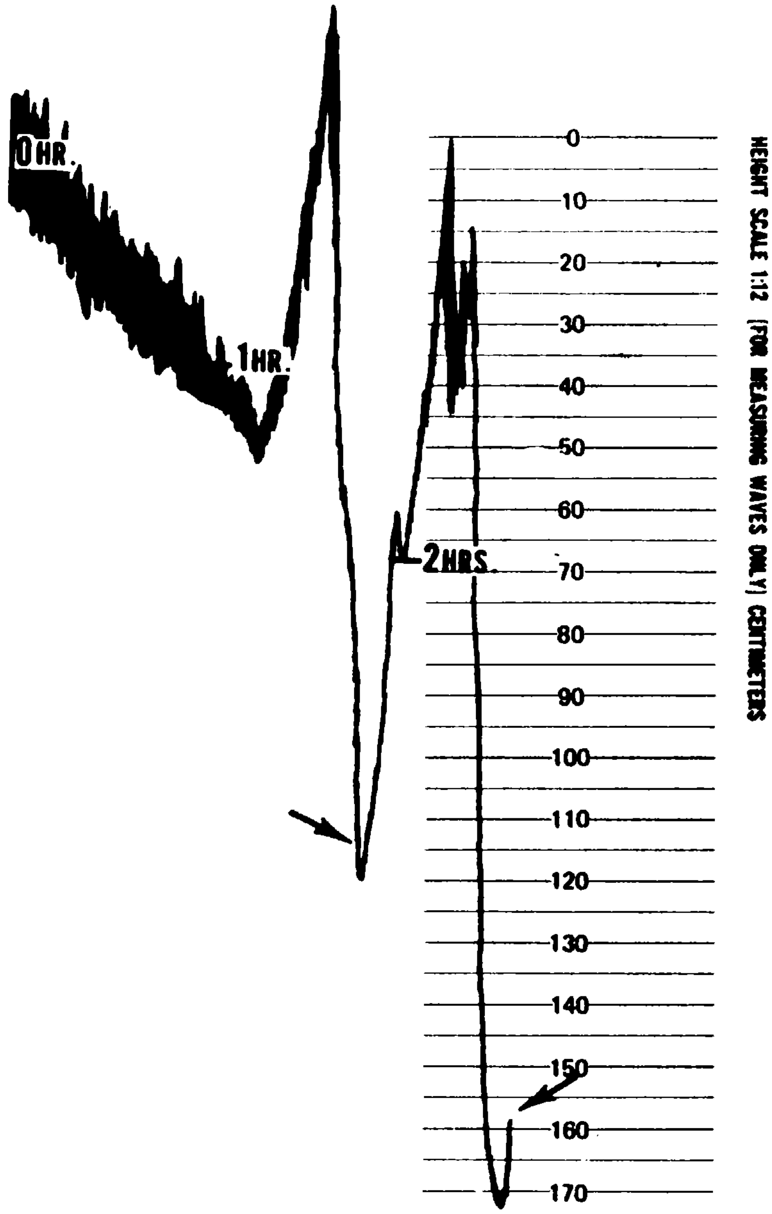


Figure 9. - Santa Monica tide record 000H to 0242H (local time).

At 0242H local time (1042Z), the Santa Monica observer would send a message such as the following:

TSUNAMI. REPORTING PERIOD 0953Z TO 1042Z. MAXIMUM WAVE HEIGHT 0173 CM. MINOR FLOODING IS OCCURRING.

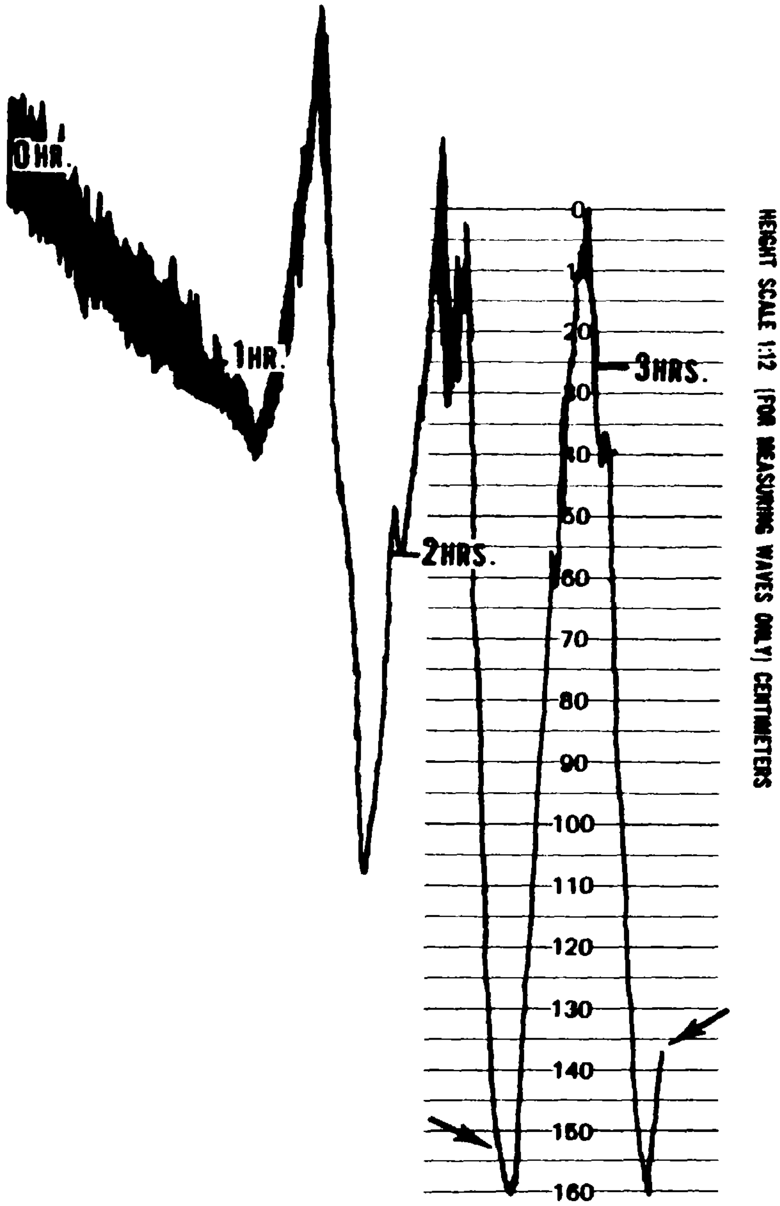


Figure 10. - Santa Monica tide record 0000H to 0325H (local time).

At 0325H local time (1125Z), the Santa Monica observer would send a message such as the following"

TSUNAMI. REPORTING PERIOD 1036Z TO 1125Z. MAXIMUM WAVE HEIGHT 0162 CM.

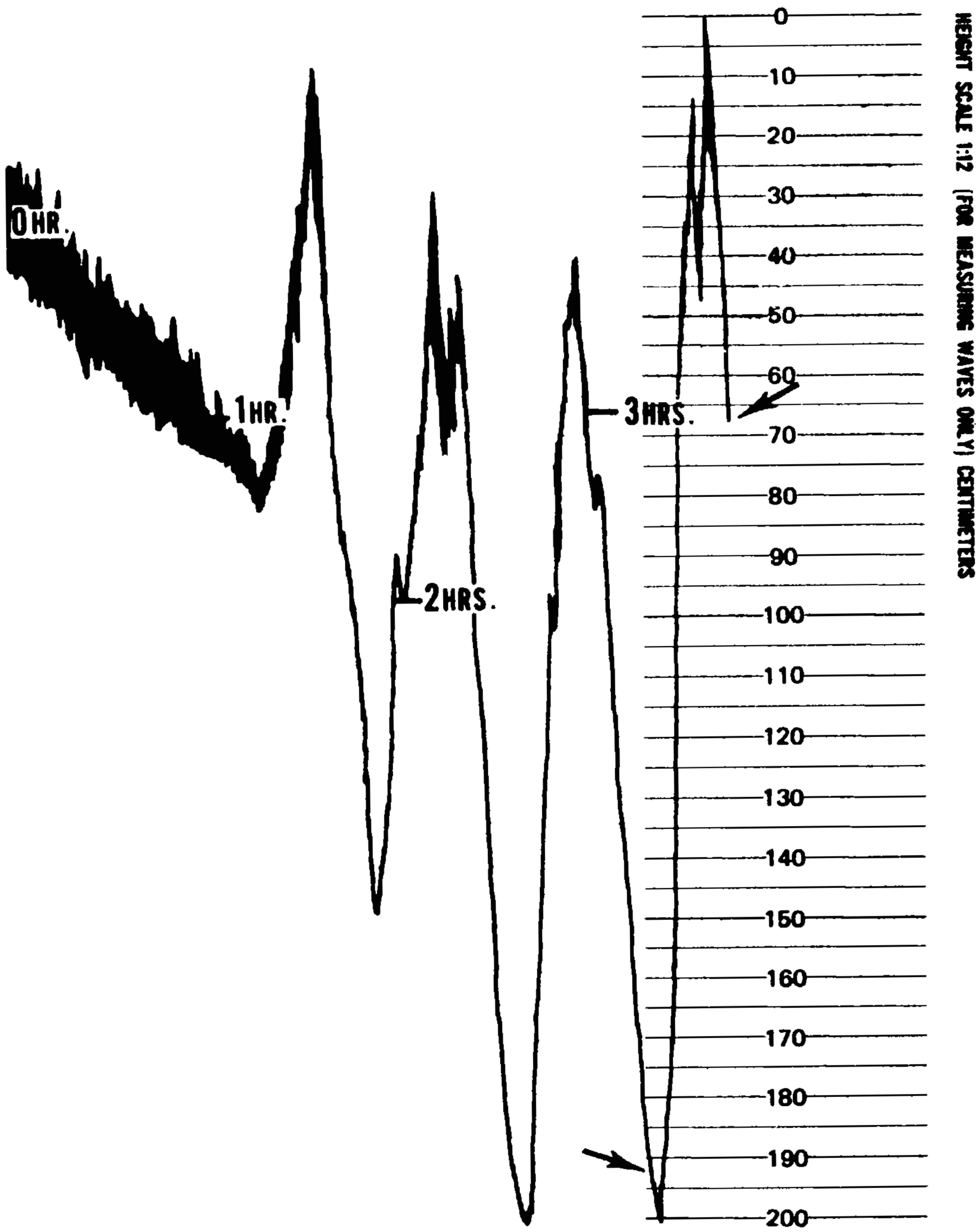


Figure 11. - Santa Monica tide record 0000H to 0347H (local time).

At 0347H local time (1147Z), the Santa Monica tide observer would send a message such as the following:

TSUNAMI. REPORTING PERIOD 1120Z TO 1147Z. MAXIMUM WAVE HEIGHT 202 CM.

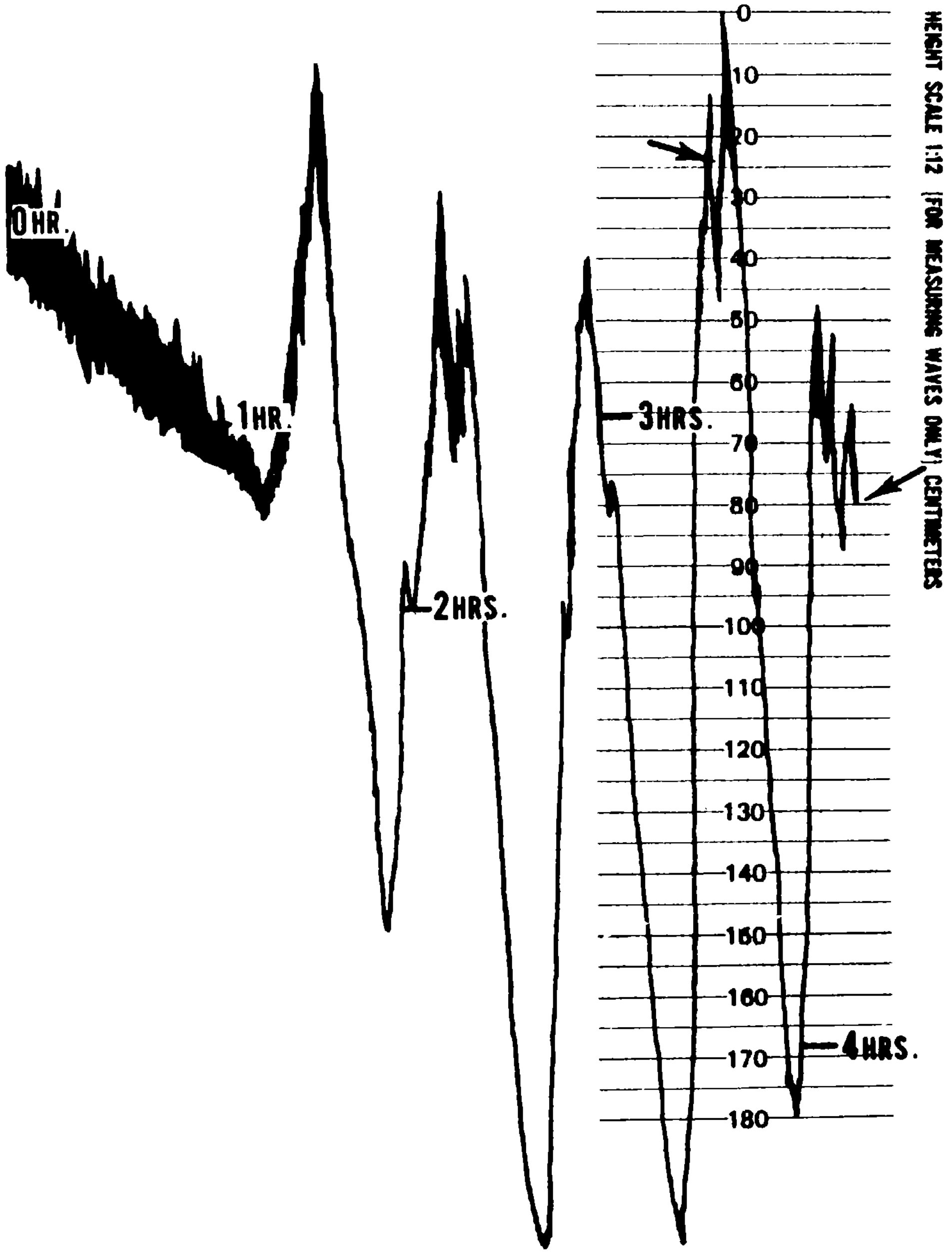


Figure 12. - Santa Monica tide record 0000H to 0422H (local time).

At 0422H local time (1222Z), the Santa Monica tide observer would send a message such as the following:

TSUNAMI. REPORTING PERIOD 1139Z TO 1222Z. MAXIMUM WAVE HEIGHT 0180 CM. WAVES DIMINISHING. WILL NOT REPORT AGAIN UNLESS WAVES INCREASE SIGNIFICANTLY.

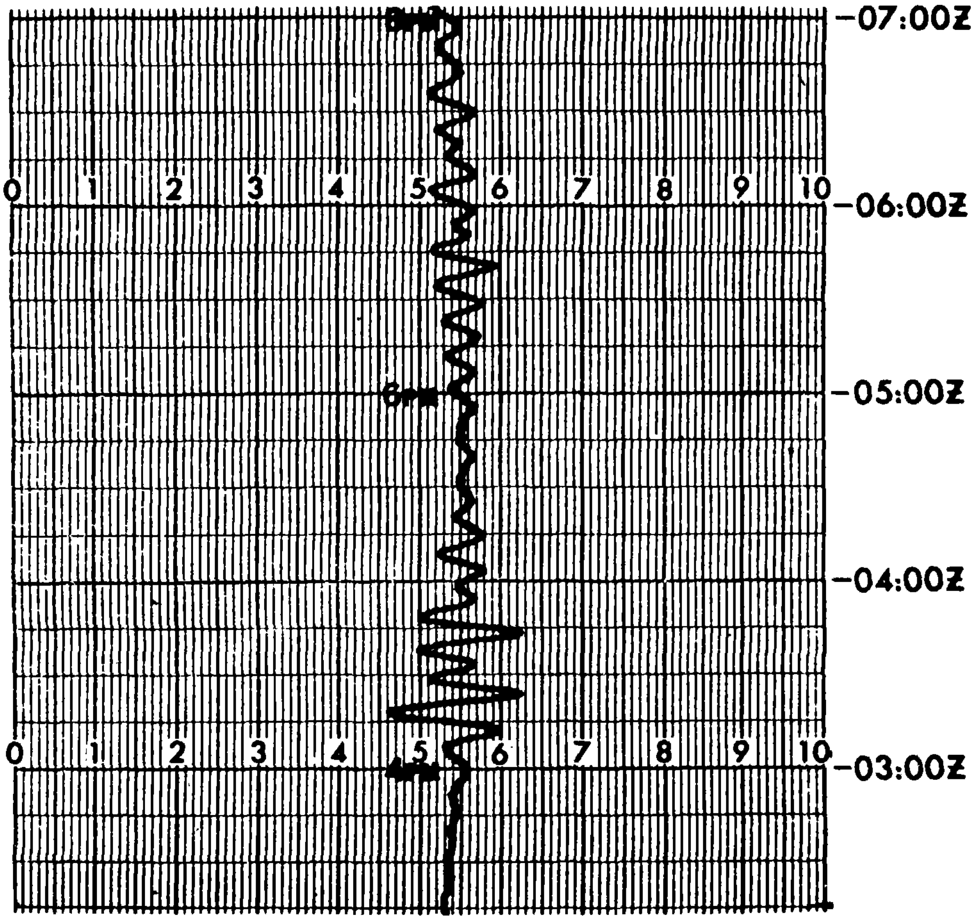
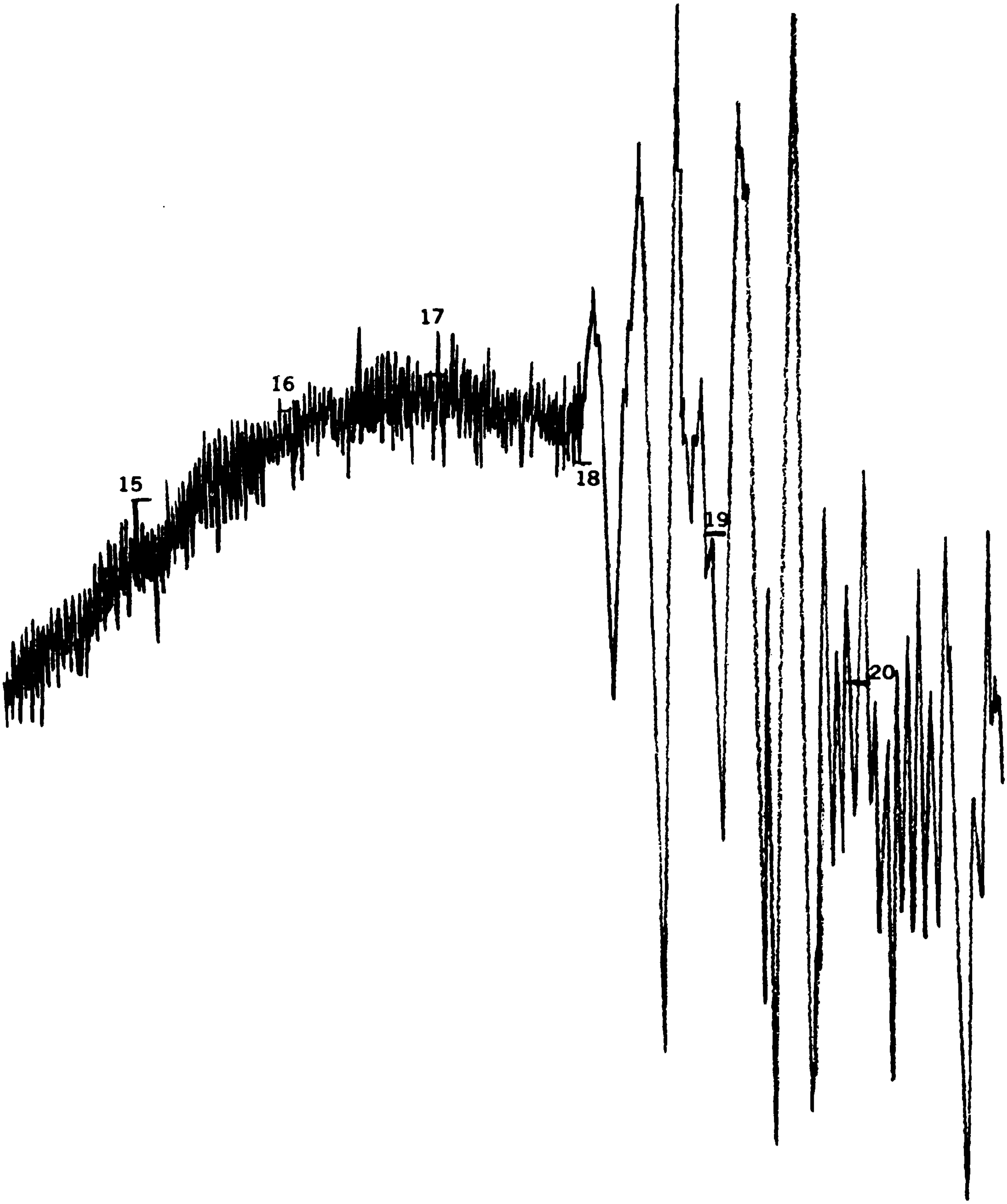
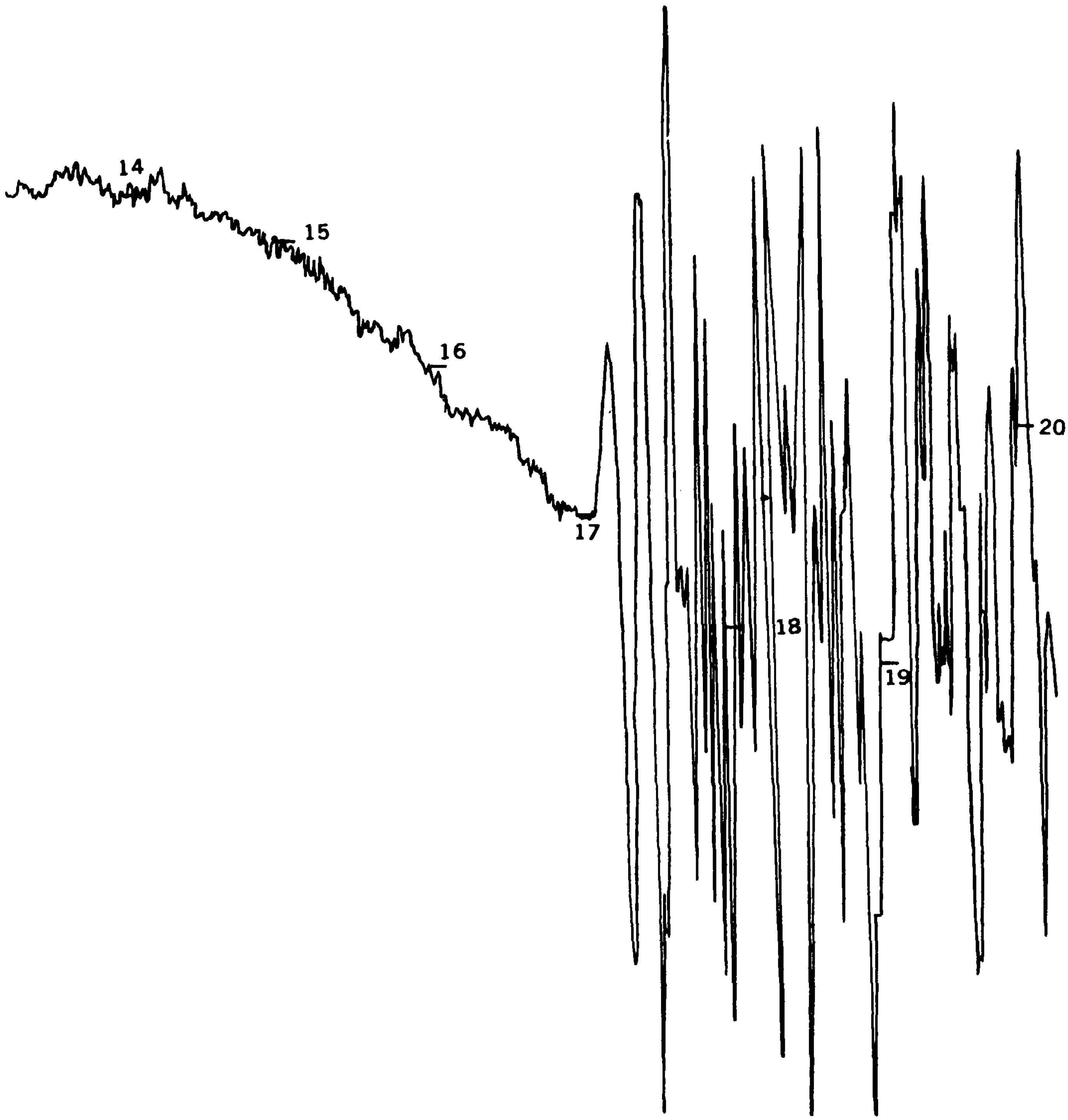


Figure 13. - Midway Island remote record showing the tsunami produced by the Kuril Islands earthquake of 2128Z, 11 August 1969.



(Scale 1:12)

Figure 14. - Tide record for Avila Beach, San Luis Obispo Bay, Calif., showing tsunami produced by earthquake in Aleutian Trench at 1229Z, 1 April 1946.



(Scale 1:6)

Figure 15. - Honolulu tide record showing tsunami produced by earthquake in Aleutian Trench at 1229Z, 1 April 1946.

This tsunami caused 173 deaths and property damage amounting to $25,000,000 in Hawaii.

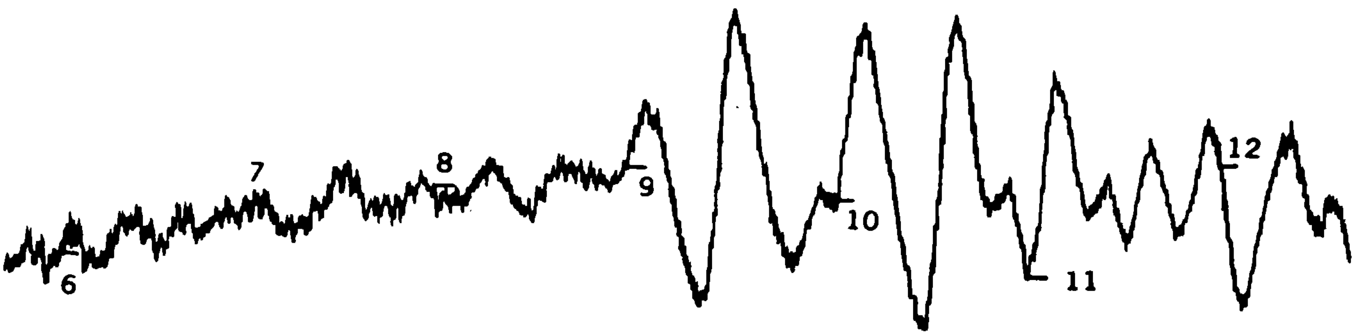
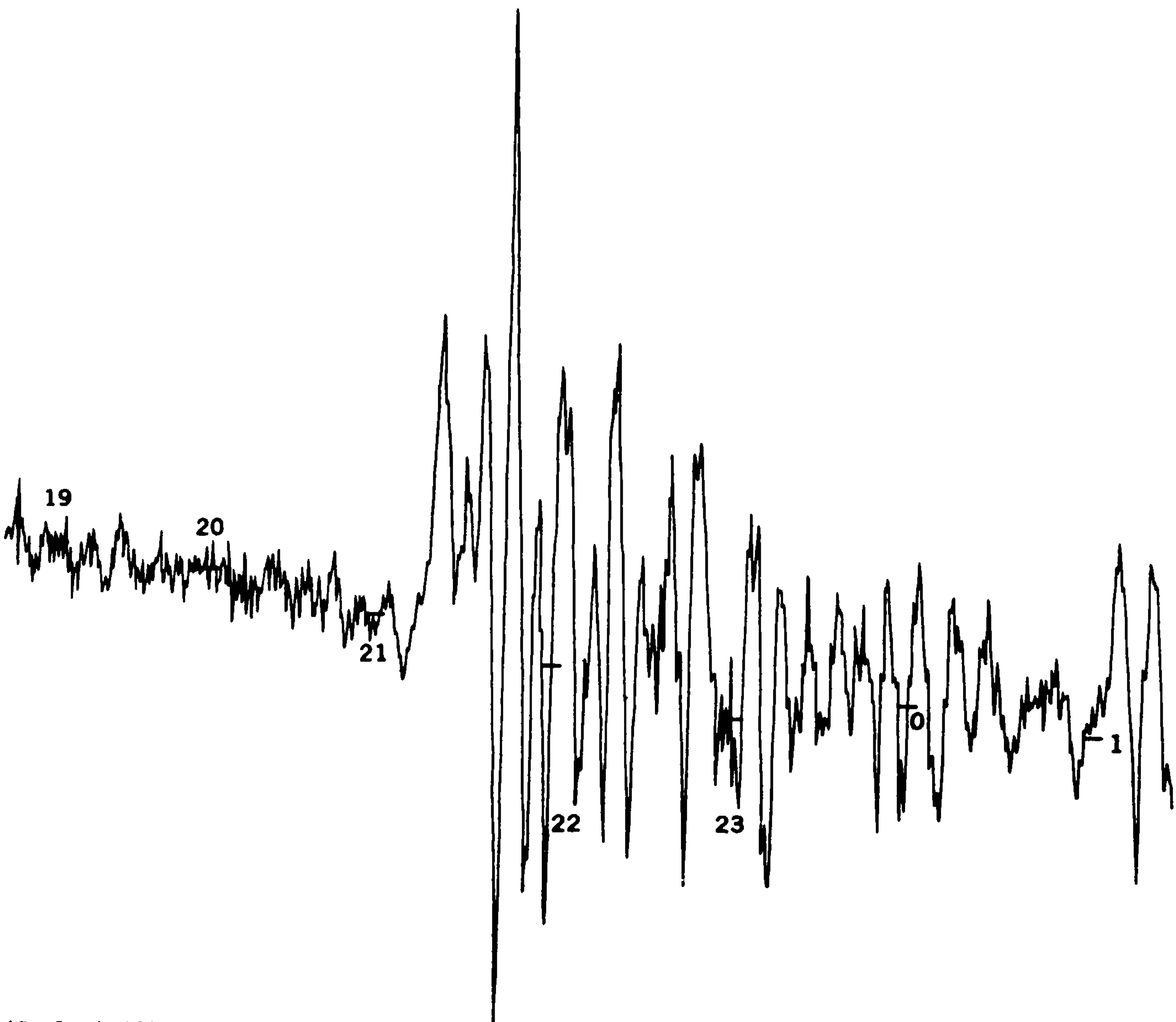
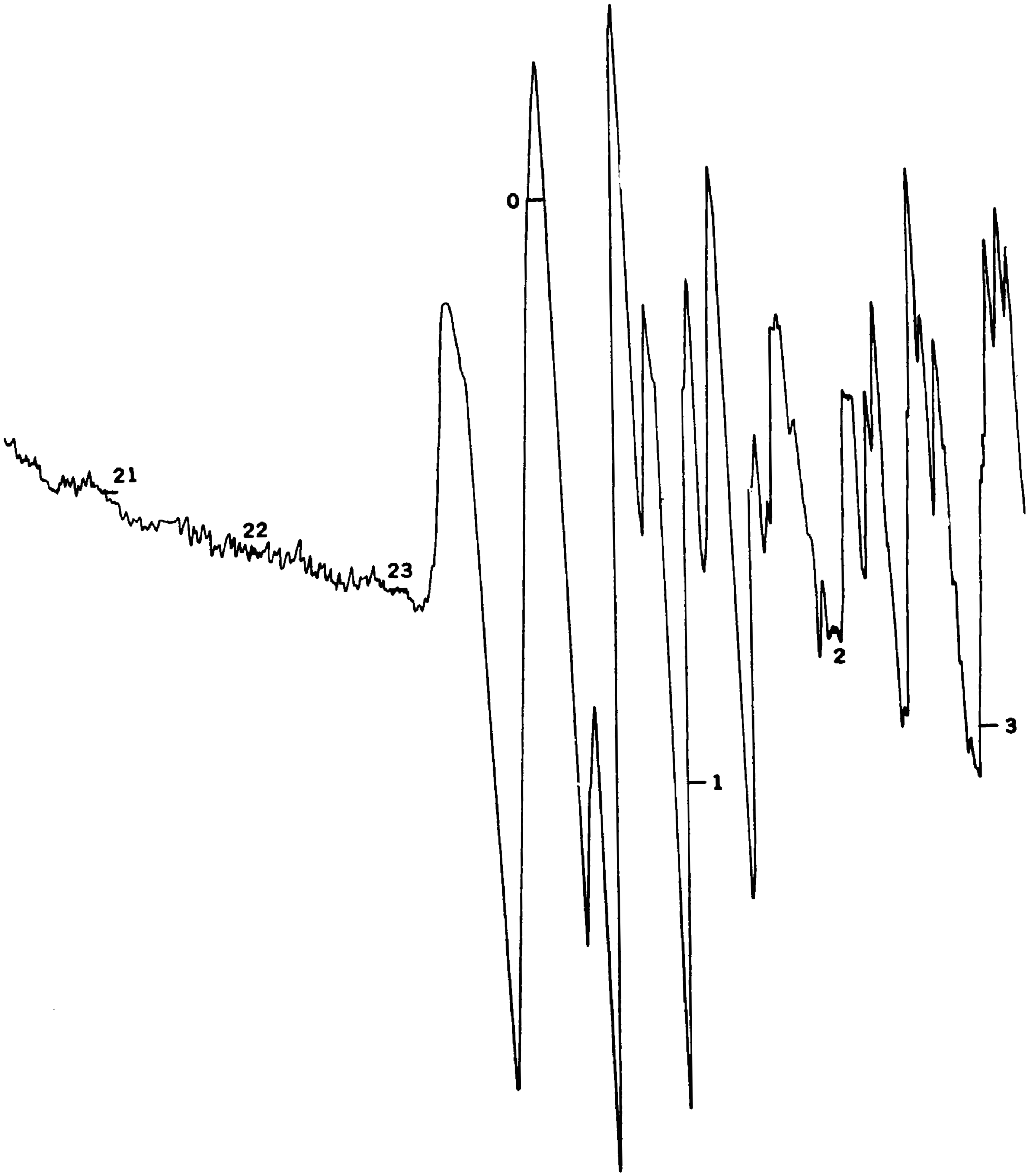


Figure 16. - Tide record for Kahului, Maui, Hawaii, showing tsunami produced by earthquake off Hokkaido, Japan, at 0123Z, 4 March 1952.



(Scale 1:12)

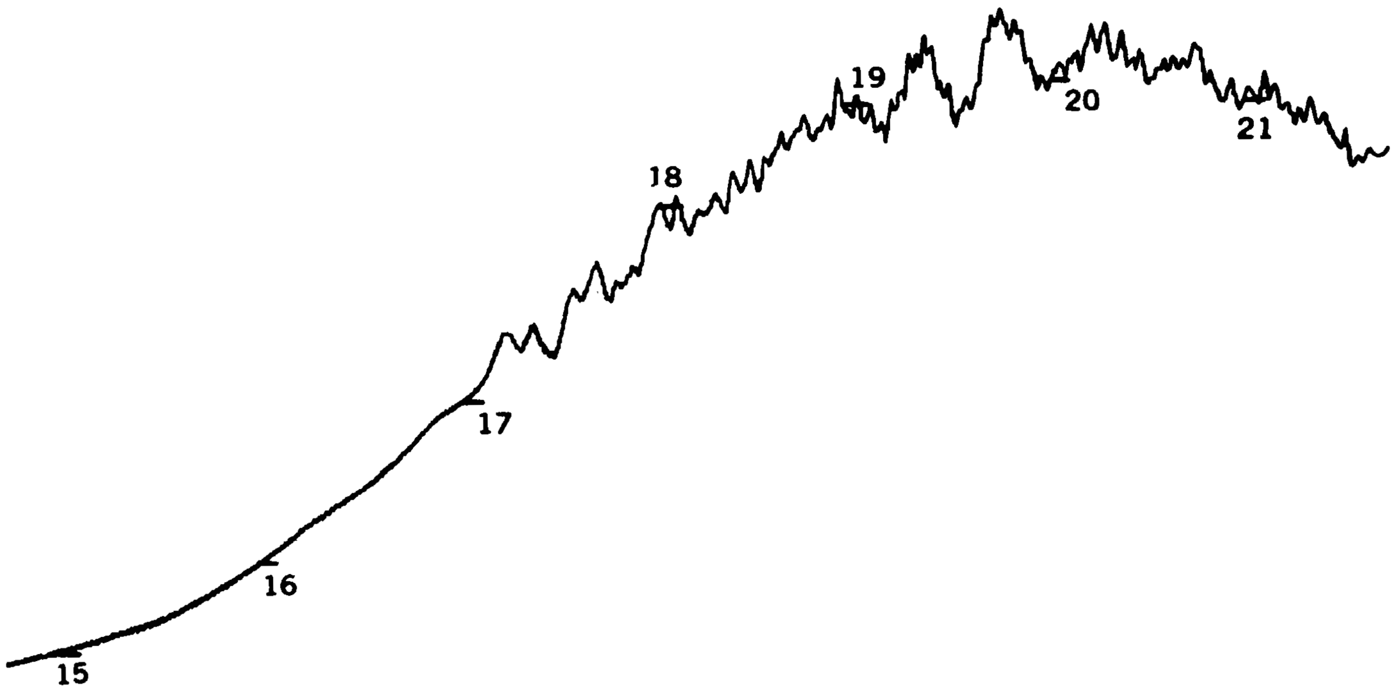
Figure 17. - Midway tide record showing tsunami produced by earthquake off Kamchatka at 1658Z, 4 November 1952.



(Scale 1:6)

Figure 18. - Honolulu tide record showing tsunami produced by earthquake off Kamchatka at 1658Z, 4 November 1952.

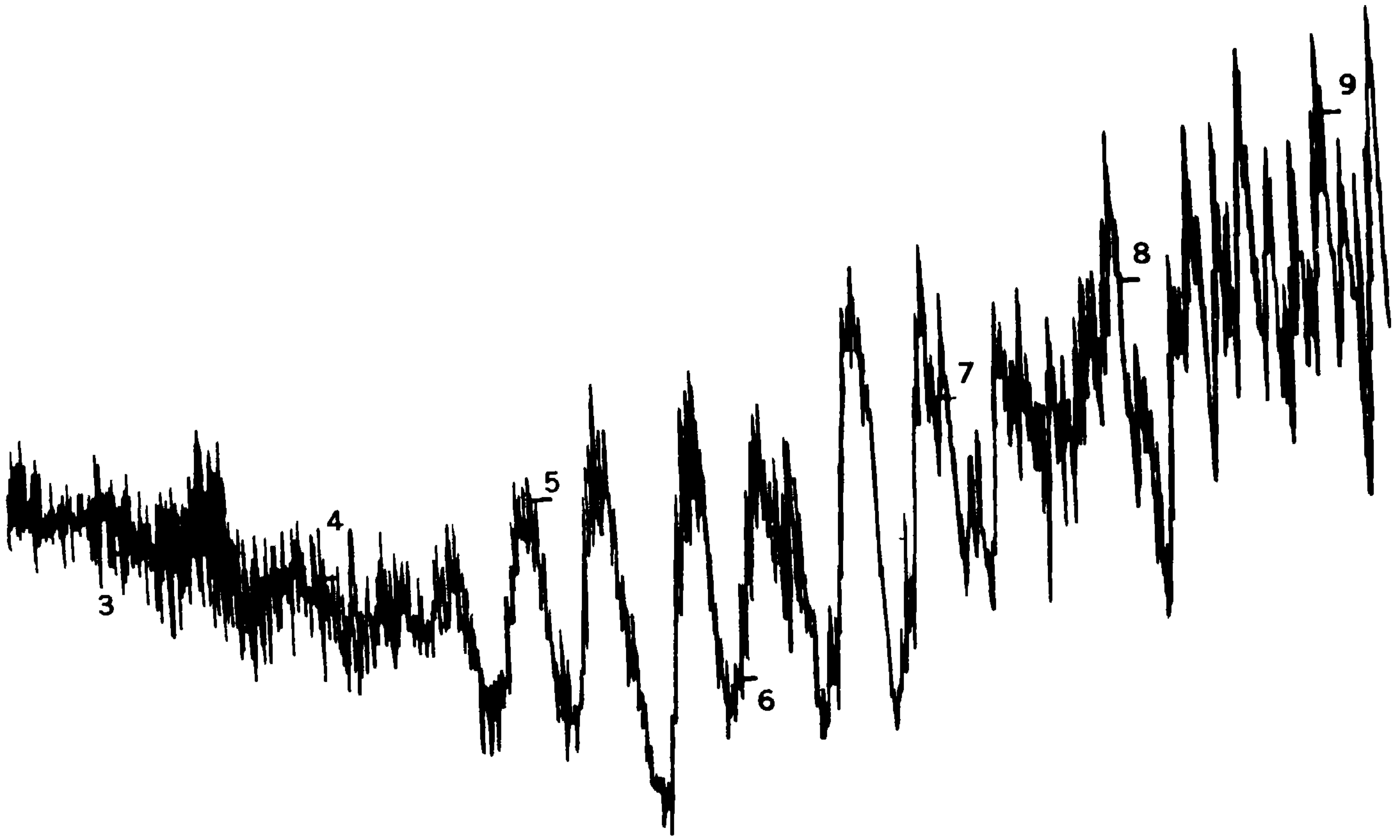
Wave reports from tide stations at Adak and Attu were received in time to issue warnings and evacuate waterfront areas. Property damage amounted to about $800,000 but lives were not lost.



(Scale 1:24)

Figure 19. - Tide record for Neah Bay, near Cape Flattery, Wash., showing tsunami produced by earthquake in Aleutian Trench at 1229Z, 1 April 1946.

This was the tsunami that was so destructive in the Hawaiian Islands (figure 15). The wave was much larger along the California (figure 14) and Peru (figure 20) coasts. Hence, even small waves should be reported, for a wave that is small at one place can be large and destructive at another location.



(Scale 1:12)

Figure 20. - Callao, Peru, tide record showing tsunami produced by earthquake in Aleutian Trench at 1229Z, 1 April 1946.