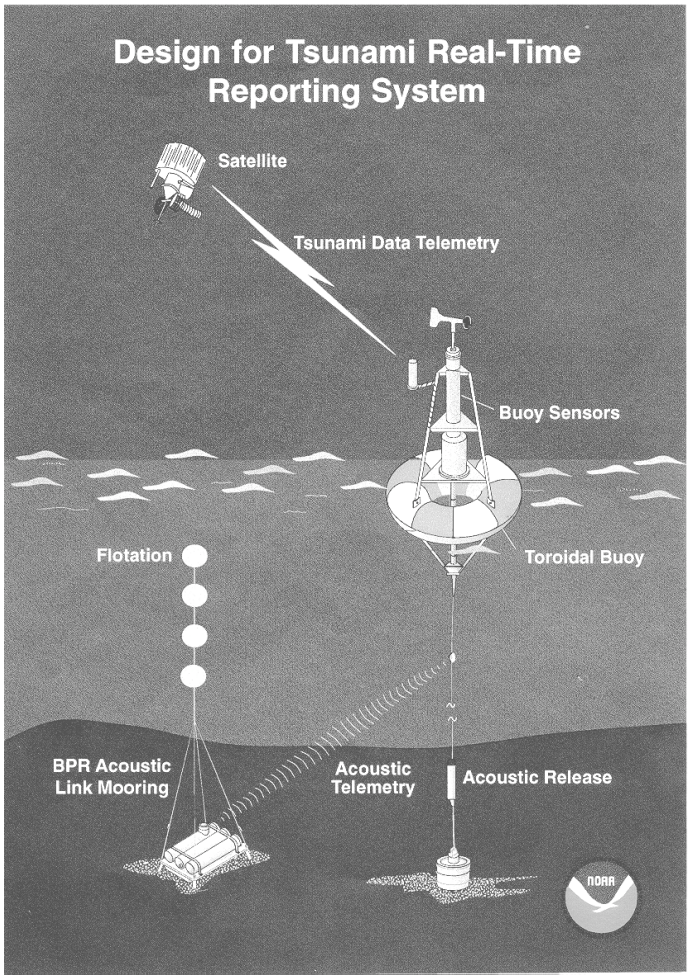
In recent years a new type of water level gauge has been designed and used specifically with tsunamis in mind. It utilizes a piezoelectric ***pressure transducer*** as its sensor. This type of sensor converts the water pressure, which is directly proportional to the water level, into a voltage. It can be mounted on the ocean bottom offshore and be connected to a land station by an electrical signal cable. Or it can be deployed on the deep mid-ocean bottom and have its signal sent to a buoy on the surface. Among the advantages of this type of sensor for tsunamis are that it can measure a greater range of water levels to accommodate even large tsunamis, and it has a wide frequency response to record the tsunami signal without distortion. In addition, these sensors can be deployed more strategically in mid-ocean where there are no islands to site other types of gauges, and where the tsunami is not distorted by the effects of shallow water and shorelines.

One type of gauge under development in the USA, is for measuring the unusual presence and level of water on land from a tsunami or other type of flood. Because this ***runup gauge*** is located entirely on land, it should be less expensive to build, install, and maintain.



System recently developed by the USA for recording tsunamis in the deep ocean with a bottom pressure gauge, and relaying the signal to warning centers through a buoy and satellite.

Japan routinely monitors seawater levels with ultrasonic sensors above the sea surface, water pressure sensors on land for runup, and Fuse-type tide gauges. Their Port and Harbour Research Institute has also developed offshore gauges to measure tsunamis about 50 km outside the entrance to Tokyo Bay.

Data from all the above types of gauges are transmitted in analog or digital form to warning centers or other organizations, and/or recorded locally on a chart recorder paper, punch tape, magnetic computer media, or computer memory.

To be effective for warning purposes, water level gauges need to be located near the tsunami source region to get the most rapid confirmation whether a tsunami has been generated or not, and an initial estimate of its size. They should also be located between the source and threatened coastal areas to monitor the tsunami and help predict its impact. For local tsunamis, many gauges are needed along coastlines at risk to get the quickest possible confirmation and evaluation of tsunami waves. Although a high level of coverage exists for some Pacific coastlines threatened by local tsunamis, for example in Japan, the USA, and Chile, other locally threatened coastlines have few or no gauges. For Pacific-wide tsunamis, less dense but nevertheless thorough coverage is needed in the source regions and across the Pacific Ocean basin. Gauges exist near all of the known source regions for major Pacific-wide tsunamis except the seismic zones off of the Kuril Islands and Kamchatka Peninsula. The Russian Federation, in a joint project with the IOC and the USA, is now working to reestablish gauges in this region that will transmit data to the Russian tsunami warning centers as well as to PTWC. Coverage in the interior of the Pacific basin, however, has many significant gaps, particularly in the north Pacific where there are only a few islands to site tide gauges. Increasing coverage in the interior of the Pacific basin will require the use of sensors such as deep ocean pressure gauges that do not need to be sited near land.