SEISMIC TECHNOLOGY

ARRELIC INSIGHT

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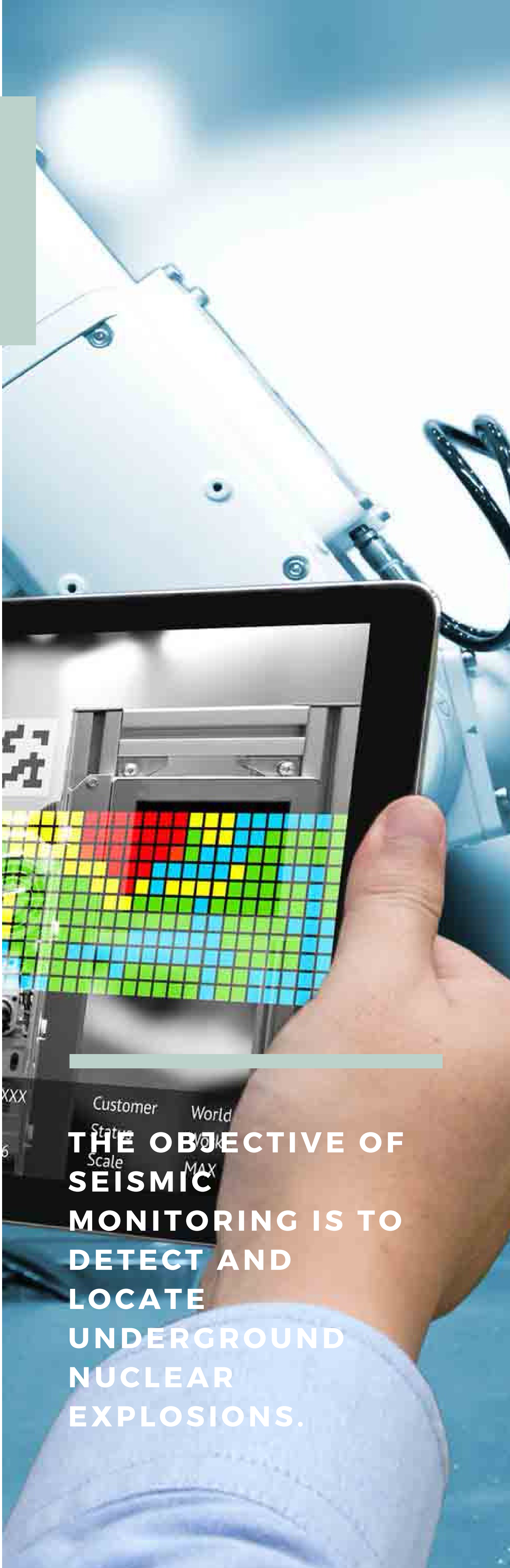
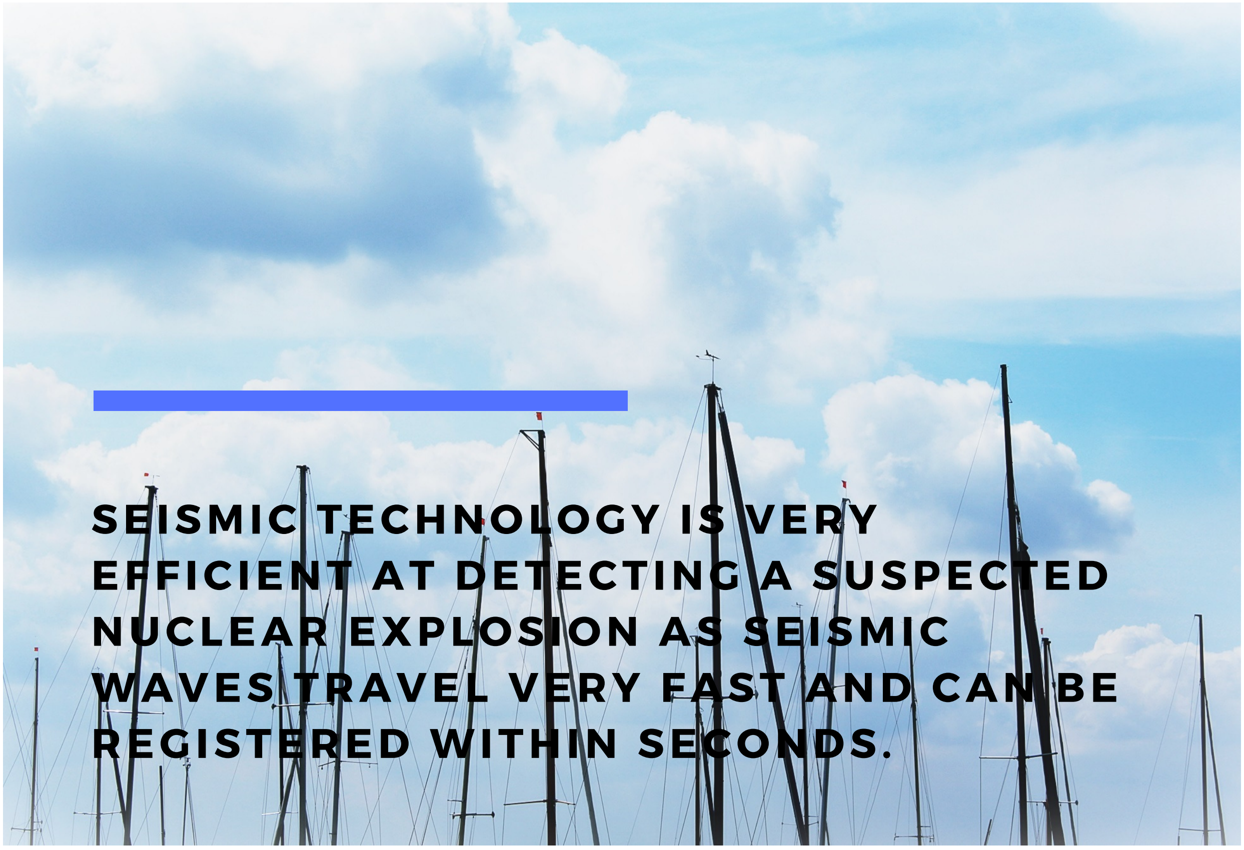
ABOUT

Seismology is the study of seismic waves, their propagation through the Earth, their sources and their effects. Seismic waves result not only from earthquakes, but also from other natural and man-made events. Even a person stomping on the ground can generate a seismic wave that can be picked up by a sensitive seismometer.
The size or magnitude of earthquakes and other seismic events is measured using the Richter scale. Several thousand earthquakes larger than magnitude 4 on the Richter scale occur each year around the globe. A magnitude 4 earthquake is a fairly light earthquake which can cause windows and doors to rattle, but which does not result in significant damages.
A seismic event generates two types of seismic waves: body waves and surface waves. The faster body waves travel through the interior of the Earth while the slower surface waves – as the name suggests – travel along its surface. Both types of wave are looked at during analysis to collect specific information on a particular event.
The instruments employed to measure seismic waves are seismometers, which are sensors converting ground motion into electrical voltage.



THE OBJECTIVE OF SEISMIC MONITORING IS TO DETECT AND LOCATE UNDERGROUND NUCLEAR EXPLOSIONS.

OBJECTIVES



Seismic monitoring is one of the three waveform technologies used by the Comprehensive Nuclear-Test-Ban Treaty (CTBT) verification regime to monitor compliance with the Treaty. The objective of seismic monitoring is to detect and locate underground nuclear explosions. Data resulting from seismic monitoring are used to distinguish between an underground nuclear explosion and the numerous natural and man-made seismic events that occur every day, such as earthquakes and mining explosions.

Underground nuclear testing began in the 1950s and provoked growing concern.

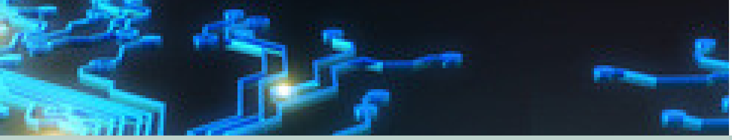
It was, however, soon recognized that seismic observations could provide a method of verifying the strength and location of these events.

Seismic technology is a very efficient means of detecting a suspected nuclear explosion. Seismic waves travel so fast that an event creating these waves can be registered by seismic stations distributed worldwide in a time span ranging from a few seconds to about ten minutes.

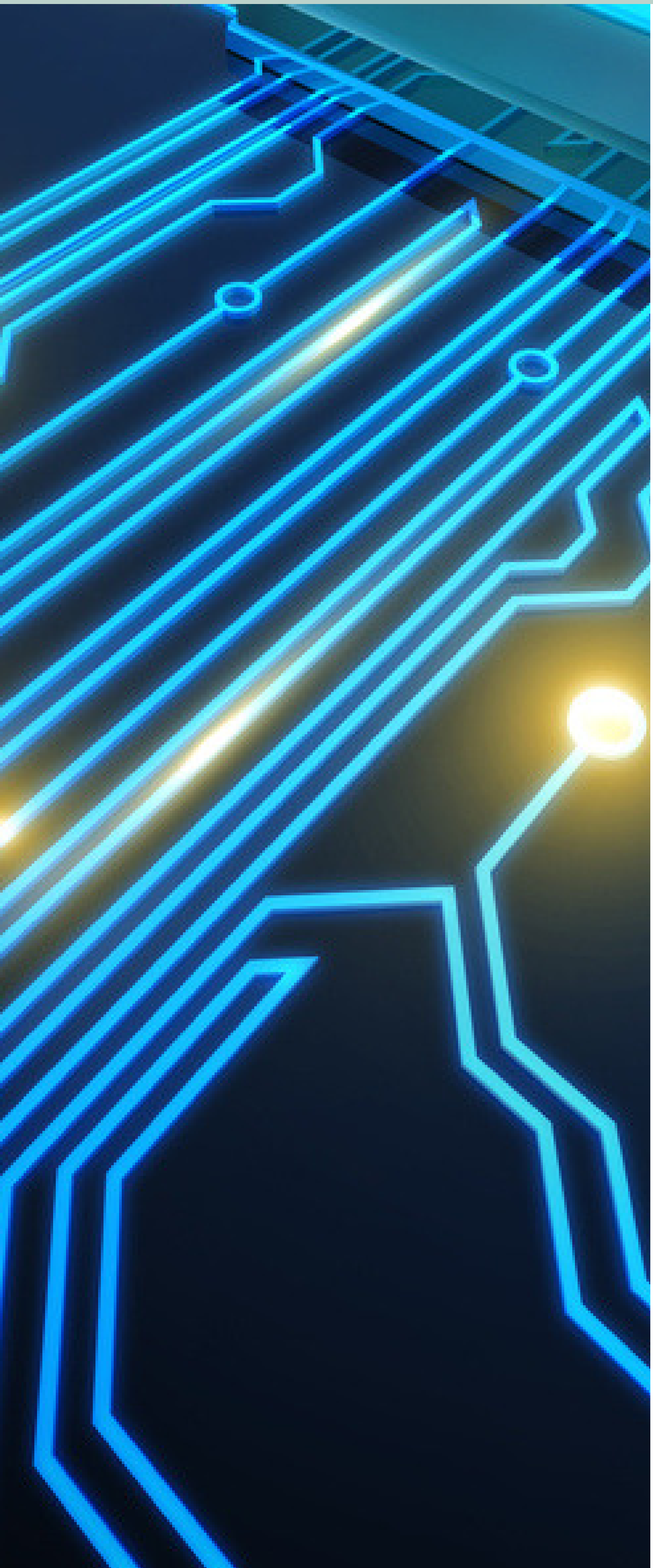
A seismic event generates body waves and surface waves. Both are of crucial importance for the analysis of a suspicious event. They provide essential information on the location, the strength and the nature of an event.

OBJECTIVES

There are two types of body waves emanating from a seismic event, P-waves and S-waves. P-waves are primary or compressional waves that alternately compress and expand the ground in the direction of the wave's propagation. These waves can move through any material.
S-waves are secondary or shear waves in the ground that move perpendicular to the direction of the wave's propagation. S-waves can only move through solids as this kind of movement is impossible in liquid or gaseous materials.
The azimuths of both P-waves and S-waves makes it possible to identify the direction from which the waves were emitted. Since the waves travel at different speeds, it is also possible to determine the distance to the source by measuring the different arrival times of the waves.
Surface waves travel along the surface of the Earth, are slower than body waves and tend to be very destructive. Technically, surface waves result from interference between the two types of body waves. During analysis, surface wave measurements help identify the depth and magnitude of an event.
Seismic monitoring is significant in preparation for an on-site inspection (OSI). The analysis of seismic data provides the necessary information on the location of a suspected underground nuclear explosion, which is a prerequisite for the identification of an inspection area.



BUILDING THE STATION



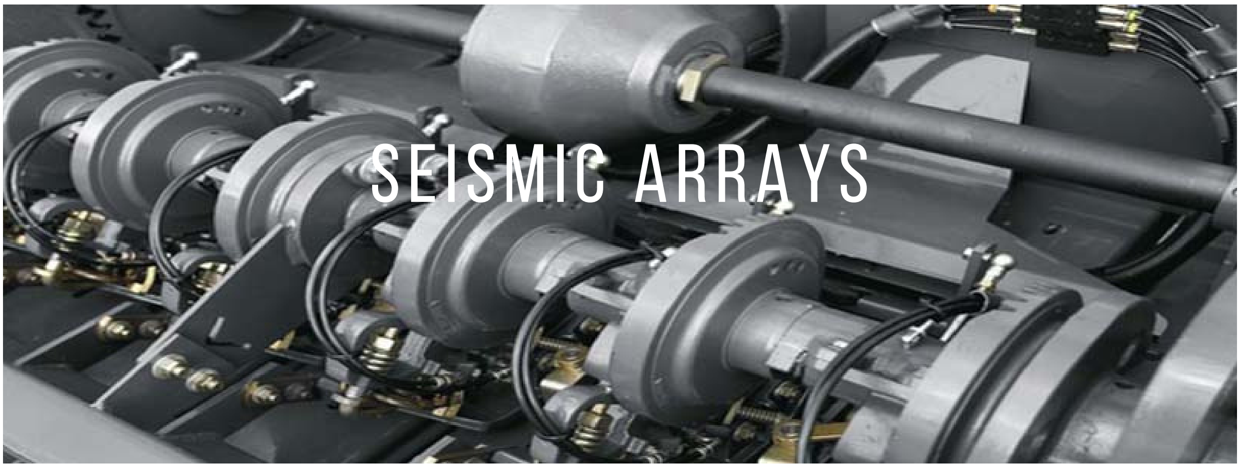
There is a sequential four-step process to building International Monitoring System (IMS) stations. It involves site surveys, installation, certification and operation.
Firstly, a site survey is conducted to assess the suitability of the site to host a station and identify any specific conditions that would impact station design. The Treaty lists the geographical coordinates for each station, but only a site survey determines the exact location of a seismic station and its elements.
Secondly, a single contractor is selected for the design, manufacture and installation of the station. This selection is generally effected through an international tendering process. The Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization(CTBTO) provides guidance for station construction work and reviews all aspects of the process to ensure that it meets all criteria so that it can be certified as a valid station within the IMS network. IMS stations must make certain that data received at the IDC are authentic. This is achieved through a special digital "signature" embedded in the data flow from each station. Tamper-detection devices are placed on enclosures for seismic equipment to preclude tampering with the hardware.
Thirdly, the IMS station must be certified to ensure that all of its equipment, infrastructure and settings meet the technical specifications set by the CTBTO and that all data are transmitted to the Vienna-based IDC through the Global Communication Infrastructure in a timely manner.
Fourthly, once certified, operation and maintenance agreements are established between the CTBTO and a station operator. Long-term quality monitoring is then undertaken to maintain the high standards of data quality, data availability and station performance.

SEISMIC MONITORING NETWORKS

THERE ARE TWO GLOBAL SEISMIC MONITORING NETWORKS. THE PRIMARY SEISMIC NETWORK AND THE AUXILIARY SEISMIC NETWORK

The Treaty calls for two global seismic monitoring networks: a primary seismic network with 50 stations and an auxiliary one with 120 stations. The stations of the primary seismic network send data continuously in real time to the IDC and will be utilized most extensively. The auxiliary seismicnetwork often takes advantage of existing seismic stations which are being upgraded to meet the IMS technical standards. These stations do not send data in real time but upon request only.

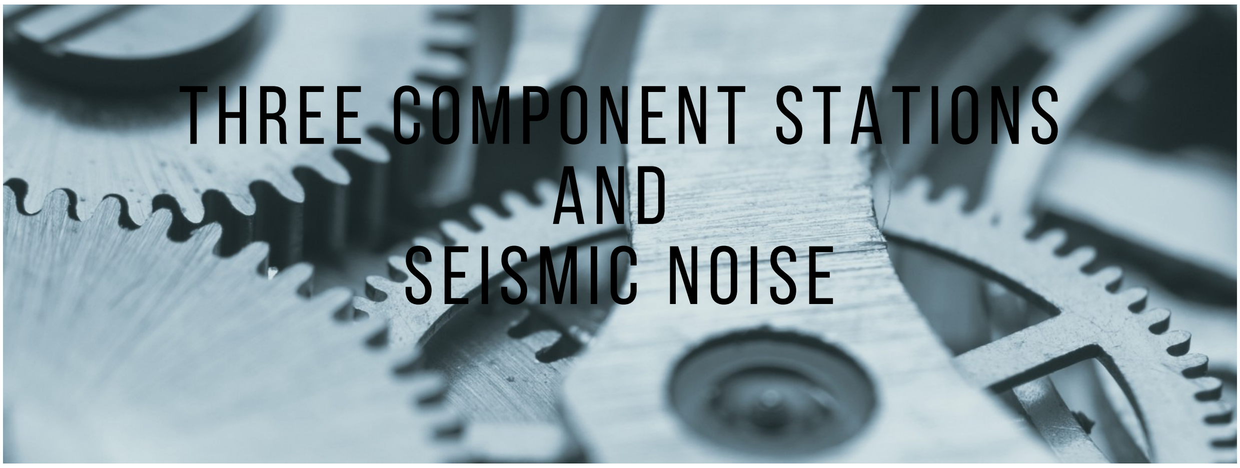
There are basically two different types of seismic stations: seismic arrays and three-component stations. About 60% of the primary seismic network will consist of seismic array stations, which are essentially sets of nine to 25 seismic sensors geometrically arranged over a wide area. Most of the stations in the auxiliary seismic network are three-component stations.



Groups of individual sensors deployed in a specific geometric pattern across an area ranging from a few to several hundred square kilometres are called “seismic arrays”. New seismic arrays built by the IMS usually have a distribution diameter of three to four kilometres. Older array stations, which have been upgraded by the IMS and incorporated into its seismic networks, may cover an area of up to 500 square kilometres.

Seismic arrays enhance monitoring capability for several reasons. They improve the signal to noise ratio. This means that it is easier to distinguish the actual signal against the background noise since it is filtered out. Array stations allow for a better estimation of the azimuth of incoming signals, i.e. they identify the direction from which the signal arrived. The spatial distribution of the sensors also permits an estimation of the seismic waves’ speed. Information on both the direction and speed of the incoming seismic waves is crucial when identifying the source of a particular event.

SEISMIC ARRAYS CONSIST OF SEVERAL SEISMIC SENSORS THAT ARE LAID OUT ACROSS A LARGE AREA.



THREE COMPONENT STATIONS AND SEISMIC NOISE

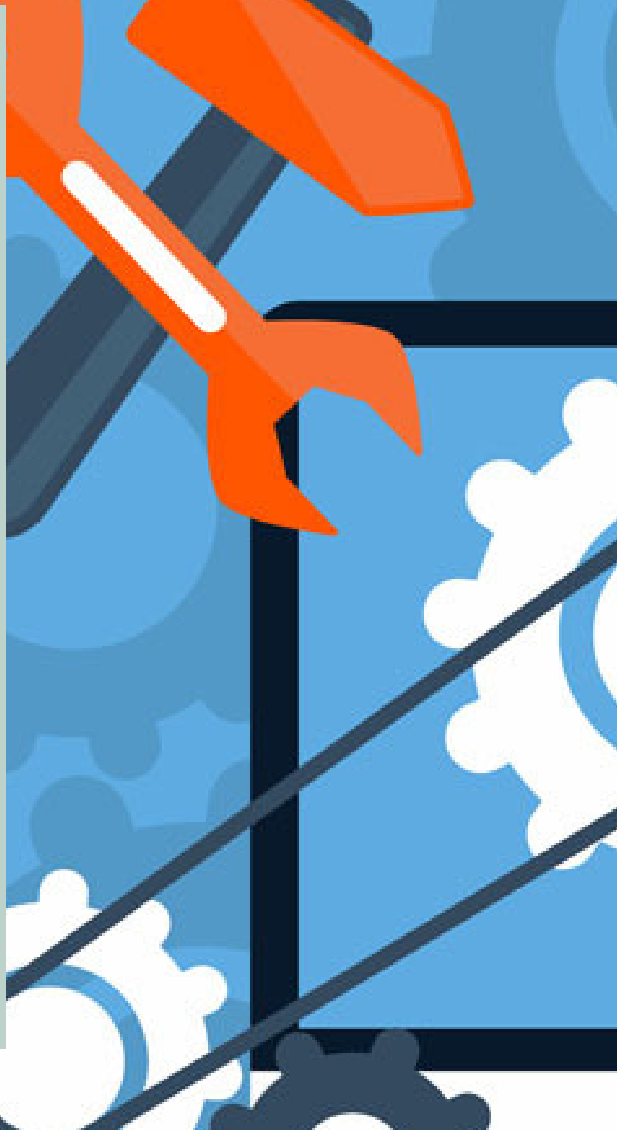
THREE-COMPONENT STATIONS EMPLOY ONLY ONE SEISMIC SENSOR THAT MEASURES THE THREE SPATIAL COMPONENTS OF SEISMIC WAVES– UP-DOWN, EAST-WEST AND NORTH-SOUTH.

Three-component stations have one seismic sensor that measures the three spatial components of the waves, i.e. up-down, East-West and North-South. In comparison with seismic array stations, three-component stations often have a bigger error margin,but are more cost-effective. This type of station also measures body and surface waves, thus providing information on the depth and strength of an event.

Modern seismometers can detect ground movements as small as the size of atomic spacing in a crystal. However, continual background vibrations, known as “seismic noise”, often distort seismic signals and limit their detection.
While seismic noise is mostly generated by wind and ocean waves, vehicle traffic and industrial activity can also contribute. In order to eliminate the influence of seismic noise, seismic stations are usually built in remote areas, preferably on the outcrops of geological hard rock and as far away as possible from human activity.

About Arrelic

Arrelic is a fast-growing deep-tech firm aiming to bring the next level of IoT based sensor technology to transform the mode of manufacturing operation and maintenance practice of various industries with extensive expertise in Reliability Engineering, Predictive Maintenance, Industrial Internet of Things (IIoT) Sensors, Machine Learning and Artificial Intelligence. We provide a single ecosystem for catering all industry needs from Consulting to IoT and Analytics as well as providing Training and Development courses for different stakeholders. We aim to help manufacturing industries to improve their overall plant productivity, reliability and minimize total production cost by 25-30% by eliminating machine downtime, lightening management decisions by analysing the machine data with right mind and expertise; for a worry free operation.



GOT ANY QUESTIONS?

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Disclaimer

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