НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ ЦИВІЛЬНОГО ЗАХИСТУ УКРАЇНИ

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Англійська мова за професійним спрямуванням

Методичні рекомендації до самостійної роботи зі спеціальності ‘‘Охорона праці’’

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Англійська мова за професійним спрямуванням для ВЗН системи МНС.
Тексти до самостійної роботи для 1-го і 2-го курсів зі спеціальності''Охорона праці''.

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Посібник спрямований на підготовку студентів та курсантів першого і другого етапів навчання до самостійного читання, розуміння й перекладу оригінальної науково-технічної літератури, а також розвиток навичок усного мовлення з тем, передбачених програмою.

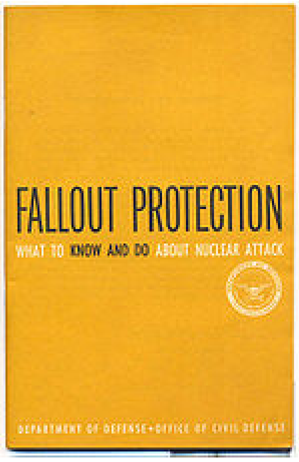
Посібник містить фахові тексти. Тексти посібника відображають спектр тематики, що вивчається студентами та курсантами протягом навчання у пожежно-технічних ВНЗ, і містять фахову термінологію та специфічну лексику технічного напряму.

Розрахований на студентів, курсантів та слухачів ВЗН, а також всіх, хто пов'язаний із пожежно-рятувальною справою та охороною навколишнього середовища.

Civil defense

Civil defense, **civil defence** or **civil protection** is an effort to prepare civilians for military attack. It uses the principles of emergency operations: prevention, mitigation, preparation, response, or emergency evacuation, and recovery. Programmes of this sort were initially discussed at least as early as the 1920s but only became widespread after the threat of nuclear weapons was realized.

Since the end of the Cold War, the focus of civil defense has largely shifted from military attack to emergencies and disasters in general. The new concept is described by a number of terms, each of which has its own specific shade of meaning, such as **crisis management**, **emergency management**, **emergency preparedness**, **contingency planning**, **emergency services**, and **civil protection**. In some countries, the all-encompassing nature of civil defense is denoted by the term "total defense". The name suggests committing all resources, hence the term total, of the nation to the defense.



Civil Defense literature such as Fallout Protection were common during the cold war era.

In most of the NATO states, such as the United States, the United Kingdom or Germany as well as the [then] Soviet Bloc, and especially in the neutral countries, such as Switzerland and in Sweden during the 1950s and 60s, many civil defense practices took place to prepare for the aftermath of a nuclear war, which seemed quite likely at that time. Such efforts were opposed by the Catholic Worker Movement and by peace activists such as Ralph DiGia , on the grounds that these programs gave the public false confidence that they could survive a nuclear war. There was never strong civil defense policy because it fundamentally violated the doctrine of "mutual assured destruction" (M.A.D.) by making provisions for survivors. Also, a fully fledged total defense would have been too expensive. Above all, compared to the power of destruction a defense would have been ineffective. In the M.A.D. doctrine, there are not supposed to be any survivors for a civil defense system to assist (thus the acronym). Governments in the West sought to implement civil defense measures against nuclear war in the face of popular apathy and scepticism.

Public Service Announcements including children's songs were created by government institutes and then distributed and released by radio stations to educate the public in case of nuclear attack.

During the Cold War, civil defense was seen largely as defending against and recovering from an attack involving nuclear weapons. After the end of the Cold War, the focus moved from defense against nuclear war to defense against a terrorist attack possibly involving chemical or biological weapons; in the context of the United States this eventually led to the replacement of the United States civil defense with the Federal Emergency Management Agency. After the September 11, 2001 attacks, in the United States the concept of civil defense has been revisited under the umbrella term of homeland security and all-hazards emergency management.

In Europe, the triangle CD logo continues to be widely used. The old US civil defense logo was used in the FEMA logo until recently and is hinted at in the United States Civil Air Patrol logo. Created in 1939 by Charles Coiner of the N. W. Ayer Advertising Agency, it was used throughout World War II and the Cold War era. In 2006, the National Emergency Management Association — a U.S. organization made up of state emergency managers — officially retired the Civil Defense triangle logo, replacing it with a stylized EM (standing for Emergency management).

The term "civil protection" is currently widely used within the European Union to refer to government-approved systems and resources tasked with protecting the civilian population, primarily in the event of natural and technological disasters. In recent years there has been emphasis on preparedness for technological disasters resulting from terrorist attack. Within EU countries the term **crisis management** emphasises the political and security dimension rather than measures to satisfy the immediate needs of the civilian population.

In Australia, civil defense is the responsibility of the volunteer-based State Emergency Service.

Importance

Relatively small investments in preparation can speed up recovery by months or years and thereby prevent millions of deaths by hunger, cold and disease. According to human capital theory in economics, a country's population is more valuable than all of the land, factories and other assets that it possesses. People rebuild a country after its destruction, and it is therefore important for the economic security of a country that it protect its people. Also, reducing fear and uncertainty via civil defense helps people's quality of life and has positive economic benefits. According to psychology, it is important for people to feel like they are in control of their own destiny, and preparing for uncertainty via civil defense may help to achieve this. If the people are not in control, and the preparations ineffective, the government loses its credibility and the respect of its citizens.

Threat assessment

Threats to civilians and civilian life include nuclear threats, biological threats, chemical threats, and others. Threat assessment involves studying each threat so that preventative measures can be built into civilian life.

Conventional

This would be conventional explosives. Shelter intended to protect against nuclear blast effects would include thick concrete and other sturdy elements which are resistant to conventional explosives. A shelter designed to protect only from radiation and fallout, however, would be much more vulnerable to conventional explosives.

Nuclear

The biggest threats from a nuclear attack are effects from the blast, fires and radiation. One of the most prepared countries for a nuclear attack is Switzerland. Almost every building in Switzerland has a shelter against the initial nuclear bomb and explosion followed by the fallout. Because of this, many people use it as a safe to protect valuables, photos, financial information and so on. Switzerland also has air-raid and nuclear raid sirens in every village.

Dirty Bomb

A "radiologically enhanced weapon, or "dirty bomb" uses an explosive to spread radioactive material. This is a theoretical risk, and such weapons have not been used by terrorists. Depending on the quantity of the radioactive material, the dangers may be mainly psychological. Toxic effects can be managed by standard hazmat techniques.

Biological

The threat here is primarily from disease-causing microorganisms such as bacteria and viruses.

Chemical

Various chemical agents are a threat such as nerve gas (VX, Sarin, etc.).

Other

There are many other possible threats besides these, for example the invasion of enemy troops and armed warfare.

Mitigation

Mitigation is the process of actively preventing the war or the release of nuclear weapons. It includes policy analysis, diplomacy, political measures, nuclear disarmament and more military responses such as a National Missile Defense and air defense artillery. In the case of counter-terrorism, mitigation would include diplomacy, intelligence gathering and direct action against terrorist groups. Mitigation may also be reflected in long-term planning such as the design of the interstate highway system and the placement of military bases further away from populated areas.

Preparation

Preparation consists of building blast shelters, and pre-positioning information, supplies and emergency infrastructure. For example, most larger cities in the U.S. now have underground emergency operations centers that can perform civil defense coordination. FEMA also has many underground facilities located near major railheads such as the one in Denton, Texas and Mount Weather, Virginia for the same purpose. Other measures would include continuous government inventories of grain silos, the Strategic National Stockpile, the uncapping of the Strategic Petroleum Reserve, the dispersal of truck-transportable bridges, water purification, mobile refineries, mobile decontamination facilities, mobile general and special purpose disaster mortuary facilities such as DMORT and DMORT-WMD, and other aids such as temporary housing to speed civil recovery.

On an individual scale, one means of preparation for exposure to nuclear fallout is to obtain potassium iodide (KI) tablets as a safety measure to protect the human thyroid gland from the uptake of dangerous radioactive iodine. Another measure is to cover the nose, mouth and eyes with a piece of cloth and sunglasses to protect against alpha particles, which are only an internal hazard.

To support and supplement efforts at national, regional and local level with regard to disaster prevention, the preparedness of those responsible for civil protection and the intervention in the event of disaster

- To establish a framework for effective and rapid cooperation between different civil protection services when mutual assistance is needed (police, fire service, healthcare service, public utility provider, voluntary agencies).
- To set up and implement training programs for intervention and coordination teams as well as assessment experts including joint courses and exchange systems.

- To enhance the coherence of actions undertaken at international level in the field of civil protection especially in the context of cooperation.

Preparing also includes sharing information:

- To contribute to the information of the public in view of increasing the level of self-protection of citizens
- To collect and disseminate validated emergency information
- To pool information on national civil protection capabilities, military and medical resources.
- To ensure efficient information sharing between the different authorities.

Response

This Federal Signal SD-10 in Los Angeles shows signs of neglect.

Response consists first of warning civilians so they can enter Fallout Shelters and protect assets.

Staffing a response is always full of problems in a civil defense emergency. After an attack, conventional full-time emergency services are dramatically overloaded, with conventional fire fighting response times often exceeding several days. Some capability is maintained by local and state agencies, and an emergency reserve is provided by specialized military units, especially civil affairs, Military Police, Judge Advocates and combat engineers.

However, the traditional response to massed attack on civilian population centers is to maintain a mass-trained force of volunteer emergency workers. Studies in World War II showed that lightly trained (40 hours or less) civilians in organized teams can perform up to 95% of emergency activities when trained, liaised and supported by local government. In this plan, the populace rescues itself from most situations, and provides information to a central office to prioritize professional emergency services.

In the 1990s, this concept was revived by the Los Angeles Fire Department to cope with civil emergencies such as earthquakes. The program was widely adopted, providing standard terms for organization. In the U.S., this is now official federal policy, and it is implemented by community emergency response teams, under the Department of Homeland Security, which certifies training programs by local governments, and registers "certified disaster service workers" who complete such training.

Recovery

Recovery consists of rebuilding damaged infrastructure, buildings and production. The recovery phase is the longest and ultimately most expensive phase. Once the immediate "crisis" has passed, cooperation fades away and recovery efforts are often politicized or seen as economic opportunities.

Preparation for recovery can be very helpful. If mitigating resources are dispersed before the attack, cascades of social failures can be prevented. One hedge against bridge damage in riverine cities is to subsidize a "tourist ferry" that performs scenic cruises on the river. When a bridge is down, the ferry takes up the load.

Implementation

Some advocates believe that government should change building codes to require autonomous buildings in order to reduce civil societies' dependence on complex, fragile networks of social services.

An example of a crucial need after a general nuclear attack would be the fuel required to transport every other item for recovery. However, oil refineries are large, immobile, and probable targets. One proposal is to preposition truck-mounted fuel refineries near oil fields and bulk storage depots. Other critical infrastructure needs would include road and bridge repair, communications, electric power, food production, and potable water.

Civil Defense organizations

The old United States civil defense logo. The triangle emphasized the 3-step Civil Defense philosophy used before the foundation of FEMA and Comprehensive Emergency Management.

Civil Defense is also the name of a number of organizations around the world dedicated to protecting civilians from military attacks, as well as to providing rescue services after natural and human-made disasters alike.

In a few countries such as Jordan and Singapore, civil defense is essentially the same organization as the fire brigade. In most countries however, civil defense is a government-managed, volunteer-staffed organization, separate from the fire brigade and the ambulance service. As the threat of Cold War eased, a number of such civil defense organizations have been disbanded or mothballed (as in the United Kingdom and the United States civil defense), while others have changed their focuses into providing rescue services after natural disasters (as for the State Emergency Service in Australia). However the ideals of Civil Defense have been brought back in the United States under FEMA's Citizens Corps and CERT. In Ireland, the Civil Defence is still very much an active organisation and is occasionally called upon for its Auxiliary Fire Service and ambulance/rescue services when emergencies such as flash flooding occur and require additional manpower. The organisation has units of trained firemen and medical responders based in key areas around the country.

Climate change

Climate change is any long-term change in the statistics of weather over periods of time that range from decades to millions of years. It can express itself as a change in the mean weather conditions, the probability of extreme conditions, or in any other part of the statistical distribution of weather. Climate change may occur in a specific region, or across the whole Earth.

In recent usage, especially in the context of environmental policy, climate change usually refers to changes in modern climate (global warming).

Causes

Factors that can shape climate are often called climate forcings. These include such processes as variations in solar radiation, deviations in the Earth's orbit, and changes in greenhouse gas concentrations. There are a variety of climate change feedbacks that can either amplify or diminish the initial forcing. Some parts of the climate system, such as the oceans and ice caps, respond slowly in reaction to climate forcing because of their large mass. Therefore, the climate system can take centuries or longer to fully respond to new external forcings.

Plate tectonics

Over the course of millions of years, the motion of tectonic plates reconfigures global land and ocean areas and generates topography. This can affect both global and local patterns of climate and atmosphere-ocean circulation.

The position of the continents determines the geometry of the oceans and therefore influences patterns of ocean circulation. Because the circulation of the ocean and the atmosphere are fundamentally linked, the locations of the continents are important in controlling the transfer of heat and moisture across the globe, and therefore, in determining global climate. A recent example of tectonic control on ocean circulation is the formation of the Isthmus of Panama about 5 million years ago, which shut off direct mixing between the Atlantic and Pacific Oceans. This strengthened the Gulf Stream and eventually led to Northern Hemisphere ice cover. Earlier, during the Carboniferous period, plate tectonics may have triggered the large-scale storage of carbon and increased glaciation. Geologic evidence points to a "megamonsoonal" circulation pattern during the time of the supercontinent Pangaea, and climate modeling suggests that the existence of the supercontinent was conductive to the establishment of monsoons.

More locally, topography can influence climate. The existence of mountains (as a product of plate tectonics through mountain-building) can cause orographic precipitation. Humidity generally decreases and diurnal temperature swings generally increase with increasing elevation. Mean temperature and the length of the growing season also decrease with increasing elevation. This, along with orographic precipitation, is important for the existence of low-latitude alpine glaciers and the varied flora and fauna along at different elevations in montane ecosystems.

The size of continents is also important. Because of the stabilizing effect of the oceans on temperature, yearly temperature variations are generally lower in coastal areas than they are inland. A larger supercontinent will therefore have more area in which climate is strongly seasonal than will several smaller continents and/or island arcs.

Solar output

Variations in solar activity during the last several centuries based on observations of sunspots and beryllium isotopes.

The sun is the predominant source for energy input to the Earth. Both long- and short-term variations in solar intensity are noted to affect global climate.

Early in Earth's history the sun emitted only 70% as much power as it does today. With the same atmospheric composition as exists today, liquid water should not have existed on Earth. However, there is evidence for the presence of water on the early Earth, in the Hadean and Archean eons, leading to what is known as the faint young sun paradox. Hypothesized solutions to this paradox include a vastly different atmosphere, with much higher concentrations of greenhouse gases than currently exist, and a stronger solar wind that could shield the Earth from the cooling effects of cosmic rays. Over the following approximately 4 billion years, the energy output of the sun increased and atmospheric composition changed, with the oxygenation of the atmosphere being the most notable alteration. The luminosity of the sun will continue to increase as it follows the main sequence. These changes in luminosity, and the sun's ultimate death as it becomes a red giant and then a white dwarf, will have large effects on climate, with the red giant phase possibly ending life on Earth.

Solar output also varies on shorter time scales, including the 11-year solar cycle and longer-term modulations. The 11-year sunspot cycle produces only a small change in temperature near Earth's surface (on the order of a tenth of a degree) but has a greater influence in the atmosphere's upper layers. Solar intensity variations are considered to have been influential in triggering the Little Ice Age, and for some of the warming observed from 1900 to 1950. The cyclical nature of the sun's energy output is not yet fully understood; it differs from the very slow change that is happening within the sun as it ages and evolves, with some studies pointing toward solar radiation increases from cyclical sunspot activity affecting global warming.

Orbital variations

Slight variations in Earth's orbit lead to changes in the amount of sunlight reaching the Earth's surface and how it is distributed across the globe. The former is similar to solar variations in that there is a change to the power input from the sun to the Earth system. The latter is due to how the orbital variations affect when and where sunlight is received by the Earth. The three types of orbital variations are variations in Earth's eccentricity, changes in the tilt angle of Earth's axis of rotation, and precession of Earth's axis. Combined together, these produce Milankovitch cycles which have a large impact on climate and are notable for their correlation to glacial and interglacial periods, their correlation with the advance and retreat of the Sahara, and for their appearance in the stratigraphic record.

Volcanism

Volcanism is the process of conveying material from the crust and mantle of the Earth to its surface. Volcanic eruptions, geysers, and hot springs, are examples of volcanic processes which release gases and/or particulates into the atmosphere.

Eruptions large enough to affect climate occur on average several times per century, and cause cooling for a period of a few years. The eruption of Mount Pinatubo in 1991, the second largest terrestrial eruption of the 20th century (after the 1912 eruption of Novarupta) affected the climate substantially. Global temperatures decreased by about 0.5 °C (0.9 °F). Much larger eruptions, known as large igneous provinces, occur only a few times every hundred million years, but can reshape climate for millions of years and cause mass extinctions. Initially, it was thought that the dust ejected into the atmosphere from large volcanic eruptions was responsible for longer-term cooling by partially blocking the transmission of solar radiation to the Earth's surface. However, measurements indicate that most of the dust hurled into the atmosphere may return to the Earth's surface within as little as six months, given the right conditions.

Volcanoes are also part of the extended carbon cycle. Over very long (geological) time periods, they release carbon dioxide from the Earth's crust and mantle, counteracting the uptake by sedimentary rocks and other geological carbon dioxide sinks. According to the US Geological Survey, however, estimates are that human activities generate more than 130 times the amount of carbon dioxide emitted by volcanoes.

Ocean variability

The ocean is a fundamental part of the climate system. Short-term fluctuations (years to a few decades) such as the El Niño–Southern Oscillation, the Pacific decadal oscillation, the North Atlantic oscillation, and the Arctic oscillation, represent climate variability rather than climate change. On longer time scales, alterations to ocean processes such as thermohaline circulation play a key role in redistributing heat by carrying out a very slow and extremely deep movement of water, and the long-term redistribution of heat in the world's oceans.

Human influences

Anthropogenic factors are human activities that change the environment. In some cases the chain of causality of human influence on the climate is direct and unambiguous (for example, the effects of irrigation on local humidity), whilst in other instances it is less clear. Various hypotheses for human-induced climate change have been argued for many years. Presently the scientific consensus on climate change is that human activity is very likely the cause for the rapid increase in global average temperatures over the past several decades.Consequently, the debate has largely shifted onto ways to reduce further human impact and to find ways to adapt to change that has already occurred.

Of most concern in these anthropogenic factors is the increase in CO_2 levels due to emissions from fossil fuel combustion, followed by aerosols (particulate matter in the atmosphere) and cement manufacture. Other factors, including land use, ozone depletion, animal agriculture and deforestation, are also of concern in the roles they play - both separately and in conjunction with other factors - in affecting climate.

Physical evidence for climatic change

Evidence for climatic change is taken from a variety of sources that can be used to reconstruct past climates. Reasonably complete global records of surface temperature are available beginning from the mid-late 1800s. For earlier periods, most of the evidence is indirect—climatic changes are inferred from changes in indicators that reflect climate, such as vegetation, ice cores, dendrochronology, sea level change, and glacial geology.

Historical & Archaeological evidence

Climate change in the recent past may be detected by corresponding changes in settlement and agricultural patterns. Archaeological evidence, oral history and historical documents can offer insights into past changes in the climate. Climate change effects have been linked to the collapse of various civilisations.

Glaciers

Variations in CO_2, temperature and dust from the Vostok ice core over the last 450,000 years

Glaciers are among the most sensitive indicators of climate change, advancing when climate cools (for example, during the period known as the Little Ice Age) and retreating when climate warms. Glaciers grow and shrink, both contributing to natural variability and amplifying externally forced changes. A world glacier inventory has been compiled since the 1970s. Initially based mainly on aerial photographs and maps, this compilation has resulted in a detailed inventory of more than 100,000 glaciers covering a total area of approximately 240,000 km^2 and, in preliminary estimates, for the recording of the remaining ice cover estimated to be around 445,000 km^2. The World Glacier Monitoring Service collects data annually on glacier retreat and glacier mass balance From this data, glaciers worldwide have been found to be shrinking significantly, with strong glacier retreats in the 1940s, stable or growing conditions during the 1920s and 1970s, and again retreating from the mid 1980s to present. Mass balance data indicate 17 consecutive years of negative glacier mass balance.

The most significant climate processes since the middle to late Pliocene (approximately 3 million years ago) are the glacial and interglacial cycles. The present interglacial period (the Holocene) has lasted about 11,700 years. Shaped by orbital variations, responses such as the rise and fall of continental ice sheets and significant sea-level changes helped create the climate. Other changes, including Heinrich events, Dansgaard–Oeschger events and the Younger Dryas, however, illustrate how glacial variations may also influence climate without the forcing effect of orbital changes.

Glaciers leave behind moraines that contain a wealth of material - including organic matter that may be accurately dated - recording the periods in which a glacier advanced and retreated. Similarly, by tephrochronological techniques, the lack of glacier cover can be identified by the presence of soil or volcanic tephra horizons whose date of deposit may also be precisely ascertained.

Vegetation

A change in the type, distribution and coverage of vegetation may occur given a change in the climate; this much is obvious. In any given scenario, a mild change in climate may result in increased precipitation and warmth, resulting in improved plant growth and the subsequent sequestration of airborne CO_2. Larger, faster or more radical changes, however, may well result in vegetation stress, rapid plant loss and desertification in certain circumstances.

Ice cores

Analysis of ice in a core drilled from a ice sheet such as the Antarctic ice sheet, can be used to show a link between temperature and global sea level variations. The air trapped in bubbles in the ice can also reveal the CO_2 variations of the atmosphere from the distant past, well before modern environmental influences. The study of these ice cores has been a significant indicator of the changes in CO_2 over many millennia, and continue to provide valuable information about the differences between ancient and modern atmospheric conditions.

Dendrochronology

Dendochronology is the analysis of tree ring growth patterns to determine the age of a tree. From a climate change viewpoint, however, Dendochronology can also indicate the climatic conditions for a given number of years. Wide and thick rings indicate a fertile, well-watered growing period, whilst thin, narrow rings indicate a time of lower rainfall and less-than-ideal growing conditions.

Pollen analysis

Palynology is the study of contemporary and fossil palynomorphs, including pollen. Palynology is used to infer the geographical distribution of plant species, which vary under different climate conditions. Different groups of plants have pollen with distinctive shapes and surface textures, and since the outer surface of pollen is composed of a very resilient material, they resist decay. Changes in the type of pollen found in different sedimentation levels in lakes, bogs or river deltas indicate changes in plant communities; which are dependent on climate conditions.

Insects

Remains of beetles are common in freshwater and land sediments. Different species of beetles tend to be found under different climatic conditions. Given the extensive lineage of beetles whose genetic makeup has not altered significantly over the millennia, knowledge of the present climatic range of the different species, and the age of the sediments in which remains are found, past climatic conditions may be inferred.

Sea level change

Global sea level change for much of the last century has generally been estimated using tide gauge measurements collated over long periods of time to give a long-term average. More recently, altimeter measurements — in combination with accurately determined satellite orbits — have provided an improved measurement of global sea level change.

Green politics

Green politics is a political ideology which places a high importance on environmental goals, and on achieving these goals through broad-based, grassroots, participatory democracy. Green politics is advocated by supporters of the Green movement, which has been active through Green parties in many nations since the early 1980s. The political term *Green*, a translation of the German *Grün*, was coined by die Grünen, the first successful Green party, formed in the late 1970s. The term *political ecology* is sometimes used in Europe and in academic circles.

Supporters of Green politics, called Greens, share many ideas with the ecology, conservation, environmental, feminist, and peace movements. In addition to democracy and ecological issues, green politics is concerned with civil liberties, social justice and nonviolence.

History and influences

Adherents to green politics tend to consider it to be part of a higher worldview and not simply a political ideology. Green politics draws its ethical stance from a variety of sources, from the values of indigenous peoples, to the ethics of Mohandas Gandhi, Spinoza and Uexküll. These people influenced green thought in their advocacy of long-term "seventh generation" foresight, and on the personal responsibility of every individual to make moral choices.

Unease about adverse consequences of human actions on nature predates the modern concept of “environmentalism". Social commentators as far apart as ancient Rome and China complained of air, water and noise pollution.

The philosophical roots of environmentalism can be traced back to enlightenment thinkers such as Rousseau in France and, later, the author and naturalist Thoreau in America. Organised environmentalism began in late 19th Century Europe and the United States as a reaction to the Industrial Revolution with its emphasis on unbridled economic expansion.

“Green politics” first began as conservation movements; for example the Sierra Club, founded in San Francisco in 1892.

In far-right and fascist parties, nationalism has demonstratedly been tied into a sort of green politics which promotes environmentalism as a form of pride in the "motherland". However, left-green platforms of the form that make up the green parties today draw terminology from the science of ecology, and policy from environmentalism, deep ecology, feminism, pacifism, anarchism, libertarian socialism, social democracy, eco-socialism, and social ecology. In the 1970s, as these movements grew in influence, green politics arose as a new philosophy which synthesized their goals.

In March of 1972 the world's first green party, the United Tasmania Group, was formed at a public meeting in Hobart, Australia. In May 1972, a meeting at Victoria University of Wellington, New Zealand, launched the *Values Party*, the world's first countrywide green party to contest Parliamentary seats nationally. A year later in 1973, Europe's first green party, the UK's Ecology Party, came into existence.

The German Green Party was not the first Green Party in Europe to have members elected nationally but the impression was created that they had been, because they attracted the most media attention: The German Greens, contended in their first national election in 1980. They started as a provisional coalition of civic groups and political campaigns which, together, felt their interests were not expressed by the conventional parties. After contesting the 1979 Euro elections they held a conference which identified Four Pillars of the Green Party which all groups in the original alliance could agree as the basis of a common Party platform: welding these groups together as a single Party. This statement of principles has since been utilised by many Green Parties around the world. It was this party that first coined the term "Green" ("Grün" in German) and adopted the sunflower symbol. In the 1983 federal election, the Greens won 27 seats in the Bundestag.

The first Canadian foray into green politics took place in the Maritimes when 11 independent candidates (including one in Montreal and one in Toronto) ran in the 1980 federal election under the banner of the Small Party. (Current Green Party of Canada leader Elizabeth May was the instigator and one of the candidates). Inspired by Schumacher's Small is Beautiful, the Small Party candidates ran for the expressed purpose of putting forward an anti-nuclear platform in that election. It was not registered as an official party, but some participants in that effort went on to form the Green Party of Canada in 1983 (the Ontario Greens and British Columbia Greens were also formed that year).

In Finland, in 1995, the Green League became the first European Green party to form part of a state-level Cabinet. The German Greens followed, forming a government with the Social Democratic Party of Germany (the "Red-Green Alliance") from 1998 to 2005. In 2001, they reached an agreement to end reliance on nuclear power in Germany, and agreed to remain in coalition and support the German government of Chancellor Gerhard Schröder in the 2001 Afghan War. This put them at odds with many Greens worldwide but demonstrated also that they were capable of difficult political tradeoffs.

Statements of principles

Since green politics emerged as an ideology, it has been defined by a few key green principles. The German Greens drafted the earliest statement of this kind, called the Four Pillars of the Green Party. The Four Pillars have been repeated by many green parties worldwide as a foundational statement of the green ideology:

- Ecological wisdom
- Social justice
- Grassroots democracy
- Nonviolence

In 1984, the Green Committees of Correspondence in the United States expanded the Four Pillars into Ten Key Values which, in addition to the Four Pillars mentioned above, include:

- Decentralization
- Community-based economics
- Post-patriarchal values (later translated to Feminism)
- Respect for diversity
- Global responsibility
- Future focus

In 2001, the Global Greens were organized as an international Green movement. The Global Greens Charter identified six guiding principles:

- Ecological wisdom
- Social justice
- Participatory democracy
- Nonviolence
- Sustainability
- Respect for diversity

Local movements

Green ideology emphasizes participatory democracy and the principle of "thinking globally, acting locally." As such, the ideal Green Party is thought to grow from the bottom up, from neighborhood to municipal to (eco-)regional to national levels. The goal is rule by a consensus decision making process. Strong local coalitions are considered a pre-requisite to higher-level electoral breakthroughs. Historically, the growth of Green parties has been sparked by a single issue where Greens can appeal to ordinary citizens' concerns. In Germany, for example, the Greens' early opposition to nuclear power won them their first successes in the federal elections.

Global organization

There is a growing level of global cooperation between Green parties. Global gatherings of Green Parties now happen. The first Planetary Meeting of Greens was held May 30-31st, in Rio de Janeiro, immediately preceding the United Nations Conference on Environment and Development held there. More than 200 Greens from 28 nations attended. The first formal Global Greens Gathering took place in Canberra, in 2001, with more than 800 Greens from 72 countries in attendance. The second Global Green Congress was held in Sao Paolo, Brasil, in May 2008, when 75 parties were represented.

Global Green networking dates back to 1990. Following the Planetary Meeting of Greens in Rio de Janeiro, a Global Green Steering Committee was created, consisting of two seats for each continent. In 1993 this Global Steering Committee met in Mexico City and authorized the creation of a Global Green Network including a Global Green Calendar, Global Green Bulletin, and Global Green Directory. The Directory was issued in several editions in the next years. In 1996, 69 Green Parties from around the world signed a common declaration opposing French nuclear testing in the South Pacific, the first statement of global greens on a current issue. A second statement was issued in December 1997, concerning the Kyoto climate change treaty.

At the 2001 Canberra Global Gathering delegates for Green Parties from 72 countries decided upon a Global Greens Charter which proposes six key principles. Over time, each Green Party can discuss this and organize itself to approve it, some by using it in the local press, some by translating it for their web site, some by incorporating it into their manifesto, some by incorporating it into their constitution. This process is taking place gradually, with online dialogue enabling parties to say where they are up to with this process.

The Gatherings also agree on organizational matters. The first Gathering voted unanimously to set up the *Global Green Network* (GGN). The GGN is composed of three representatives from each Green Party. A companion organization was set up by the same resolution: *Global Green Coordination* (GGC). This is composed of three representatives from each Federation (Africa, Europe, The Americas, Asia/Pacific, see below). Discussion of the planned organization took place in several Green Parties prior to the Canberra meeting. The GGC communicates chiefly by email. Any agreement by it has to be by unanimity of its members. It may identify possible global campaigns to propose to Green Parties world wide. The GGC may endorse statements by individual Green Parties. For example, it endorsed a statement by the US Green Party on the Israel-Palestine conflict.

Thirdly, Global Green Gatherings are an opportunity for informal networking, from which joint campaigning may arise. For example, a campaign to protect the New Caledonian coral reef, by getting it nominated for World Heritage Status: a joint campaign by the New Caledonia Green Party, New Caldonian indigenous leaders, the French Green Party, and the Australian Greens.[12] Another example concerns Ingrid Betancourt, the leader of the Green Party in Colombia, the Green Oxygen Party (*Partido Verde Oxigeno*). Ingrid Betancourt and the party's Campaign Manager, Claire Rojas, were kidnapped by a hard-line faction of FARC on 7 March 2002, while travelling in FARC-controlled territory. Betancourt had spoken at the Canberra Gathering, making many friends. As a result, Green Parties all over the world have organized, pressing their governments to bring pressure to bear. For example, Green Parties in African countries, Austria, Canada, Brazil, Peru, Mexico, France, Scotland, Sweden and other countries have launched campaigns calling for Betancourt's release. Bob Brown, the leader of the Australian Greens, went to Colombia, as did an envoy from the European Federation, Alain Lipietz, who issued a report.The four Federations of Green Parties issued a message to FARC. Ingrid Betancourt was rescued by the Colombian military in Operation Jaque in 2008. However, the efforts of the Green Parties shows their potential to unite and campaign jointly.

Global Green meetings

Separately from the Global Green Gatherings, *Global Green Meetings* take place. For instance, one took place on the fringe of the World Summit on Sustainable Development in Johannesberg. Green Parties attended from Australia, Taiwan, Korea, South Africa, Mauritius, Uganda, Cameroon, Republic of Cyprus, Italy, France, Belgium, Germany, Finland, Sweden, Norway, the USA, Mexico and Chile. The Global Green Meeting discussed the situation of Green Parties on the

African continent; heard a report from Mike Feinstein, former Mayor of Santa Monica, about setting up a web site of the GGN; discussed procedures for the better working of the GGC; and decided two topics on which the Global Greens could issue statements in the near future: Iraq and the 2003 WTO meeting in Cancun.

Green federations

The member parties of the Global Greens are organised into four continental federations:

- Federation of Green Parties of Africa
- Federation of the Green Parties of the Americas / Federación de los Partidos Verdes de las Américas
- Asia-Pacific Green Network
- European Federation of Green Parties

The European Federation of Green Parties formed itself as the European Green Party on 22 February 2004, in the run-up to European Parliament elections in June 2004, a further step in trans-national integration.

Green issues

Green economics focuses on the importance of the health of the biosphere to human well-being. Consequently, most Greens distrust conventional capitalism, as it tends to emphasize economic growth while ignoring ecological health; the "full cost" of economic growth often includes damage to the biosphere, which is unacceptable according to green politics. Green economics considers such growth to be "uneconomic growth"— material increase that nonetheless lowers overall quality of life.

Some Greens refer to productivism, consumerism and scientism as "grey", as contrasted with "green", economic views. "Grey" implies age, concrete, and lifelessness.

Therefore, adherents to green politics advocate economic policies designed to safeguard the environment. Greens want governments to stop subsidizing companies that waste resources or pollute the natural world, subsidies that Greens refer to as "dirty subsidies". Some currents of green politics place automobile and agribusiness subsidies in this category, as they may harm human health. On the contrary, Greens look to a green tax shift that will encourage both producers and consumers to make ecologically friendly choices.

Green economics is on the whole anti-globalist. Economic globalization is considered a threat to well-being, which will replace natural environments and local cultures with a single trade economy, termed the global economic monoculture.

Since green economics emphasizes biospheric health, an issue outside the traditional left-right spectrum, different currents within green politics incorporate ideas from socialism and capitalism. Greens on the Left are often identified as Eco-socialists, who merge ecology and environmentalism with socialism and Marxism and blame the capitalist system for environmental degradation, social injustice, inequality and conflict. Eco-capitalists, on the other hand, believe that the free market system, with some modification, is capable of addressing ecological problems. This belief is documented in the business experiences of eco-capitalists in the book, *The Gort Cloud* that describes the gort cloud as the green community that supports eco-friendly businesses.

Participatory democracy

Since the beginning, green politics has emphasized local, grassroots-level political activity and decision-making. According to its adherents, it is crucial that citizens play a direct role in the decisions that influence their lives and their environment. Therefore, green politics seeks to increase the role of deliberative democracy, based on direct citizen involvement and consensus decision making, wherever it is feasible.

Green politics also encourages political action on the individual level, such as ethical consumerism, or buying things that are made according to environmentally ethical standards. Indeed, many green parties emphasize individual and grassroots action at the local and regional levels over electoral politics. Historically, green parties have grown at the local level, gradually gaining influence and spreading to regional or provincial politics, only entering the national arena when there is a strong network of local support.

In addition, many Greens believe that governments should not levy taxes against strictly local production and trade. Some Greens advocate new ways of organizing authority to increase local control, including urban secession and bioregional democracy.

Other issues

The sunflower is an internationally recognized symbol of Green politics.

Green politics on the whole is opposed to nuclear power and the buildup of persistent organic pollutants, supporting adherence to the precautionary principle, by which technologies are rejected unless they can be proven to not cause significant harm to the health of living things or the biosphere. In Germany and Sweden programs have been initiated to shut down all nuclear plants (known as nuclear power phase-out).

In the spirit of nonviolence, Green politics opposes the War on Terrorism and the curtailment of civil rights, focusing instead on nurturing deliberative democracy in war-torn regions and the construction of a civil society with an increased role for women.

Although Greens in the United States "call for an end to the 'War on Drugs'" and "for decriminalization of victimless crimes", they also call for developing "a firm approach to law enforcement that directly addresses violent crime, including trafficking in hard drugs" .

Green platforms generally favor tariffs on fossil fuels, restricting genetically modified organisms, and protections for ecoregions or communities. In keeping with their commitment to the preservation of diversity, greens are often committed to the maintenance and protection of indigenous communities, languages, and traditions. An example of this is the Irish Green Party's commitment to the preservation of the Irish Language.

Currents

Green politics is usually said to include the green anarchism, eco-anarchism, anti-nuclear and peace movements - although these often claim not to be aligned with any party. Some claim it also includes feminism, pacifism and the animal rights movements. Most Greens support special policy measures to empower women, especially mothers; to oppose war and de-escalate conflicts and stop proliferating technologies useful in conflict or likely to lead to conflict, and such radical measures as Great Ape personhood.

Greens on the Left adhere to eco-socialism, an ideology that combines ecology, environmentalism, socialism and Marxism to criticise the capitalist system as the cause of ecological crises, social exclusion, inequality and conflict. Many Green Parties are not avowedly eco-socialist but most Green Parties around the world have or have had a large Eco-socialist membership. This has led some on the right to refer to Greens as "watermelons" – green on the outside, red in the middle.

Despite this stereotype, some centrist Greens follow more geo-libertarian views which emphasize natural capitalism – and shifting taxes away from value created by labor or service and charging instead for human consumption of the wealth created by the natural world. Greens may view the processes by which living beings compete for mates, homes, and food, ecology, and the cognitive and political sciences very differently. These differences tend to drive debate on ethics, formation of policy, and the public resolution of these differences in leadership races. There is no single *Green Ethic*.

Critique of green policy

Critics sometimes claim that the universal and immersive nature of ecology, and the necessity of converting some of it to serve humanity, predisposes the movement towards authoritarian and intrusive policies, particularly with regard to the means of production, as these sustain human life.Skeptics point out that industrial nations are in the best position to adopt state-of-the-art clean energy and corresponding high pollution standards, and that Green Parties advocate going against economic progress. However, Greens respond that industrial nations are still those which use the most resources, and contribute most to climate change, and that as the poor world develops, we must help it develop with renewable rather than finite/carbon-based energy sources.A further criticism is that Green parties are strongest among the well educated in the developed world, while many policies could be seen as operating against the interests of the poor both in rich countries and globally. For example, some Greens support increases in the indirect taxation of goods ("ecotax") which they perceive to be polluting. This can result in the less well off paying a higher share of the tax burden because more of their income goes to purchasing essentials. Green defenders of the shift towards ecotaxes respond that the poor are often the first and greatest victims of environmental degradation and do not have the resources to adapt or move away. Protecting ecosystems therefore protects the poor even more than the rich who can better adapt or move. Furthermore, equity positive tax or refund adjustments can be made to the progressive income tax system to compensate for any socially regressive consequences of the green tax shift.

Globally, Green opposition to heavy industry is seen by critics as acting against the interests of rapidly industrializing poor countries such as China or Thailand. A counter view is that emerging nations from the South would benefit environmentally and economically given the rising cost of fossil fuels by leap-frogging the fossil-driven industrial stage and moving directly to the post-fossil powered stage of production.Green participation in the anti-globalization movement, and the leading role taken by Green parties in countries such as the United States in opposing free trade agreements, also leads critics to argue that Greens are against opening up rich country markets to goods from the developing world, although many Greens would argue that they are in favour of trade justice - Fair trade over Free Trade. Contrary to the above view, Greens in Europe advocate the lowering of trade barriers and argue for the elimination of export subsidies for agricultural products in the industrialized nations.Critics argue that Greens have a Luddite view of technology, opposing technologies such as genetic modification which their critics see as positive. Greens have often taken the lead in raising concerns about public health issues such as obesity which critics see as a modern form of moral panic. Whereas a technophobic point of view can be found in the early Green movement and parties, Greens today reject the accusation of Luddism, countering that their policies of sustainable growth encourage 'clean' technological innovation like renewable energy and anti-pollution technology.

Natural Disasters

Natural disasters are extreme, sudden events caused by environmental factors that injure people and damage property. Earthquakes, windstorms, floods, and disease all strike anywhere on earth, often without warning. As examples, we've chosen disasters that have occurred around the world throughout history.

Avalanches

An avalanche is any swift movement of snow, ice, mud, or rock down a mountainside or slope. Avalanches, which are natural forms of erosion and often seasonal, can reach speeds of more than 200 miles per hour. They are triggered by such events as earthquake tremors, human-made disturbances, or excessive rainfall.

Destruction from avalanches results both from the avalanche wind (the air pushed ahead of the mass) and from the actual impact of the avalanche material.

Where: Italian Alps

When: 218 B.C.

When Hannibal, the Carthaginian general, crossed the Alps to conquer Rome, 18,000 soldiers, 2,000 horses, and many elephants died. Most of the deaths were caused by Alpine avalanches.

Where: United States

When: 1910

The worst snowslide in U.S. history occurred in the Cascade Mountains in Wellington, Washington, when 96 people were trapped when their train became snowbound. An avalanche then swept them to their deaths in a gorge 150 feet below the tracks.

Where: Peru

When: 1962

When tons of ice and snow slid down Huascaran Peak in the Andes Mountains, nearly 4,000 people were killed. Some 30 years later, it is still considered the world's worst avalanche.

Blizzards and Hailstorms

A blizzard is a winter storm characterized by high winds, low temperatures, and driving snow. (According to the official definition given in 1958 by the U.S. Weather Bureau, the winds must exceed 35 miles (56 km) per hour and the must drop to temperature 20° F (-7° C) or lower.)

A hailstorm is precipitation in the form of balls or lumps of clear ice and compact snow. It is not known for sure how hailstones form and grow. We do know that

they are spherical or irregularly spherical and usually vary in diameter up to 1/2 in. (1.3 cm); in rare cases hailstones having diameters up to 5 in. (12.7 cm) have been observed. Hail causes much damage and injury to crops, livestock, property, and airplanes.
Where: United States
When: 1999
Major blizzard and sub-zero temperatures wreak havoc in Illinois, Wisconsin, Indiana, Michigan, and Ohio; 73 were killed in the blizzard and transportation systems in the region were paralyzed. Damages reached about $500 million.
Where: United States
When: 1978
The blizzard of 1978 was one of the most powerful snowstorms to hit the East Coast. It crippled New York and New England for days, in many areas dumping more than three feet of snow.
Where: United States
When: 1888
The worst winter storm in U.S. history, the Blizzard of 1888 surprised the northeastern United States with as much as five feet of snow in some areas. Two hundred boats sank and more than 400 people died due to very powerful winds and cold temperatures.
Where: Russia (formerly the Soviet Union)
When: 1923
In Rostov, 23 people and even more cattle were killed by hailstones weighing up to 2 pounds each.
Where: India
When: 1939
A hailstorm over a 30-square-mile area in the southern part of the country killed cattle and sheep and damaged crops. Some of the hailstones were said to weigh 71/2 pounds.
Droughts and Famines

Droughts are unusually long periods of insufficient rainfall.

Since ancient times droughts have had far-reaching effects on humankind by causing the failure of crops, decreasing natural vegetation, and depleting water supplies. Livestock and wildlife, as well as humans, die of thirst and famine; large land areas often suffer damage from dust storms or fire.

Famines are extreme shortages of food that cause people to die of starvation.
Where: Egypt
When: 1200-02
The Egyptian people relied on the annual flooding of the Nile River to leave soil for growing crops. After a shortage of rain, however, the Nile didn't rise. People were unable to grow food and began to starve to death. The final death toll was 110,000, due to starvation, cannibalism, and disease.
Where: Ireland

When: 1845-49
Potatoes were the mainstay of the Irish diet. When the crop was struck by a potato blight (a fungus that killed the crop), farmers and their families began to starve. The grain and livestock raised in Ireland were owned by the English, and the laws of the time prevented the Irish people from importing grain to eat. This combination of plant disease and politics resulted in the Great Potato Famine, which killed 1.5 million people and caused a million more to move to America.
Where: The Great Plains of the U.S.
When: 1930s
The U.S. experienced its longest drought of the twentieth century. Peak periods were 1930, 1934, 1936, 1939, and 1940. During 1934, dry regions stretched solidly from New York and Pennsylvania across the Great Plains to the California coast. A great "dust bowl" covered 50 million acres in the south central plains during the winter of 1935–1936. Heavy winds caused the dry soil to be blown into huge clouds. Crops and pasture lands were ruined by the harsh dust storms, which also proved a severe health hazard.
Where: Northern China
When: 1959-61
The world's deadliest famine killed an estimated 30 million people in China. Drought was followed by crop failure, which was followed by starvation, disease, and cannibalism. News of the famine was not revealed to the rest of the world until 1981, some 20 years later.
Where: Biafra, Africa (present-day Nigeria)
When: 1967-69
As a result of civil war, famine conditions killed an estimated 1 million people and left another 3.5 million suffering from extreme malnutrition.
Where: Europe
When: 2003
Drought conditions and a heat wave, one of the worst in 150 years, broke temperature records from London to Portugal, fueled forest fires, ruined crops, and caused thousands of deaths. (French fatalities estimated at more than 14,000.)

Tsunamis

Source: The Federal Emergency Management Agency (FEMA)
A tsunami (pronounced soo-nahm-ee) is a series of huge waves that happen after an undersea disturbance, such as an earthquake or volcano eruption. Tsunami is from the Japanese word for "harbor wave."
The waves travel in all directions from the area of disturbance, much like the ripples that happen after throwing a rock. The waves may travel in the open sea as fast as 450 miles per hour. As the big waves approach shallow waters along the coast they grow to a great height and smash into the shore. They can be as high as 100 feet. They can cause a lot of destruction on the shore. They are sometimes mistakenly called "tidal waves," but tsunami have nothing to do with the tides.

Hawaii is the state at greatest risk for a tsunami. They get about one a year, with a damaging tsunami happening about every seven years. Alaska is also at high risk.

California, Oregon and Washington experience a damaging tsunami about every 18 years.
Did You Know?

On Dec. 26, 2004, a 9.0 magnitude earthquake—the largest earthquake in 40 years—occurred off the west coast of the Indonesian island of Sumatra. The earthquake triggered a tsunami in the Indian Ocean, the deadliest in world history. More than 226,000 died and twelve countries felt the devastation. Hardest hit were Indonesia (particularly the province of Aceh), Sri Lanka, India, Thailand, and the Maldives. Millions were left homeless by the disaster.
Earthquakes and Tsunami

An earthquake is a trembling movement of the earth's crust. These tremors are generally caused by shifts of the plates that make up the earth's surface. The movements cause vibrations to pass through and around the earth in wave form, just as ripples are generated when a pebble is dropped into water. Volcanic eruptions, rockfalls, landslides, and explosions can also cause a quake.

A tsunami (pronounced soo-NAHM-ee) is a series of huge waves that occur as the result of a violent underwater disturbance, such as an earthquake or volcanic eruption. They are sometimes mistakenly referred to as tidal waves, but tsunamis have nothing to do with the tides.
Where: China
When: 1556
More than 830,000 people in the Shensi Province were killed by this earthquake. It caused the collapse of caves that people had carved out of cliffs and used for homes.
Where: Prince William Sound, Alaska
When: 1964
The strongest earthquake in North America, 9.2 magnitude, was followed by a seismic wave 50 ft high..
Where: Armenia
When: 1988
Nearly 4,000 square miles of densely populated land was ravaged by an earthquake. Three cities were leveled, killing more than 25,000 people. Other countries were able to send the Armenians supplies and rescue workers. Miraculously, 15,000 people were recovered from the rubble.
Where: Papua New Guinea
When: 1998
A tsunami wiped out many villages in the island nation. More than 2,000 people were killed and many more were left homeless.
Where: Sumatra, Indonesia
When: 2004

A 9.0 earthquake triggered a tsunami in the Indian Ocean, that killed more than 226,000 in 12 countries and left millions homeless, making it the deadliest tsunami in world history.
Where: China
When: 2008
A 7.9 earthquake killed over 40,000 people and injured thousands more in the Sichuan, Gansu, and Yunnan Provinces in western China. Nearly 900 students were trapped when Juyuan Middle School in the Sichuan Province collapsed from the quake.

For a list of recent earthquakes and largest earthquakes, see Earthquakes.

For a list of earthquakes, see Earthquakes and Volcanic Eruptions at Infoplease.com.

For more information about earthquakes, see The Severity of an Earthquake and Number of Earthquakes Worldwide at Infoplease.com.
Tsunami FAQs From the International Tsunami Information Center

What is a tsunami?

The phenomenon we call tsunami is a series of large waves of extremely long wavelength and period usually generated by a violent, impulsive undersea disturbance or activity near the coast or in the ocean. When a sudden displacement of a large volume of water occurs, or if the sea floor is suddenly raised or dropped by an earthquake, big tsunami waves can be formed by forces of gravity. The waves travel out of the area of origin and can be extremely dangerous and damaging when they reach the shore. The word tsunami (pronounced tsoo-nah'-mee) is composed of the Japanese words “tsu” (which means harbor) and “nami” (which means “wave”). Often the term, “seismic or tidal sea wave” is used to describe the same phenomenon, however the terms are misleading, because tsunami waves can be generated by other, non seismic disturbances such as volcanic eruptions or underwater landslides, and have physical characteristics different of tidal waves. The tsunami waves are completely unrelated to the astronomical tides—which are caused by the extraterrestrial, gravitational influences of the moon, sun, and the planets. Thus, the Japanese word “tsunami”, meaning “harbor wave” is the correct, official, and all-inclusive term. It has been internationally adopted because it covers all forms of impulsive wave generation.
How do earthquakes generate tsunamis?

By far, the most destructive tsunamis are generated from large, shallow earthquakes with an epicenter or fault line near or on the ocean floor. These usually occur in regions of the earth characterized by tectonic subduction along tectonic plate boundaries. The high seismicity of such regions is caused by the collision of tectonic plates. When these plates move past each other, they cause large earthquakes, which tilt, offset, or displace large areas of the ocean floor from a few kilometers to as much as a 1,000 km or more. The sudden vertical displacements over such large areas disturb the ocean's surface, displace water, and generate destructive tsunami waves. The waves can travel great distances from the source region, spreading destruction along their path. For example, the Great 1960 Chilean tsunami was generated by a magnitude 9.5 earthquake that had a rupture zone of over 1,000 km. Its waves were destructive not only in Chile, but also as far away as Hawaii, Japan and elsewhere in the Pacific. It should be noted that not all earthquakes generate tsunamis. Usually, it takes an earthquake with a Richter magnitude exceeding 7.5 to produce a destructive tsunami.

How do volcanic eruptions generate tsunamis?

Although relatively infrequent, violent volcanic eruptions represent also impulsive disturbances, which can displace a great volume of water and generate extremely destructive tsunami waves in the immediate source area. According to this mechanism, waves may be generated by the sudden displacement of water caused by a volcanic explosion, by a volcano's slope failure, or more likely by a phreatomagmatic explosion and collapse/engulfment of the volcanic magmatic chambers. One of the largest and most destructive tsunamis ever recorded was generated in August 26, 1883, after the explosion and collapse of the volcano of Krakatoa (Krakatau), in Indonesia. This explosion generated waves that reached 135 feet, destroyed coastal towns and villages along the Sunda Strait in both the islands of Java and Sumatra, killing 36,417 people. It is also believed that the destruction of the Minoan civilization in Greece was caused in 1490 B.C. by the explosion/collapse of the volcano of Santorin in the Aegean Sea.
How do submarine landslides, rock falls and underwater slumps generate tsunamis?

Less frequently, tsunami waves can be generated from displacements of water resulting from rock falls, icefalls and sudden submarine landslides or slumps. Such events may be caused impulsively from the instability and sudden failure of submarine slopes, which are sometimes triggered by the ground motions of a strong earthquake. For example in the 1980s, earth moving and construction work of an airport runway along the coast of Southern France, triggered an underwater landslide, which generated destructive tsunami waves in the harbor of Thebes. Major earthquakes are suspected to cause many underwater landslides, which may contribute significantly to tsunami generation. For example, many scientists believe that the 1998 tsunami, which killed thousands of people and destroyed coastal villages along the northern coast of Papua New Guinea, was generated by a large underwater slump of sediments, triggered by an earthquake. In general, the energy of tsunami waves generated from landslides or rock falls is rapidly dissipated as they travel away from the source and across the ocean, or within an enclosed or semi-enclosed body of water—such as a lake or a fjord.
Can asteroids, meteorites or man-made explosions cause tsunamis?

Fortunately, for mankind, it is indeed very rare for a meteorite or an asteroid to reach the earth. No asteroid has fallen on the earth within recorded history. Most meteorites burn as they reach the earth's atmosphere. However, large meteorites have hit the earth's surface in the distant past. This is indicated by large craters, which have been found in different parts of the earth. Also, it is possible that an asteroid may have fallen on the earth in prehistoric times—the last one some 65 million years ago during the Cretaceous period. Since evidence of the fall of meteorites and asteroids on earth exists, we must conclude that they have fallen also in the oceans and seas of the earth, particularly since four fifths of our planet is covered by water. The fall of meteorites or asteroids in the earth's oceans has the potential of generating tsunamis of cataclysmic proportions. Scientists studying this possibility have concluded that the impact of moderately large asteroid, 5–6 km in diameter, in the middle of the large ocean basin such as the Atlantic Ocean, would produce a tsunami that would travel all the way to the Appalachian Mountains in the upper two-thirds of the United States. On both sides of the Atlantic, coastal cities would be washed out by such a tsunami. An asteroid 5–6 kilometers in diameter impacting between the Hawaiian Islands and the West Coast of North America, would produce a tsunami which would wash out the coastal cities on the West coasts of Canada, U.S. and Mexico and would cover most of the inhabited coastal areas of the Hawaiian islands. Conceivably tsunami waves can also be generated from very large nuclear explosions. However, no tsunami of any significance has ever resulted from the testing of nuclear weapons in the past. Furthermore, such testing is presently prohibited by international treaty. Where and how frequently are tsunamis generated?

Tsunamis are disasters that can be generated in all of the world's oceans, inland seas, and in any large body of water. Each region of the world appears to have its own cycle of frequency and pattern in generating tsunamis that range in size from small to the large and highly destructive events. Most tsunamis occur in the Pacific Ocean and its marginal seas. The reason is that the Pacific covers more than one-third of the earth's surface and is surrounded by a series of mountain chains, deep-ocean trenches and island arcs called the "ring of fire"—where most earthquakes occur (off the coasts of Kamchatka, Japan, the Kuril Islands, Alaska and South America). Many tsunamis have also been generated in the seas which border the Pacific Ocean. Tsunamis are generated by shallow earthquakes all around the Pacific, but those from earthquakes in the tropical Pacific tend to be modest in size. While such tsunamis in these areas may be devastating locally, their energy decays rapidly with distance. Usually, they are not destructive a few hundred kilometers away from their sources. That is not the case with tsunamis generated by great earthquakes in the North Pacific or along the Pacific coast of South America. On the average of about half-a-dozen times per century, a tsunami from one of these regions sweeps across the entire Pacific, is reflected from distant shores, and sets the entire ocean in motion for days. For example, the 1960 Chilean tsunami caused death and destruction throughout the Pacific. Hawaii, Samoa, and Easter Island all recorded runups exceeding 4 m; 61 people were killed in Hawaii. In Japan 200

people died. A similar tsunami in 1868 from northern Chile caused extensive damage in the Austral Islands, Hawaii, Samoa, and New Zealand. Although not as frequent, destructive tsunamis have been also been generated in the Atlantic and the Indian Oceans, the Mediterranean Sea, and even within smaller bodies of water, like the Sea of Marmara, in Turkey. The deadliest tsunami on record occurred on Dec. 26, 2004, in the Indian Ocean, causing damage in eleven countries and killing more than a quarter million. In the last decade alone, destructive tsunamis have occurred in Nicaragua (1992), Indonesia (1992, 1994, 1996, 2004), Japan (1993), Philippines (1994), Mexico (1995), Peru (1996, 2001), Papua-New Guinea (1998), Turkey (1999), and Vanuatu (1999).
How does tsunami energy travel across the ocean and how far can tsunamis waves reach?

Once a tsunami has been generated, its energy is distributed throughout the water column, regardless of the ocean's depth. A tsunami is made up of a series of very long waves. The waves will travel outward on the surface of the ocean in all directions away from the source area, much like the ripples caused by throwing a rock into a pond. The wavelength of the tsunami waves and their period will depend on the generating mechanism and the dimensions of the source event. If the tsunami is generated from a large earthquake over a large area, its initial wavelength and period will be greater. If the tsunami is caused by a local landslide, both its initial wavelength and period will be shorter. The period of the tsunami waves may range from 5 to 90 minutes. The wave crests of a tsunami can be a thousand km long, and from a few to a hundred kilometers or more apart as they travel across the ocean. On the open ocean, the wavelength of a tsunami may be as much as two hundred kilometers, many times greater than the ocean depth, which is on the order of a few kilometers. In the deep ocean, the height of the tsunami from trough to crest may be only a few centimeters to a meter or more—again depending on the generating source. Tsunami waves in the deep ocean can travel at high speeds for long periods of time for distances of thousands of kilometers and lose very little energy in the process. The deeper the water, the greater the speed of tsunami waves will be. For example, at the deepest ocean depths the tsunami wave speed will be as much as 800 km/h, about the same as that of a jet aircraft. Since the average depth of the Pacific ocean is 4000 m (14,000 feet) , tsunami wave speed will average about 200 m/s or over 700 km/h (500 mph). At such high speeds, a tsunami generated in Aleutian Islands may reach Hawaii in less than four and a half hours. In 1960, great tsunami waves generated in Chile reached Japan, more than 16,800 km away in less than 24 hours, killing hundreds of people.
Why aren't tsunamis seen at sea or from the air?

In the deep ocean, tsunami wave amplitude is usually less than 1 m (3.3 feet). The crests of tsunami waves may be more than a hundred kilometers or more away from each other. Therefore, passengers on boats at sea, far away from shore where the water is deep, will not feel nor see the tsunami waves as they pass by underneath at high speeds. The tsunami may be perceived as nothing more than a gentle rise and fall of the sea surface. The Great Sanriku tsunami, which struck Honshu, Japan, on June 15, 1896, was completely undetected by fishermen twenty miles out to sea. The deep-water height of this tsunami was only about 40 centimeters when it passed them and yet, when it arrived on the shore, it had transformed into huge waves that killed 28,000 people, destroyed the port of Sanriku and villages along 275 km of coastline. For the same reason of low amplitude and very long periods in the deep ocean, tsunami waves cannot be seen nor detected from the air. From the sky, tsunami waves cannot be distinguished from ordinary ocean waves.

What types of destruction are caused by tsunamis?

There are three: inundation, wave impact on structures, and erosion. Strong, tsunami-induced currents lead to the erosion of foundations and the collapse of bridges and seawalls. Flotation and drag forces move houses and overturn railroad cars. Considerable damage is caused by the resultant floating debris, including boats and cars that become dangerous projectiles that may crash into buildings, break power lines, and may start fires. Fires from damaged ships in ports or from ruptured coastal oil storage tanks and refinery facilities, can cause damage greater than that inflicted directly by the tsunami. Of increasing concern is the potential effect of tsunami draw down, when receding waters uncover cooling water intakes of nuclear power plants.

What determines how destructive a tsunami will be near the origin and at a distant shore?

Tsunamis arrive at a coastline as a series of successive crests (high water levels) and troughs (low water levels)—usually occurring 10 to 45 minutes apart. As they enter the shallow waters of coastlines, bays, or harbors, their speed decreases to about 50–60 km/h. For example, in 15 m of water the speed of a tsunami will be only 45 km/h. However 100 or more kilometers away, another tsunami wave travels in deep water towards the same shore at a much greater speed, and still behind it there is another wave, traveling at even greater speed. As the tsunami waves become compressed near the coast, the wavelength is shortened and the wave energy is directed upward—thus increasing their heights considerably. Just as with ordinary surf, the energy of the tsunami waves must be contained in a smaller volume of water, so the waves grow in height. Even though the wavelength shortens near the coast, a tsunami will typically have a wavelength in excess of ten kilometers when it comes ashore. Depending on the water depth and the coastal configuration, the waves may undergo extensive refraction—another process that may converge their energy to particular areas on the shore and thus increase the heights even more. Even if a tsunami wave may have been 1 meter of less in the deep ocean, it may grow into a huge 30–35 meter wave when it sweeps over the shore. Thus, tsunami waves may smash into the shore like a wall of water or move in as a fast moving flood or tide—carrying everything on their path. Either way, the waves become a significant threat to life and property. If the tsunami waves arrive at high tide, or if there are concurrent storm waves in the area, the effects will be cumulative and the inundation and destruction even greater. The historic record shows that there have been many tsunamis that have struck the shores with devastating force, sometimes reaching heights of more than 30–50 meters. For example, the 1946 tsunami generated by an earthquake off Unimak island in Alaska's Aleutian Islands, reached heights of more than 35 meters, which destroyed a reinforced concrete lighthouse and killed its occupants. Finally, the maximum height a tsunami reaches on shore is called the runup. It is the vertical distance between the maximum height reached by the water on shore and the mean sea level surface. Any tsunami runup over a meter is dangerous. The flooding by individual waves will typically last from ten minutes to a half-hour, so the danger period can last for hours. Tsunami runup at the point of impact will depend on how the energy is focused, the travel path of the tsunami waves, the coastal configuration, and the offshore topography. Small islands with steep slopes usually experience little runup—wave heights there are only slightly greater than on the open ocean. This is the reason that islands with steep-sided fringing or barrier reefs are only at moderate risk from tsunamis. However, this is not the case for islands such as the Hawaiian or the Marquesas. Both of these island chains do not have extensive barrier reefs and have broad bays exposed to the open ocean. For example, Hilo Bay at the island of Hawaii and Tahauku Bay at Hiva Oa in the Marquesas are especially vulnerable. The 1946 Aleutian tsunami resulted in runup, which exceeded 8 m at Hilo and 10 m at Tahauku; 59 people were killed in Hilo and two in Tahauku. Similarly, any gap in a reef puts the adjacent shoreline at risk. The local tsunami from the Suva earthquake of 1953 did little damage because of Fiji's extensive offshore reefs. However, two villages on the island of Viti Levu, located on opposite gaps in the reef, were extensively damaged and five people were drowned.

Floods

A flood occurs when a body of water rises and overflows onto normally dry land. Floods occur most commonly when water from heavy rainfall, from melting ice and snow, or from a combination of these exceeds the carrying capacity of the river system, lake, or ocean into which it runs.

Where: The Netherlands and England
When: 1099
A combination of high tides and storm waves on the North Sea flooded coastal areas of England and the Netherlands, killing 100,000 people.

Where: United States
When: 1889
The Johnstown Flood, in Pennsylvania, was considered one of the worst disasters in U.S. history. After an unusually heavy rainstorm, a dam several miles upriver from Johnstown broke. One out of every 10 people in the path of the flood died, a total of 2,000 people in less than an hour.

Where: Italy
When: 1966

After a heavy rainfall, the Arno River overflowed, flooding the streets of Florence. Many great works of art in the museums were damaged, as was the architecture of the city. In two days, more than 100 people died and the city was covered with half a million tons of mud, silt, and sewage.

Volcanic Eruptions

A volcanic eruption occurs when molten rock, ash and steam pour through a vent in the earth's crust.

Volcanoes are described as active (in eruption), dormant (not erupting at the present time), or extinct (having ceased eruption; no longer active). Some volcanoes explode. Others are slow-flowing fountains of lava, which is hot fluid rock.

The following are examples of famous volcanic eruptions.

Where: Italy

When: A.D. 79

The eruption of Mount Vesuvius buried the towns of Pompeii and Herculaneum under 20 feet of ash and lava, killing an estimated 20,000 people. The ash that buried the town and the people also preserved them. The work of uncovering the ancient cities began in 1748 and continues to this day.

Where: Indonesia

When: 1883

The greatest explosion in modern times occurred when Krakatoa erupted. The power of the explosion was thought to be 26 times the power of the greatest H bomb, and the roar was heard over one-thirteenth of the surface of the earth. The eruption wiped out 163 villages, killing 36,380 people.

For a list of other volcanic eruptions, see Recent Volcanic Activity and Earthquakes and Volcanic Eruptions at Infoplease.com.

For other information on volcanoes, see also Volcanoes of the World, The Nature of Volcanoes, Principal Types of Volcanoes, Types of Volcanic Eruptions, and Earth's Greatest Volcanic Field.

Volcanoes of the World

Source: U.S. Dept. of the Interior, Geological Survey

About 550 volcanoes have erupted on Earth's surface since recorded history; about 60 are active each year. Far more have erupted unobserved on the ocean floor. Most volcanoes exist at the boundaries of Earth's crustal plates, such as the famous Ring of Fire that surrounds the Pacific Ocean plate. Fifty volcanoes have erupted in the United States since recorded history, and the United States ranks third, behind Indonesia and Japan, in the number of historically active volcanoes.

Types of Volcanoes

Geologists generally group volcanoes into four main kinds—cinder cones, composite volcanoes, shield volcanoes, and lava domes.

Cinder cones

Cinder cones are the simplest type of volcano. They are built from particles and blobs of congealed lava ejected from a single vent. As the gas-charged lava is blown violently into the air, it breaks into small fragments that solidify and fall as cinders around the vent to form a circular or oval cone. Most cinder cones have a bowl-shaped crater at the summit and rarely rise more than a thousand feet or so above their surroundings. Cinder cones are numerous in western North America as well as throughout other volcanic terrains of the world.

In 1943 a cinder cone started growing on a farm near the village of Parícutin in Mexico. Explosive eruptions caused by gas rapidly expanding and escaping from molten lava formed cinders that fell back around the vent, building up the cone to a height of 1,200 feet. The last explosive eruption left a funnel-shaped crater at the top of the cone. After the excess gases had largely dissipated, the molten rock quietly poured out on the surrounding surface of the cone and moved downslope as lava flows. This order of events—eruption, formation of cone and crater, lava flow—is a common sequence in the formation of cinder cones.

During 9 years of activity, Parícutin built a prominent cone, covered about 100 square miles with ashes, and destroyed the town of San Juan. Geologists from many parts of the world studied Parícutin during its lifetime and learned a great deal about volcanism, its products, and the modification of a volcanic landform by erosion.

Composite volcanoes

Some of the Earth's grandest mountains are composite volcanoes—sometimes called stratovolcanoes. They are typically steep-sided, symmetrical cones of large dimension built of alternating layers of lava flows, volcanic ash, cinders, blocks, and bombs and may rise as much as 8,000 feet above their bases. Some of the most conspicuous and beautiful mountains in the world are composite volcanoes, including Mount Fuji in Japan, Mount Cotopaxi in Ecuador, Mount Shasta in California, Mount Hood in Oregon, and Mount St. Helens and Mount Rainier in Washington.

Most composite volcanoes have a crater at the summit which contains a central vent or a clustered group of vents. Lavas either flow through breaks in the crater wall or issue from fissures on the flanks of the cone. Lava, solidified within the fissures, forms dikes that act as ribs which greatly strengthen the cone.

The essential feature of a composite volcano is a conduit system through which magma from a reservoir deep in the Earth's crust rises to the surface. The volcano is built up by the accumulation of material erupted through the conduit and increases in size as lava, cinders, ash, etc., are added to its slopes.

When a composite volcano becomes dormant, erosion begins to destroy the cone. As the cone is stripped away, the hardened magma filling the conduit (the volcanic plug) and fissures (the dikes) becomes exposed, and it too is slowly reduced by erosion. Finally, all that remains is the plug and dike complex projecting above the land surface—a telltale remnant of the vanished volcano.

An interesting variation of a composite volcano can be seen at Crater Lake in Oregon. From what geologists can interpret of its past, a high volcano—called Mount Mazama- probably similar in appearance to present-day Mount Rainier was once located at this spot. Following a series of tremendous explosions about 6,800 years ago, the volcano lost its top. Enormous volumes of volcanic ash and dust were expelled and swept down the slopes as ash flows and avalanches. These large-volume explosions rapidly drained the lava beneath the mountain and weakened the upper part. The top then collapsed to form a large depression, which later filled with water and is now completely occupied by beautiful Crater Lake. A last gasp of eruptions produced a small cinder cone, which rises above the water surface as Wizard Island near the rim of the lake. Depressions such as Crater Lake, formed by collapse of volcanoes, are known as calderas. They are usually large, steep-walled, basin-shaped depressions formed by the collapse of a large area over, and around, a volcanic vent or vents. Calderas range in form and size from roughly circular depressions 1 to 15 miles in diameter to huge elongated depressions as much as 60 miles long.

Shield volcanoes

Shield volcanoes, the third type of volcano, are built almost entirely of fluid lava flows. Flow after flow pours out in all directions from a central summit vent, or group of vents, building a broad, gently sloping cone of flat, domical shape, with a profile much like that of a warrior's shield. They are built up slowly by the accretion of thousands of highly fluid lava flows called basalt lava that spread widely over great distances, and then cool as thin, gently dipping sheets. Lavas also commonly erupt from vents along fractures (rift zones) that develop on the flanks of the cone. Some of the largest volcanoes in the world are shield volcanoes. In northern California and Oregon, many shield volcanoes have diameters of 3 or 4 miles and heights of 1,500 to 2,000 feet. The Hawaiian Islands are composed of linear chains of these volcanoes including Kilauea and Mauna Loa on the island of Hawaii—two of the world's most active volcanoes. The floor of the ocean is more than 15,000 feet deep at the bases of the islands. As Mauna Loa, the largest of the shield volcanoes (and also the world's largest active volcano), projects 13,677 feet above sea level, its top is over 28,000 feet above the deep ocean floor.

In some eruptions, basaltic lava pours out quietly from long fissures instead of central vents and floods the surrounding countryside with lava flow upon lava flow, forming broad plateaus. Lava plateaus of this type can be seen in Iceland, southeastern Washington, eastern Oregon, and southern Idaho. Along the Snake River in Idaho, and the Columbia River in Washington and Oregon, these lava flows are beautifully exposed and measure more than a mile in total thickness.

Lava domes

Volcanic or lava domes are formed by relatively small, bulbous masses of lava too viscous to flow any great distance; consequently, on extrusion, the lava piles over and around its vent. A dome grows largely by expansion from within. As it grows its outer surface cools and hardens, then shatters, spilling loose fragments down its sides. Some domes form craggy knobs or spines over the volcanic vent, whereas others form short, steep-sided lava flows known as "coulees."

Volcanic domes commonly occur within the craters or on the flanks of large composite volcanoes. The nearly circular Novarupta Dome that formed during the 1912 eruption of Katmai Volcano, Alaska, measures 800 feet across and 200 feet high. The internal structure of this dome—defined by layering of lava fanning upward and outward from the center—indicates that it grew largely by expansion from within. Mont Pelée in Martinique, Lesser Antilles, and Lassen Peak and Mono domes in California are examples of lava domes. An extremely destructive eruption accompanied the growth of a dome at Mont Pelée in 1902. The coastal town of St. Pierre, about 4 miles downslope to the south, was demolished and nearly 30,000 inhabitants were killed by an incandescent, high-velocity ash flow and associated hot gases and volcanic dust.

Types of Volcanic Eruptions

During an episode of activity, a volcano commonly displays a distinctive pattern of behavior. Some mild eruptions merely discharge steam and other gases, whereas other eruptions extrude quantities of lava. The most spectacular eruptions consist of violent explosions that blast great clouds of gas-laden debris into the atmosphere.

The type of volcanic eruption is often labeled with the name of a well-known volcano where characteristic behavior is similar—hence the use of such terms as "Strombolian," "Vulcanian," "Vesuvian," "Pelean," "Hawaiian," and others. Some volcanoes may exhibit only one characteristic type of eruption during an interval of activity—others may display an entire sequence of types.

In a "Strombolian"-type eruption observed during the 1965 activity of Irazu Volcano in Costa Rica, huge clots of molten lava burst from the summit crater to form luminous arcs through the sky. Collecting on the flanks of the cone, lava clots combined to stream down the slopes in fiery rivulets.

In contrast, the eruptive activity of Parícutin Volcano in 1947 demonstrated a "Vulcanian"-type eruption, in which a dense cloud of ash-laden gas explodes from the crater and rises high above the peak. Steaming ash forms a whitish cloud near the upper level of the cone.

In a "Vesuvian" eruption, as typified by the eruption of Mount Vesuvius in Italy in A.D. 79, great quantities of ash-laden gas are violently discharged to form cauliflower-shaped cloud high above the volcano.

In a “Peléan” or “Nuée Ardente” (glowing cloud) eruption, such as occurred on the Mayon Volcano in the Philippines in 1968, a large quantity of gas, dust, ash, and incandescent lava fragments are blown out of a central crater, fall back, and form tongue-like, glowing avalanches that move downslope at velocities as great as 100 miles per hour. Such eruptive activity can cause great destruction and loss of life if it occurs in populated areas, as demonstrated by the devastation of St. Pierre during the 1902 eruption of Mont Pelée on Martinique, Lesser Antilles.

“Hawaiian” eruptions may occur along fissures or fractures that serve as linear vents, such as during the eruption of Mauna Loa Volcano in Hawaii in 1950; or they may occur at a central vent such as during the 1959 eruption in Kilauea Iki Crater of Kilauea Volcano, Hawaii. In fissure-type eruptions, molten, incandescent lava spurts from a fissure on the volcano's rift zone and feeds lava streams that flow downslope. In central-vent eruptions, a fountain of fiery lava spurts to a height of several hundred feet or more. Such lava may collect in old pit craters to form lava lakes, or form cones, or feed radiating flows.

“Phreatic” (or “steam-blast”) eruptions are driven by explosive expanding steam resulting from cold ground or surface water coming into contact with hot rock or magma. The distinguishing feature of phreatic explosions is that they only blast out fragments of preexisting solid rock from the volcanic conduit; no new magma is erupted. Phreatic activity is generally weak, but can be quite violent in some cases, such as the 1965 eruption of Taal Volcano, Philippines, and the 1975-76 activity at La Soufrière, Guadeloupe (Lesser Antilles).

The most powerful eruptions are called “Plinian” and involve the explosive ejection of relatively viscous lava. Large plinian eruptions—such as during 18 May 1980 at Mount St. Helens or, more recently, during 15 June 1991 at Pinatubo in the Philippines—can send ash and volcanic gas tens of miles into the air. The resulting ash fallout can affect large areas hundreds of miles downwind. Fast-moving deadly pyroclastic flows (“nuées ardentes”) are also commonly associated with plinian eruptions

Industrial disasters

Industrial disasters are mass disasters caused by industrial companies, either by accident, negligence or incompetence.

- Pemberton Mill was a large factory in Lawrence, Massachusetts that collapsed without warning on January 10, 1860. An estimated 145 workers were killed and 166 injured.

- Grover Shoe Factory disaster was a boiler explosion, building collapse and fire that killed 58 people and injured 150 in Brockton, Massachusetts on March 20, 1905.
- Courrières mine disaster in Courrières, France, on March 10, 1906. 1,099 workers died, including children, in the worst mine accident ever in Europe.
- Triangle Shirtwaist Factory fire in New York City on March 25, 1911. This was a major industrial disaster in the U.S., causing the death of more than one hundred garment workers who either died in the fire or jumped to their deaths. The fire led to legislation requiring improved factory safety standards and helped spur the growth of the International Ladies' Garment Workers' Union, which fought for better working conditions for sweatshop workers in that industry.
- The Boston Molasses Disaster occurred on January 15, 1919. A large molasses tank burst and a wave of molasses rushed through the streets at an estimated 35 mph (56 km/h), killing 21 and injuring 150. The event has entered local folklore, and residents claim that on hot summer days the area still smells of molasses.
- Oppau explosion in Germany occurred on September 21, 1921 when a tower silo storing 4500 tonnes of a mixture of ammonium sulfate and ammonium nitrate fertilizer exploded at a BASF plant in Oppau, now part of Ludwigshafen, Germany, killing 500–600 people and injuring about 2000 more.
- Minamata disaster. This was caused by the dumping of mercury compounds in Minamata Bay, Japan. The Chisso Corporation, a fertilizer and later petrochemical company, was found responsible for polluting the bay during the years 1932-1968. It is estimated that over 3,000 people suffered various deformities, severe mercury poisoning symptoms or death from what became known as Minamata disease.
- Port Chicago Disaster. On 17 July [[1944, an explosion that killed 320 people occurred at the Port Chicago Naval Magazine in Port Chicago, California.
- Texas City Disaster, Texas 1947. On April 16, 1947 at 9:15 AM an explosion aboard a docked ship named the Grandcamp, and subsequent fires and explosions, is referred to as the worst industrial disaster in America. A minimum of 578 people lost their lives and another 3,500 were injured as the blast shattered windows from as far away as 25 miles (40 km). Huge boulders of steel flew into the sky to rain down more than a mile from ground zero. The origin of the explosion was fire in the cargo on board the ship. Detonation of 3,200 tons of ammonium nitrate fertilizer aboard the Grandcamp led to further explosions and fires. The fertilizer shipment was to aid the struggling farmers of Europe recovering from World War II. The fire was thought to have been ignited by a discarded cigarette. Although this industrial disaster was one of the largest involving ammonium nitrate many others have been reported, including a recent one in North Korea.

- Ludwigshafen, Germany, 1948: The explosion of a tank wagon within the BASF-site, loaded with chemicals, causes 207 fatalities.
- Little Rock AFB: Searcy,Arkansas. August 9, 1965 53 contract workers were killed during a fire at a Titan missile silo.The cause of the fire was determined to be a welding rod damaging a hydraulic hose allowing hydraulic vapors to leak and spread throughout silo, which were then ignited by an open flame source.
- Flixborough disaster on June 1, 1974. An explosion at a chemical plant near the village of Flixborough, England, kills 28 people and seriously injures another 36.
- Seveso disaster. This was an industrial accident that occurred in Seveso, Italy, on July 10, 1976, in a small chemical manufacturing plant of ICMESA. Due to the release of dioxins into the atmosphere and throughout a large section of the Lombard Plain, 3,000 pets and farm animals died and, later, 70,000 animals were slaughtered to prevent dioxins from entering the food chain. In addition, 193 people in the affected areas suffered from chloracne and other symptoms. The disaster lead to the Seveso Directive, which was issued by the European Community and imposed much harsher industrial regulations.
- Bhopal disaster in India (1984). This was one of the worst industrial disasters on record. A faulty tank containing poisonous methyl isocyanate leaked at a Union Carbide plant and left nearly 3,000 people dead initially, and at least 15,000 from related illnesses.[1] The disaster caused the region's human and animal populations severe health problems to the present.
- Romeoville, Illinois, Union Oil Refinery Explosion on July 23, 1984 kills 19 people.
- Norco, Louisiana, Shell Oil Refinery Explosion on May 5, 1988 after hydrocarbon gas escaped from a corroded pipe in a catalytic cracker and was ignited. Louisiana state police evacuated 2,800 residents from nearby neighborhoods. Seven workers were killed and 42 injured. The total cost arising from the Norco blast is estimated at US$706m.
- Auburn, Indiana, improper mixing of chemicals kills four workers at a local metal-plating plant on June 28, 1988, in the worst confined-space industrial accident in U.S. history; a fifth victim died two days later. [2]
- Piper Alpha disaster on July 6, 1988. An explosion and resulting fire on a North Sea oil production platform kill 167 men. Total insured loss is about US$ 3.4 billion. To date it is rated as the world's worst offshore oil disaster in terms both of lives lost and impact to industry.
- Phillips Disaster on October 23, 1989. Explosion and fire killed 23 and injured 314 in Pasadena, Texas. Registered 3.5 on the Richter scale.
- 1991 Hamlet chicken processing plant fire, where locked doors trapped workers in a burning processing plant, causing 25 deaths.
- Kader Toy Factory fire. On May 10, 1993, a fire started in a poorly built factory in Thailand. Exit doors were locked and the stairwell soon collapsed. 188 workers were killed, mostly young women.

- Enschede fireworks disaster on May 13, 2000. A fire and explosion at a fireworks depot in Enschede, Netherlands leaves 22 people dead and 947 injured. About 1,500 homes are damaged or destroyed. The damage is estimated to be over US$ 300 million in insured losses.
- Texas City Refinery explosion. On March 23, 2005, an explosion occurred at a petroleum refinery in Texas City, Texas, that belonged to BP. It is the third largest refinery in the United States and one of the largest in the world, processing 433,000 barrels of crude oil per day and accounting for 3% of that nation's gasoline supply. Over 100 were injured, and 15 were confirmed dead, including employees of the Fluor Corporation as well as BP. BP has since accepted that its employees contributed to the accident. Several level indicators failed, leading to overfilling of a knock out drum, and light hydrocarbons concentrated at ground level throughout the area. A nearby running diesel truck set off the explosion.
- Hertfordshire Oil Storage Terminal fire, on December 11, 2005 a series of explosions at the Buncefield oil storage depot described as the largest peacetime explosion in Europe, devastated the terminal and many surrounding properties. Fortunately there were no fatalities, however, as the explosions occurred early on a Sunday the neighbouring industrial estate, which was severley damaged, it is likely that there would have been extensive casualties/fatalities if the explosions had occurred during a working day. Total damages have been forecast as £750 million.
- Qinghe Special Steel Corporation disaster, on April 18, 2007, a ladle holding molten steel separated from the overhead iron rail, fell, tipped, and killed 32 workers, injuring another 6.
- The 2008 Georgia sugar refinery explosion occurred on February 7, 2008 in Port Wentworth, Georgia, United States. Thirteen people were killed and 42 injured when a dust explosion occurred at a sugar refinery owned by Imperial Sugar.

Other disasters can be considered industrial disasters, because their causes are rooted in the products or processes of industry. For example, the Great Chicago Fire of 1871 was severe due to the heavy concentration of lumber industry, wood houses, fuel and other chemicals in a small area.

Abnormal Situation Management

The **Abnormal Situation Management** (ASM) Consortium is a long-running and active Honeywell-led research and development consortium of 12 companies and universities that are concerned about the negative effects of industrial accidents. An *abnormal situation* is a disturbance or series of disturbances in a process that causes plant operations to deviate from their normal operating state. The disturbances may be minimal or catastrophic, and cause production losses or, in serious cases, endanger human life. The result of an abnormal situation can be unnecessary costly due to production losses, off-spec product, equipment damage, or worse.

Data collected by the consortium has demonstrated that operations practices can lead to costs of 3-8 percent of plant capacity due to unexpected events. Based on these data, the consortium has estimated the cost of lost production due to abnormal situations is at least $10 billion annually in the U.S. petrochemical industry. These estimates were developed early in the consortium's activities, and it is likely that today's costs are much higher.

At the core of the ASM problem is the “Paradox of Automation”. As systems get more complicated, the operator is put into an untenable position. Why? First, as systems become more complex, they become more difficult to operate. One solution to operational difficulty is to add automation. But automation itself increases complexity. In addition to the increase in complexity, it is difficult to maintain operational skills in an automated environment. Those skills are precisely the ones that are most needed when the automated system is unable to handle a problem and the operator is required to intervene.

Hence the consortium's focus has been on addressing the complex human-system interaction and factors that influence successful performance. Automation solutions have often been developed without consideration of the human that needs to interact with the solution. We can provide automation that effectively solves a problem under normal conditions, but when an anomaly occurs the complexity of the automation undermines the ability of people to intervene and correct the problem. One of the goals of the ASM R&D program is to define requirements for user-centered automation and support technologies

Causes of Abnormal Situations

The Consortium’s early studies of incident reporting systems across multiple sites confirmed three principal sources of abnormal situations: people or work context factors; equipment factors; and process factors.

People and work context factors accounts for an average 42 percent of incidents (range of 35% to 58%). The influences on this factor are the training, skill and experience levels of the operations teams and their stress levels when situations reach alarm conditions. As well, the organizational structure, communications, environment and documented procedures and practices (or lack thereof) play a role in operator response.

Equipment factors account for an average 36 percent of incidents (range 30% to 45%). This category includes degradation and failures in the process equipment, such as pumps, compressors and furnaces, and failures in the control equipment, such as sensors, valves and controllers.

Process factors account for an average 22 percent of incidents (range 3% to 35%). Impacts include process complexity, types of materials and manufacturing (batch vs. continuous) and state of operation—steady state vs. startups, shutdowns and transitions

Description

The ASM Consortium aims to identify problems facing industrial plant operations during abnormal conditions, and to develop solution concepts. The output of ASM Consortium research includes products and services, guidelines and other documents, and information-sharing workshops; all incorporating ASM knowledge. Abnormal Situation Management, like general emergency management, is achieved through *Prevention*, *Early Detection*, and *Mitigation* of abnormal situations, thereby reducing unplanned outages, process variability, fires, explosions and emissions that are reducing profits and putting plant employees and local residents at risk.

The ASM Consortium promotes their vision by conducting research, testing and evaluating solutions that develop and advance the collective knowledge of the members, and by directing development of best practices, service and tools that facilitate the conversion of ASM knowledge into practice.

Consortium members pay an initiation fee and annual dues. These monies are augmented with control over part of Honeywell's engineering docket for R&D spending to fund ongoing research. The collaborative consortium approach allows the consortium to benchmark across different companies and plant sites to determine best practices and root causes for incidents. The fundamental approach is a pooling of knowledge.

Objectives

The ASM Consortium achieves its mission with three programs - Research, Development and Deployment, and Communications - each has specific, interrelated objectives. In alignment with these high-level objectives, the ASM Consortium Executive Steering Committee develops detailed objectives on an annual basis to focus activities in specific areas where there is a potential to significantly improve ASM practices. The amount of emphasis given to projects in each focus area is determined jointly by members of the Consortium.

Research Objectives Program activities seek to identify, develop, evaluate and prove the feasibility of new solutions and associated enabling technologies to reduce risks even further; and facilitate technology transfer to user member sites and the Development Program.

Development and Deployment Objectives The objective of the development and deployment program is to capture the knowledge represented in and developed by the Consortium and to return it to customers in the form of products and services that are successfully deployed. The driving force of these developments will be to further the mission of converting ASM knowledge into practice.

Communications Objectives A primary objective of the ASM Consortium continues to be the exchange of information within the Consortium membership to enhance the understanding and use of effective ASM practices within Consortium member organizations. As appropriate, the Consortium publishes externally in the public domain to influence the global adoption of ASM solution concepts. The Consortium has recently increased its focus on external communications, and will begin public release of guideline documents in late 2008.

Effective Operating Practices

The ASM Consortium has identified 7 categories of practices that impact ASM performance, based on assessment of effective operations practices in plant studies. Consortium research and development focuses on issues in these areas, and typically involves testing and observation at member company sites. These seven focus areas that fundamentally help customers improve safety, reliability and efficiency of their process operations. In each area the Consortium develops examples, research and analysis, develop product recommendations, and in some cases guidelines to help implement solutions.

1. **Understanding Abnormal Situations**: This area focuses on issues that can lead to a better understanding of current incident causes. These factors are widely distributed but can provide insight to reduce future abnormal situations, and to prepare operations teams to efficiently and accurately handle the abnormal situations that do occur.

2. **Organizational Roles, Responsibilities and Work Processes**: This area focuses on the impact of management structure and policy on the ability of the operations team to prevent and respond appropriately to abnormal situations.

3. **Knowledge & Skill Development**: This area focuses on the impact of training and skill development, in anticipating and coping with abnormal situations.

4. **Communications**: This area focuses on communications issues among plant personnel and with the use of information technology under normal, abnormal and emergency situations.

5. **Procedures**: This area focuses on all aspects of procedures used to accomplish important tasks at an industrial site, particularly start-up and shut-down.

6. **Work Environment**: This category focuses on the impact of the control building environments for effective operations.

7. **Process Monitoring Control & Support Applications**: This area focuses on automation technologies for effective operations.

Explosion

An **explosion** is a rapid increase in volume and release of energy in an extreme manner, usually with the generation of high temperatures and the release of gases. An explosion creates a shock wave.

Types of explosives

Natural

Explosions can occur in nature. Most natural explosions arise from volcanic processes of various sorts. Explosive volcanic eruptions occur when magma rising from below has much dissolved gas in it; the reduction of pressure as the magma rises causes the gas to bubble out of solution, resulting in a rapid increase in volume. Explosions also occur as a result of impact events. Explosions can also occur outside of Earth in the universe in events such as supernova. Explosions frequently occur during Bushfires in Eucalyptus forests where the volatile oils in the tree tops suddenly combust.

Chemical

Main article: Explosive material

The most common artificial explosives are chemical explosives, usually involving a rapid and violent oxidation reaction that produces large amounts of hot gas. Gunpowder was the first explosive to be discovered and put to use. Other notable early developments in chemical explosive technology were Frederick Augustus Abel's development of nitrocellulose in 1865 and Alfred Nobel's invention of dynamite in 1866.

Nuclear

Main article: Effects of nuclear explosions

A nuclear weapon is a type of explosive weapon that derives its destructive force from the nuclear reaction of fission or from a combination of fission and fusion. As a result, even a nuclear weapon with a small yield is significantly more powerful than the largest conventional explosives available, with a single weapon capable of destroying an entire city.

Electrical

A high current electrical fault can create an *electrical explosion* by forming a high energy electrical arc which rapidly vaporizes metal and insulation material. Also, excessive magnetic pressure within an ultra-strong electromagnet can cause a *magnetic explosion*.

Vapour

Boiling liquid expanding vapour explosions are a type of explosion that can occur when a vessel containing a pressurized liquid is ruptured, causing a rapid increase in volume as the liquid evaporates.

Astronomical

Among the largest known explosions in the universe are supernovae, which result from stars exploding, and gamma ray bursts, whose nature is still in some dispute. Solar flares are an example of explosion common on the Sun, and presumably on most other stars as well. The energy source for solar flare activity comes from the tangling of magnetic field lines resulting from the rotation of the Sun's conductive plasma.

Mechanical

Strictly a physical process, as opposed to chemical or nuclear, eg, a the bursting of a sealed or partially-sealed container under internal pressure is often referred to as a 'mechanical explosion'. Examples include an overheated boiler or a simple tin can of beans tossed into a fire. A BLEVE (see above) is one type of mechanical explosion, but depending on the contents of the container, the effects can be dramatically more serious - consider a propane tank in the midst of a fire. In such a case, to the limited effects of the simple mechanical explosion when the tank fails are added the chemical explosion resulting from the released (initially liquid and then almost instanteaously gaseous) propane in the presence of an ignition source. For this reason, emergency workers often differentiate between the two events.

List of the largest artificial non-nuclear explosions

Since the invention of high explosives, there have been a number of extremely large explosions, many accidental. This list contains the largest known examples, sorted by date. The weight of the explosive does not directly correlate with the size of the explosion, so an accurate ranking of the power of these explosions is impossible. A 1994 study by scientists and historians of 130 such explosions suggested such large explosions need to be measured by an overall effect of power, quantity, radius, loss of life and property destruction, but still concluded that such rankings are difficult to assess.

2001–present

2005 Hertfordshire Oil Storage Terminal fire

On December 11, 2005 there were a series of major explosions at the 60,000,000 imp gal (270,000,000 L) capacity Buncefield oil depot near Hemel Hempstead, Hertfordshire, England. The explosions were heard over 100 mi (160 km) away, as far as the Netherlands and France, and the resulting flames were visible for many miles around the depot. A smoke cloud covered Hemel Hempstead and other nearby towns in west Hertfordshire and Buckinghamshire. There were no fatalities, but there were around 43 injuries (two serious).

Ryongchon disaster

A train explosion in North Korea; according to official figures, 54 people were killed and 1,249 were injured on April 22, 2004.

Seest fireworks disaster

On November 3, 2004 about 800 tonnes of fireworks exploded in the Danish town of Kolding. One firefighter was killed, but the mass evacuation of 2,000 people saved many lives. The cost of the damage has been estimated at €100 million.

2001 AZF chemical factory explosion in Toulouse, France

On September 21, 2001 the disaster caused 30 deaths, 2,500 seriously wounded and 8,000 light casualties.

1901–2000

Post World War II era

Enschede fireworks disaster

On May 13, 2000 about 177 tonnes of fireworks exploded in the Dutch town of Enschede. 23 people were killed, and hundreds were injured.

1996 Manchester bombing

On Saturday June 15, 1996, the IRA detonated a bomb containing 1,500 kg (3,300 lb) of explosives in Manchester. The bomb was located in a Ford lorry parked two hours earlier in the centre of the city's shopping district. It was the largest IRA bomb ever detonated in Great Britain, and the largest bomb to explode in Great Britain since World War II. Due to the evacuation of the area around the lorry, there were no fatalities.

Oklahoma City bombing

At 9:02 am CDT on April 19, 1995, a truck bomb detonated next to the Alfred P. Murrah Federal Building in Oklahoma City, Oklahoma. The bomb was set by Timothy McVeigh in retalitation for the sieges at Waco and Ruby

Ridge. The 4,800 lb (2,200 kg) ammonium nitrate bomb killed 186, injured over 680, destoyed 86 cars, and damaged or destroyed 324 buildings within a sixteen block radius, including the Murrah building. It was the largest terrorist act in the United States before the September 11 attacks.

Ufa train disaster

On June 4, 1989, a gas explosion with a strength of 10 kilotons of TNT destroyed two trains in the Soviet Union.

PEPCON disaster

On May 4, 1988 about 8,500,000 lb (3,860 t) of ammonium perchlorate either burned or exploded in a fire and several massive explosions near Henderson, Nevada. Two people were killed, and hundreds were injured. The largest explosion was estimated to be equivalent to a 1 kiloton nuclear air burst.

Minor Scale and Misty Picture

Many very large deliberate detonations have been carried out in order to simulate the effects of nuclear weapons on vehicles and military material in general. The largest publicly-known test was conducted by the United States Defense Nuclear Agency (now part of the Defense Threat Reduction Agency) on June 27, 1985 at the White Sands Missile Range in New Mexico. This test, called Minor Scale, used 4744 short tons of ANFO, with a yield of about 4 kt. Although comparing explosions is difficult, this is probably the largest artificial non-nuclear explosion in history. Misty Picture was another similar test a few years later, just slightly smaller (4,685 short tons/4,250 t).

Another similar test (Operation Blowdown) was a joint UK-Australian test out on July 18, 1963 in the Iron Range area of Queensland, Australia, to test the feasibility of nuclear weapons for clearing forests and using mangled forests to slow troop movement in South East Asia, primarily Indonesia and Malaysia in the escalation against Sukarno and the *Konfrontasi* Malay Emergency and with a view to later Myanmar and Vietnam conflicts simmering at the time.

Medeo Dam, near Alma-Ata, Kazakhstan

On October 21, 1966 a mud flow protection dam was created by a series of four preliminary explosions of 1,800 tonnes total and a final explosion of 3,600 tonnes of ammonium nitrate based explosive. On April 14, 1967 the dam was reinforced by an explosion of 3,900 tonnes of ammonium nitrate based explosive.

Operation Sailor Hat, off Kaho'olawe Island, Hawaii, 1965

A series of tests was performed, using conventional explosives to simulate the shock effects of nuclear blasts on naval vessels. Each test saw the detonation of a 500-short-ton (450 t) mass of high explosives.

500 short tons (450 t) tons of HE awaiting detonation for Operation Sailor Hat.

Detonation of explosive during Operation Sailor Hat. Shock front visible moving across the water, shock condensation cloud visible overheard.

Ripple Rock, Canada

On April 5, 1958 an underwater mountain was decapitated by the explosion of 1,375 tonnes of Nitramex 2H (an ammonium nitrate based explosive).

The Texas City Disaster

On April 16, 1947, the SS *Grandcamp*, loaded with 8,500 short tons (7,700 t) of ammonium nitrate, exploded in port at Texas City, Texas; this is generally considered the worst industrial accident in United States history. 581 died, over 5,000 injured. Using standard chemical data for decomposition of ammonium nitrate gives 2.7 kilotons of energy released. The US Army rates the relative effectiveness of ammonium nitrate, compared to TNT, as 0.42. This conversion factor makes the blast the equivalent of 3.2 kilotons of TNT.

Heligoland

On April 18, 1947 British engineers attempted to destroy the entire island in what became known as the "British Bang". Roughly 4,000 long tons (4,100 t) of surplus World War II ammunition were placed in various locations around the island and set off. The island survived, although the extensive fortifications were destroyed. According to Willmore, the energy released was 13,000,000,000E10 erg (1.3×10^{13} J), or about 3.2 kilotons of TNT equivalent. The blast is listed in the *Guinness Book of World Records* under *largest single explosive* **detonation**, although Minor Scale would appear to be larger.

World War II era

RAF Fauld Explosion

On November 27, 1944 the RAF Ammunition Depot at Fauld, Staffordshire became the site of the largest explosion in the UK, when 3,700 tonnes of bombs stored in underground bunkers covering 17,000 square metres exploded en masse. The explosion was caused by bombs being taken out of store - primed for use and replaced unused, with the detonators still installed. The crater is 30 metres deep and covers 5 hectares. The death toll was approximately 78 including RAF, six Italian POWs, civilian employees and local people. In the similar Port Chicago disaster below, about half the weight of bombs was high explosive. If the same is true of the Fauld Explosion, it would have been equivalent to about 2 kilotons of TNT.

Cleveland East Ohio Gas Explosion

On October 20, 1944 Gas Storage tanks at Cleveland Ohio exploded; 1 square mile destroyed; 160 killed; 600 homeless

Port Chicago disaster

On July 17, 1944 in Port Chicago, California the SS *E. A. Bryan* exploded while loading ammunition bound for the Pacific, with an estimated 4,606 short tons (4,178 t) of high explosive, incendiary bombs, depth charges, and other ammunition. Another 429 short tons (389 t) were waiting on nearby rail cars, which also exploded. The total explosive content is described as between 1,600 and 2,136 tons of TNT. 320 were killed instantly, another 390 wounded. Most of the killed and wounded were African American enlisted men. Following the explosion, 258 fellow sailors refused to load ordnance; 50 of these, called the "Port Chicago 50", were convicted of mutiny even though they were willing to carry out any order that did not involve loading ordnance under unsafe conditions.

Bombay Docks Explosion

On April 14, 1944 the SS *Fort Stikine* carrying around 1,400 long tons (1,400 t) of explosives (among other goods) caught fire and exploded killing around 800 people.

Interwar period

New London School explosion

On March 18, 1937, a natural gas leak caused an explosion, destroying the New London School of the city of New London, Texas. Over 300 students and teachers died.

The Oppau explosion

On September 21, 1921 a silo filled with 4,500 tonnes of fertilizer exploded, killing around 560, largely destroying Oppau, Germany and causing damage more than 30 km away.

World War I era

Halifax Explosion

On December 6, 1917 the SS *Imo* and *SS Mont-Blanc* collided in the harbour of Halifax, Nova Scotia. *Mont-Blanc* carried 2,653 tonnes of various explosives, mostly picric acid. After the collision the ship caught on fire, drifted into town and eventually exploded. More than 2,000 people were killed and much of Halifax was destroyed. An evaluation of the explosion's force puts it at 2900 tonnes of TNT.

Battle of Messines

On June 7, 1917 nineteen (of a planned twenty-one) huge mines — containing over 455 t (1,000,000 lb) of ammonal explosives — were set off beneath German lines on the Messines-Wytschaete ridge. Approximately 10,000 Germans were killed, and the explosion was heard as far away as London and Dublin.

Quickborn Explosion

On February 10, 1917 a chain reaction in an ammunition plant "Explosivstoffwerk Thorn" in Quickborn-Heide (northern Germany) killed at least 115 people, mostly young female workers. Some sources claim over 200 victims.

Silvertown explosion

On January 19, 1917 at 18:52 parts of Silvertown in East London were devastated by a massive TNT explosion at the Brunner-Mond munitions factory. 73 people died and hundreds were injured. The blast was felt across London and Essex, and was heard over 100 mi (160 km) away, with the resulting fires visible for 30 mi (48 km).

Split Rock explosion

On July 2, 1918 a munitions factory near Syracuse, New York exploded after a mixing motor in the main TNT building overheated. The fire rapidly spread through the wooden structure of the main factory. Approximately 1-3 thousand tons of TNT were involved in the blast, which leveled the structure and killed 50 workers (conflicting reports mention 52 deaths).

Black Tom explosion

On July 30, 1916 1,000 short tons (910 t) of explosives bound for Europe, along with another 50 short tons (45 t) on the *Johnson Barge No. 17*, exploded in Jersey City, New Jersey, a major dock serving New York. There were few deaths, but about 100 injuries; also, the buildings on Ellis Island and the Statue of Liberty were damaged, along with much of Jersey City.

Lochnagar Mine

On July 1, 1916 on the start of Battle of the Somme a charge of 60,000 lb (27 t) of ammonal explosive was blown at 7:28 am. The explosions constituted what was then the loudest man-made sound in history, and could be heard in London. The mine created a crater 300 ft (90 m) across and 90 ft (30 m) deep, with a lip 15 ft (5 m) high. The crater is known as Lochnagar Crater after the trench from where the main tunnel was started.