NUCLEAR ACCIDENT

8.1 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Photos: Guillaume Bression/Fabien Recoquillé/Médiathèque IRSN, Arnaud Bouissou/MEDDE/Médiathèque IRSN

AUTORITÉ DE SÛRETÉ NUCLÉAIRE

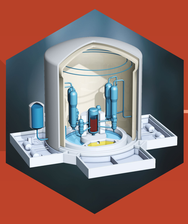
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

NUCLEAR ACCIDENT

FROM INCIDENT TO ACCIDENT, A DREADED SEQUENCE OF EVENTS

The most serious accident that can occur in a nuclear power plant is the **meltdown of the fuel** and **the release of radioactive particles into the environment**. What cascade of events does it take to trigger a disaster like Fukushima? Nuclear safety also means being aware of this chain of events and trying to prevent it.

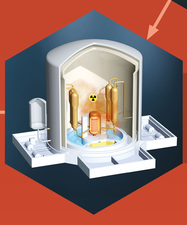
THE CHAIN OF EVENTS



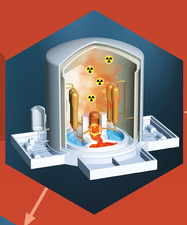
A breakdown occurs in the cooling system.
If there is the slightest problem, the chain reaction within the reactor is stopped by the fall of control rods.
Despite this, the fuel continues to heat up and must be cooled.

The emergency cooling systems are activated (external reservoir).

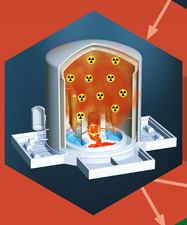
Emergency cooling systems no longer function because there is no water or no electricity.



360°C
The temperature of the fuel rises.
Zircaloy cladding corrodes and releases hydrogen.
Water vapour invades the reactor building, and the pressure rises.



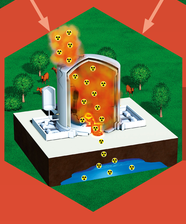
2,000°C
The fuel pellets heat up, melt and, by mixing with structural elements of the reactor, gradually form corium, a kind of magma at over 2,000°C that can pierce the reactor vessel and flow into the reactor building.



As the reactor heats up, hydrogen continues to be released and fission products escape into the reactor building.
The pressure is rising. There is a risk of loss of containment.

The pressure in the building could cause it to explode, so it is deliberately depressurised and radioactive products are dispersed into the atmosphere in a controlled and filtered manner.

In the event of unanticipated leakage and damage to the building, radioactive products are dispersed into the atmosphere, forming an invisible plume, carried by the wind and spread on the ground by deposition and rain.



The corium can pierce the basemat of the reactor building.
It can then reach the ground beneath the power plant, or even spread into the groundwater.

8.2 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustrations: La-fabrique-créative/Bruno Bourgeois

asn AUTORITÉ DE SÛRETÉ NUCLÉAIRE

IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

NUCLEAR ACCIDENT

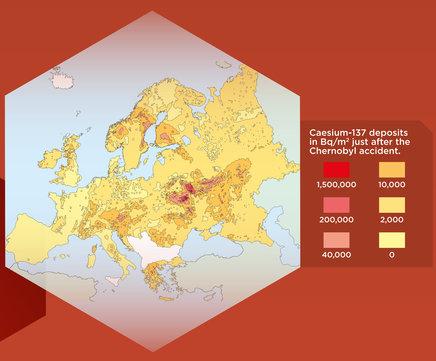
THE CONSEQUENCES OF A NUCLEAR ACCIDENT ON THE ENVIRONMENT

A nuclear accident would have consequences for the entire environment, creating a risk of exposure to radioactivity for the population.

RELEASES AND FALLOUT

Following a nuclear accident, fission products such as caesium, iodine and strontium may be dispersed in the air.
The radioactive cloud will move with the wind and radionuclides will gradually settle on the ground, even more so if it is raining or snowing. The weather is therefore a determining factor in a nuclear accident, and will determine the extent of the area affected.

In the case of the Chernobyl accident, for example, the plume affected the whole of Europe, resulting in deposits that varied from region to region.



5 years after the accident, decontamination work on the Wide Area Farm road in Fukushima Prefecture.

DEPOSITS AND LONGER-TERM CONSEQUENCES

After the plume has passed, deposits in the environment can be significant, leading to heavy soil contamination. Some radionuclides, such as plutonium and americium, are more likely to contaminate the area close to the facility, while others, such as iodine-131 and caesium-134 and -137, will be carried to greater or lesser distances, depending on weather conditions, with rainfall tending to wash them down to the ground.

In addition, rainfall run-off, by washing radioactive particles downhill, can tend to concentrate radioactivity locally.

Contamination of the environment leads to external exposure of the population, which is all the more significant the larger the radioactive deposits. In some cases, the area may be closed off and the population relocated for a certain period of time, or access may be restricted in highly contaminated areas (forests, etc.).

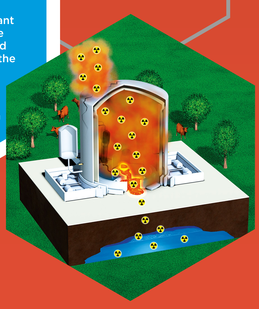
Deposits in the environment also lead to contamination of foodstuffs and consumer goods. A ban on the consumption of locally-produced foods and checks on agricultural products prior to their commercialisation help to protect the population and consumers.

THE CONSEQUENCES FOR WATER

As the plume is transported in the atmosphere, rainwater and run-off become loaded with the radioactive elements in the air and deposited on the ground.

The groundwater beneath the power plant could also be at risk if the reactor core were to melt and the reactor vessel and basemat were to rupture. This is one of the most feared scenarios in the event of an accident.

Drinking water wells, as well as sites linked to the fishing and tourism industries, are therefore checked before use.



8.3 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Map: IRSN - Illustration: La-fabrique-créative/Bruno Bourgeois - Photo: Noak / Le bar Floréal / Médiathèque IRSN

AUTORITÉ DE SÛRETÉ NUCLÉAIRE

IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

NUCLEAR ACCIDENT

IN THE EVENT OF A NUCLEAR ALERT, YOU KNOW WHAT TO DO!

An alert is triggered when an event at a nuclear facility is likely to result in radioactive releases and have consequences for people and the environment.

QUICKLY SEEK SHELTER IN A BUILDING

Quickly but calmly make your way to a permanent building (with foundation).

If you're already in a building, isolate yourself from the outside: close the doors and windows and turn off the ventilation.

STAY INFORMED

Listen to the public authorities' protection instructions on the radio (France Bleu, France Info, etc.), on television (France Télévisions, etc.) and on your prefecture's website.

Use a battery-powered radio and make sure you have spare batteries on hand.

KEEP TELEPHONE CALLS TO A MINIMUM

Don't saturate communication networks.

They are needed to organise emergency services and broadcast information.

DON'T COLLECT YOUR CHILDREN FROM SCHOOL

Stay sheltered.

At school, your children are looked after by the teachers.

You've already discussed this with the teachers.

TAKE IODINE AS SOON AS YOU ARE INSTRUCTED TO DO SO

The dose of stable iodine must be taken at the right time, and you must wait for the prefect's instructions.

PREPARE FOR A POSSIBLE EVACUATION

Pack your emergency kit, which includes your personal documents, any medicines you may need, clothes, food and drink.

When evacuating, follow the traffic laws and help your family and friends.

Scan the QR codes to view the safety plans

The specific safety plan (PPMS)

The family safety plan (PFMS)

8.4 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustrations: La-fabrique-créative/Bruno Bourgeois

asn AUTORITÉ DE SÛRETÉ NUCLÉAIRE

IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

NUCLEAR ACCIDENT

WHY IODINE TABLETS?

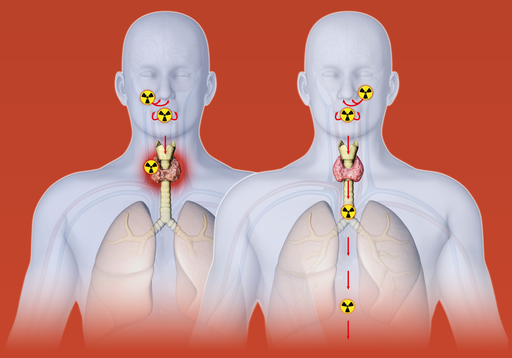
An accident at a nuclear reactor can result in a release of radioactive iodine. When inhaled or swallowed, radioactive iodine binds to the thyroid gland and can increase the risk of cancer of this organ, especially in young people. Iodine tablets protect the thyroid.

IODINE
TO PROTECT YOUR THYROID

WHY IODINE TABLETS?

The thyroid is an essential organ which regulates a number of functions (growth, development of the nervous system, heart rate, etc.). The thyroid naturally stores iodine.

In the event of radioactive iodine being released, this gland needs to be saturated with stable iodine tablets, so that it no longer has room to store radioactive iodine.



WARNING

Iodine tablets are not a cure-all against the effects of radioactivity: They do not protect against other radioactive elements (uranium, caesium, strontium).

This is why other protective measures are needed.

Map of average prevailing winds in summer

WHAT SHOULD YOU DO?

TAKE IODINE AS SOON AS YOU ARE INSTRUCTED TO DO SO

If a problem were to occur in a nuclear power plant, the experts in the emergency response center would be able to estimate quite precisely the amount of radioactivity released, the location and the time of its dispersion in the environment. They would calculate the dose to the thyroid glands of residents exposed to the radioactive plume.

In France, and most neighbouring countries, the threshold for thyroid protection is set at 50 millisieverts. When expert forecasts exceed this threshold, the Prefect issues an order to take the tablet.

IT IS IMPORTANT TO WAIT FOR THE PREFECT'S ORDER

As the thyroid gland is constantly producing hormones, the body is constantly looking for iodine in the air or in food to supply it to the thyroid gland.

If the iodine tablet is taken too soon, the stable iodine will be incorporated too early and the thyroid will no longer be saturated when the releases occur.

IT ALL DEPENDS ON THE WEATHER

The areas affected by the accident depend largely on wind direction and rainfall.

The map above shows the prevailing winds in France over the largest cities.

The number of people affected will depend on the size of the contaminated area and its population density.

Iodine-131 at Fukushima

Radioactive iodine released during an accident has a half-life of around 8 days, so after 80 days there is no more in the environment.

That's why there's no point in taking iodine tablets if you're travelling near Chernobyl or Fukushima, where the contaminated areas have not contained any radioactive iodine for a long time.

8.5 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustration: La-fabrique-créative/Bruno Bourgeois - Map: La-fabrique-créative/Bruno Bourgeois - Photo: Célia Goumard/Médiatheque IRSN

AUTORITÉ DE SÛRETÉ NUCLÉAIRE

IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

NUCLEAR ACCIDENT

WHO IS INVOLVED IN NUCLEAR EMERGENCY RESPONSE?

Despite the precautions taken, a serious nuclear accident remains a possibility in France. However, its consequences can be limited by taking appropriate protective measures. Citizens and public authorities have a role to play: risk awareness is everyone's business.

THE STAKEHOLDERS

PUBLIC AUTHORITIES UNDER THE AUTHORITY OF THE PREFECT, IN LIAISON WITH THE GOVERNMENT

The Prefect triggers the Orsec Plan (Organisation of the civil security response) and the Special Emergency Plan (PPI). These plans provide for the organisation of all available emergency and response resources.

In addition, local and national emergency response units combine their efforts to limit the health effects of the accident.

ASN

The nuclear safety authority has 4 essential missions:

- **control** the validity of the actions taken by the operator;
- **advise** authorities on measures to protect the population;
- **inform** the public and the media;
- **send and receive** notifications and requests for international assistance.

IRSN

The institute has various missions:

- **assess** the situation on the basis of data from the facility, **model** it and **propose** preventive action to the public authorities;
- **calculate** possible releases, **anticipate** the path of the plume and **estimate** the doses in the area on the basis of meteorological data;
- **contribute** to informing the public.

THE NUCLEAR OPERATOR (in France mainly Orano, the CEA or EDF)

The Internal Emergency Plan (PUI) is drawn up and implemented by the operator, i.e. the industrial company responsible for the nuclear facility.

In the event of an accident, **the operator must intervene to prevent or limit radioactive leaks** while protecting personnel working on the nuclear site.

It must keep the public authorities informed of developments in the situation.

ACTIONS IMPLEMENTED

DURING THE EMERGENCY

The prefect decides on and organises the implementation of measures to protect the population, such as sheltering in place, distributing and taking stable iodine tablets, evacuating the population and restricting consumption of local foodstuffs.

Civil protection services are preparing to help people in areas that could be affected. Every year, around ten exercises are organised to train the various actors involved in a nuclear emergency.

AFTER THE EMERGENCY

In the weeks following the accident, maps are drawn up showing the precise level of contamination in the areas affected.

Depending on the level of radioactivity, action will be taken to protect the population and introduce restrictions on the consumption and sale of products grown and manufactured in the affected area.

8.6 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustration: La-fabrique-créative/Bruno Bourgeois Photos: Guillaume Murat/Signatures/Médiathèque IRSN, Arnaud Bouissou/MEDDE/Médiathèque IRSN, Florence Levillain/Signatures/Médiathèque IRSN ASN/N. Robin

asn AUTORITÉ DE SÛRETÉ NUCLÉAIRE

IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

NUCLEAR ACCIDENT

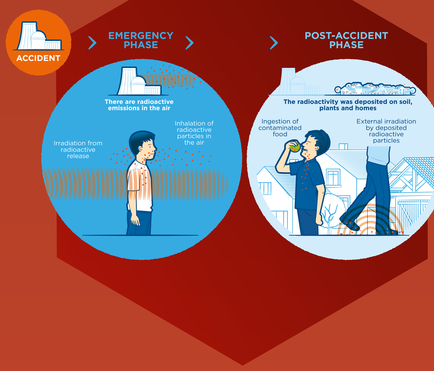
AFTER THE ACCIDENT

The consequences of a nuclear accident continue long after the release of radioactivity has ceased. Steps must then be taken to manage this post-accident phase.

SUPPORTING THE POPULATION

Radioactive deposits following a nuclear accident in a power plant can have long-term health consequences that must be limited. But it also has major economic, psychological and social repercussions that need to be taken into account:

- people are likely to be relocated from the area if exposure to radioactivity in the environment is too high;
- foodstuffs from contaminated areas may be banned from consumption and sale;
- industrial, agricultural and tourism sectors may be affected by the loss of business.



EVALUATE THE SITUATION

The nature of the accident, the extent of the releases and the meteorological conditions at the time (wind direction and strength, rain) will determine the extent and levels of contamination in the environment.

In order to specify the measures to be taken to protect the population, the public authorities will have to roll out a major programme of measures, in particular to:

- precisely map the level of contamination in a given area;
- measure the radioactivity of goods and food.

WHAT ARE THE HEALTH RISKS AND HOW CAN YOU PROTECT YOURSELF?

The risks are related to:

- internal contamination through ingestion of contaminated foodstuffs. This includes fruit and vegetables grown in contaminated areas, as well as meat from locally raised animals, and animal products (milk, eggs). To protect yourself, limit your consumption of contaminated products or check the level of contamination of locally produced products (vegetable gardens, for example) before consumption;
- external irradiation due to radiation emitted by radionuclides deposited during the accident. To protect yourself, simply avoid going to or staying in the most contaminated areas.

POST-ACCIDENT ZONING, THE MAIN TOOL FOR MANAGING CONTAMINATED AREAS

The aim of post-accident zoning is to protect the population while ensuring the economic and social recovery of the area. It complements the general actions and recommendations. It is decided by the Prefect, on the recommendation of ASN.

At the end of the emergency phase, IRSN carries out measurements to map the contamination of the environment and foodstuffs. Based on this data, ASN recommends that the prefect take action to protect the population, structured by zone.

This zoning comprises a relocation zone, a zone where consumption of fresh local produce is prohibited and a zone where agricultural produce is checked before being marketed.

PREPARING FOR POST-ACCIDENT MANAGEMENT IN FRANCE

The Steering Committee for the Management of the Post-Accident Phase of a Nuclear Accident (CODIRPA) was set up by the French Nuclear Safety Authority (ASN) in 2005, as a multi-stakeholder body to consider how to manage the consequences of a major nuclear accident.

The post-accident website: https://www.post-accident-nucleaire.fr/ helps you prepare.

In the event of an accident, a guide for residents of a contaminated area and a question and answer guide for health professionals can be used.

8.7 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustration: ASN - Maps: ASN

AUTORITÉ DE SÛRETÉ NUCLÉAIRE
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

NUCLEAR ACCIDENT

CLASSIFICATION OF NUCLEAR EVENTS

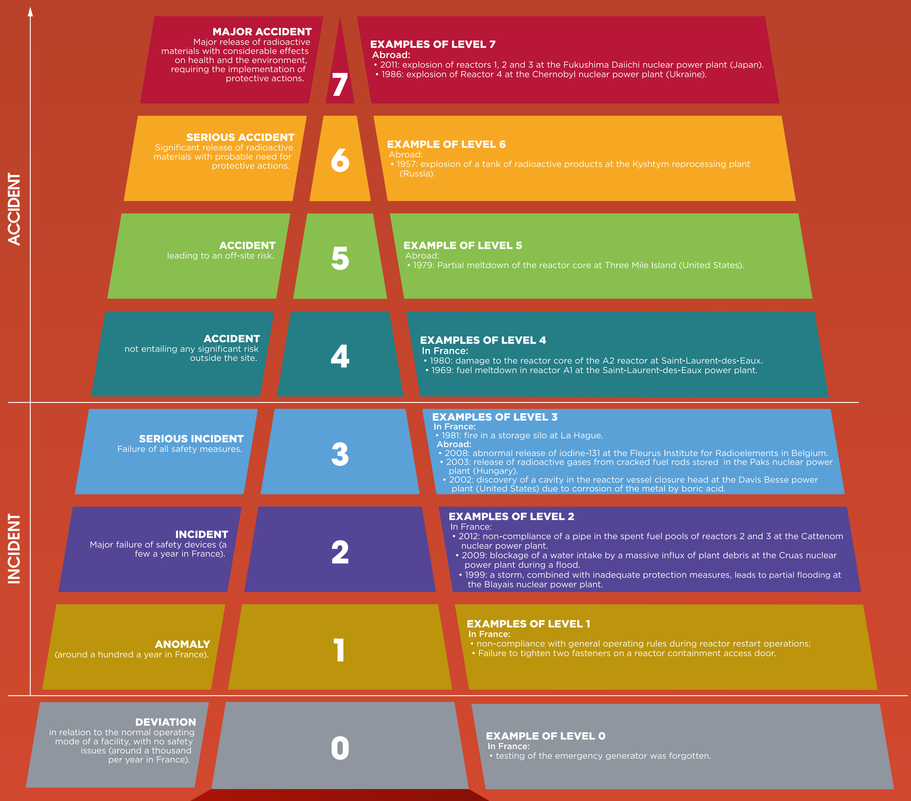
Like the Richter scale for earthquakes, the severity of nuclear events is measured on a scale called INES (International Nuclear Event Scale).

ANALYSIS AND CATEGORISATION OF EVENTS

There is no causal relationship between the number of non-serious events detected and reported and the probability of a serious accident occurring at a facility.

On the other hand, in-depth analysis of each event is a fundamental source of learning. Detecting and then reporting events to ASN is essential to advancing nuclear safety.

This process must therefore be encouraged at both a national and international level.



8.8 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustration: Kazoar

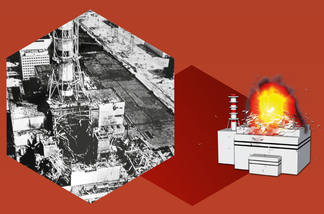
asn AUTORITÉ DE SÛRETÉ NUCLÉAIRE

IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

NUCLEAR ACCIDENT

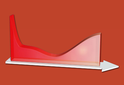
PAST ACCIDENTS

There have been several nuclear accidents around the world since the 1950s. The most serious, at level 7 on the INES scale, occurred at Chernobyl in 1986 and Fukushima Daiichi in 2011. These accidents are the subject of international experience feedback. What are the consequences of these major accidents? Permanently contaminated land, health consequences and the disruption of many people's lives.



CHERNOBYL: 26 APRIL 1986

A sudden and uncontrolled increase in the nuclear reaction (multiplied by 100 in a fraction of a second) led to the explosion of a reactor core and the destruction of the building. The nuclear fuel was dispersed around the facility.



RELEASES

Releases were continuous for 10 days, changing according to the extent of the fire in the reactor and the delivery of sand and lead by helicopter.

RELEASE DEPOSITS

The whole of Europe was contaminated to varying degrees. Caesium-137 contamination in excess of 600,000 Bq/m² was dispersed over more than 13,000 km². It has since been halved.

POPULATION EVACUATION

270,000 people were evacuated by the government.

FOOD CONTAMINATION

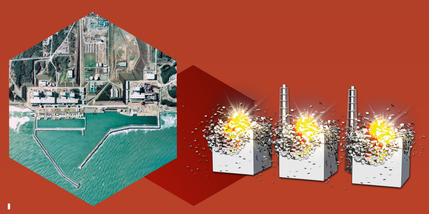
At first, there were no immediate restrictions on the consumption of local foodstuffs, followed by a ban on agricultural activities.

FUTURE OF THE FACILITIES

Construction of a sarcophagus to contain the reactor's radioactive materials, pending a long-term solution, to be defined.

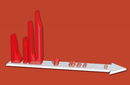
WASTE MANAGEMENT

Waste is disposed of on site: trenches were dug in the exclusion zone.



FUKUSHIMA: 12, 14, 15 MARCH 2011

The loss of power and cooling led to core meltdowns in three reactors, releasing radioactive products into the environment. The molten fuel remained inside the containment vessels.



RELEASES

About fifteen episodes of discontinuous releases over two weeks following successive reactor explosions.

RELEASE DEPOSITS

Caesium-137 contamination in excess of 600,000 Bq/m² was dispersed over more than 600 km² around the plant and up to a distance of 250 km away.

POPULATION EVACUATION

More than 150,000 people were evacuated from exclusion zones by the government. 50,000 people decided to leave contaminated areas of their own accord.

FOOD CONTAMINATION

Food contamination monitoring and commercialisation restrictions.

FUTURE OF THE FACILITIES

The corium has formed a mass that must continuously be cooled. Hundreds of thousands of tonnes of water will be used and then stored on the site awaiting treatment. The reactors will be dismantled by 2050.

WASTE MANAGEMENT

The strategy has not yet been defined: temporary storage.

8.9 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustrations: La-fabrique-créative/Bruno Bourgeois - Photos: IAEA Imagebank, Ministry of Land, Infrastructure, Transport and Tourism of Japan

asn AUTORITÉ DE SÛRETÉ NUCLÉAIRE

IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

NUCLEAR ACCIDENT

CHERNOBYL
AND ITS CONSEQUENCES

In 1986, the reactor at the Chernobyl nuclear power plant in Ukraine exploded, releasing radioactive dust and particles.

THE LOCAL CONSEQUENCES

The human toll of the Chernobyl accident is the subject of controversy (see the "Debate" section). The World Health Organisation (WHO) report, published in 2006, recorded 47 deaths in the weeks following the accident. It also predicts thousands of cancer deaths (between 9,000 and 16,000) in the 50 years following the disaster.

Among those at risk of developing these diseases are **the liquidators,** the hundreds of thousands of people who secured the site, built the sarcophagus and cleaned up the surrounding area.

Children who breathed in radioactive iodine and ate contaminated food may have developed **thyroid cancer**.

In **Belarus, Russia and Ukraine,** between 1991 and 2005, 6,848 thyroid cancers were diagnosed in children who were under the age of 18 in 1986; the majority were under 14 at the time (Unscear report 2008).

These illnesses are linked to the passage of the radioactive plume and contamination of the environment **and food**.

The reactor did not have robust safety systems or a containment vessel. The reactor core melted and spread to the lower parts of the reactor building.

The 50,000 residents of Pripyat, three kilometres from the power plant, were not evacuated until the following day.

The sarcophagus, built between April and November 1986 under extremely difficult conditions, has deteriorated and rain can penetrate it. It was covered by a new confinement arch, the construction of which was completed in 2018.

FALLOUT IN EUROPE

The contaminated air mass travelled over a large part of Europe, with areas of significant contamination in Norway, Sweden and the UK.

Measures were **taken in various countries** to limit the exposure of local residents, and in particular the consumption of contaminated products was restricted.

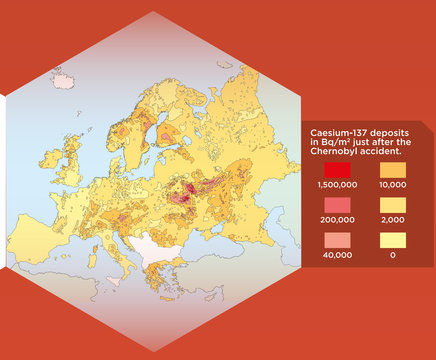
The **eastern part of France** was affected, particularly where it rained during the plume's passage.

CAESIUM-137 DEPOSITS

in Bq/m² just after the Chernobyl accident.

From 26 April 1986, the contaminated air masses progressed towards the west and north of Europe.

Caesium-137 was selected as the standard for characterising contamination in Europe.



DEBATE
HOW MANY VICTIMS?

Numerous contradictory reports by agencies, NGOs and researchers have been published on the Chernobyl disaster. Figures of tens or even hundreds of thousands of victims of the disaster have been put forward, and are far greater than the official figures.

It remains very difficult to establish a reliable estimate, given the scientific uncertainties and the risks of using the figures for political ends.

There is no doubt that 47 deaths were directly attributable to the disaster among liquidators, firefighters and plant operators, as a result of massive irradiation.

There have also been 7,000 cases of thyroid cancer among the most exposed children in Belarus, Russia and Ukraine. 15 deaths were reported among these patients.

8.10 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Map: IRSN - Photos: IAEA Imagebank, Tiia Monto

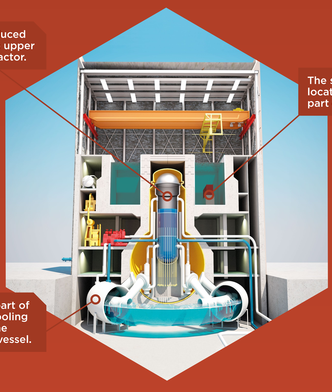
asn AUTORITÉ DE SÛRETÉ NUCLÉAIRE

IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

NUCLEAR ACCIDENT

FUKUSHIMA, THE DAMAGED REACTORS

The Fukushima Daiichi reactors were damaged by the earthquake and tsunami of 11 March 2011.



THE FUKUSHIMA REACTORS

They are boiling water reactors (BWRs) in which the steam produced by the core turns the turbine directly.

There is no secondary system and no steam generator.

TWO NATURAL DISASTERS IN QUICK SUCCESSION

1. The magnitude 9 earthquake, whose epicentre was 180 km away, destroyed the reactor's power supply.

2. Forty minutes later, a 14-metre wave drowned the emergency generators and safety systems. The control rooms were in darkness, and most of the sensors indicating system operation were out of order.

CONSEQUENCES ON THE POWER PLANT

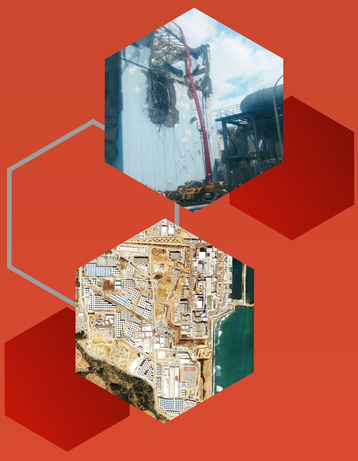
THE CORES OF REACTORS 1, 2 AND 3 MELTED DOWN

The reactor cores formed corium which pierced the reactor vessels and containment walls. The volume of the corium and its exact location are not known. The fission products contained in the corium continue to produce heat. If the corium is not cooled, it could release radioactive products into the air again. This is why the operator injects around 200 m^3 of water per day. The water becomes loaded with fission products when it comes into contact with the corium.

The explosion of the hydrogen released by the core meltdown blew away the structure of the building.

The pressure in the containment vessel rose, and it was necessary to depressurise, releasing fission products and hydrogen into the atmosphere.

The corium pierced the reactor vessel and sank into the concrete.



THE PERIL OF THE REACTOR 4 POOL

There was no nuclear fuel in the core of Reactor 4, which had been unloaded. But the spent fuel from three cores was stored in its pool, requiring continuous cooling.

With no cooling, the three cores heated up and the water in the pool began to boil and evaporate. These cores could also have melted, releasing fission products, if the fire brigade had not used exceptional means to inject water.

600,000 M^3 OF CONTAMINATED WATER STORED ON THE SITE IN MARCH 2014... AND DOUBLE THAT AMOUNT IN 2021!

The cooling water injected into the reactors leaked into the basements of the buildings, where it mixed with groundwater seepage. The operator (Tepco) partially treats this water and has to manage ever-increasing storage volumes.

Current storage capacity at the Fukushima site is expected to reach saturation in the summer of 2022. To deal with this situation, Japan plans to discharge waste into the sea starting from 2023.

Read about the situation at Fukushima in 2021

10 years after the accident at the Fukushima Daiichi nuclear power plant

8.11 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Map: Iffo-RME/Google map - Illustration: EPSIM - Photos: TEPCO

asn AUTORITÉ DE SÛRETÉ NUCLÉAIRE

IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

NUCLEAR ACCIDENT

FUKUSHIMA, SOCIETY'S RESPONSE

In areas where annual exposure to radioactivity exceeded 20 mSv/year, the population was evacuated. Where it was below this threshold, in addition to government action, local residents **organised to limit the doses** they received.

THE AREA WITH AN EXPOSURE LEVEL > 20mSv/year WAS EVACUATED

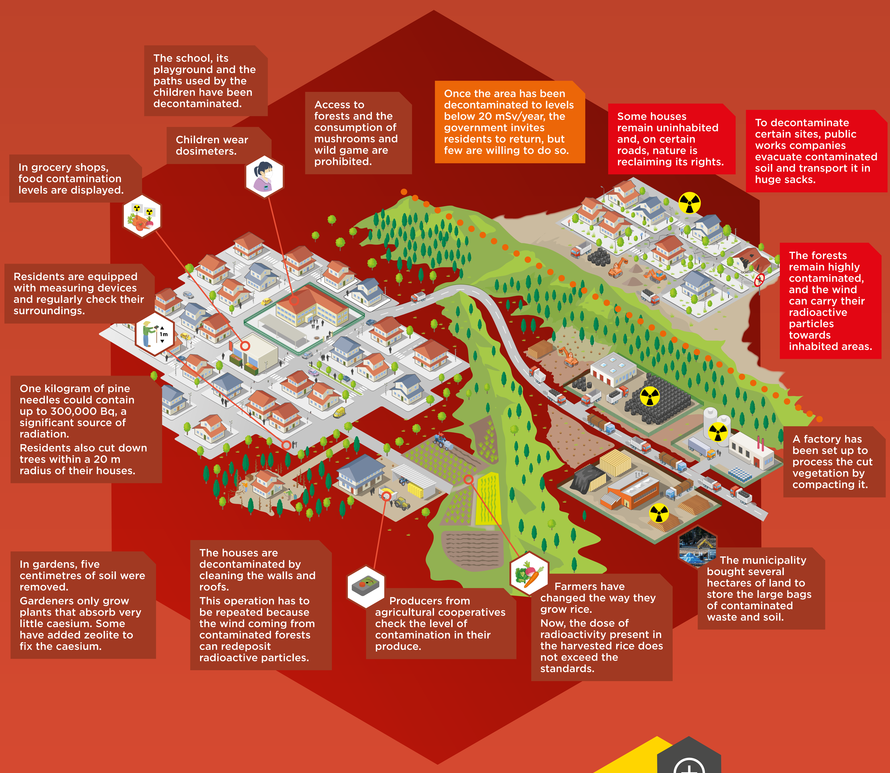
Here, the residents have been evacuated.

The government is funding the decontamination of this area so that they can return. But it won't be possible for the population to return everywhere.

IN THE ZONE WITH AN EXPOSURE LEVEL < 20mSv/year, SOCIETY HAS ORGANISED

This dose is measured outside, one metre above the ground. This is the dose a person would receive if they stayed outdoors for a year.

Local authorities and residents have taken various steps to reduce ambient doses.



Actions taken

by local residents, cities and the national government have resulted in a significant reduction in the doses received compared with the initial measurements.

8.12 Design: ASN and IRSN Communications Departments - May 2022

Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustrations: La-fabrique-créative/Bruno Bourgeois - Photo: Guillaume Bression/Fabien Recoquillé/IRSN Media Library

ASN AUTORITÉ DE SÛRETÉ NUCLÉAIRE

IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

NUCLEAR ACCIDENT

FUKUSHIMA, THE CHALLENGES

Evacuation, decontamination, return of the relocated population, monitoring of residents' health, measurement of foodstuffs: these actions by the State are essential in the post-accident situation.

EVACUEES' CHOICES

More than 120,000 people have been relocated because of contamination in their homes, resulting in exposure of more than 20 mSv/year. Initially housed in 2,200 shelters, they were then moved into temporary accommodation.

More than 40,000 people have voluntarily evacuated their land, worried about contamination. Some cities have been decontaminated, and the population is invited to return.

What will they do?

CONTAMINATION IN 2011

Most of the contamination was deposited downwind within a few hours.

It rained and snowed: some communities were harder hit because of the intensity of the precipitation.

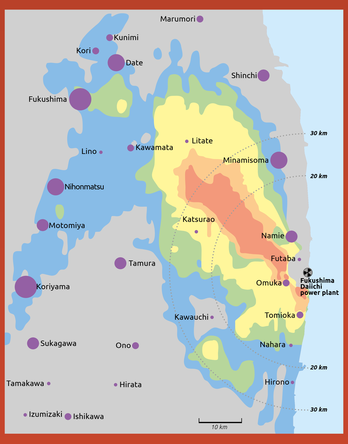
THE FUTURE OF EVACUATED MUNICIPALITIES

Depending on the extent of the contamination and the possibility of decontamination, a government plan has provided for a differentiated future for each municipality.

WINNING BACK THE LAND

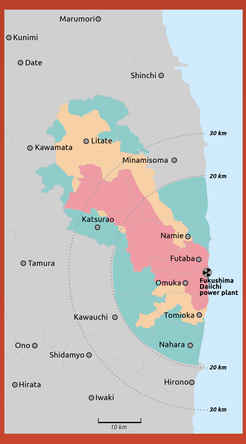
Decontamination can significantly reduce people's exposure.

The State planned this work and undertook it.



Caesium-134 and caesium-137 deposits (Bq/m²)
- 6,000,000 to 30,000,000
- 3,000,000 to 6,000,000
- 1,000,000 to 3,000,000
- 600,000 to 1,000,000
- 300,000 to 600,000

Number of inhabitants
- 200,000 to 350,000
- 50,000 to 100,000
- 20,000 to 50,000
- 10,000 to 20,000
- 0 to 10,000



Evacuation and return zones
- Difficult to return before a long period of time. External dose > 50 millisieverts/year
- Restriction, prohibited for residential use. External dose between 20 and 50 millisieverts/year
- Preparing to return in 2015. External dose < 20 millisieverts/year

Decontamination areas
- Completed
- Started
- Decided
- Not decided
- Difficult for a long time

HEALTH OVERVIEW

A vast programme has been set up by the Japanese authorities to monitor the health of people living in the Fukushima prefecture and to learn lessons from this event. It is based on four 30-year epidemiological studies, the first of which covers the 2.1 million people living in the Fukushima prefecture at the time of the accident.
Three at-risk populations are being monitored more closely: children, evacuees and pregnant women.

DEATHS

Officially, no one has died as a result of the radioactivity at Fukushima. Evacuations were carried out to limit doses and prevent cancer in the long term. How many cancers have been prevented as a result of the evacuations? This is a question currently under discussion in the scientific community.

The prefecture of Fukushima has recorded more than 1,600 deaths as a result of the evacuations: deaths of elderly people due to lack of care, deaths during transport and suicides. A nuclear disaster goes beyond the direct risk associated with radioactivity.

PREGNANT WOMEN

The main findings were drawn from a survey of over 20,000 pregnant women:

- no significant change in the rate of miscarriages. After an increase in the rate of premature births between 2011 and 2012, this rate fell in 2013;
- for birth defects, the rate was 2.85% for births between August 2010 and July 2011. These figures are comparable to the Japanese national average between 3% and 5%.

360,000 THYROID CHECKS

All children who were under the age of 18 in 2011 in the Fukushima prefecture underwent a thyroid check-up. These examinations will continue over the next few years.

In 2015, more than a hundred cancers were diagnosed. How many were caused by the Fukushima accident?

8.13 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Maps: IRSN - Photo: The Asahi Shimbun/GettyImages

AUTORITÉ DE SÛRETÉ NUCLÉAIRE

IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE