NUCLEAR STRESS TESTS

Flaws, blind spots and complacency

June 2012

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Catalysing an energy revolution

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"In the end, there always remains a degree of risk that you can reduce through retrofitting and investments. But you can never completely eliminate it."

Günther Oettinger
European Commissioner for Energy

interview with Der Spiegel

Introduction

The European governments that requested nuclear stress tests in response to the Fukushima disaster in Japan are due to take stock of the findings in June 2012. This briefing, a digest of a larger study[1] ordered by Greenpeace, outlines the findings and shortcomings of the European nuclear stress tests. It singles out reactors in Spain, Belgium, Germany, Slovenia, Slovakia, Sweden, the Czech Republic, the UK, France, and neighbouring Switzerland, and demonstrates through colour maps what a likely fallout pattern would be following a severe accident at each.

Fukushima shook faith in the safety of nuclear power, not just because of its scale, but because it happened in perhaps the world's most technologically advanced country. European heads of state and government, together with the power production establishment, responded by pledging a uniform, comprehensive and transparent risk and safety assessment - stress test - of all European reactors. Europe's Energy Commissioner Günther Oettinger assured the public that the tests would be based on the concrete causes of the Fukushima catastrophe as well as threats like plane crashes and cyber-attack. Nuclear plants not meeting the strongest safety requirements would have to be shut down, he said[2]. This spring, Commissioner Oettinger admitted the tests were insufficient and announced the inspection of additional reactors. Without substantial changes in the approach, however, the assessment of additional plants will not be enough to complete the analysis. National governments saw to it that major blind spots have been introduced, and even the multiple-disaster scenarios that led to Fukushima and the birth of the tests in the first place are now largely excluded. Despite this, the review teams examining nuclear plants came to alarming conclusions.

The stress tests, in which all EU member states participated as well as Switzerland and the Ukraine, were originally conceived as targeted reassessments of the safety margins of nuclear power plants. In particular, they were meant to examine the consequences of earthquakes and floods, and to combination of events, which was previously excluded from routine testing. Tests were quickly carried out by plant operators before the results were peer reviewed, also with much haste, by the European Nuclear Safety Regulators Group (ENSREG).

The stress tests eased off the pressure in areas of major concern to independent experts. Across Europe, factors such as ageing or design faults were not taken into account. Little attention has been paid to multiple-reactor failure like that at Fukushima, or multi-installation failure, such as a communication breakdown likely in the chaos of a nuclear disaster. Multiple disaster scenarios that gave birth to the tests were omitted and most member states refused to analyse the consequences of airplane crashes leading either directly, or indirectly (planes crashing nearby) to nuclear disaster. Operators and regulators in Spain, Switzerland, the Czech Republic, Hungary and Slovakia disagreed with their counterparts in Germany, the UK and France about the need for secondary containment, a clear structural weakness that added to the complexity of the Fukushima catastrophe. They ignored the fact that many of their plants lack secondary containment.

Other significant ommissions include off-site emergency reponse, including evacuation plans, disruption of economic processes, information supply and communication. These essential areas fall between the cracks, with nuclear regulators and security authorities pointing to each other as the responsible authority.

Matters of security and terrorism were moved to a closed working group with no outside scrutiny. Apart from conceding that plane crashes were not in its remit, the ENSREG's one big announcement after 11 months of talks has been that more discussion is needed between its members.

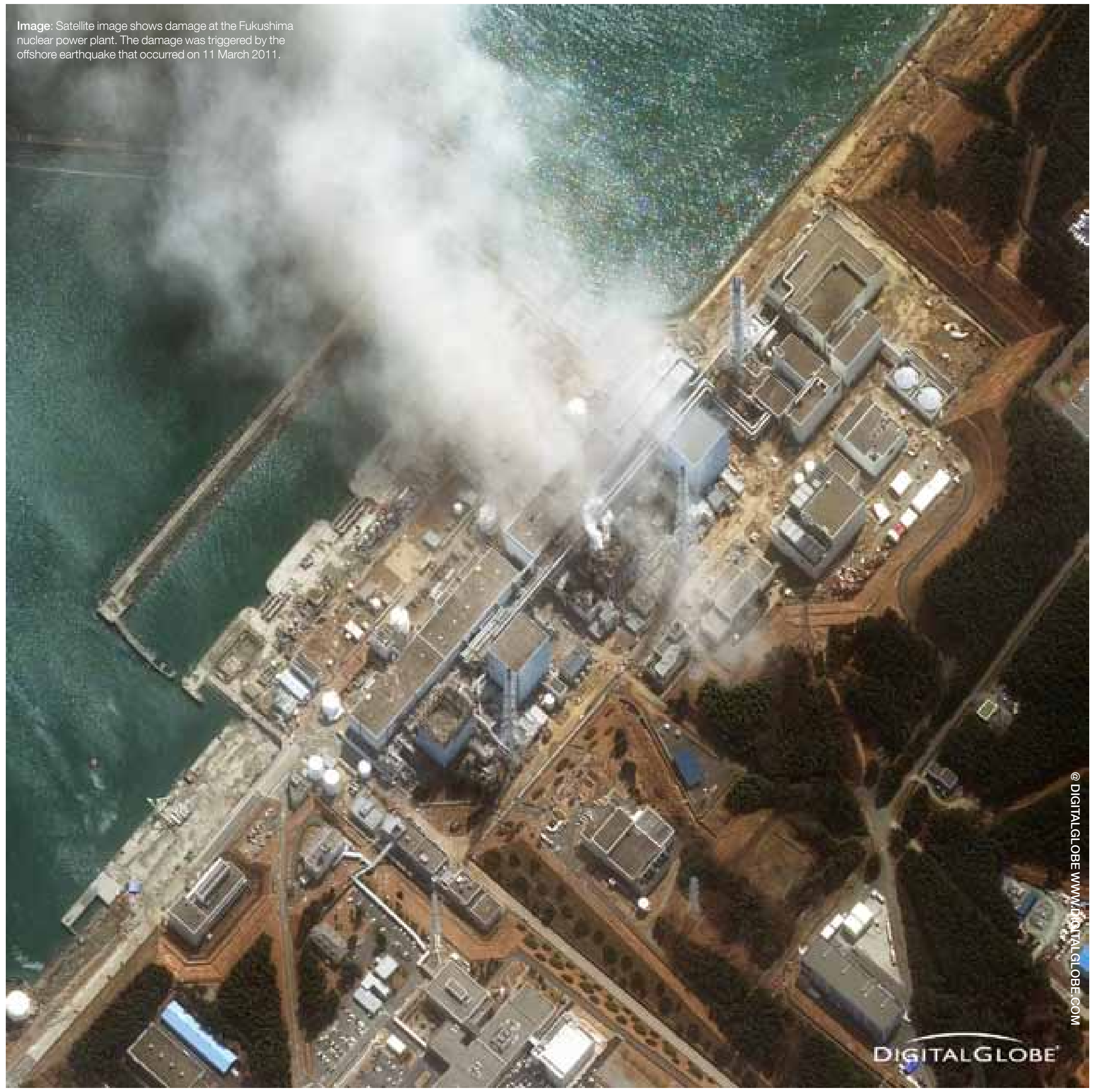


Image: Satellite image shows damage at the Fukushima nuclear power plant. The damage was triggered by the offshore earthquake that occurred on 11 March 2011.

Besides the blind spots, there has been an enormous lack of clarity on the detail of test procedures. So, for example, operators took varying approaches in their assessment and evaluation of threats like earthquakes. The resulting data cannot be compared between countries. With no pass or fail mark, it seems the tests were designed, whether intentionally or otherwise, not to be failed.

The credibility of the peer review process is also in question. The EURATOM nuclear safety directive states that national regulators, assembled in ENSREG, should be functionally independent from institutions promoting or operating nuclear energy. Not all regulators fulfil this criterion. Lack of independence was pivotal to the catastrophe in Japan. Although peer-review is a structural breakthrough in the traditionally nationalized area of nuclear safety, the lack of independence casts doubt on the thoroughness and impartiality of the process.

This briefing's opening section examines the headline shortcomings of the European nuclear stress stress tests. The mid-section highlights the main findings and points out the failings of the tests for plants across Europe.

Main shortcomings of the EU stress tests

Natural Hazards: Earthquakes

The threat

An earthquake can damage structures, systems and components of a nuclear power plant and result in a severe accident.

Vibrations from earthquakes can also induce fire or flooding. Any deficiencies in fire protection or the proper storage of emergency equipment in plants could aggravate an accident. The design basis of many European nuclear power plants was determined decades ago and many operators have failed to reassess these potential hazards according to state-of-the-art methodologies. In many countries seismic threat was not considered in early plant design and in the UK, for example, factoring for earthquakes did not become commonplace before the 1980s[3]. Reassessments of seismic hazards for nuclear power plants almost always show that the protection is not sufficient (e.g. in Krško, Mochovce and Ringhals).

Test results

The assessment of earthquake resistance involves many assumptions in what is a complex field of investigation. There are no commonly accepted rules to determine what data to assess or present as results. The stress tests fail to give proper guidance on this issue, meaning some countries have used inadequate assumptions.

Europe's stress tests were an opportunity to fully evaluate seismic hazards using the many available modern methodologies. Most countries, including Belgium, the Czech Republic, Sweden, the UK, Germany and France did not make use of this opportunity. Only a few countries, such as Spain, considered indirect impacts of earthquakes, like damage to secondary buildings, fires or flooding of corridors due to pipe-breaks.

Natural Hazards: Flooding

The threat

All nuclear plants are situated by the sea, rivers or lakes for cooling purposes, making the threat posed by flooding a key consideration.

This threat has increased at many nuclear power plant sites over the last few decades and is set to continue rising as a result of changes in climate patterns, the construction of dams and the reduction of natural flood plains, as well as changes in the assessment of flooding threats. Large, destructive floods are now expected to happen more frequently. Not all plants are designed to withstand floods of a scale likely to be seen once every 10,000 years, as is required by international standards. Appropriate safety margins rarely exist despite the fact that Fukushima highlighted the need for better flood protection.

Test results

The stress tests do not properly assess the increasing risk from flooding, raising the question if operators and regulatory authorities are fully aware of this problem. Countries also failed to use a common methodology for testing flood design, making comparisons impossible.

Previous incidents of flooding at nuclear plants have damaged safety equipment, particularly when located below the level of the site. Stress tests in some countries, including France, highlighted such problems but failed to recommend adequate solutions.

Natural Hazards: Extreme Weather

The threat

The type, frequency and intensity of extreme weather events are expected to alter as our climate changes. More frequent and more intense heat waves and extreme rainfalls are already being observed and are expected to increase. Many design standards for nuclear plants are based on outdated climate models.

Test results

The stress tests do not reveal whether or not nuclear plants could continue operating safely during extreme weather events. Safety margins are estimated on an *ad hoc* basis by individual experts rather than according to an agreed standard. The effect of tornadoes, heavy rainfall, extreme temperatures and the cumulative effects of extreme weather events have not been adequately analysed in all considered countries (France, Spain, Belgium, Germany, Slovakia, Slovenia, Switzerland, Sweden, the UK and the Czech Republic). Such extreme weather events can trigger or aggravate an accident.

Safety Issues: Increasing power output

The threat

Power plant owners can increase profitability by forcing more power out of nuclear plants. This is often combined with lifetime extension. The IAEA recently warned that increasing the thermal power of a plant can put many systems under pressure and lead to numerous "opportunities" to overlook potential problems. Higher steam flows can result in reduced valve performance and more vibration accelerates wear of supporting structures. Effects on electrical components may be overlooked because of a lack of knowledge or incorrect assumptions. Larger power increases are known to have resulted in systems and equipment being degraded and damaged in secondary piping.

The possibility of such effects leading to an accident cannot be excluded but short of causing an accident such effects would certainly aggravate any incident by accelerating the sequence of events, shortening the time available for intervention or by considerably increasing any potential radioactive release.

Test results

The stress tests have not tested any power increase scenarios.

Safety Issues: Ageing Effects

The threat

Most European nuclear power plants are more than 25 years old. Hazards from ageing components and systems set in approximately twenty years into a plant's lifetime and increase thereafter. The impacts of ageing can occur in many different forms.

Test results

Degradation, in particular from ageing and material fatigue, is not taken into account in the stress tests. The tests assume that all structures, systems and components of a plant are in place and operating without deficiencies. But experience shows this not to be the case.

Safety Issues: Severe Accident Management

The threat

None of the considered European reactors has effective severe accident management measures in place to prevent a core melt accident or at least mitigate its consequences (large radioactive release). The last resort in such cases is desperate work by emergency workers using mobile equipment to cope with a severe nuclear accident as witnessed at the Fukushima Daiichi plant in 2011.

One important preventative measure is filtered venting of a plant's containment vessel. If pressure builds, containment integrity is maintained by the controlled release of potentially contaminated air through filters. However, not all venting systems are earthquake-proof, including those of the French pressurised water reactor fleet, which totals some 58 reactors. If a pipe breaks during an earthquake, it is not guaranteed that venting will be possible. Indeed, ventilation problems occurred at Fukushima, adding to the eventual contamination. Some plants do not have filtered venting systems at all, including Doel in Belgium and Temelín in the Czech Republic.

To cope with severe accidents, control rooms must be habitable for their operators. Several became too dangerous during the Fukushima disaster, greatly complicating rescue efforts. Several European plants have alternative control rooms for emergencies with some bunkered in an appropriate separate building, such as Mühleberg in Switzerland. Others have no emergency control rooms.

Finally, the prevention of hydrogen explosions and fire is important during severe accidents. Hydrogen explosions can cause damage to even robust structures, as demonstrated by the Fukushima accident. As the stress test reveals, hydrogen is an issue for nearly all European nuclear power plants.

Test results

The stress tests reveal that accident management by the operator only works under ideal conditions. As desk-based exercises they completely fail to take into account confusion or other complicating circumstances that are inevitable during severe accidents. The Czech national report describes one accident sequence in the following way: The station blackout scenario is examined under the assumption that all other safety systems are working and no other event occurs. All systems in the power plant, besides those systems that caused the loss of power supply for own consumption, continue to work correctly. "No design accident or failure was registered immediately before or after the station black out, in particular the following are excluded: seismicity, fire, floods."

Image: Greenpeace has been conducting radiation monitoring around the Fukushima area for the past year, and has found serious risks to public health

© NORIKO HAYASHI / GREENPEACE

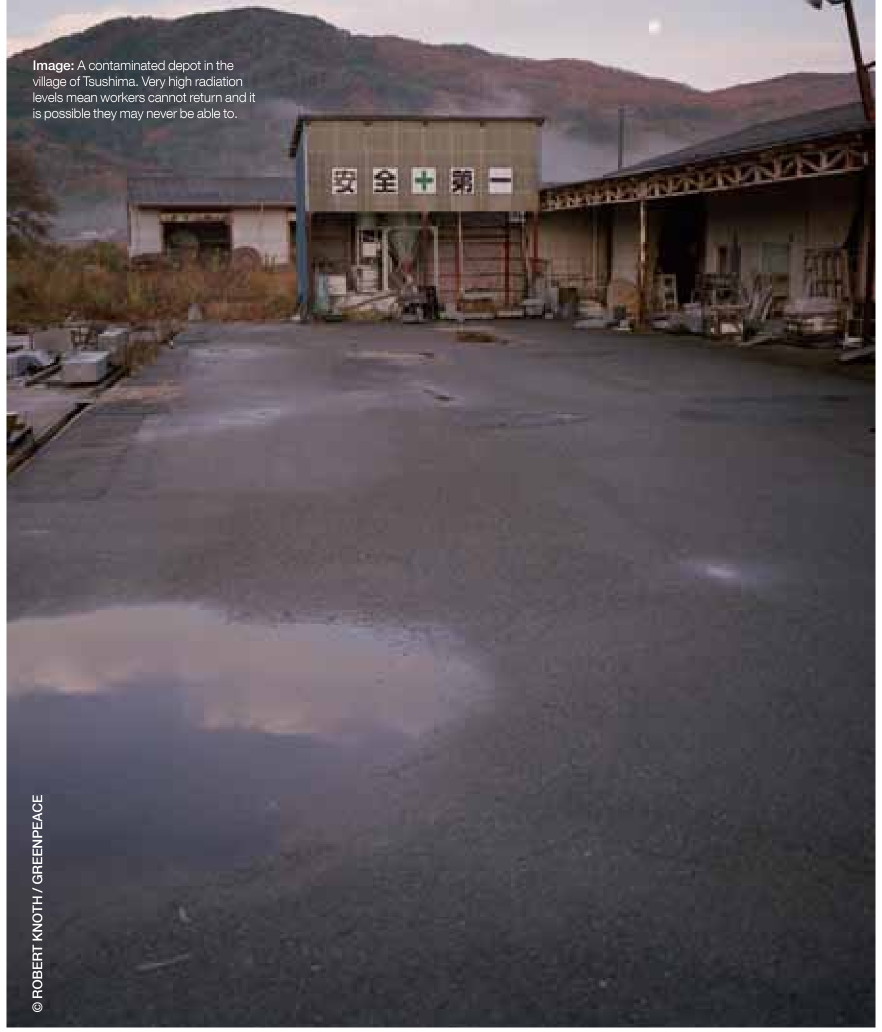


Image: A contaminated depot in the village of Tsushima. Very high radiation levels mean workers cannot return and it is possible they may never be able to.

© ROBERT KNOTH / GREENPEACE

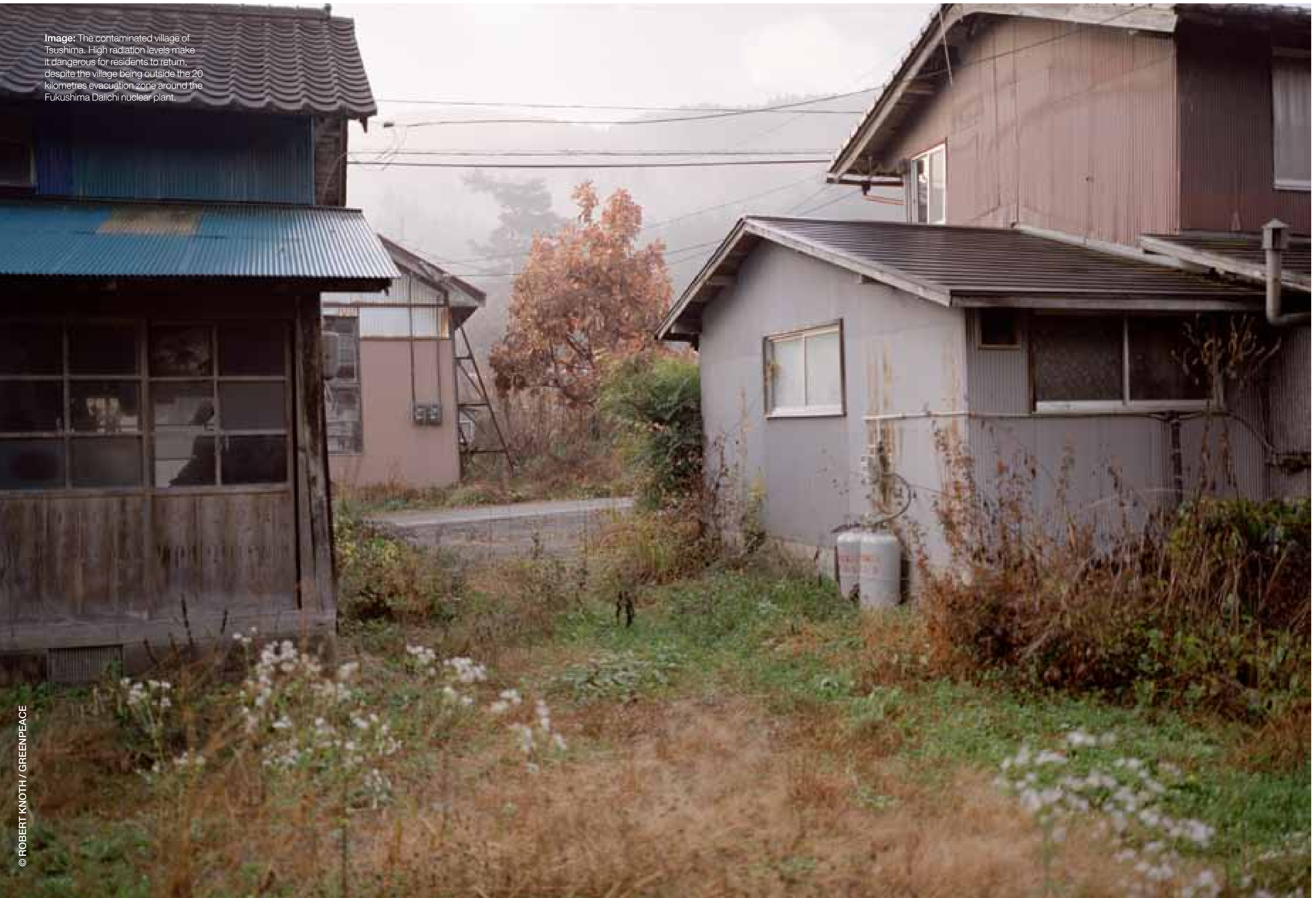


Image: The contaminated village of Tsushima. High radiation levels make it dangerous for residents to return, despite the village being outside the 20 kilometres evacuation zone around the Fukushima Daiichi nuclear plant.

© ROBERT KNOTH / GREENPEACE

Critical review of selected nuclear power plants

SPAIN: Almaraz

The situation

Almaraz is located by a reservoir 180 kilometres from Madrid and 100 kilometres from the Portuguese border. The plant has two reactors, the oldest of which started running in1983.

Test findings

The regulator points out that the plant operator's analyses of impacts from a dam break upstream are not sufficient. The estimated impacts fall below standard national practice for dam emergency plans and the regulator has required the owner to review the analyses.

Almaraz has just one additional air-cooled diesel generator to provide cooling and other functions during a station black-out situation. The plant operator intends to use this back up facility alternately for each of the two units, meaning that just one may be powered at a time, a cause for concern to the regulator.

Areas the tests ignore

A crash of a large or a midsize airliner is very likely to cause major damage to Almaraz's reactor building[4]. Such a crash, either accidental or deliberate, could result in a severe nuclear disaster. As with most countries, vulnerability to plane crashes was ignored by the regulator.

The spent fuel pool buildings are ordinary industrial buildings without any kind of special containment. If the walls of a spent fuel pool are damaged, large amounts of radioactive material could be released. Yet Almaraz has no effective accident management measures, such as filtered venting, able to prevent or mitigate a severe accident. Almaraz's power supply and cooling deficiencies make a severe accident possible. Neither factor is flagged by the regulator. Despite all the concerns about this plant, unit two was given permission to operate with increased power just a month after the Fukushima disaster.

Greenpeace verdict

Greenpeace recommends both units be phased out as soon as possible.

BELGIUM: Doel

The situation

The plant is by the Scheldt River 15 kilometres from the city of Antwerp and just three kilometres from the Dutch border. It has four reactors, the oldest of which has been running since 1975.

Test findings

The national regulator highlights that risk analyses undertaken for the plant owner fail to take into account fire and flooding, and do not consider threats to spent fuel pools. It also points out that fire following an earthquake had not been considered. Yet fire is a particular hazard with old plants like Doel, where there is limited physical separation of some redundant safety systems and a fire has the potential to damage all such systems simultaneously.

Venting could prevent containment collapse during a severe accident, but none of the four units is equipped with filtered venting, the regulator notes.

Areas the tests ignore

The stress tests ignore the fact that not all safety systems[5] are physically separated and/or resistant to earthquakes that other areas of the plant are designed to cope with. Some safety systems are housed in an unprotected building, despite being mainly manually operated. These would be hard to operate under severe accident conditions, complicating the situation greatly.

Most of the plant's fire extinction system is not designed to be earthquake resistant.

The tests also ignore the fact that spent nuclear fuel is stored in buildings without any kind of special containment. If problems occur, there is no way of effectively containing a radioactive release into the environment.

As with all other countries, off-site emergency response plans are ignored in the stress tests. Doel is close to Antwerp and in case of a severe accident prompt evacuation is nearly impossible. The absence of any kind of filtered venting could lead to a relatively high radioactive exposure.

Image: Greenpeace radiation monitoring team members check contamination levels in Watari, a suburb of Fukushima City.

© NORIKO HAYASHI / GREENPEACE

Greenpeace verdict

Doel's 1 and 2 reactors should be shut down immediately. Reactors 3 and 4 should be phased out as soon as possible. In the meantime, an immediate and transparent action plan is needed to deal with identified deficiencies at reactors 3 and 4. The units should be taken offline until high priority improvements, such as the introduction of filtered venting, are complete.

BELGIUM: Tihange

The situation

The plant is by the river Meuse, 25 kilometres from Liège, a town of about 200,000 inhabitants, and 80 kilometres from the capital Brussels. Tihange has three reactors, the oldest of which has been running since 1975.

Test findings

Flood protection at this plant is not compliant with national and international requirements. Tihange should be protected against a flood with a statistical return period up to 10,000 years but it is only protected against a flood with a return period up to 400 years. In the event of such a decamillennial flood, all safety systems of the three units would be flooded and rendered inoperable. At Tihange 1 all safety-related equipment would be damaged by floods with return periods of 600 years.

The national regulator points to the fact that risk analyses conducted for the plant owner fail to take into account fire and flooding, and do not consider threats to spent fuel pools.

The regulator highlights the fact that 21 systems, structures and components, including main switchboards and transformers, will probably not function properly in case of an earthquake exceeding a so-called Review Level Earthquake (an earthquake reasonably likely to occur, but that is not totally overwhelming). The regulator has called for a detailed action plan for earthquake improvements. Fire caused by any earthquake has not been considered at all[6].

Areas the tests ignore

During the design of reactor 1 only a limited number of 'initiating events' (the first in a chain of incidents) were considered. The reactor only has partial physical separation of some safety systems, meaning a fire could damage all these systems simultaneously. The base of the reactor containment vessel 1 is only 2.15 metres thick, limiting the time available to try and contain any melt-through situation of molten fuel.

As in other EU countries, stress tests were done on paper only and the effects of ageing were not included. Tihange has been in operation for 37 years and ageing is a major issue likely to lead to more incidents and aggravate accidents.

Conversely, the Belgian regulator is among the few to consider plane crashes. These are flagged as a problem by the regulator, but no adequate countermeasures are recommended.

Greenpeace verdict

Greenpeace considers the safety risk at Tihange to be significant. Reactor 1 should be shut down immediately. In the short-term, reactors 2 and 3 should be taken offline until all flood protection measures are completed and a transparent action plan for identified shortcomings is needed.

Image: Nuclear power plant Gundremmingen units B and C.

© PAUL LANGROCK / ZENIT / GREENPEACE

GERMANY: Gundremmingen

The situation

Gundremmingen is by the River Danube about 90 kilometres from Munich and 100 kilometres from the Austrian border. It has two reactors, the oldest of which is 28 years old.

Test findings

The national regulator notes out that the safety of the plant during the course of a longer-lasting flood is not assured. Moreover, the protection against earthquakes is probably not sufficient.

If the plant loses power and cooling fails, the operator plans to rely on fire fighting water pumps to cool the plant's spent fuel pool. The stress test point out that these have to become operational within twelve hours, leaving little time for error or complications arising due to accident conditions. It also highlights the fact that there are no specific severe accident management measures in place for restricting releases or preventing hydrogen explosions after severe damage to spent fuel rods.

Areas the tests ignore

The stress tests do consider the fact that mixed-oxide fuel used at Gundremmingen makes reactor control more complicated. In case of an accident, overheating of mixed-oxide fuel occurs faster and in the case of a radioactive release, potential exposure by inhalation and contaminated food is increased.

The tests ignore the fact that spent fuel pools at Gundremmingen have no special containment to mitigate radiation release into the environment during an accident. Consequences of a meltdown in the spent fuel pool have not been considered by the operator and mitigation plans have therefore not been created, something that is not flagged by regulators.

The prevention of severe accidents relies on outdated accident management measures that ignore hazard conditions. The feasibility of these accident management measures has not been proven, nor have mitigation measures been properly defined.

Greenpeace verdict

Gundremmingen should be phased out before 2015.

SLOVENIA: Krško

The situation

Krško nuclear power plant is located on a site prone to flooding and in a seismically active region. A total of 55,000 Slovenians and 147,700 Croatians live within 25 kilometres of the plant. It is an old plant, in operation since 1983, but there are plans to extend its lifetime by 20 years.

Risks the tests highlighted

Earthquake risk to the plant has been revised upwards since construction. Larger earthquakes are considered a hazard for the reactor core. Partial core melt and radioactive release cannot be excluded. Severe accident management measures are foreseen to mitigate any release. Smaller earthquakes endanger the spent fuel pool. After 76 hours fuel will be uncovered. Access for emergency workers could become "very problematic". A severe flood, on a scale expected once every million years, would cause a 'cliff edge effect'. Plant owners are yet to complete construction of an alternative control room and cooling water intake.

Risks the tests ignore

A strong earthquake could damage the reactor and spent fuel pools almost simultaneously. The tests assess both events separately without considering the availability of equipment and personnel to manage both. An earthquake could cause a flood wave followed by a dike break and flood the site. External events, such as storms and earthquakes, are mentioned, but a systematic assessment is missing. Ageing effects of components after 30 years of service are ignored. As in all stress tests, emergency response plans are not considered. But such plans are especially important where plants are located in border areas, where cross border emergency response is more complex.

Greenpeace verdict

Slovenia should phase out Krško.

SLOVAK REPUBLIC: Mochovce

The situation

The Mochovce nuclear power plant is 90 kilometres from Bratislava. It has two reactors, the oldest of which has been operating since 1998. Two additional reactors are under construction.

Test findings

The Slovak stress test evaluates only the minimum of natural events and other sequences leading to the loss of reactor cooling and station black out.

However, the national regulator does point out that an earthquake could cause pipe or tank rupture, leading to flooding of the reactor building. It also highlights that there is no analysis for resilience of equipment needed for plant shutdown and cool-down in the event of an earthquake beyond the plant's designed limit. A 'cliff edge effect' cannot be excluded, it says.

Mochovce has a number of design deficits, which the Slovak regulator proposes be remedied through plant upgrades. Reactor buildings lack secondary containment and hence do not provide sufficient protection from airplane crashes or explosions. Several connections for mobile pumps for emergency cooling purposes are planned but not installed. However, some failings cannot be fixed through upgrades, such as adding to the thickness of reactor confinement walls.

Areas the tests ignore

Indirect consequences of human induced events, such as accidents, are not assessed in the stress tests. Neither is the fact that roofs of buildings where heavy machinery is used are not necessarily designed to withstand earthquakes beyond the plant's design limit. The roof could collapse and, for example, damage vital cooling equipment.

Greenpeace verdict

Greenpeace recommends halting the construction of Mochovce 3 and 4 and phasing out the reactors 1 and 2 as soon as possible.

Image: The village of Cenmaes in Anglesey, north Wales, is dominated by Wylfa magnox nuclear power station.

© RICHARD SMITH / GREENPEACE

Image: View of the nuclear power plant Mühleberg in Switzerland

SWITZERLAND: Mühleberg

The situation

Mühleberg is by the River Aare, downstream from a dam and the city of Bern. Its single reactor has been in operation since 1972.

Test findings

Instrumentation for measuring the water level and temperature of the spent fuel pool is not accident-proof, the national regulator points out. This makes it vulnerable during accident conditions. The regulator also points to the lack of a back-up cooling system for the pool and the absence of physically separated additional emergency water supply. The regulator flags as a concern the fact that Mühleberg has no measures to prevent hydrogen explosions in the reactor building. If spent fuel becomes overheated, hydrogen could be released in the upper part of the reactor building. If the ventilation system fails, an explosion and possible radiation release could follow.

Areas the tests ignore

It is not possible to exclude a seismic event exceeding the plant's design limit. The stress tests ignore the fact that a severe earthquake could lead to emergency cooling water being blocked with debris and dirt, causing station black-out and a total loss of cooling.

Mühleberg is one of the oldest nuclear plants in Europe, with a 40-year lifespan. Yet inevitable material fatigue, abrasion and cracks have been ignored in the stress tests. The fact that all emergency cooling pumps and systems are stored without any physical separation was overlooked. In a flood or fire situation, they would all be threatened simultaneously.

Greenpeace verdict

The risk of earthquake, design flaws and age of Mühleberg mean that the plant should be taken offline immediately.

SWEDEN: Ringhals

The situation

Ringhals is a coastal plant 60 kilometres from Gothenburg and 100 kilometres from Denmark. It is the largest plant in Sweden, consisting of four reactors, the oldest of which started running in 1975.

Test findings

The stress tests point out that the current flood protection for the whole plant is inadequate with the risk of flooding not calculated according to state-of-art methodologies. The regulator acknowledges that all four Ringhals reactors are not built to resist earthquakes and has given the plant owners until 2013 to remedy the situation. Disturbingly, the stress tests reveal that all reactors are currently operating without any safety margins for earthquakes.

Evaluation of the Ringhals 1 reactor building indicates that the roof could be a risk. An earthquake of a magnitude that the plant is supposed to be able to withstand according to national requirements could still cause roof material to fall into the spent fuel pool, potentially damaging the fuel and endangering cooling systems. No seismic analysis has been performed to see how robust spent fuel cooling systems are. Alternative cooling methods are only available if the water level in the spent fuel pool is high enough to provide radiation shielding for emergency workers. In relation to reactors 3 and 4, the operator has not demonstrated that if cooling water intake pipes are blocked due to a technical failure or external events, these reactors can be safely shut down and maintained in a safe condition.

Areas the tests ignore

In July 2009, Ringhals was placed under special investigative measures by the Swedish Radiation Safety Authority to address problems in the safety culture there. The authority highlights a series of failures since 2005 which could have jeopardised reactor safety. This shocking complacency is not acknowledged under the stress tests.

Greenpeace verdict

Ringhals is not a robust plant and should be phased out. In the short term, its reactors should quickly be brought offline, at least until improvements against earthquakes, flooding and known deficiencies are made.

Image: Temelín nuclear power plant. The Czech national regulator considered a minimum number of crisis scenarios.

© WARTHA / GREENPEACE

CZECH REPUBLIC: Temelín

The situation

Temelín is 25 kilometres from the city of České Budějovice. It has two reactors, the oldest of which has been in operation since 2000.

Test findings

The national regulator flags a lack of diversity of cooling methods essential to keep the plant under control. It also points out that hydrogen removal measures are missing. Other improvements the regulator wants to see related to emergency procedures, alternative cooling for the spent fuel pool and habitability of the main control room and the emergency control room. It points out that there are open questions about the vulnerability of the plant to earthquakes and points out that the operator relies too heavily on fire brigades for emergency cooling of the reactor.

Areas the tests ignore

The Czech national regulator considers a minimum number of crisis scenarios, including earthquakes, floods, extreme weather and the obligatory assessment for loss of cooling and power. The tests it carries out were conducted as if the plant were new and without problems, such as the faulty repair on the main cooling pipes of reactor 1.

Only some reactor switches are assured against earthquakes. Yet the operator's analysis assumes that all switches, lines and connections will be available during an accident scenario and that all pipes, pumps, and tanks will be intact. The regulator failed to flag this.

Since there is no possibility of cooling the reactor pressure vessel by flooding the reactor shaft (as envisaged in Mochovce), melting fuel would penetrate the reactor vessel. Under this condition, the prevention of a containment breach is not guaranteed.

Greenpeace verdict

Temelín reactor 1 should be taken offline immediately and reactor 2 phased out as soon as possible.

UNITED KINGDOM: Wylfa

The situation

Wylfa is a coastal plant in North Wales. Its one remaining operational reactor began work in 1971 and is due to be shut down in 2014.

Test findings

The regulator notes that the reactor has no automatic shutdown system for earthquake conditions, a common requirement at most other nuclear plants. The dry fuel storage facilities are shown to be robust against earthquakes, but its cooling system is not.

The regulator points out that Magnox reactors lack secondary containment with the only barrier to radioactive release being the concrete reactor vessel.

Areas the tests ignore

The operator and regulator seem to show little interest in adequate safety upgrades in the soon-to-be shut down Wylfa nuclear power plant. For instance, a ventilation system has not been installed to maintain safe working conditions in the control room during accidents and staff will have to rely on respiratory equipment, a weakness not noted for criticism by ENSREG. Severe accident management measures will be carried out mainly by staff using mobile emergency equipment since the plant lacks inbuilt safety systems, yet regulators do not express concern over this arrangement.

As seen in other countries, material degradation due to aging is not factored into the tests meaning that Wylfa was tested as if it were a new plant. Other issues are overlooked, such as a design flaw meaning that steam pipe failure can lead to overheating of the reactor fuel. The tests also fail to mention the fact that the plant has three separate shutdown systems, which are not diverse enough to guarantee safe reactor shutdown should conditions threaten all systems simultaneously.

Greenpeace verdict

Wylfa's remaining reactor should be shut down immediately.

FRANCE: Cattenom, Fessenheim and Gravelines

The situation

Fessenheim's two reactors are the oldest in France, having been commissioned in 1978. The plant is situated in an area of relatively high seismic activity just one kilometre from the German border and 30 kilometres from the city of Freiburg.

Gravelines is the largest nuclear plant in France with six reactors, the oldest of which started commercial operation in 1980. It is a coastal plant about 20 kilometres from Calais and Dunkirk, 35 kilometres from Belgium and 90 kilometres from the city of Bruges.

Cattenom has four reactors, the oldest of which started running in 1987. It is located by the river Mosel, about nine kilometres from the border with Luxembourg and 50 kilometres from its capital.

Test findings: all three plants

There are several shortcomings regarding protections against earthquakes and flooding, with the risk of earthquakes not appropriately assessed. The national regulator notes that studies analysing risks from extreme weather events (snow, hail, lightning and wind gust) have not been prepared for any of the three plants.

The regulator also notes that only one emergency diesel generator is available per site, and that these generators are not designed to withstand an earthquake. In the event that multiple reactors need to call on the backup generator, only one could get emergency power at a time. Worse, if an earthquake were to knock out that single generator, the plant would be without any back-up cooling. Additionally, no reactor has access to an alternate cooling source, something highlighted as a concern in the findings.

Fire detection and fixed extinguishing systems are not backed-up with earthquake resistant equipment. The regulator will require the operator (EDF) to improve fire protection measures.

Accessibility and safe working conditions in the emergency management rooms and control rooms during filtered venting are not guaranteed. Emergency venting filters are designed to block caesium, but not harmful iodine and these systems could fail during an earthquake.

Image: Radiation testing near the Fukushima Daiichi nuclear plant.

NORIKO HAYASHI / GREENPEACE

Fessenheim specific findings

The ability of flood defences to cope during earthquake-induced flooding has not been analysed, nor have the possible consequences been considered. The French Institute for Radiological Protection and Nuclear Safety has called for immediate improvements to earthquake and flood protection at Fessenheim.

Gravelines specific findings:

The regulator notes that any leak of toxic gas at nearby industrial facilities could make it impossible for staff to remain at the reactor. As such, the plant is not protected against such accidents.

Cattenom specific findings:

Regulators raise concerns over the plant's ability to deal with earthquakes and flooding. There are doubts about the earthquake safety margins in relation to one of the essential cooling sources at the plant. It is possible that both of the plant's cooling sources could be affected by the same earthquake. The absence of siphon breakers, a water drainage safety feature, is just one example of non-conformance with regulations revealed during stress tests at Cattenom. During checks conducted last August, national regulators found 35 non-conformances with national regulations during spot check. This indicates a poor safety culture at the site as managed by EDF[7].

Areas the tests ignore

Age-related micro-cracks that exist in an instrumentation nozzle in the reactor vessel of Gravelines 1 are ignored. All six reactors at Gravelines are authorised to use mixed-oxide fuel and five currently do. The fuel has a set of safety problems detailed in the section for Gundremmingen nuclear power plant. This complicating factor has been ignored by regulators.

Greenpeace verdict

Of the three plants, Fessenheim is the most vulnerable to earthquakes and flooding, while at the same time at the highest risk from these disasters. It should be shut down immediately. Gravelines' six reactors have insufficient flood protection. They are completely unprepared for a multi-reactor crisis, are suffering age-related problems and, to complicate matters, they use mixed-oxide fuel. The plant should be shut down immediately. Cattenom should be phased out as soon as possible. In the shorter term, the recent incident (International Nuclear Event Scale 2: significant failure in safety provisions) at Cattenom should be enough of a warning to halt operations immediately and conduct a thorough safety inspection of the plant, rather than spot checks.

Image: Greenpeace Radiation Safety Advisors in Chernobyl.

Assessment of the EU stress tests

The EU stress tests are not a safety assessment of the European nuclear power plants. They represent a limited analysis of the vulnerability of such plants with respect to natural hazards. The accident scenarios are focused on external events: the quality of the structures, systems and components and the degradation of the oldest nuclear power plants in Europe are not subject of the analysis. The peer review team did not consider all safety issues that could trigger or aggravate an accident situation (e.g. ageing, use of MOX fuel, safety culture).

The design of the plants with respect to natural events varies, therefore the safety margins can only be assessed through an engineering judgment. In December 2011, the IAEA has published a new guide for extreme weather hazards. We recommend that all plants make an assessment of weather hazards according to the new IAEA guide.

Severe accident management, especially regarding spent fuel pools and multi-unit accidents like at Fukushima, is an issue everywhere, but the way it is tackled varies immensely. Only one country (Slovenia) has a simulator for severe accident management.

The peer review team has not assessed the current safety level of the European nuclear power plants, but only the potential increase in the level of safety in the next decade. Currently, there are several known shortcomings with respect to the protection against earthquake, flooding and extreme weather. Furthermore, it is well known that it will be impossible to cope with a severe accident, especially if it is accompanied by earthquake or flooding. The reviewers only described the weaknesses they identified, but not an overall assessment of all facts, which would allow a risk assessment.

The EU stress tests have no direct effect on the European nuclear power plant fleet. ENSREG has no say on the life-time extension applications of even the oldest plants with the most obvious problems (Mühleberg, Doel, Rivne etc.). To gain an accurate picture of nuclear risk, EU decision makers should add a third leg to the nuclear stress tests - a full assessment of emergency response preparedness, which examines the viability of emergency response plans, address weaknesses and purpose improvements.

Conclusion

Far from restoring faith in the safety of nuclear power in Europe, the stress tests and ENSREG report published in April 2012 serve to further undermine it. At their most basic level, nuclear plants are concrete shielding to a fission process that creates large quantities of energy. Energy Commissioner Oettinger has acknowledged that the elimination of risk at such facilities is impossible, with efforts limited to merely minimising the threat. Across Europe, the stress tests have revealed some unacceptable failures in risk management. Serious gaps have repeatedly been found in readiness for emergencies. No guarantee can be given that plants operating in earthquake zones will remain safe in the event of serious seismic activity. Many lack any form of safe containment for their spent fuel pools and some have entirely inadequate access to emergency power. In short, the lessons from Fukushima are clearly yet to be learned in Europe.

Yet some plants are located just 10 kilometres from major urban populations like the city of Antwerp, raising the question why evacuation plans were not considered as part of the stress tests. The tests also failed to consider the impacts of multiple disaster scenarios as experienced at Fukushima in 2011 – the very crisis that originally prompted the stress tests. On top of these questionable omissions, the test results are not standardized in any way, making comparisons effectively impossible. The results are lack of any kind of pass or fail criteria and the partiality of those carrying and vetting the tests and falls short of providing the relevant authorities with the necessary information to draw proper conclusions.

When EU heads of state and government meet in autumn 2012 to discuss the results of this exercise, they can only conclude that the stress tests and peer review fall far short of expectations. They should recognise that nuclear power will always remain a dangerous technology. This is why all European governments should develop a credible phase-out plan for nuclear power in Europe, starting with the most risky reactors.

Image: Greenpeace demonstrating the vulnerability of a French nuclear facility. A smoke flare was dropped onto a reactor roof.

The fallout of a severe nuclear accident in Europe

European stress tests were supposed to probe for weaknesses in the safety of nuclear plants. As European Energy Commissioner Oettinger has pointed out, it is impossible to eliminate risk from nuclear power and severe accidents in Europe can never be ruled out. To complement this report, we include the findings of research by the University of Natural Resources and Applied Life Sciences in Vienna, which has calculated how a severe nuclear accident is likely to unfold. Modelling of the dispersion of radioactive material from core meltdown has been mapped for the 13 reactors discussed in detail above.

The large-scale dispersion of radionuclides in the atmosphere is simulated under about 1,000 meteorological situations. Wind and rain determine which region will be affected to what extent by a release of radioactive material. The maps below are merely isolated examples and are not meant to predict the actual course of any nuclear crisis at these plants.

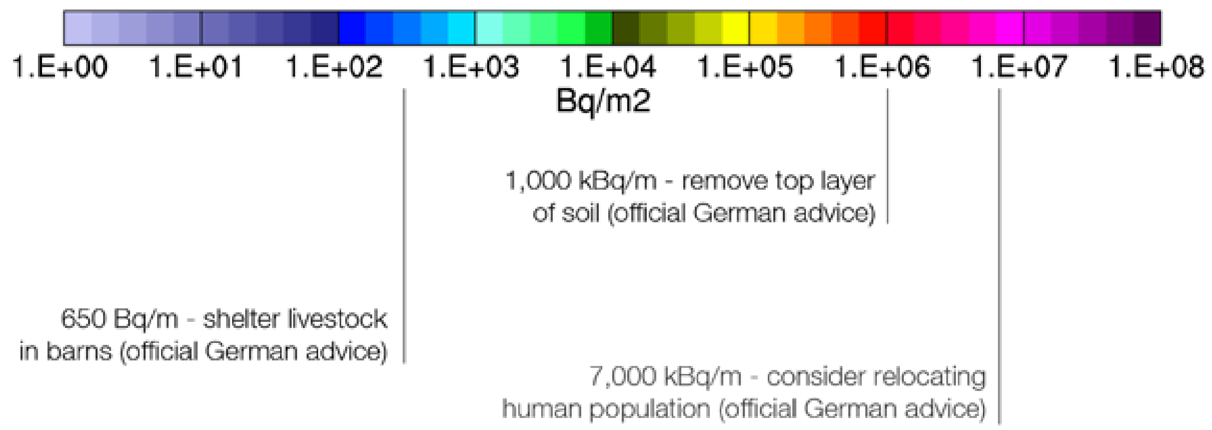
Core damage can result in the release of radioactive material, including noble gases, iodine and caesium. Caesium-137 deposits per square metre are used as the indicator for contamination.

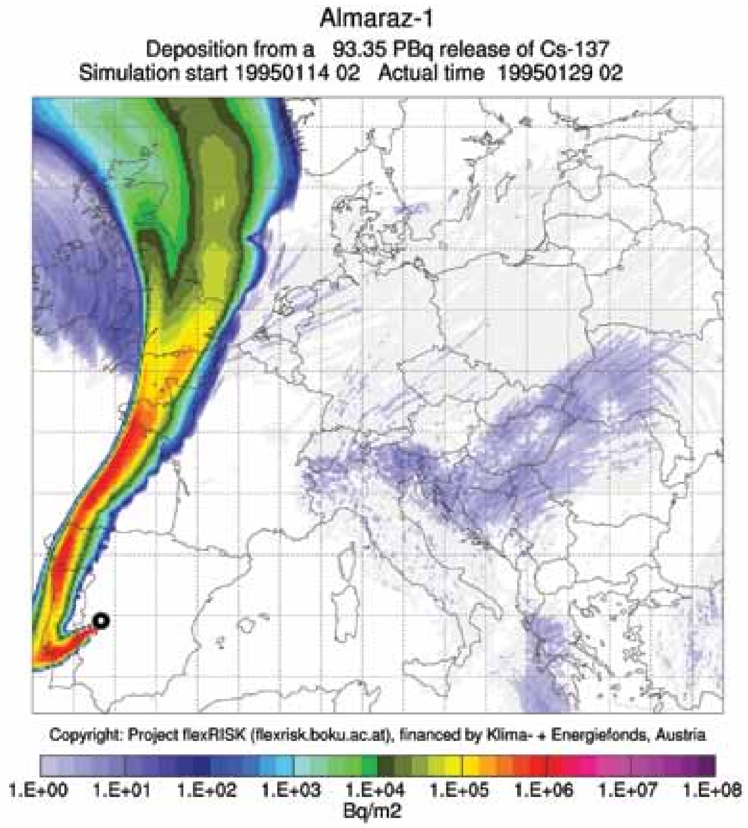
A dangerous substance with a 30 year half-life, it was chosen here because of the accuracy attached to calculating deposition rates after any nuclear accident. Concentrations of radionuclides in the air as well as their deposition on the ground were calculated and are overlaid on maps.

For each reactor, an accident scenario leading to a large release of nuclear material was selected. To determine the severity of radioactive release for the chosen scenarios, the specific characteristics of each nuclear installation, such as the type of nuclear fuel used, containment measures etc. were factored in according to the best available public information.

Modelling work has been done under the two year Austrian Flexible Tools for Assessment of Nuclear Risk in Europe (flexRISK) programme, conducted by the University of Natural Resources and Applied Life Sciences, Vienna.[8]

For higher resolution images email pressdesk.eu@greenpeace.org

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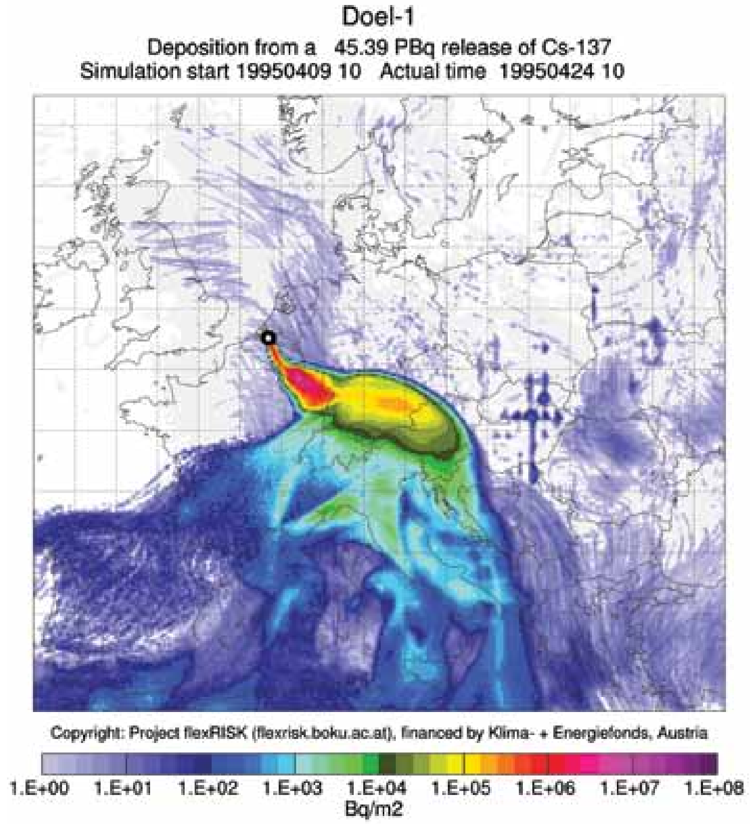
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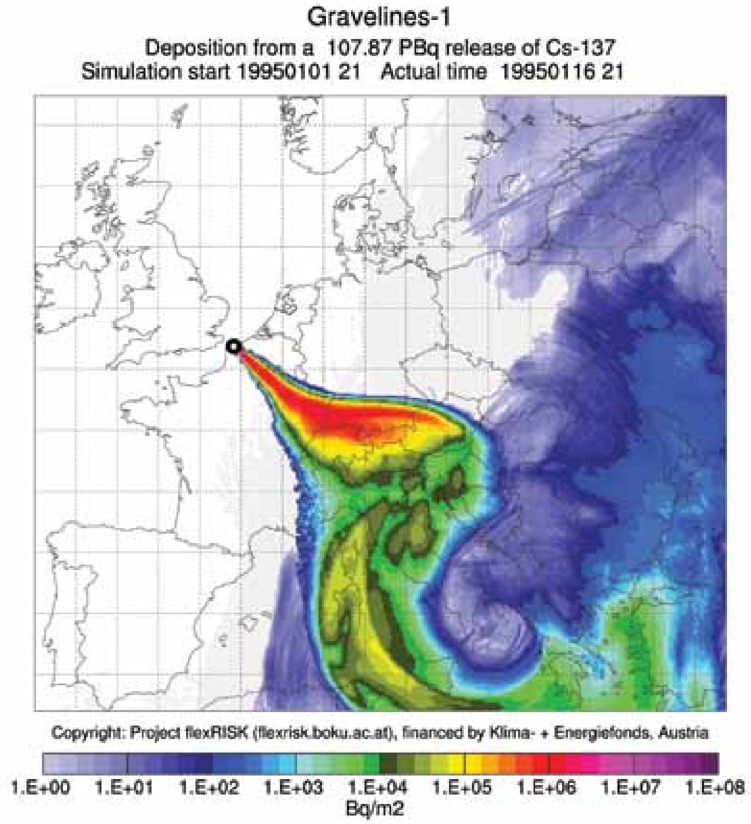
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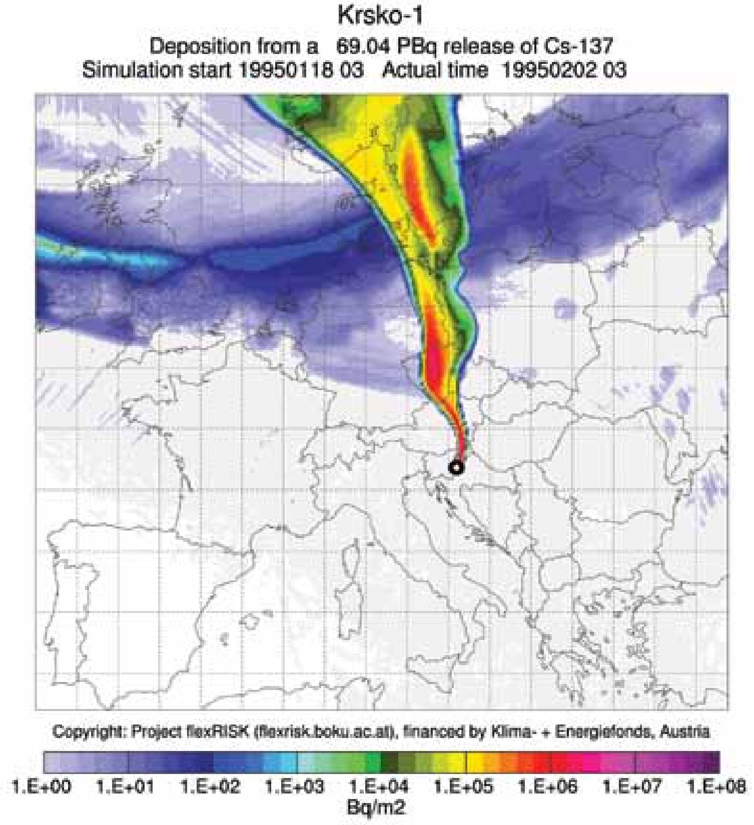
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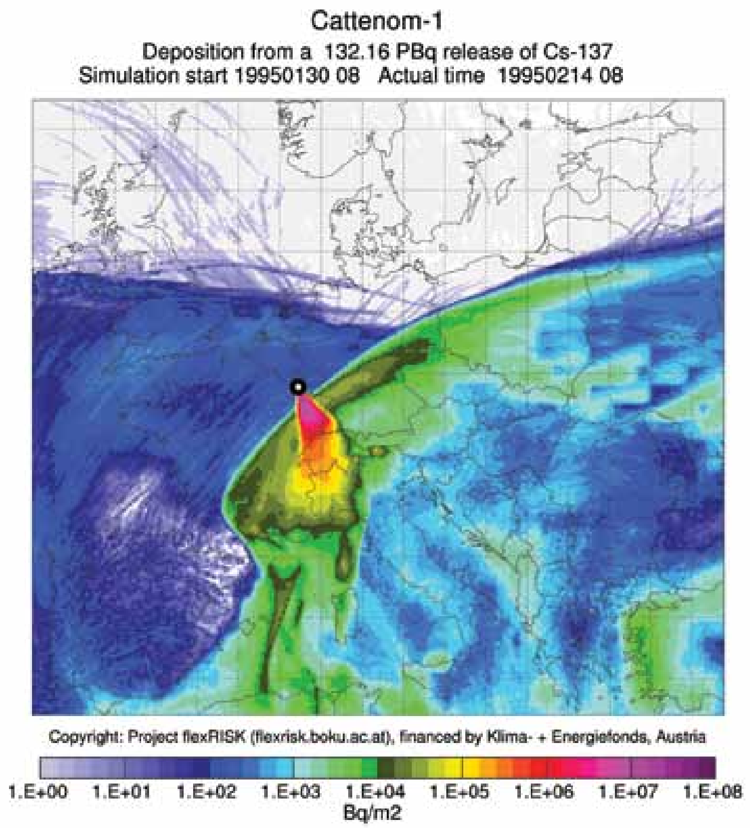
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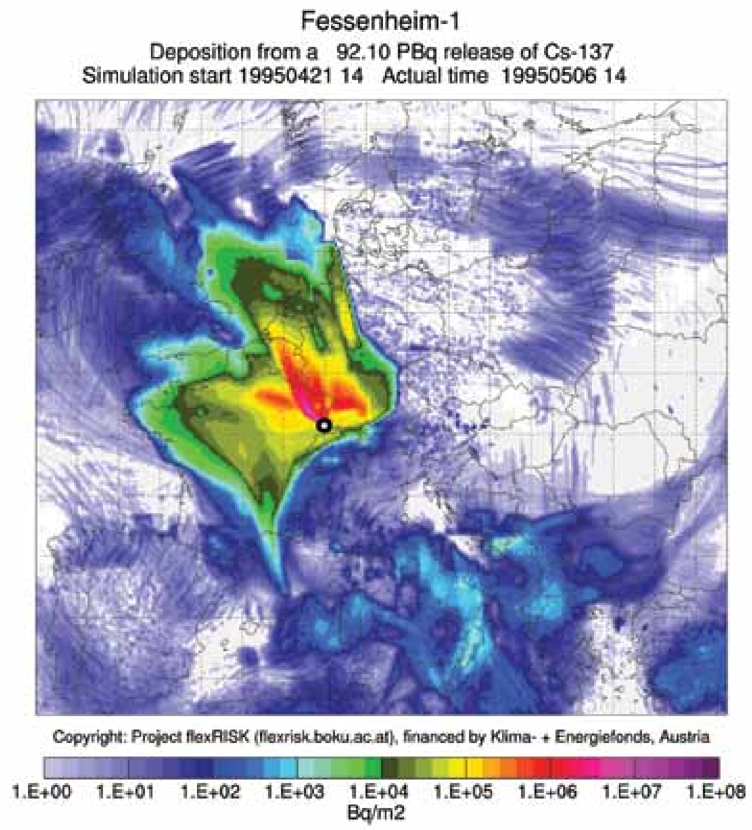
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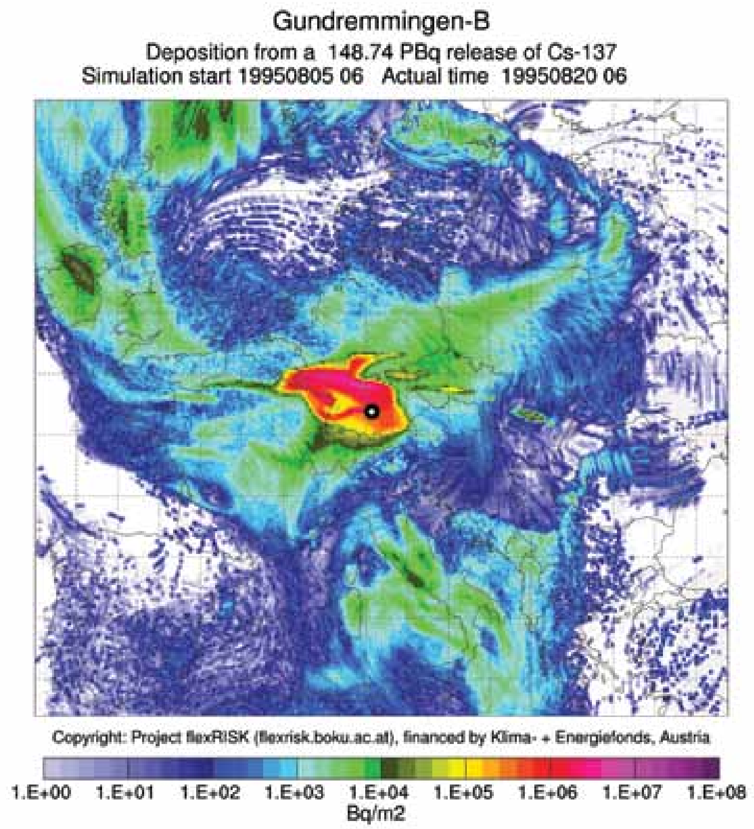
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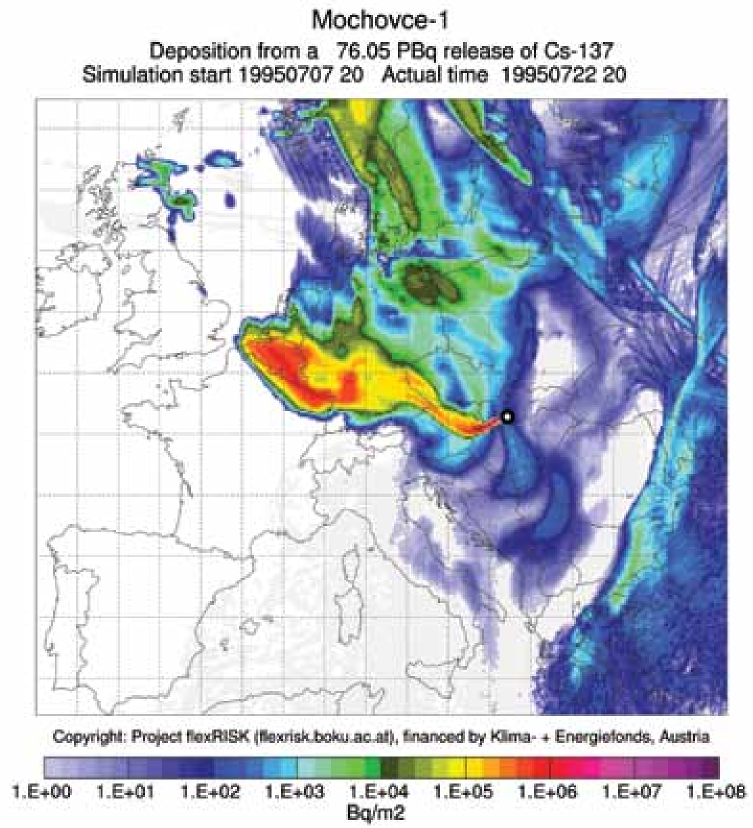
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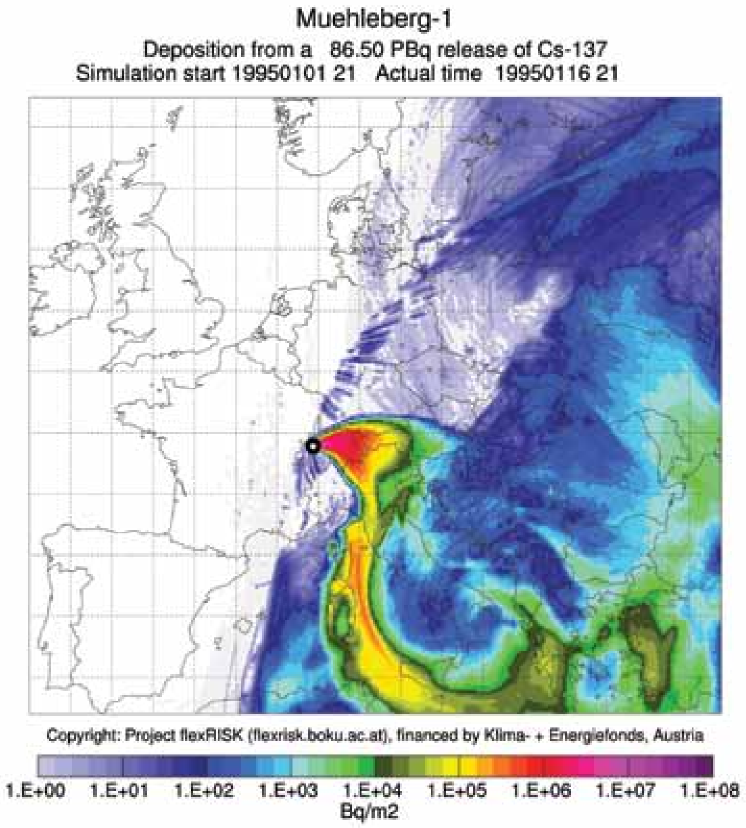

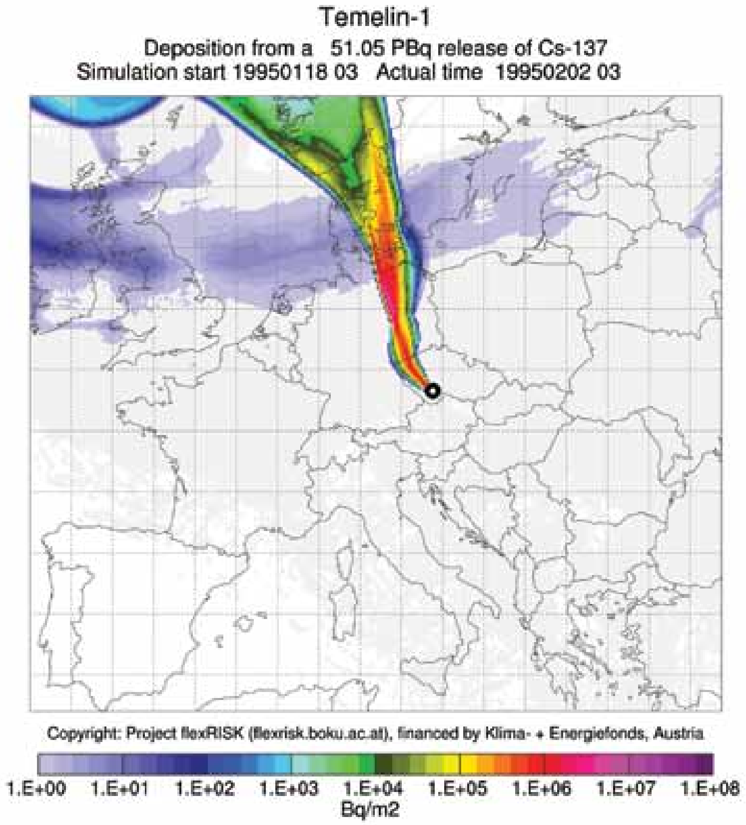

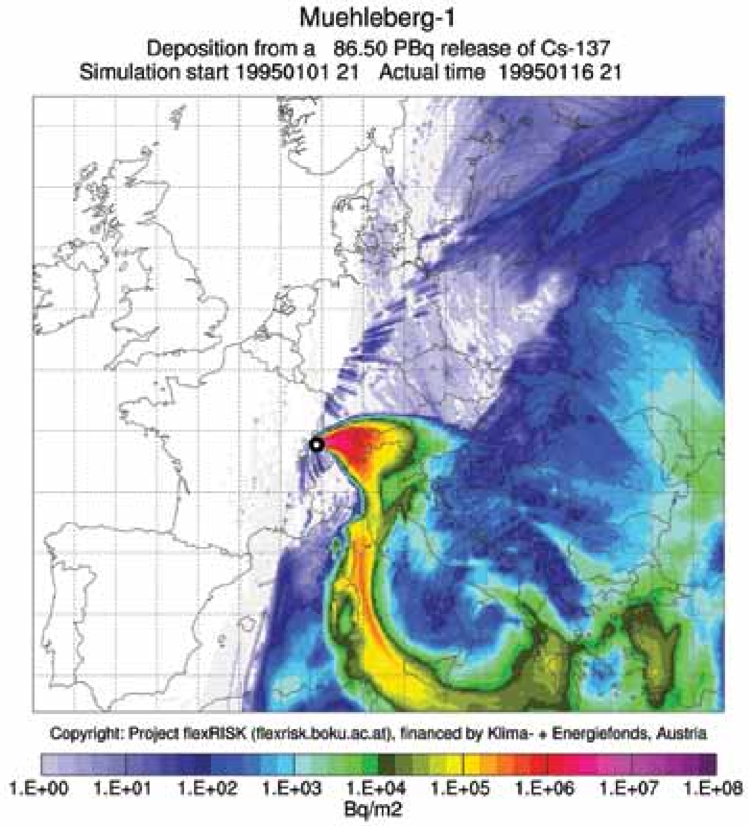

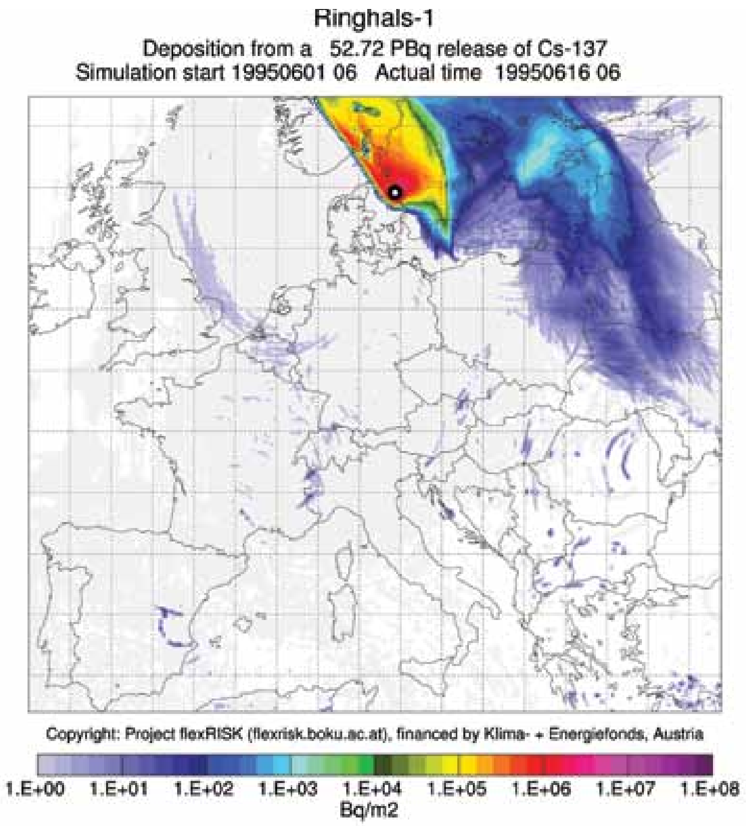

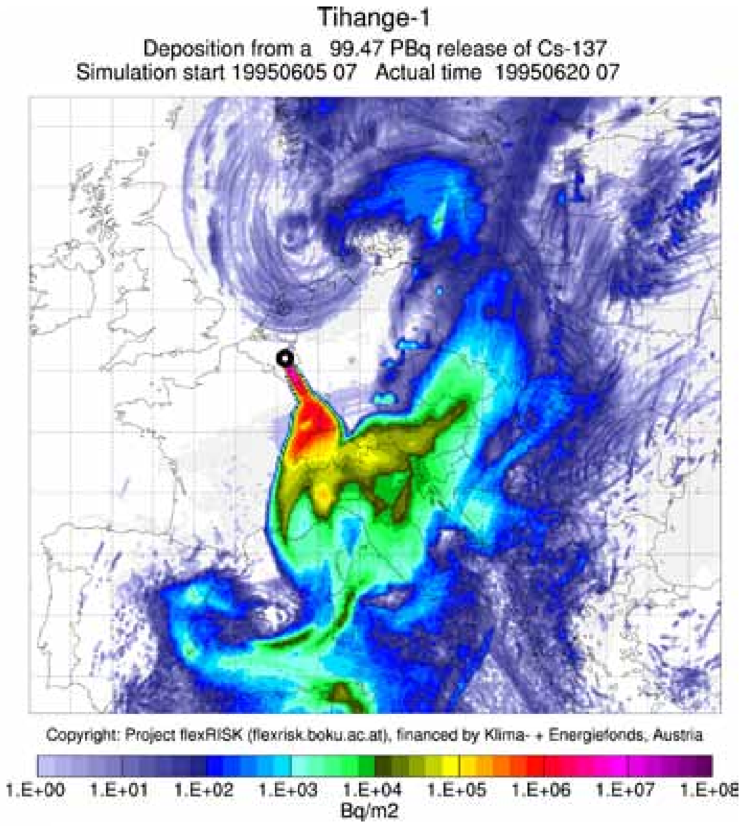

Endnotes

1 Critical Review of the EU Stress Test performed on Nuclear Power Plants; Study commissioned by Greenpeace; Antonia Wenisch, Oda Becker; Wien, Hannover May 2012

2 Oettinger, EU Commissioner for Energy, Interview "Tagesschau" 15.03.2011, http://www.spiegel.de/international/europe/spiegel-interview-with-energy-commissioner-oettinger-fukushima-has-made-me-start-to-doubt-a-754888.html

3 ONR 2011: Office for Nuclear Regulation - An agency of HSE, European Council "Stress Tests" for UK nuclear power plants; National Final Report; December 2011

4 A generic study carried by order of the German Federal Environment Ministry (BMU) revealed, among other things, that the crash of even a small-sized commercial aircraft (e.g. an Airbus A320) against a reactor building, which has a wall thickness of 0.6 to 1 metres, would result in a major damage to the reactor building [BMU 2002].

5 The first level safety systems intended for incidents and accidents of internal origin and earthquakes, and the second level emergency systems dedicated to external hazards.

6 The peer review team recommends to analyse the impact of failure of a fuel tank containing 500 m³ fuel, which is not seismically qualified.

7 MAJER 2012: Abschlussbericht zum Kernkraftwerk Cattenom; Dieter Majer; Februar 2012

8 http://flexrisk.boku.ac.at/en/team.html

GREENPEACE

Greenpeace is an independent global campaigning organisation that acts to change attitudes and behaviour, to protect and conserve the environment and to promote peace.

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