Office for Nuclear Regulation

A guide to

Nuclear Regulation in the UK

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Introduction

The Office for Nuclear Regulation (ONR) independently regulates safety and security at 37 licensed nuclear sites in the UK. These include the existing fleet of operating reactors, fuel cycle facilities, waste management and decommissioning sites and the defence nuclear sector. In addition, we regulate the design and construction of new nuclear facilities and the transport and safeguarding of nuclear and radioactive materials. We co-operate with international regulators on safety and security issues of common concern, including associated research.

ONR is not responsible for delivering a safe and secure nuclear industry; this is the responsibility of the nuclear industry itself. Our role, captured in our mission statement, is to provide efficient and effective regulation of the nuclear industry, holding it to account on behalf of the public. We use a wide range of regulatory tools to influence positively those we regulate, and to encourage the achievement of sustained excellence and continuous improvement in safety and security performance across the nuclear sector.

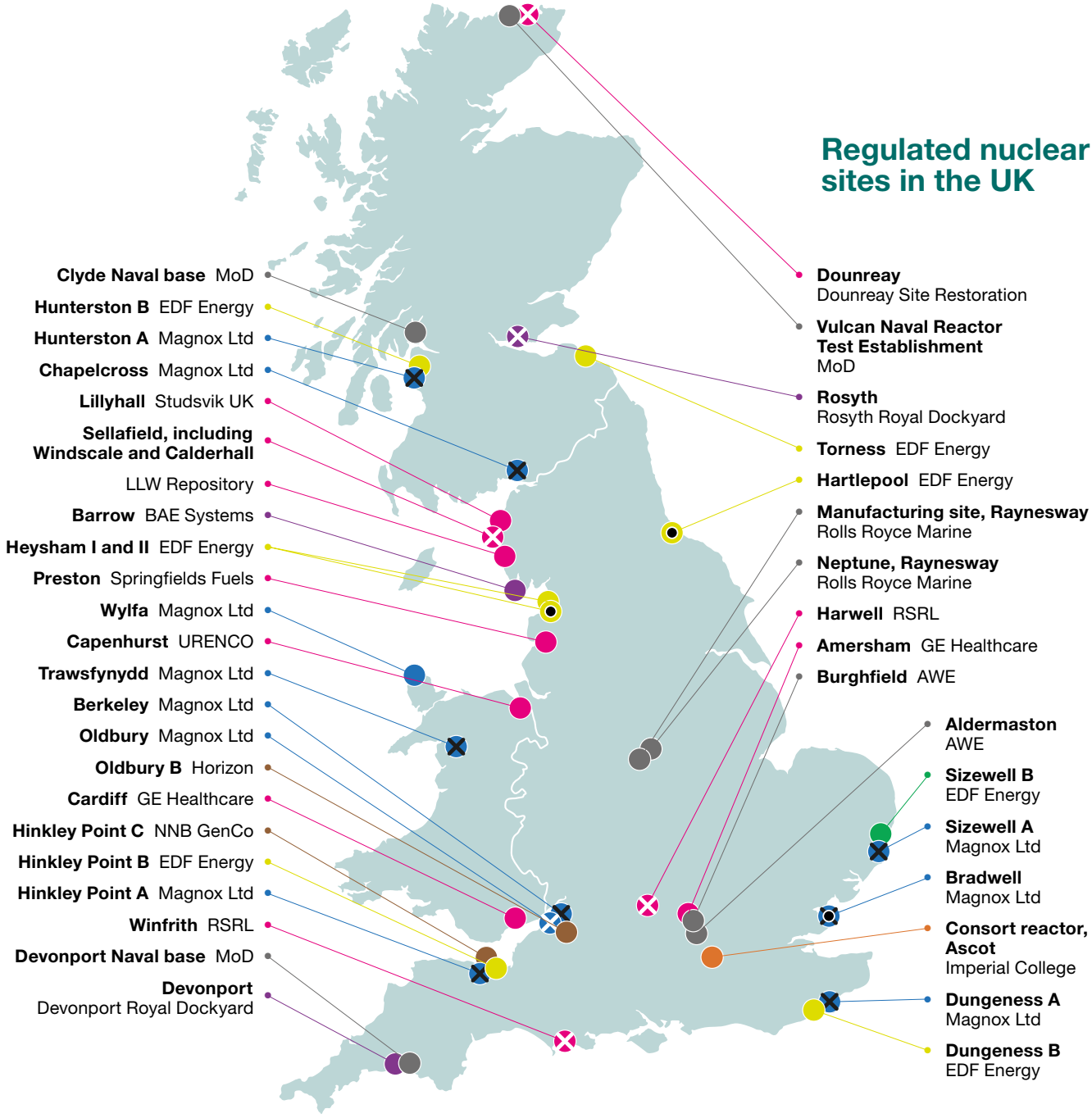
As ONR acts on behalf of the public, it is vital that we regulate with rigour, diligence and with an appropriate level of assurance that our work is targeted and proportionate to the hazards and risks presented by the industry at the right quality and cost.

This guide describes our regulatory activity and explains how we carry out our work in a clear and straightforward manner. It puts the regulation of the nuclear industry into context showing that despite its hazards, all the activities we regulate can be kept safe and secure.

John Jenkins
Chief Executive Officer

Our vision is to be an exemplary regulator that inspires respect, trust and confidence.

Regulated nuclear sites in the UK



- Defence site
- Magnox reactor
- Chemical plants and other facilities
- Pressurised water reactor (PWR)
- Research reactor
- Submarine facilities
- Advanced gas cooled reactor (AGR)
- Proposed nuclear power station
- Partly operational/decommissioning
- Decommissioning
- Identified by DECC as potential new build sites

The UK nuclear industry

Nuclear power has been produced commercially since the 1950s and grew out of the policy need for a UK nuclear deterrent. At Windscale in Cumbria, two reactors were built to produce plutonium for defence purposes. These were then followed at the adjacent Calder Hall site by four energy producing reactors designed to supply electricity. This saw the UK host the world's first commercial nuclear power station in 1956.

Today, the UK's nuclear activity consists of:

- generating electricity through power-producing nuclear reactors;
- non-power-producing nuclear facilities, eg producing and reprocessing nuclear fuel;
- decommissioning of nuclear power reactors and other facilities;
- new nuclear build; and
- defence facilities (licensed and non-licensed sites).

Table 1: UK operating (power producing) reactors

Power Station	*Owner*	*Operator*	*Reactor Type*	*Electrical Output per Unit (MW)*	*First Power Generation*
Wylfa (single reactor)	NDA	Magnox Ltd	Magnox	475	1971
Dungeness B (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	520	1983
Hartlepool (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	595	1983
Heysham 1 (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	585	1983
Heysham 2 (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	615	1988
Hunterston B (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	430	1976
Hinkley B (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	430	1976
Torness (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	600	1988
Sizewell B (single reactor)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	PWR	1188	1995

This table does not include the reactor sites that are no longer operating

Power-producing nuclear reactors

There are nine operating power stations, producing electricity for the national grid with three different types of reactors (refer to Table 1).

Magnox, First Generation Reactor – One station at Wylfa, North Wales, owned by the Nuclear Decommissioning Authority (NDA) and operated under contract by Magnox Ltd. This is the last of the ten 'first generation' Magnox stations which started operation between 1956 and 1971 (the rest of which have closed). They are carbon dioxide, gas-cooled, graphite-moderated reactors using natural uranium fuel in a magnesium alloy cladding.

Advanced Gas-cooled Reactors (AGR) – Seven stations owned and operated by EDF Energy. These have two reactors each and were commissioned between 1976 and 1988. They are 'second generation' nuclear reactors, which use enriched uranium oxide fuel in stainless-steel cladding, allowing for higher temperatures in the carbon dioxide coolant gas and more efficient electricity production.

Wylfa power station (courtesy of Magnox Ltd)

Dungeness B power station (courtesy of EDF NGL)

The UK's nuclear power stations produce about 18% of the country's electricity.

Pressurised Water Reactor (PWR) – One station owned and operated by EDF Energy. Located at Sizewell B, this is the UK's newest nuclear power station. It began operations in 1995 and uses enriched uranium oxide fuel, clad in zirconium alloy. PWRs are the world's most common type of nuclear reactor.

Between them, the UK's nuclear power stations produce about 18% of the country's electricity.

There are nine Magnox stations now being decommissioned. These are Berkeley, Bradwell, Hinkley Point A, Hunterston A, Sizewell A, Chapelcross, Dungeness A, Trawsfynydd and Oldbury.

Non-power-producing nuclear facilities

There are a number of other nuclear facilities, which do not generate power but are dedicated instead to activities such as producing nuclear fuel, processing used nuclear fuel, and storing or treating radioactive material. Some of the sites are being decommissioned because they are no longer needed. Many of these sites are owned by the NDA and operated on the NDA's behalf by contractors. ONR works with the NDA to optimise the safe decommissioning of its sites (see Table 2).

Sizewell B power station (courtesy of EDF NGL)

Sellafield (courtesy of Sellafield Ltd)

Table 2: Non-power-producing nuclear facilities

Site	*Owner*	*Operator*	*Current activities*	*Status*
Dounreay, Caithness Scotland	NDA	Dounreay Site Restoration Limited	Originally used for research, development and prototype operation of fast reactors, it is now being decommissioned. The site still stores used and unused nuclear fuel, together with liquid reprocessing liquors and other waste.	Decommissioning of the reactors and other plants is well advanced
Winfrith, Dorset	NDA	Research Sites Restoration Limited - charged with the closure of the site	Former nuclear power research and development site, housing laboratories and research/prototype reactors.	Decommissioning
Harwell, Oxon	United Kingdom Atomic Energy Authority	Research Sites Restoration Limited - charged with the closure of the site	Former nuclear power research and development site, housing laboratories and research reactors. The site still stores intermediate level radioactive waste arising from its historic operations.	Decommissioning
Springfields, Preston	NDA	Westinghouse Electric UK Limited	Manufacture of fuels for AGRs and light water reactors, manufacture of uranium hexafluoride, processing of residues.	Operational and decommissioning/ demolition of redundant plants and buildings
Capenhurst Works, Chester	Urenco Ltd	Urenco UK	Plants producing enriched uranium for international markets. The site stores depleted uranium hexafluoride. Part of site operated by a tenant on behalf of the NDA to provide the UK site for uranic materials storage.	Operational and storage
Low Level Waste Repository, Cumbria	NDA	LLW Repository Ltd	UK's national low level waste disposal site.	Operational
Metals Recycling Facility, Cumbria	Studsvik UK	Studsvik UK	Decontaminates and recycles metal waste as part of the UK's low level waste strategy.	Operational
Imperial College Consort Reactor, Berkshire	Imperial College	Imperial College	At the early stages of a decommissioning programme.	Decommissioning
GE Healthcare Limited, Amersham and Cardiff sites	GE Healthcare	GE Healthcare	Manufacture of radiopharmaceutical products.	Operational
Sellafield, Cumbria	NDA	Sellafield Ltd	Has one of the largest groupings of nuclear facilities in Europe and houses a large inventory of nuclear materials. Operations centre around the nuclear fuel cycle, with two spent fuel reprocessing plants and a number of waste and effluent treatment plants and associated storage facilities. Many are at different stages of decommissioning. A key activity is moving radioactive materials from ageing legacy facilities to more robust modern facilities. The site also houses the decommissioning Calder Hall Magnox reactors.	Operational - reprocessing plants and decommissioning

Defence facilities

Nuclear licensed sites

There are seven nuclear licensed sites which, under contract to the Ministry of Defence (MoD), provide and maintain the warheads for the UK's nuclear deterrent, and support for the UK fleet of nuclear powered submarines, including:

- submarine reactor fuel manufacture, including a test reactor research facility;
- submarine construction and commissioning;
- submarine maintenance and refuelling.

HMS Astute (courtesy of BAE Systems)

Nuclear non-licensed sites

Several naval sites involving nuclear-related activities are exempt from aspects of ONR regulation as they are under the control of the Crown (MoD). On these sites, nuclear and radiation safety is regulated jointly by the Defence Nuclear Safety Regulator (DSNR) and ONR. ONR is also the enforcing authority for conventional safety regulation within these sites.

ONR regulates these sites through the Health and Safety at Work etc. Act (HSWA), the Ionising Radiations Regulations (IRR99) and the Radiation (Emergency Preparedness and Public Information) Regulations (REPPIR). These sites are HM naval bases at Devonport and Clyde (comprising the Faslane and Coulport sites), the Vulcan Naval Reactor Test Establishment at Dounreay, 5 Basin at Devonport and a range of operational berths around the UK, including Southampton, Portsmouth, Portland and Clyde (see Table 3).

Table 3: Nuclear defence sites

Site	*Owner*	*Operator*	*Current activities*
Atomic Weapons Establishment, Aldermaston, Berkshire	MoD	AWE plc	Manufactures and maintains the warheads for the UK's submarine launched nuclear deterrent.
Atomic Weapons Establishment, Burghfield, Berkshire	MoD	AWE plc	Manufactures, maintains and decommissions the warheads for the UK's submarine launched nuclear deterrent.
Rolls Royce Marine Power Operations Limited, Derby, Derbyshire (two sites)	Rolls-Royce plc	Rolls Royce Marine Power Operations Limited	Carries out the manufacture of nuclear fuel for submarine reactors. They also operate a low energy naval research reactor. These are separate licensed sites with a single operator.
Devonshire Dock Complex, Barrow in Furness, Cumbria	BAE Systems Maritime - Submarines	BAE Systems Marine Limited	Carries out submarine construction and commissioning activities. Currently the Astute Class hunter killer submarines are being built there for the Royal Navy.
Devonport Royal Dockyard Limited, Plymouth, Devon	Babcock International Group	Devonport Royal Dockyard Limited	Carries out the maintenance and refuelling of the Royal Navy's submarines. Plant and site modifications are currently being progressed that will enable future defuelling activities to be carried out on redundant hunter killer submarines.
Rosyth Royal Dockyard Limited, Fife	Babcock International Group	Rosyth Royal Dockyard Limited	Most of the nuclear related facilities have been decommissioned, leaving only a small inventory of radioactive waste. Defuelled submarines are stored at Rosyth off the licensed site, but are occasionally brought onto the licensed site for work to be carried out.

Safety of the nuclear industry

Hazards of radiation and the risks from exposure

Communicating the difference between what constitutes a hazard, as opposed to something which represents a risk, is a challenge that ONR faces when providing reassurance to a wide variety of groups, including communities living in the vicinity of nuclear sites, the wider public and government.

The terms 'hazard' and 'risk' are often used interchangeably in everyday vocabulary. Common definitions when discussing workplace health and safety are that:

- a **hazard** is any source that has the potential to cause harm; and
- **risk** is the likelihood of the hazard arising, combined with the effect of the hazard.

The primary hazards associated with the nuclear industry arise from radiation given off by radioactive materials. The risk represents the likelihood that people are exposed to that radiation. Table 4 below gives an indication of some of the risks we face in everyday life. These can be contrasted with the risk of dying as a result of a nuclear accident, which in the UK is about 1 in 100 million per year.

The harm to people's health from radiation depends on the amount of radiation being given off by the substance per second and how energetic that radiation is. An important property of a radioactive substance is that the rate of radiation emitted will diminish naturally, over time. This is measured by its half-life – the time it takes for a radioactive substance to reduce its radioactivity by half. This can range from seconds to millions of years depending on the particular substance.

There are various ways in which radioactive substances can affect the body, for example by direct exposure to the radiation, by internal exposure due to ingestion or inhalation of the substance, or by entering the bloodstream via wounds.

Table 4: Annual risk of death for various causes averaged over the entire population (taken from Annex 4 of HSE's *Reducing risks, protecting people*)

Cause of death	*Annual risk*
Cancer	1 in 387
Injury and poisoning	1 in 3 137
All types of accidents and all other external causes	1 in 4 064
All forms of road accident	1 in 16 800
Lung cancer caused by radon in dwellings	1 in 29 000
Gas incident (fire, explosion or carbon monoxide poisoning)	1 in 1 510 000
Lightning	1 in 18 700 000

Some ingested or inhaled substances will be excreted and exposure will diminish with time. The degree of harm depends on the combination of these factors and, although highly complex, the International Commission on Radiation Protection provides recognised models for measuring exposure and assessing harm.

Potential harm to an individual is normally considered to be either direct or latent. Direct harm usually affects those who receive a very large dose of radiation, for example workers in close proximity to a nuclear accident or those exposed to a highly radioactive source. Effects may include vomiting, damage to the skin and internal organs and, at high enough exposures, death.

Latent harm manifests itself as an increased risk of cancer of various types, some of which may lead to death, or possible genetic defects. These latent effects may not become apparent for many years after exposure and may not materialise at all.

Estimates of the likelihood of latent effects are based on the assumption that the increase in cancer risk is directly proportionate to the increase in exposure to radiation, no matter how small that increase may be. Such risks arise from both naturally occurring as well as man-made sources of radiation.

Nuclear emergency planning is based on the prevention of direct effects and limitation of the risk of latent effects.

The primary hazards associated with the nuclear industry arise from radiation given off by radioactive materials.

The risk represents the likelihood that people are exposed to that radiation, combined with the effect of the radiation.

(Courtesy of EDF Energy)

Measuring exposure

For nuclear power station reactors, the main hazard derives from the large amount of radioactivity in the fuel which has been created by nuclear fission. To ensure that this radioactivity is not released, nuclear power stations employ the barriers of controlling, cooling and containment.

- **Controlling** nuclear and chemical reactions to limit the release of energy will prevent the degrading of the containment and release of radioactive material.
- **Cooling** the radioactive material, if it is heat-generating, ensures that excessive temperatures do not occur which may degrade the containment and lead to the escape of radioactive material.
- **Containment** of the radiation or radioactive material is done by shielding with concrete walls, which stop or absorb radiation, and with robust vessels, cells and flasks to stop radioactive material escaping.

In non-power-generating nuclear facilities the most significant hazard arises from heat-generating radioactive materials in facilities dealing with used nuclear fuel. Here, cooling will be a key feature and where there is the potential for release of radioactivity, there is always the need to ensure containment.

The unit of radiation exposure is the Sievert (Sv). One Sv represents a large dose and in an adult equates to increased chance of getting cancer of about 1 in 20 (for comparison, the normal chance of dying from cancer is about 1 in 4). Most exposures will be measured in millisieverts (mSv) which is one thousandth of a Sievert.

The annual regulatory limits for normal radiation exposure from nuclear power plants are 20 mSv for radiation workers on plants, and 1 mSv for members of the public who may be exposed by discharges and direct radiation from a plant. The legal requirement to take all necessary steps to restrict so far as is reasonably practicable exposure means that radiation workers in the UK are exposed, on average in a year, to around 1 mSv. This is in addition to the average 2.5 mSv per year we all incur, from our normal activities. Exposure to natural radiation varies around the country depending on the local geology. Some areas, such as Cornwall with its high amounts of naturally radioactive granite, give rise to annual background exposures around four times the average (ie 10 mSv). We also incur increased cosmic radiation doses when we fly, as well as radiation doses when we eat certain naturally radioactive foods, or when we are exposed to X-rays.

The annual regulatory limits for normal radiation exposure from nuclear power plants are 20 mSv for radiation workers on plants, and 1 mSv for members of the public.

Ensuring safety

The safety of a nuclear facility depends on controlling the risk of exposure to radiation from both routine operational activities and from potential accidents. On site, ONR regulates both of these aspects, but various environment regulators (in England, Wales and Scotland) regulate routine discharges of radioactive materials into the environment. A number of factors combine to ensure the safety of a nuclear site:

- a robust design with limits and conditions for operation;
- a rigorous operating regime with peer checking, self assessment, training accreditation and internal oversight;
- an experienced regulatory group within the licensee's organisation;
- external peer review of the licensee from organisations such as the World Association of Nuclear Operators (WANO) and the Institute of Nuclear Power Operations;
- oversight by a strong independent external regulator (ONR) staffed by highly trained, qualified professionals undertaking site inspection and technical assessment work. As well as a rigorous internal assurance process, the regulator's performance is monitored via international peer review (eg by the IAEA).

The worldwide consensus strategy for nuclear safety is to use a 'defence in depth' approach. This is an approach which puts in place layers of protective systems which will contain and delay the release of radiation and limit the risk of harm. Defence in depth is embedded in ONR's Safety Assessment Principles (SAPs) which are used to judge the adequacy of licensees' safety cases.

The aim is to ensure that:

- faults do not occur;
- if faults do occur they are controlled; and
- if the protection fails, systems are in place to mitigate the consequences.

Conservative design, good operating practice and proper maintenance and testing should minimise the likelihood of faults. Nevertheless, the design of nuclear facilities must be shown to be capable of tolerating a wide range of possible faults.

The principle of 'defence in depth' also requires licensees to analyse fault sequences leading to severe accidents in order to identify any additional equipment that may be needed and to ensure that realistic guidance on the actions to be taken is available.

The worldwide consensus strategy for nuclear safety is to use a 'defence in depth' approach.

Safety legislation

The legal framework for the nuclear industry is based around the Health and Safety at Work etc. Act 1974 (HSWA), the Energy Act 2013 and the Nuclear Installations Act 1965.

HSWA places duties on all employers, including those in the nuclear industry, to look after the health and safety of both their employees and the public. However, because of the particular hazards associated with the nuclear industry, including the potential for accidents to cause widespread harm and social disruption, some legislation is targeted at the nuclear industry, specifically the Nuclear Installations Act 1965. Additionally, there may be nuclear regulations made under the Energy Act 2013 that are also relevant, as well as regulations under HSWA such as the Ionising Radiations Regulations 1999 (IRR99) and Radiation (Emergency Preparedness and Public Information) Regulations (REPPIR).

A key principle of the UK's approach is that nuclear licensees are required to build, operate and decommission nuclear sites in a way that ensures that risks are kept as low as reasonably practicable. This is referred to as the ALARP principle and requires licensees to demonstrate that they have done everything 'reasonably practicable' to reduce risks. This requires them to balance the level of risk posed by their activities against the measures needed to control that risk in terms of money, time or trouble. However, they do not have to take action if those measures would be grossly disproportionate to the level of risk averted.

Ensuring safety

In addition to nuclear safety ONR is also responsible for regulating non-nuclear, or conventional, health and safety on nuclear licensed sites. The aim of regulation is to ensure that the site has reduced risks to employees and other persons so far as is reasonably practicable. This includes fire safety.

Torness power station (courtesy of EDF Energy)

The legal framework for the nuclear industry is based around the Health and Safety at Work etc. Act 1974, the Energy Act 2013 and the Nuclear Installations Act 1965.

How ONR regulates nuclear safety

Although ONR is in charge of regulating nuclear sites in the UK, the legal responsibility for ensuring nuclear safety rests with the licensee. The Government is responsible for establishing nuclear policy through a legislative regulatory framework. It does not set regulatory standards or make regulatory decisions. These matters are the responsibility of ONR.

The UK generally operates a goal-setting regime rather than the more prescriptive, standards-based regimes applied in some other countries. This means that ONR sets out its regulatory expectations, and requires licensees to determine and justify how best to achieve them. This approach allows an operator to be innovative and to achieve the required high levels of nuclear safety by adopting practices that meet its particular circumstances. It also encourages continuous improvement and the adoption of relevant good practices.

ONR has attached 36 conditions to each nuclear site licence within which the licensees are required to operate, Table 5 lists these licence conditions. These set goals requiring the licensee to create and implement 'adequate arrangements' for compliance with the licence condition, as well as some more prescriptive requirements. Adequacy, in this context, means ONR's evidence-based judgement that the licensee's arrangements for the management of nuclear safety meet the high standards expected of the nuclear industry in both the UK and internationally.

A combination of ONR's assessment and inspection functions allows ONR to judge whether licensees are operating with risks reduced to as low as reasonably practicable.

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In coming to a judgement on whether an acceptable level of safety is being achieved, a significant body of information is considered, for example:

- safety cases;
- reports on the licensees' periodic reviews of safety;
- results of on-site compliance inspections, including joint inspections with the licensees' own regulatory compliance teams;
- annual reviews of safety at each site, and information from start-up meetings at the end of each reactor statutory outage;
- the findings from investigations of incidents and events;
- insights and intelligence gained from the licensees' senior management and internal regulator; and
- the annual demonstration of emergency exercises at each site.

A combination of ONR's assessment and inspection functions allows ONR to judge whether licensees are operating with risks as low as reasonably practicable.

An important part of ONR's safety assurance is its monitoring of the performance of the licensee's internal regulator or internal assurance function, which can provide useful information and help inform the development of site inspection plans and assessments.

Assessment is the process ONR applies to reach an independent and informed judgement on the adequacy of a nuclear safety case and underpins our application of the regulatory regime. For any operation that may affect safety, licensees are required to produce an adequate safety case to demonstrate the safety of that operation. The overriding regulatory requirement is that the safety case shows that the licensee has reduced risks as low as reasonably practicable.

ONR's assessment resources are organised around a number of specialist technical disciplines, such as structural integrity, fault studies, electrical engineering and human factors. Assessors, who are appointed as nuclear inspectors, are recruited on the basis of their high technical qualifications and extensive experience in nuclear or other high-hazard industries. In reaching decisions on the adequacy of a licensee's safety case, assessors will use ONR's Safety Assessment Principles as guidance. They may also visit sites to check the veracity of what is said in the safety cases and to resolve technical issues with the licensee's staff. In order to ensure that regulatory assessment

Table 5: Licence conditions

1	Interpretation
2	Marking of the site boundary
3	Control of property transactions
4	Restrictions on nuclear matter on the site
5	Consignment of nuclear matter
6	Documents, records, authorities and certificates
7	Incidents on the site
8	Warning notices
9	Instructions to persons on the site
10	Training
11	Emergency arrangements
12	Duly authorised and other suitably qualified and experienced persons
13	Nuclear safety committee
14	Safety documentation
15	Periodic review
16	Site plans, designs and specifications
17	Management systems
18	Radiological protection
19	Construction or installation of new plant
20	Modification to design of plant under construction
21	Commissioning
22	Modification or experiment on existing plant
23	Operating rules
24	Operating instructions
25	Operational records
26	Control and supervision of operations
27	Safety mechanisms, devices and circuits
28	Examination, inspection, maintenance and testing
29	Duty to carry out tests, inspections and examinations
30	Periodic shutdown
31	Shutdown of specified operations
32	Accumulation of radioactive waste
33	Disposal of radioactive waste
34	Leakage and escape of radioactive material and radioactive waste
35	Decommissioning
36	Organisational capability

An important part of ONR's safety assurance is its monitoring of the performance of the licensee's internal regulator.

decisions are robust and consistent, assessment reports are peer reviewed internally and authorised by a senior inspector.

Inspection is the structured gathering of intelligence about nuclear licensees' safety and security performance, through direct first-hand observation of plant, procedures and work activities and the questioning of staff on the site. Safety inspection activities focus on checking licensee compliance with the nuclear site licence conditions and enforcing other safety legislation for which ONR is the statutory regulator.

ONR targets its attention on sites and facilities which hold the highest hazard and pose the greatest risk. Where an operator's safety standards fall short of what is required by law, ONR will implement an enforcement response which is proportionate to the degree of shortfall. ONR generally seeks to bring about safety improvements through a persuasive and influencing approach, but it will increase the severity of its enforcement action as necessary, including taking criminal prosecutions as appropriate.

Regulatory intelligence

Nuclear sites may experience unplanned events that can be described as anomalies, incidents or accidents depending on their severity. In general, the more significant the event the more that could be learned from it. In order to prevent the recurrence of incidents and accidents, ONR encourages licensees and others with legal duties on the site to disclose events to ensure lessons are being derived. This provides assurance that the dutyholder is taking steps to learn from mistakes and helps ONR focus attention in areas where further investigation or advice might be needed. This contributes towards a culture of continuous improvement in the nuclear industry.

The UK uses the International Nuclear and Radiological Event Scale (INES) to rate reported events. The INES scale is a tool devised and maintained by the International Atomic Energy Agency (IAEA) for use worldwide, to facilitate consistent communication and understanding between the technical community, the media and the public of the safety significance of events associated with sources of radiation.

Nuclear sites may experience unplanned events that can be described as anomalies, incidents or accidents depending on their severity.

In disclosing events to ONR, nuclear sites provide an initial INES rating for the event. ONR employs a nuclear safety inspector as the UK INES National Officer to verify the ratings given by the site.

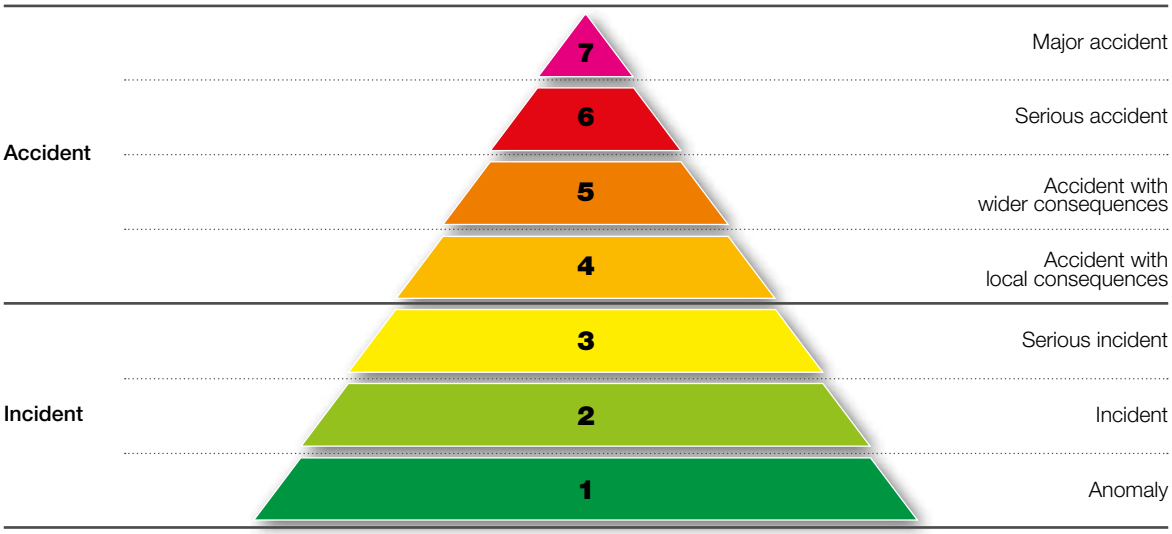
Events are classified on the scale at seven levels:

- Levels 4-7 are in the accident category.
- Levels 1-3 are in the incident category.

Events without safety significance are classified as “Below Scale / Level 0”.

The Fukushima accident in 2011 and Chernobyl in 1986 were classified as Level 7. In the UK there has only been one event that was rated as a nuclear accident, ie Level 4 or above; this was the Windscale fire in 1957, which was retrospectively classified as a Level 5 event. This event was instrumental in the Government setting up the Nuclear Installations Inspectorate, since incorporated in the ONR, to provide independent regulation of the civil nuclear power programme which was then being embarked on.

The IAEA International Nuclear and Radiological Event Scale (INES)



Below scale / level 0
NO SAFETY SIGNIFICANCE

Security of the civil nuclear estate

Security legislation

Effective security arrangements in the nuclear industry are essential to prevent the theft of nuclear or other radioactive materials, the sabotage of nuclear facilities and to protect sensitive nuclear information. ONR plays an important role in reviewing security requirements and keeping the civil nuclear industry informed so it is able to put in place preventative security measures commensurate with the threat. Doing this requires collaboration between a number of national and international bodies.

(Courtesy of Civil Nuclear Police Authority)

The Nuclear Industries Security Regulations 2003 (NISR) place significant obligations on the operators of civil licensed nuclear sites with regard to physical security measures covering not only facilities and nuclear material, but also the security of Sensitive Nuclear Information (SNI). Also covered is the vetting of permanent staff and contractors, and the movement of nuclear material by road and rail within the UK and globally in UK-flagged vessels. This legislation also requires all civil nuclear operators to have a robust Nuclear Site Security Plan (NSSP) in place.

Strict requirements exist for the reporting of security incidents, and developers of civil nuclear sites have obligations during the design and construction process.

ONR regulates:

- civil licensed nuclear sites, each with an NSSP, as well as tenants at some of these sites who are required to maintain their own security plans;

Effective security arrangements in the nuclear industry are essential.

- one unlicensed nuclear site holding nuclear material;
- companies approved by ONR to transport nuclear material within the UK and globally in UK-flagged vessels;
- locations where SNI and technology is held – ONR regulates the security of SNI whether on or off nuclear licensed sites;
- the vetting of permanent staff and contractors involved with nuclear materials or SNI.

ONR does not regulate the security of radioactive sources held outside nuclear licensed sites; these are regulated by the environment agencies and supported by police counter-terrorist security advisors. Security at nuclear premises operated primarily or exclusively by MoD or its contractors is also outside of ONR's regulatory remit.

ONR has the power to compel plant operators, carriers of nuclear material and those holding sensitive information and technology to make improvements to their security arrangements if necessary.

How ONR regulates nuclear security

ONR's regulation of nuclear security prioritises areas that involve the greatest hazard and present the greatest risk. As with safety, security in the nuclear industry is based on the principle of defence in depth where there are multiple layers of protection so that if one is breached, further barriers exist. Our enforcement of security legislation is conducted in accordance with the same policies and procedures as those governing the enforcement of safety legislation. ONR has the power and duty to compel plant operators, carriers of nuclear material and those holding sensitive information and technology to make improvements to their security arrangements if necessary.

Fundamental to the regulation of security is the requirement for ONR's National Objectives, Requirements and Model Standards (NORMS) to be met. NORMS provides guidance on how the industry can meet the duties placed on it by security legislation and has moved the regulation of civil nuclear security towards a more goal-setting, outcome-based approach, with far greater onus on dutyholders to propose and justify security arrangements that meet ONR's defined security objectives.

A programme of planned and no-notice inspections is carried out by teams of security inspectors, to ensure compliance with the approved arrangements. Regular site security exercises are also observed to assess the performance of security systems against a range of scenarios.

Emergency planning and preparedness

Responding to an emergency

Although the design, operation and maintenance of nuclear installations makes the risk of accidents involving the release of radiation extremely low, regulations are in place to ensure there are adequate arrangements for responding to a nuclear or radiological emergency. These regulations are enforced by ONR.

The Department of Energy and Climate Change (DECC) is the Lead Government Department in the event of any emergency resulting from off-site radiological consequences from a licensed civil nuclear site in England and Wales. In Scotland, the main national coordinating role would fall to the Scottish Government. DECC has established national governance arrangements where representatives from nuclear operators, police, fire service, local authority emergency planning officers, nuclear regulators and government departments and agencies come together to consider measures required to respond to a nuclear emergency.

All nuclear operators and relevant local authorities prepare, in consultation with the emergency services and other bodies, emergency plans for the protection of the public and their workforce in a nuclear emergency. These emergency plans are subject to regular tests under three categories:

- **Level 1 exercises** are held at each nuclear site generally once a year and concentrate primarily on the operator's actions on and off the site.
- **Level 2 exercises** are aimed primarily at demonstrating the adequacy of the arrangements made by the local authority to deal with the off-site aspects of the emergency.
- **Level 3 exercises** rehearse the wider involvement of central government.

All nuclear operators and relevant local authorities prepare, in consultation with the emergency services and other bodies, emergency plans for the protection of the public.

The police, working in conjunction with other emergency services, expert bodies, and local and national agencies, are responsible for coordinating response effort locally. The lead government department coordinates the response at a national level, briefing ministers and the UK's international partners, and acting as the main source of information to the public and the media at national level.

ONR works closely with Public Health England's Centre for Radiation, Chemical and Environmental Hazards which provides guidance on public protection countermeasures. Such countermeasures include sheltering, evacuation and the taking of potassium iodate tablets to reduce the uptake of radiation to the public in the early stages of some types of nuclear emergency.

Emergency exercise

ONR determines the size of the local authority off-site emergency planning area in accordance with the Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR). In determining the size, consideration is given to the level of emergency risk presented by the site, local and practical considerations relevant to the implementation of the plan itself, and any other relevant factors that ONR judges to be necessary in the interests of public safety. The off-site emergency planning area is based on reasonably foreseeable emergency conditions, and whilst not currently a statutory requirement, it is good practice that local authorities consider the means by which the area might be extended in the highly unlikely event of a larger accident.

Transport of radioactive materials

ONR regulates the movement of all radioactive material in Great Britain (with the exception of some material related to defence). This includes flasks carrying spent nuclear fuel from operating and decommissioning nuclear reactors, radio-pharmaceuticals needed for hospitals, sealed radioactive sources needed in the construction industry and, for instance, in the non-destructive testing of North Sea oil rigs.

The regulations for the transport of radioactive materials are prescriptive to meet international requirements that enable transport of packages across international borders. The UK regulations are based on those of the IAEA, which are applied internationally. They also reference other international regulations for radioactive materials transport by land, sea and air. Although complex, this arrangement has worked successfully for many years.

ONR carries out a range of regulatory activities to assure the safe transport of radioactive materials and approves the designs of the packages used to carry high-hazard radioactive materials. It also ensures that packages are built to robust quality assurance plans, and that these are correctly used and maintained.

Significant incidents or accidents must be reported to ONR so that they can be investigated and appropriate lessons learnt and acted on. ONR implements an inspection and audit programme to judge the extent to which the nuclear industry complies with transport regulatory requirements.

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(Courtesy of IAEA)

International activities

ONR meets its strategic international objectives through involvement in a wide variety of international activities, including:

Conventions

At the request of DECC, on behalf of UK Government, ONR provides the technical expertise to support the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. ONR also fulfils the Article 5 obligations on the UK under *Convention on the Physical Protection of Nuclear Material* (CPPNM) through its designation as the competent authority for matters concerning the physical protection of civil nuclear material.

IAEA Standards

As part of its commitment to continuous improvement and the adoption of good international practice, ONR takes a close interest in the development of the IAEA's safety standards and represents the UK on the IAEA Commission for Safety Standards. ONR also promotes continuous improvement and the adoption of good security practice, and provides technical experts to the IAEA to assist in the production and review of the Nuclear Security Series publications.

Integrated Regulatory Review Service (IRRS)

In addition to being reviewed itself in 2013, ONR has provided technical staff to participate in several IAEA IRRS missions.

European Commission (EC)

ONR participates in the European Nuclear Safety Regulators group (ENSREG) to provide nuclear safety advice to the EC. ENSREG is a high-level EU group aimed at furthering a common approach where this could add value to the safety of nuclear installations, the safety of the management of spent fuel and radioactive waste and

ONR meeting with Hitachi-GE, the British Embassy and the Nuclear Regulatory Authority (NRA), Japan's nuclear safety regulatory body.

the financing of the decommissioning of nuclear installations. All EU Member States and the EC are represented in ENSREG by senior officials from their national regulatory or nuclear safety authorities. Dr Andy Hall, Chief Nuclear Inspector (CNI), is currently the Chair of ENSREG.

International Physical Protection Advisory Service (IPPAS)

The UK hosted an IPPAS mission in 2011 and regularly provides technical staff to participate in IPPAS missions worldwide.

Organisation for Economic Co-operation and Development/ Nuclear Energy Agency (NEA)

ONR represents the UK on the two main nuclear safety committees of the NEA.

Western European Nuclear Regulators Association (WENRA)

WENRA's 'safety reference levels' continue to inform the development of ONR Safety Assessment Principles (SAPs) and assessment guides, and accordingly ONR strongly supports WENRA at all levels.

European Nuclear Security Regulators' Association (ENSRA)

Based on the WENRA model, ONR are part of ENSRA, ensuring the maintenance of cooperative relationships with other government bodies that have responsibility for nuclear security.

G8 Nuclear Safety and Security Group (NSSG)

The UK took the presidency of the G8 in 2013 and ONR provides technical support to DECC who chair the NSSG.

Global Threat Reduction Programme (GTRP)

ONR contributes to the DECC GTRP through the provision of technical experts to deliver IAEA sponsored international protective security training courses.

Centrifuge Collaboration Security Working Group (CCSWG)

As members of the CCSWG, ONR represent the UK's interests in the Centrifuge Collaboration Pentapartite with France, Germany, the Netherlands and USA.

ONR meets its strategic international objectives through involvement in a wide variety of international activities.

Nuclear safeguards

Nuclear safeguards are measures put in place to verify that countries comply with their international obligations not to use nuclear materials (plutonium, uranium and thorium) for the creation of nuclear explosives. This requires international, third-party, verification as part of the international non-proliferation regime.

The inspection of national compliance with safeguards obligations is carried out by the international safeguards inspectorates of the IAEA and the European Commission, with whom ONR's safeguards team works closely to ensure the UK's obligations are met. ONR also fulfils the safeguards related reporting obligations on behalf of the Government and provides advice to DECC, who are responsible to Parliament for the UK's international safeguards obligations.

(Courtesy of IAEA)

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List of abbreviations

AGR ..... Advanced gas-cooled reactor
ALARP .... As low as reasonably practicable
AWE ..... Atomic Weapons Establishment

CCSWG ... Centrifuge Collaboration Security Working Group
CNI ..... Chief Nuclear Inspector
CPPNW ... Convention on the Physical Protection of Nuclear Material

DECC ..... Department of Energy and Climate Change
DNSR ..... Defence Nuclear Safety Regulator

EC ..... European Commission
ENSRA .... European Nuclear Regulator Association
ENSREG .. European Nuclear Safety Regulators Group
EPA ..... Emergency Planning Area

GTRP ..... Global Threat Reduction Programme

HSE ..... Health and Safety Executive
HSWA ..... Health and Safety at Work etc. Act 1974

IAEA ..... International Atomic Energy Agency
INES ..... International Nuclear and Radiological Event Scale
IPPAS ..... International Physical Protection Advisory Service
IRR99 ..... Ionising Radiations Regulations 1999
IRRS ..... Integrated Regulatory Review Service

MoD ..... Ministry of Defence
mSv ..... millisievert

NDA ..... Nuclear Decommissioning Authority
NEA ..... Nuclear Energy Agency
NEPDC .... Nuclear Emergency Planning Delivery Committee
NISR ..... Nuclear Industries Security Regulations 2003
NORMS ... National Objectives, Requirements and Model Standards
NSSG ..... Nuclear Safety and Security Group
NSSP ..... Nuclear Site Security Plan

OECD ..... Organisation for Economic Co-operation and Development
ONR ..... Office for Nuclear Regulation

PWR ..... Pressurised water reactor
REPPIR ... Radiation (Emergency Preparedness and Public Information) Regulations 2001

SAPs ..... Safety Assessment Principle(s)
SNI ..... Sensitive Nuclear Information
Sv ..... Sievert

WANO .... World Association of Nuclear Operators
WENRA ... Western European Nuclear Regulators Association

Further reading

The ONR website contains the latest reports, information and details of the standards and guides used in its work, as well as summaries of how it has arrived at regulatory decisions.

www.onr.org.uk

To get regular updates on ONR's work sign up for ONR's ebulletin via the website.

ONR

- Strategy
- Annual plan
- Annual report
- Safety Assessment Principles

HSE

- Reducing Risks, Protecting People www.hse.gov.uk/risk/theory/r2p2.pdf
- www.hse.gov.uk/risk/theory/alarpglance.htm

Useful websites

Department of Energy and Climate Change:

- www.decc.gov.uk Nuclear Emergency Planning Liaison Group Consolidated Guidance
- www.gov.uk/government/publications/nuclear-emergency-planning-consolidated-guidance

Environment Agency

- www.environment-agency.gov.uk

Scottish Environment Protection Agency

- www.sepa.org.uk

Defence Nuclear Safety Regulator

- www.gov.uk/defence-safety-and-environment-authority

Public Health England

- www.gov.uk/government/organisations/public-health-england

International Atomic Energy Agency

- www.iaea.org
- Preparedness and Response for a Nuclear or Radiological Emergency, GS-R-2

Nuclear Safety and Security

- http://www-ns.iaea.org/security
- Publication: The Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Rev5)

Acts and regulations

- The Energy Act 2013
- Ionising Radiations Regulations 1999
- Nuclear Industries Security Regulations 2003
- Nuclear Installations Act 1965 (as amended)
- Radiation (Emergency Preparedness and Public Information) Regulations 2001

Office for Nuclear Regulation

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Any enquiries regarding this publication should be addressed to:

ONR communications team
Office for Nuclear Regulation
Redgrave Court
Merton Road
Bootle
Merseyside L20 7HS

Email: onr@onr.gsi.gov.uk

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