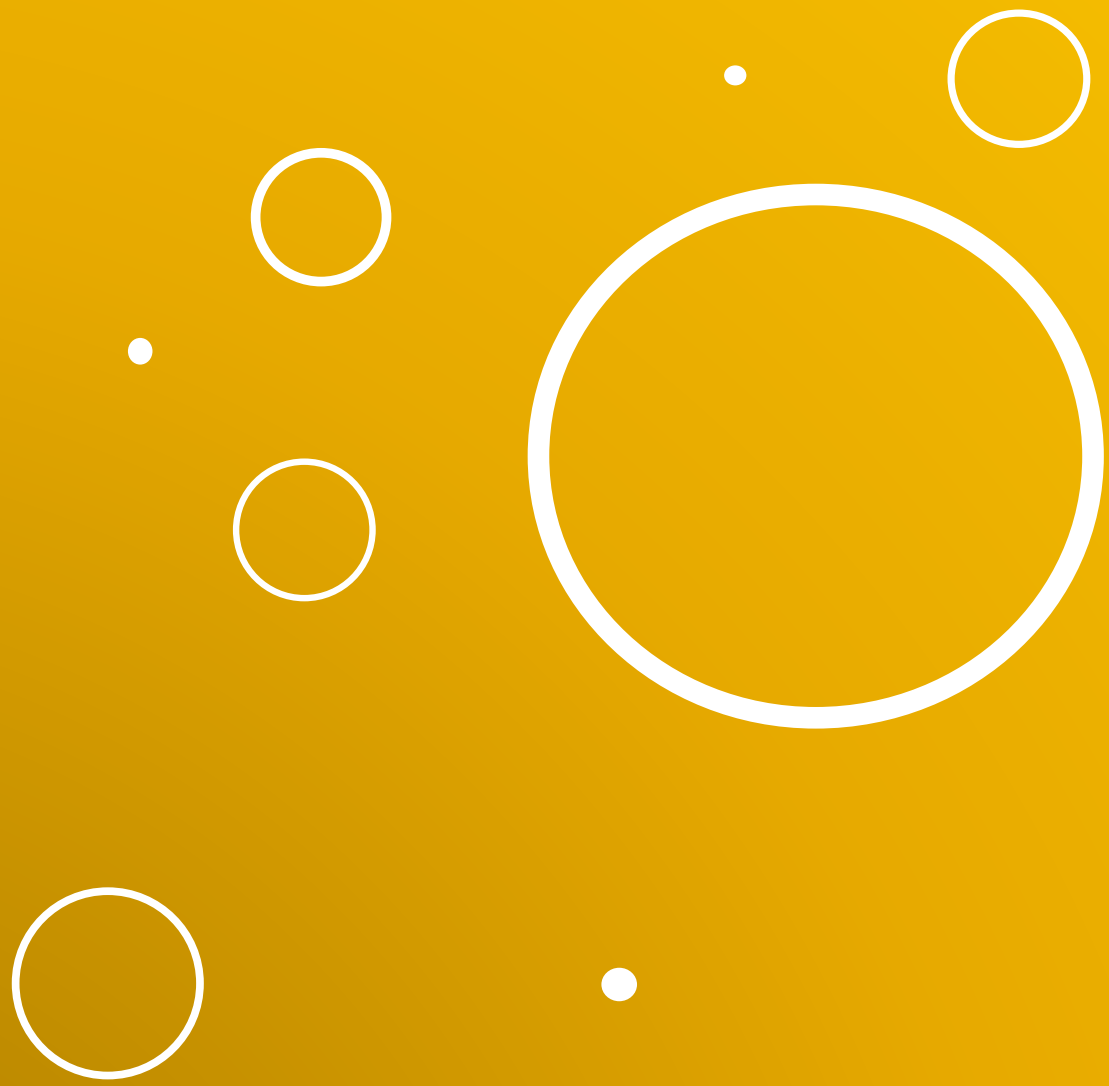
Nuclear Security
Awareness Guide

Material Categorisation and Vital Areas Identification



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This guide is part of a comprehensive series of Nuclear Security Awareness Guides that focus on key aspects of nuclear security. These guides have been developed by security specialists for non security practitioners.

These documents are for guidance only and do not constitute relevant good practice.

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Introduction

Radioactive materials present an attractive target to malicious actors, who could seek to use them to cause disruption, harm, or to raise the profile of their cause.

It therefore follows that there is a need to protect radioactive material to ensure that these are stored securely, and to protect the facilities against the threat from malicious actions.

To ensure protection against theft and sabotage is both focused and proportionate, the design of a security system follows a number of steps. Initially, the potential targets for theft or for sabotage are graded according to the potential threat to the public. A security system will then be design to reduce the risk of theft and sabotage, according to how serious the public threat is. Once the system has been designed, it will be subject to a further assessment to confirm that it will be robust and will deliver the level of protection required for the targets identified. After this is confirmed, the system will be built and commissioned. There will be processes put in place to review its effectiveness and ensure that it remains effective into the future.

This awareness guide addresses the initial grading stage of the process, only. This is referred to as ‘categorisation’. The purpose of the categorisation is to highlight those materials and areas where theft and sabotage would pose the greatest threat to the public, so that the security provisions at the site are able to be proportionate and focused on the most dangerous materials and areas. This awareness guide is an introduction for those wishing to understand categorisation, but it is not a best practice guide.

Categorisation Principles

There are two distinct threats which are considered when categorising radioactive materials. The first threat is that material is stolen, which would then allow terrorists to deploy or threaten to deploy the material anywhere they choose. The second threat is that a malicious act (sabotage) is carried out on the site, to destabilise nuclear operations or release stored materials, where the intent would be for radioactivity to cause harm to the public nearby.

Theft

By far the greatest concern is the theft of fissile material. If a sufficient quantity was stolen, it would give a terrorist organisation the necessary material to create an improvised nuclear device (an improvised atom bomb). The creation of a functional nuclear device would be very difficult to achieve, but if successful would pose a severe threat to society. The key factor is access to sufficient fissile material. Because quantity is of central importance, categorisation of fissile material is directly based on the total amount available at a site.

Other radioactive materials, if stolen, could be used to make a radioactive-material dispersal device (a 'dirty bomb'), or could be used as a radiation device. The threats to the wider society from such devices are lower than the threat from an improvised nuclear device, although the threat to an individual could still be serious. Unlike fissile material, quantity is not as important. From the perspective of a terrorist, selecting material with the highest potential to cause harm is more important since not all radioactive materials are equally harmful. Categorisation is therefore based on how harmful the material would be if deployed as a weapon.

Sabotage

Sabotage covers malicious acts within the site boundaries, in particular where the malicious intent is to cause radioactive material to affect people beyond the site boundary. Broadly, this means the use of explosives to aerosolise and release radioactive materials to the atmosphere, or to remove shielding to create a significant radiation threat at the site boundary. It also includes malicious acts which destabilise a nuclear facility causing loss of control and the subsequent release of radioactivity.

Categorisation against sabotage is focused on facilities and locations, and is driven by the worst outcome should the facility be subject to an attack. Categorisation may also be applied to specific systems or components, to provide more of a focus on the specific vulnerabilities within a complex facility. Each distinct facility or location on a site would be assessed, to determine whether an attack could result in significant off-site harm.

Material Categorisation process

Materials are categorised based on the scale of the threat to the public if the material is stolen and ends up in the hands of persons intending to cause public harm. The process of material categorisation is based on identifying the amounts of the different types of radioactive material, which are then compared to appropriate criteria. The detailed process is different if the material is specifically identified as 'nuclear material'.

Nuclear Material

Within the UK legislation, "nuclear material" is defined. Nuclear materials are plutonium, uranium 233, uranium 235, americium, and neptunium 237. Natural uranium is not considered to be nuclear material, even though it does contain a small amount of uranium 235. Categorisation of nuclear material is based on the total amount held across the whole site.

Each different type of nuclear material, the plutonium, the americium, etc, is categorised separately. The category associated with the site reflects the highest category found. The category is strictly based on the total amount of the nuclear material, even though the nuclear material might be mixed into other materials or stored across many locations on the site meaning that it might be impractical to steal the whole amount in one go. However, this is not considered when categorising.

Although categorisation addresses the amount of nuclear material on the site as a whole, where the site consists of a number of quite separate facilities the amount of nuclear material in each separate facility may also be categorised as this can help the site security plan focus on the most important locations. There might, for example, be just one facility identified as holding a Category III amount of nuclear material, with all the other facilities holding no significant amounts.

The category assigned to the nuclear material will be in accordance with the definitions in The Nuclear Industries Security Regulations 2003. Because these definitions are in the Regulations, they are part of UK law and must be followed. The following points need to be appreciated to fully understand the categorisation of nuclear material:

- Firstly, in UK law there are only two nuclear material categories defined, either "Category III" or "Category I/II". Category III material is significantly less of a threat than Category I/II material. UK legislation does not differentiate between Category I and Category II, even though there are separate definitions associated with these two categories in the International Atomic Energy Authority (IAEA) standards and guidance. The ONR additionally identify Category IV, but this additional category does not exist in either UK law or within IAEA standards and guidance. If the total amount of a nuclear material is below Category III it is unlikely to be of any practical use in the construction of an improvised nuclear device, but it could still pose a significant threat to health if used in a 'dirty bomb'. It is better that small

amounts of nuclear material are categorised as a part of 'other radioactive material'. That is covered in the next section of this guide.

- Secondly, there is a possibility that the nuclear material held on a site will be emitting a significant amount of radiation. If the unshielded dose rate exceeds 1gray per hour at 1 metre distance, then the nuclear material is deemed to be "irradiated" and Category III, regardless of the amount. This typically only applies to used nuclear fuel.

Categorisation of other radioactive material

The phrase 'other radioactive material' means radioactive material other than the nuclear material which has already been categorised. Other radioactive materials fall into three distinct types; radioactive sources, active materials and contaminated materials.

Radioactive sources are used for many purposes and in many locations. Radioactive sources should already be categorised to ensure that they are handled with due care, using a well-established scheme set out in IAEA standards and guidance.

Active materials includes materials which have become radioactive (activated) due to exposure to intense neutron radiation, typically material in or close to a nuclear reactor. They also includes fission products formed during the fission of uranium and plutonium in reactor fuel. Typically, on a nuclear site there will be large volumes of materials which are activated. Depending on the nature of the work carried out on the site, there may also be large quantities of fission products.

Contaminated materials are materials which are not inherently radioactive but have become contaminated by radioactive materials. Typically this will include filtration materials as well as disposable items such as tools, gloves and cleaning swabs.

The difficulty with categorising radioactive materials is that a facility may, in total, contain a lot of radioactivity but much of it would be very difficult to steal because it is an integral part of a substantial facility (like a reactor core), or because the activity is dispersed through a substantial volume of other materials. To be helpful, the category assigned needs to distinguish between materials which could realistically be stolen and taken away and that which could not be.

There are no rules for the categorisation of active or contaminated materials in UK legislation, but the ONR have set out their expectations in their Security Assessment Principles (SyAPs). The ONR expectations are difficult to follow, so different nuclear site operators are likely to use somewhat different categorisation schemes. Broadly speaking, the intent will be to categorise the material using the radioactive source categorisation scheme, but adjustments may be made to limit the volume of the material being categorised to the amount that could credibly be stolen in one go.

Concluding the material categorisation assessment

At the conclusion of the materials categorisation assessment, a report would normally be written to communicate the findings of the assessment to those responsible for providing security. The report should be clear which materials require protection against the threat of theft, and it would normally declare the category of each material addressed.

The material category is merely a statement which reflects the level of threat the material poses to society if it were to be stolen. This should then be used to decide how robust the measures to prevent theft should be. The level of protection that would be appropriate is not covered in this awareness guide.

Sabotage categorisation

Categorisation against sabotage is intended to identify the public threat if a facility on a nuclear site were to be sabotaged. Sabotage could be an attack by outsiders usings weapons such as explosives, or could be malicious actions by an insider. In general a nuclear site will include a number of distinct areas or facilities, any of which could be the focus of an attack. The purpose of categorisation is to identify those facilities where sabotage presents the greatest threat to the public, so that measures to prevent sabotage can be focussed where they provide the most benefit.

An act of sabotage may directly release radioactive material into the public domain, or destroy shielding so that the radiation level off-site becomes severe. However, it may also act indirectly, so that the damage caused destabilises operations causing loss of control and runaway of a reactor or it could cause a criticality excursion. A total loss of control can result in very severe societal harm, as has been seen when this has occurred accidentally. An example is the reactor explosion at Chernobyl.

Categorisation against sabotage uses a descriptive scale directly linked to the degree of protection needed, rather than a simple code letter or number describing the potential threat from the facility. The three categories normally used in the UK are ‘Baseline Area’, ‘Vital Area’ and ‘High Consequence Vital Area’.

Basis of sabotage categorisation.

The category of a facility is based on the radiation dose a person could receive if the sabotage is successfully undertaken. There are two factors which are key to the categorisation; firstly the nature of the attack, and secondly how the attack can cause dose uptake for people off site.

The nature of an attack on a facility can range from minor disruption to an overwhelming attack. The UK Government provides guidance to the civil nuclear industry on what it judges to be credible sabotage threats. For the categorisation assessment, it is common practice to assume that the worst combination of the sabotage threats in the government’s guidance will occur.

The expected dose uptake, if an attack was successful, is needed to decide how severe the effects would be on the public. This is a complex matter. The categorisation of stolen radioactive materials, discussed in the previous section of this awareness guide, assumed that the stolen material would be used in certain very specific ways to cause public harm. Unfortunately, there is no equivalent scheme for sabotage, so it is necessary for the dose consequences for each credible threats to be calculated separately.

To categorise an area on a nuclear site against sabotage, the key issue is to decide whether the public dose predicted following the sabotage is minor (acceptable),

moderate or serious. The UK government has defined what it considers to be the upper limit of acceptable consequence in the event of sabotage of a nuclear facility. The definition is based on the dose uptake of a person who is assumed to be at the site perimeter. The UK government considers that a dose no greater than 30mSv to this hypothetical person indicates that the real consequences to people, property and the environment would be acceptable. Above that figure, the consequences are deemed 'unacceptable'.

It is common practice to identify two levels of unacceptable consequences, moderate or serious, with the expectation that significantly greater efforts would be made to prevent sabotage with serious consequences from sabotage with moderate consequences. Serious (or 'high') consequences are generally understood to mean death or serious bodily injury or substantial harm to the environment, but currently, for the purposes of sabotage categorisation, the threshold is set well below that level.

Definition of an area

Sabotage categorisation is based on the logic that an 'area' is targeted. An area might be a complete stand-alone facility on a site, or it might be a defined area within a facility. The purpose of the categorisation is to identify whether the area might need enhanced protection, so it needs to be able to be protected by being contained within physical barriers. If the area cannot be effectively isolated and provided with enhanced security, it should not be assessed as a distinct area. In some circumstances, in particular on an operating nuclear power station, sabotage categorisation is also applied to systems. This can be useful if the facility contains a lot of systems, but only a small part needs to be protected against sabotage.

The areas identified for categorisation against sabotage do not necessarily have to contain radioactive materials. For an operating nuclear power station, sabotage which disables safety systems or disables reactor controls may not directly expose any radioactive material, but loss of control of the reactor may then subsequently result in uncontrolled release of radioactive materials.

Detailed assessment

The assessment which leads to the sabotage category for each of the areas being considered is likely to be complex. It has to address the range of different threats as identified in the UK government's guidance. Typically, assessments will consider sabotage by an insider as well as attacks carried out by people coming on to the site, and will also consider cyber-attack.

The dose assessments undertaken to determine whether the sabotage scenarios will lead to unacceptable consequences are also complex, because the consequences may be dependent on the operational status of the plant at the time, as well as factors such

as the state of the weather. Typically, the assessments will focus on the worst combination of factors, although there are no set rules about how far that should be taken.

It is not normal for the detailed assessments to be made accessible except to those with a valid need to know, because the information within them could be used by adversaries to identify the best targets for sabotage. However, the conclusions of the assessment have to be made available to the people who are responsible for providing security, so that they know which areas require enhanced protection, and so that they know which threats need to be addressed.

Concluding the sabotage assessment

At the conclusion of the assessment, the most severe outcome will be used to categorise the specific area; if the dose predicted exceeds 30mSv the area would be categorised as a 'Vital Area'. If the dose predicted exceeds the boundary to 'high consequence' it would be categorised as a 'High Consequence Vital Area'. The concluding report which provides these summaries is often referred to as the Vital Area Identification (VAI) report. The level of protection that would be appropriate is not described in the VAI report, and is outside the scope of this awareness guide.

There is scope for confusion with the category descriptions, unfortunately. The term 'vital area' has a different meaning within IAEA documents and guidance compared to UK usage. The difference makes cross-reference to IAEA standards and guidance difficult:

UK categorisation	Equivalent IAEA classification
Baseline Area	Limited access area
Vital Area	Protected area
High Consequence Vital Area	Vital area

Summary

This Awareness Guide has explained the need for radioactive materials on nuclear industry's sites to be categorised assuming they were to be stolen, and for areas within the sites to be categorised assuming they were subject to sabotage. The purpose of the categorisation is to highlight those materials and areas where theft and sabotage would pose the greatest threat to the public, so that the security provisions at the site are able to be proportionate and focused on the most dangerous materials and areas.

Material categorisation and 'Vital Area' identification are the first steps in protecting the public from harm. They do not define what security is required, they merely identify where security might be appropriate. An appropriate security plan will need to be prepared, based on the provision of physical security measures and security personnel to deliver the protection against theft or sabotage judged necessary. This will need to be checked via a vulnerability assessment to confirm that there are no unacceptable lines of weakness in the security plan. These next steps will be covered in further Awareness Guides planned to be published alongside this guide.

Glossary

Term	Meaning
Radioactive material	Any material which is inherently radioactive, or material which includes radioactive material.
Nuclear material	A subset of radioactive material, covering radionuclides which could credibly be used to create an improvised nuclear explosive device.
Radioactive source	A radioactive source is a package containing a known quantity of a radionuclide, and is normally designed to be transportable. Sources may be used for sterilisation, medical examination, cancer treatment, instrumentation, research, etc. Sources are normally categorised following guidance in IAEA Safety Standards Series No. RS-G-1.9
Fission products	Atomic fragments left after a large atomic nucleus such as uranium undergoes fission. In particular, the term refers to the radionuclides formed. Iodine-131 and Caesium-137 are well-known examples.
Criticality excursion	A situation where unintended nuclear fission takes place.