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SUB-CHAPTER 3.7 - CONVENTIONAL RISKS OF NON-NUCLEAR ORIGIN

1. INTRODUCTION

This sub-chapter considers risks to the environment (including human beings), which are of non-nuclear origin and which arise within the nuclear site boundary i.e. risks due to non-nuclear facilities and/or human activities on the site.

Such conventional risks, which may originate either inside or outside buildings, have the potential to cause damage to the environment (including human beings). Examples of such risks are those due to failures of pipes, vessels, tanks, pumps, valves, rotating machines etc. which could cause damage due to flooding, fires, explosions, missiles and dropped loads etc.

Note: on-site risks of conventional origin that are a threat to safety classified equipment, are addressed in Sub-chapter 13.2 of the PCSR (internal hazards), except for the risk due to flooding from tanks, pipes or other water storage facilities located outside classified buildings, which is addressed in Section 5 of Sub-chapter 13.1 of the PCSR (external flooding).

The on-site hazards in this category currently identified for the UK EPR are flooding, explosion, turbine missiles and failure of high energy components in the turbine hall. It is possible that other hazards of this type could be present on a particular EPR site (for example, storage of toxic gases may be required on sites using atmospheric cooling rather than seawater cooling systems): such hazards, and the measures to protect against them, would be identified during the site licensing phase of a UK EPR.

Sections 2 and 3 of the present PCSR subchapter outline the general approach and methodology used to identify and analyse events of this type. Note that the application of the methodology is not addressed in the PCSR, as the risks are of a site dependent nature and are therefore considered outside the scope of GDA.

2. GENERAL APPROACH

The proposed methodology aims to demonstrate that all potential risks arising from on site events, which are of conventional (non-nuclear) origin, have been identified, and that their consequences are acceptable for the environment, and especially for members of the public off-site.

The proposed approach is based on the following steps:

- identifying installations on the site which have the potential to create conventional risks,
- identifying those events which could lead to consequences to the environment or to other installations on the site and which are not dealt with, at the source, by design provisions,

- identifying initiating events that enable one or more bounding scenarios to be defined, then implementing lines of defence (physical or organisational) for those installations with potential to impact on the environment,

- verifying the effectiveness of the lines of defence by assessing the bounding scenarios.

In addition, the non-nuclear risks arising from bounding accidents that could affect individuals off-site are presented as frequency / consequence functions.

3. DESCRIPTION OF THE METHODOLOGY

It is considered that an installation creates a risk if activities or product handling associated with its operation, could lead to unacceptable consequences for the environment. The risks identified are:

- abnormal increased in temperature due to fire,

- air pressure shock wave due to explosion,

- emission of a toxic or corrosive gas cloud (due to accidental release, or formation of gas and smoke produced by a fire),

- liquid chemical pollution,

- missile generation (following the explosion of a gas cylinder, disruptive failure of rotating machinery, etc.).

The reference thresholds for evaluating the consequences are as follows:

- fire:
  - irreversible effects threshold for a person, defined as a radiative heat flux of 3 kW/m²,
  - domino effects threshold for installations, defined as a radiative heat flux of 8 kW/m²,

- overpressure: irreversible effects threshold for people and minor damage threshold for structures, defined as an overpressure of 50 mbar,

- toxic or corrosive cloud: irreversible effects threshold for exposure of 1 to 60 minutes for a person (no effect on structures),

- liquid chemical pollution:
  - for the water table: reference values are defined using the concept of the Impact Report Value which depend on each individual product. When a material has not been referenced, it is conservatively assumed that it has an unacceptable effect on drinking water supplies for members of the public,
  - for sea water: acute toxicity thresholds for products are defined,

  - o chemical pollution is not considered to threaten the structures and equipment within the nuclear-licensed site boundary.

- missile generation: it is considered that a missile impact on the equipment under consideration results in a complete loss of the equipment.

3.1. LISTING OF INSTALLATIONS CONTRIBUTING TO RISK

The identification of the list of installations contributing to the risk must comply with applicable European and UK Regulations.

The selection is basically made by using the physical-chemical characteristics of the materials stored or used and identifying the risk generated by the process. The quantity of material stored is a risk-aggravating factor.

The physical-chemical properties of the materials are identified in the various databases and the installation is selected if the material it stores presents a real danger. This step is described in sections 3.1.1 to 3.1.5 below.

Pipelines carrying hazardous materials would not normally be included in the risk analysis. Such pipelines would be protected from external risks (handling, traffic). Any required excavation works would be subject to prior authorisation and the pipelines suitably marked. Inspections and preventive maintenance on pipe networks containing hazardous fluids would be carried out subject to local regulations and would be subject to a site specific safety case, to demonstrate protection against unforeseen incidents during the service life of the installation. In addition, stop valves within circuits would be expected to be available to allow leaks to be rapidly isolated and the consequences of leakages to be limited.

3.1.1. Risk due to fire

All flammable liquids or combustible materials will be addressed in bounding fire scenarios. European and UK national regulations, governing the carriage of hazardous goods by road may be used to identify flammable products.

Note: explosive products or easily dispersed products are included in scenarios relating to on-site explosions and explosive or toxic vapour clouds (see below).

Combustion of conventional materials (PVC, cables, paint, etc.) may also generate clouds of toxic products (Chlorine, NO_x, SO_2, CO, etc.). Some of the resulting risk is eliminated by compliance with construction regulations: in particular the use of halogen free cables prevents the formation of toxic clouds (Cl_2) in the event of fire. The risk due to formation of pollutants is dealt with in applicable regulations.

3.1.2. Risk of on-site explosion

Products likely to cause an explosion on site are identified as follows:

- explosives and explosive substances.

- flammable liquids which meet the following characteristics:

  - o products which, when they decompose, are likely to release significant energy,

- o flammable liquids (as above), mixed with air in proportions which allow combustion (between the lower and upper flammability limits). For the mixture to exist, the storage tank must be partly empty and/or not degassed,
- o pressurised flammable gases. The explosion of a cylinder is assumed to require the addition of external energy (by handling impact, fire, etc.).

Note: on-site explosion may be accompanied by the generation of missiles from bursting of the tank.

3.1.3. Risk of drifting toxic or explosive cloud

For drifting gas cloud scenarios, only easily dispersed products are included, i.e. those existing in the gaseous phase at atmospheric pressure.

Some liquids boil at relatively low temperature thus giving rise to a potential gaseous release. The boiling point (T < 100°C) of the liquid is used as the selection criterion.

3.1.4. Risk of liquid chemical pollution

Products likely to cause a risk of chemical pollution are identified, in particular toxic and corrosive substances.

For simplification, all chemical products that are in liquid form at ambient temperature are included.

3.1.5. Risk of missile generation

The risk of missile generation is associated with:

- the presence of pressurised or flammable gas,
- the use of pressurised equipment,
- the presence of high speed rotating machinery.

For gas storage, the risk of missile generation is accentuated in the event of a fire, as the elevated external temperature leads to increased internal pressure in the tank.

Therefore, the sources of missiles considered are:

- vessels containing pressurised or flammable gas,
- rotating machinery with a casing not designed to contain missiles that might be generated,
- missile generation as a consequence of on-site explosions (e.g. tank fragments).

3.2. IDENTIFICATION OF BOUNDING SCENARIOS / LINES OF DEFENCE

For installations where there are potential consequences for the nuclear safety functions or the environment, and where the risk is not addressed, at the source, by design provisions, it is necessary to identify the internal and external initiating events which may lead to the undesirable consequences.

After the initiating event has been identified, one or more bounding scenarios are defined for the installation.

For each type of threat listed, the identified initiating events are assessed to investigate the possibility of:

- a cumulative effect of the threats,
- potential for common cause failure between the installations concerned, i.e. can a single threat simultaneously affect more than one installation?

Physical or organisational lines of defence are put in place in order to reach the required level of control. The lines of defence are mainly based on prevention.

3.3. VERIFICATION

The performance and capability required of each line of defence is established by quantifying the consequences of the bounding scenarios and thus ensuring that they are adequate.

The acceptability of the risk is based on the objective of not initiating the Offsite Emergency Plan. The acceptability of the risk is also assessed by in terms of frequency / consequence.