



L08.- Description of the severity of the potential consequences (I)

International Atomic Energy Agency



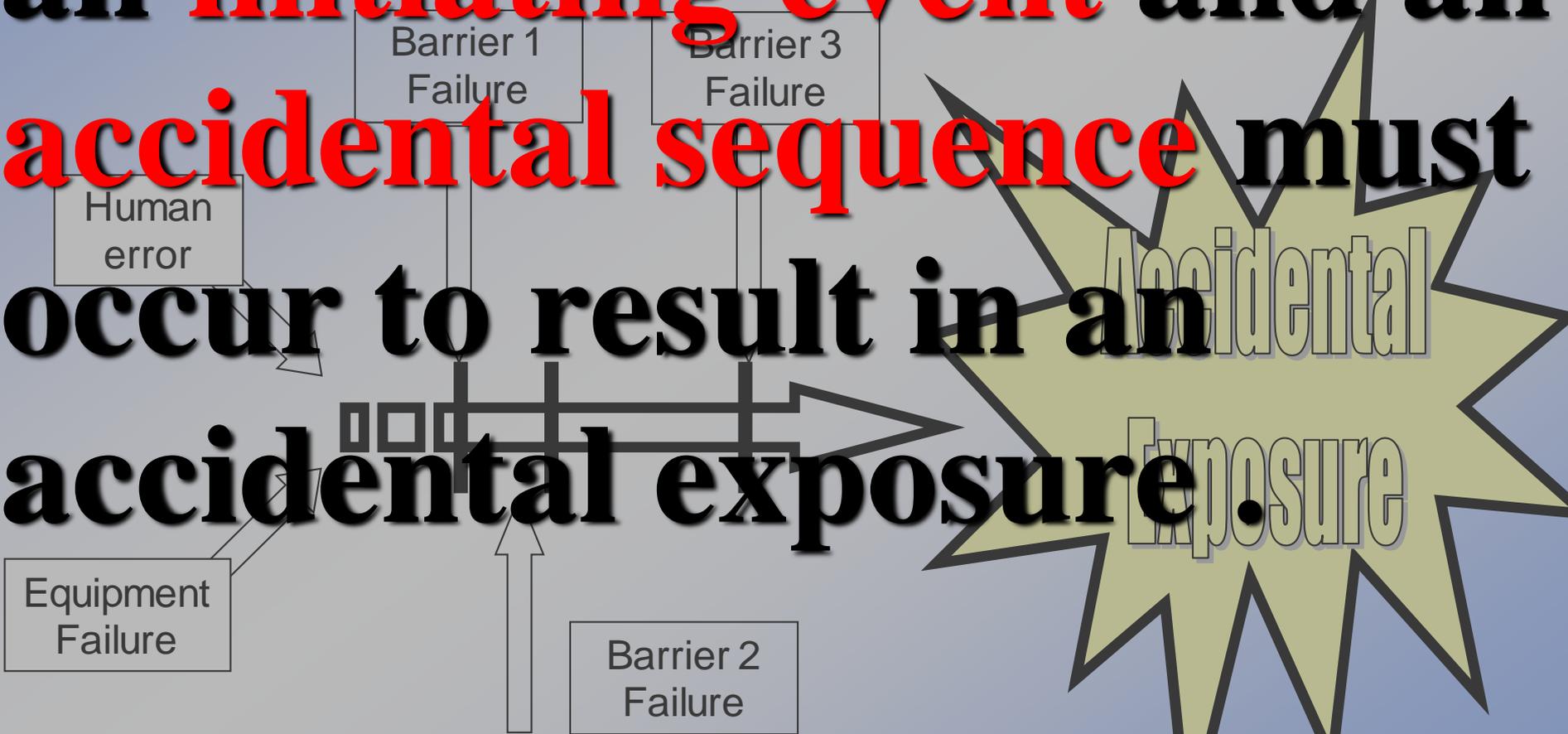
OBJECTIVE

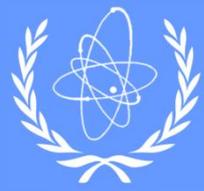
Identify the elements of the safety assessment that includes a probabilistic approach based on the risk appraisal:

- **Magnitude of the consequences**
- **Analysis of safety barriers**
- Risk estimation methods
- Risk management – decision making

Lesson learnt from accidents: *few times accidents happen due to a single event*

an initiating event and an accidental sequence must occur to result in an accidental exposure.





Magnitude of the consequences



Magnitude of the consequences

In radiation protection, consequences are assessed in terms of radiation doses.

To assess the consequences, it is necessary to estimate the dose received by individuals as a result of an initiating event (hence, deviations of normal operation).

The assessment of the consequences implies:

- Identify individual(s) who may be exposed (workers, public and patients)
- Estimate the magnitude of the dose received by the exposed individual(s)





Magnitude of the consequences

Identify individuals who may be exposed (example)

Activity: HDR Brachytherapy

Initiating Event: Breakage of the weld joining the drive cable and the source, which causes the source to remain inside the patient's body after the treatment.

Patient: Events will have consequences for the patient in terms of an excessive radiation dose

Worker: Events may have consequences for the worker in terms of anomalous exposure

Public: Events may have consequences for the public; if it is not detected that the source is in the body of the patient, he/she may leave the hospital and cause radiation exposure to people near to him/her

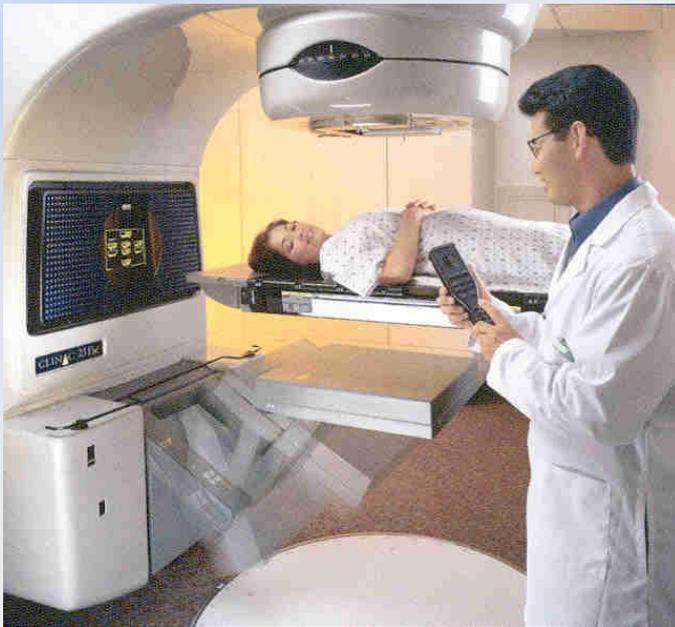




Magnitude of the consequences

Important

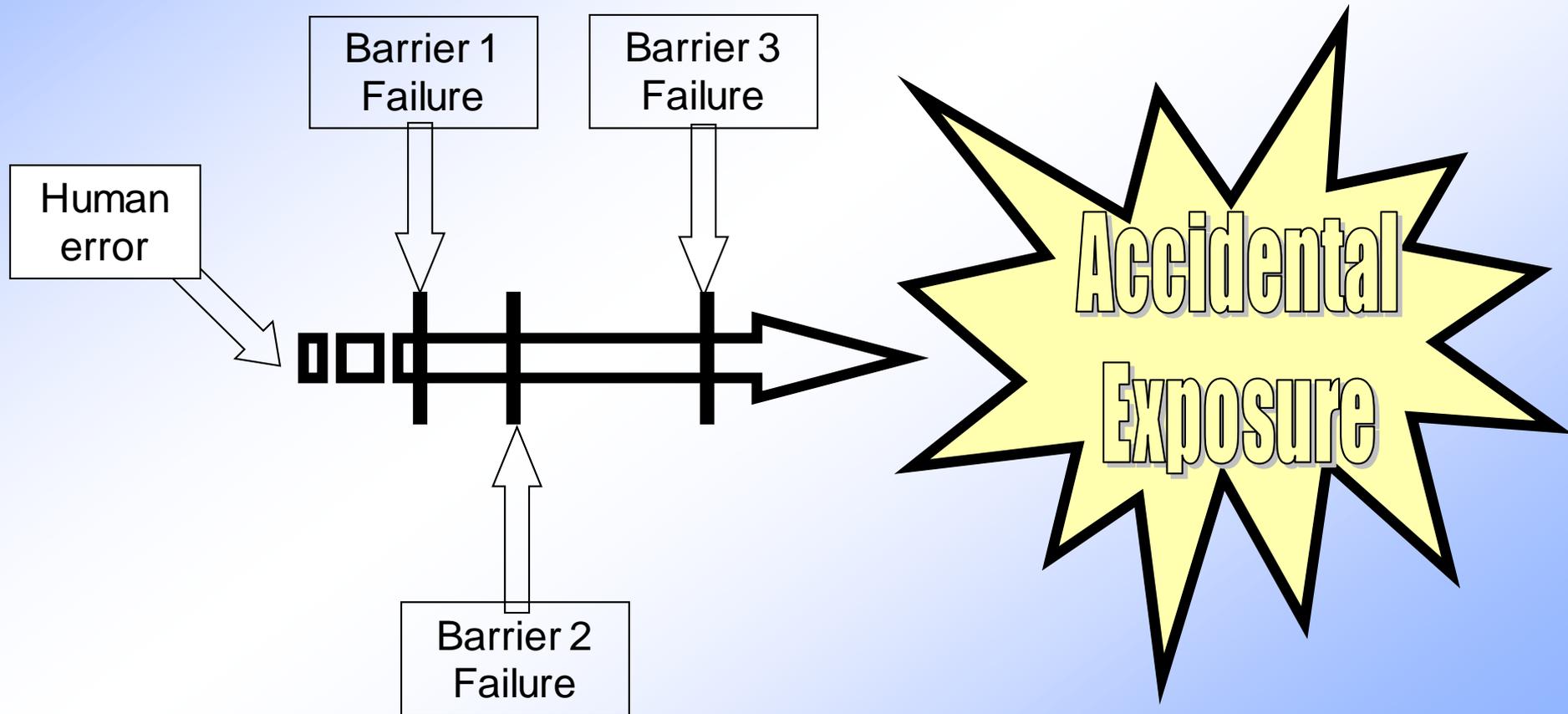
In the case of medical practice (radiotherapy and therapeutic nuclear medicine) a too low radiation dose has adverse consequences for patients





Magnitude of the consequences

Failure of all barriers of the defence in depth must be assumed to estimate the consequences of an initiating event





Magnitude of the consequences

According to duration and the number of people affected, the consequences may be classified into three groups:

Episodic consequences

Can affect an individual by chance

Example: Binding of the source in a gammagraphy device, when scanning a welded joint.

Programmatic consequences

Affect an individual for a long period of time

Example: Error in the preparation of a teletherapy patient treatment plan

Systematic consequences

Affect many individuals for a long period of time

Example: Theft of a radioactive source used in oil well logging which is sold as scrap



Magnitude of the consequences

The magnitude of the consequences may be assessed quantitatively or qualitatively, but this assessment should always be carried out on the basis of the doses individuals receive as a result of the analyzed initiating event



Analysis of Safety Barriers



Safety barriers

Passive systems, automatically or manually initiated safety systems, or administrative controls that are provided to ensure that the required safety functions are achieved



What are safety barriers?

Protection measures to avoid or mitigate the consequences of an accident

Safety barriers may consist of for example hardware, software, including personnel and procedures as well as computer software, management control,



Analysis of Safety Barriers

Barriers

Interlocks

Systems and/or technological equipment with a protective function that are able to automatically detect an unsafe condition

Alarms

Sound or visual signals that facilitates people to take decisions, but which require human involvement to restore safety conditions

Procedures

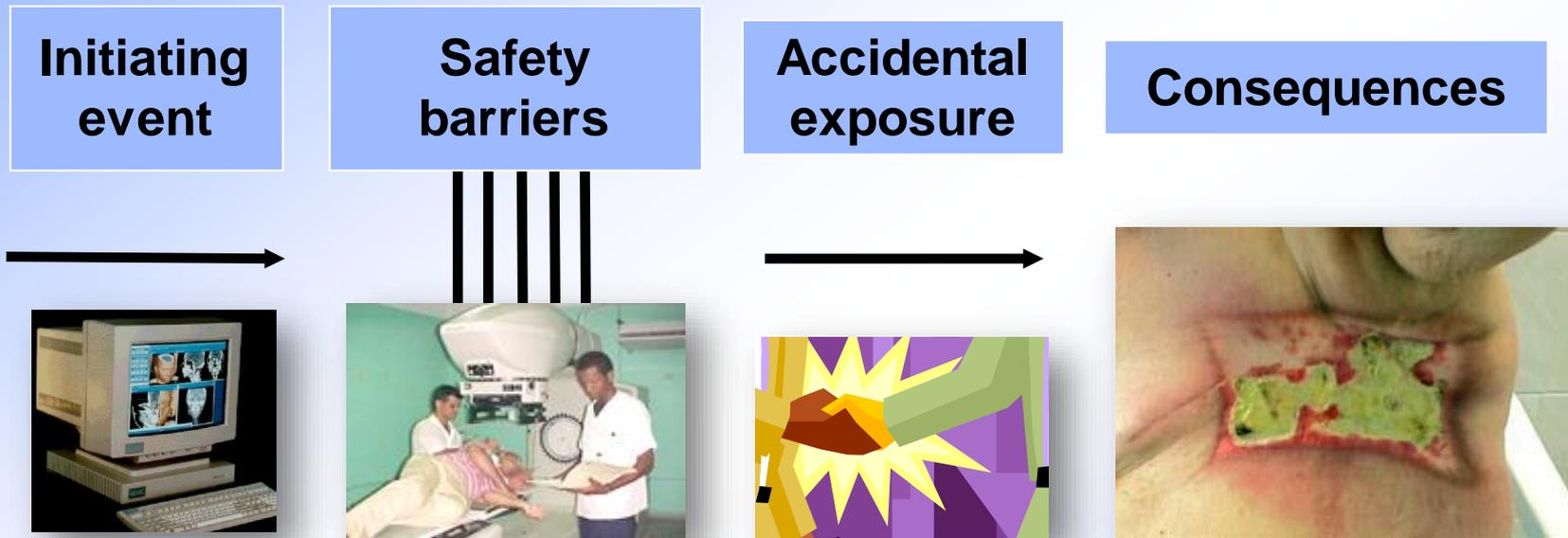
Written instructions and/or accepted as normal practice that permit avoid, prevent, detect, control or limit an unsafe condition which can potentially lead to an accident

Emergency procedures

Written instructions and or accepted as practice, provided to mitigate accident consequences



Analysis of Safety Barriers



Depending on when barriers operate, they are classified as:





The analysis of safety barriers is based on assessing four generic safety functions:

- Avoid
- Prevent
- Detect & Control
- Detect & Limit



Assess the generic safety function **AVOID**

- It allows to find safety measures that **avoid** the occurrence of the initiating event.
- They are generally administrative measures adopted by the facility.
- Example: *"Never abandon the gammagraphy equipment when works are carried out in field"*



Assess the generic safety function **PREVENT**

- It allows to find safety measures that **prevent** the occurrence of the initiating event
- Typically are measures such as staff training, equipment maintenance, reducing the burden of work, use of working protocols, etc.
- Example: *“Moderate workload for nuclear medicine assessments”*



Assess the generic safety function **DETECT & CONTROL**

- It allows to find safety measures that **detect** the occurrence of the initiating event, and **control** it to prevent postulated consequences from occurring
- This generic function is evaluated as the sum of the two actions since the safety function is not met if the barrier only satisfies the action of detecting the event
- Example: *“Perform a portal image during the first session of the treatment in the accelerator and correction of errors in positioning of the patient in the equipment”*



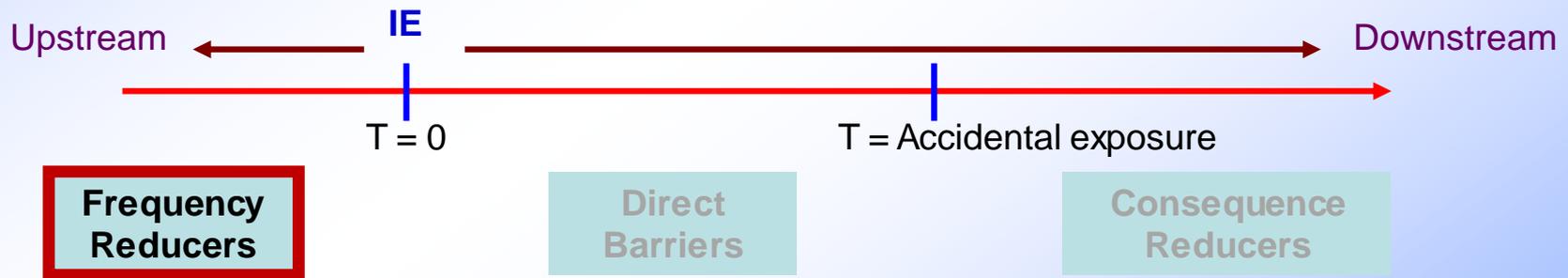
Assess the generic safety function **DETECT & LIMIT**

- It allows to find safety measures that **detect** the occurrence of an operational incident or accident and **limit** the consequences by reducing the doses to individuals or reducing the number of exposed individuals
- This generic function is evaluated as the sum of the two actions
- Example: *“Periodic (monthly) radiometric survey which allows to detect a neutron source and their placement within their shielding container ”*



Analysis of Safety Barriers

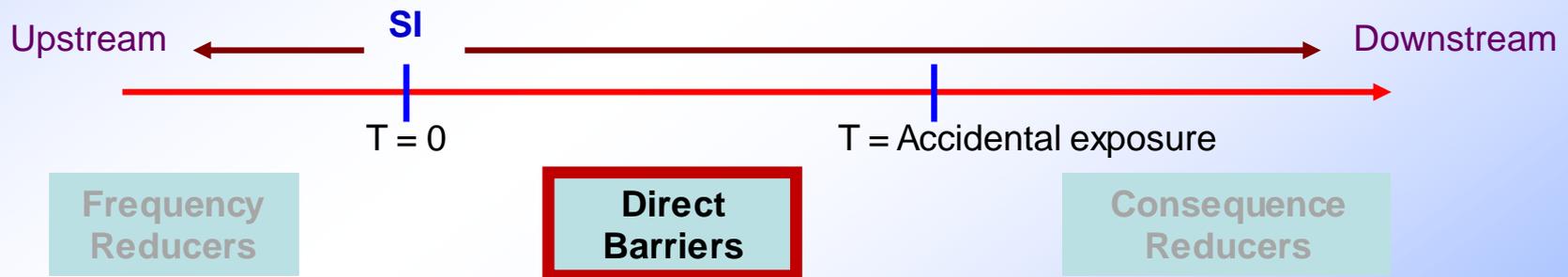
- **Avoid** and **Prevent** generic safety functions are classified as *frequency reducers*
- Allow to identify safety measures that make possible to reduce the frequency of occurrence of the initiating event

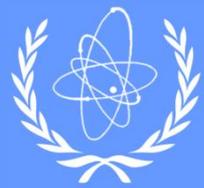




Analysis of Safety Barriers

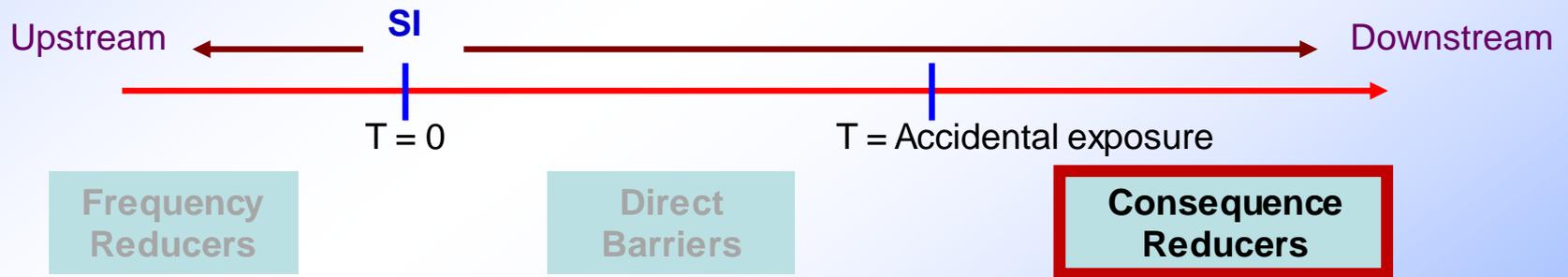
- **Detect & Control** generic safety functions are classified as *direct barriers*
- Allow to identify safety measures that directly prevent (cut) the accidental sequence

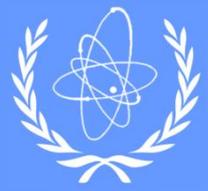




Analysis of Safety Barriers

- **Detect & Limit** generic safety functions are classified as *consequence reducers*
- Allow to identify safety measures to mitigate the magnitude of consequences





Thank you!