L06.- Elements of the Safety Assessment (II)

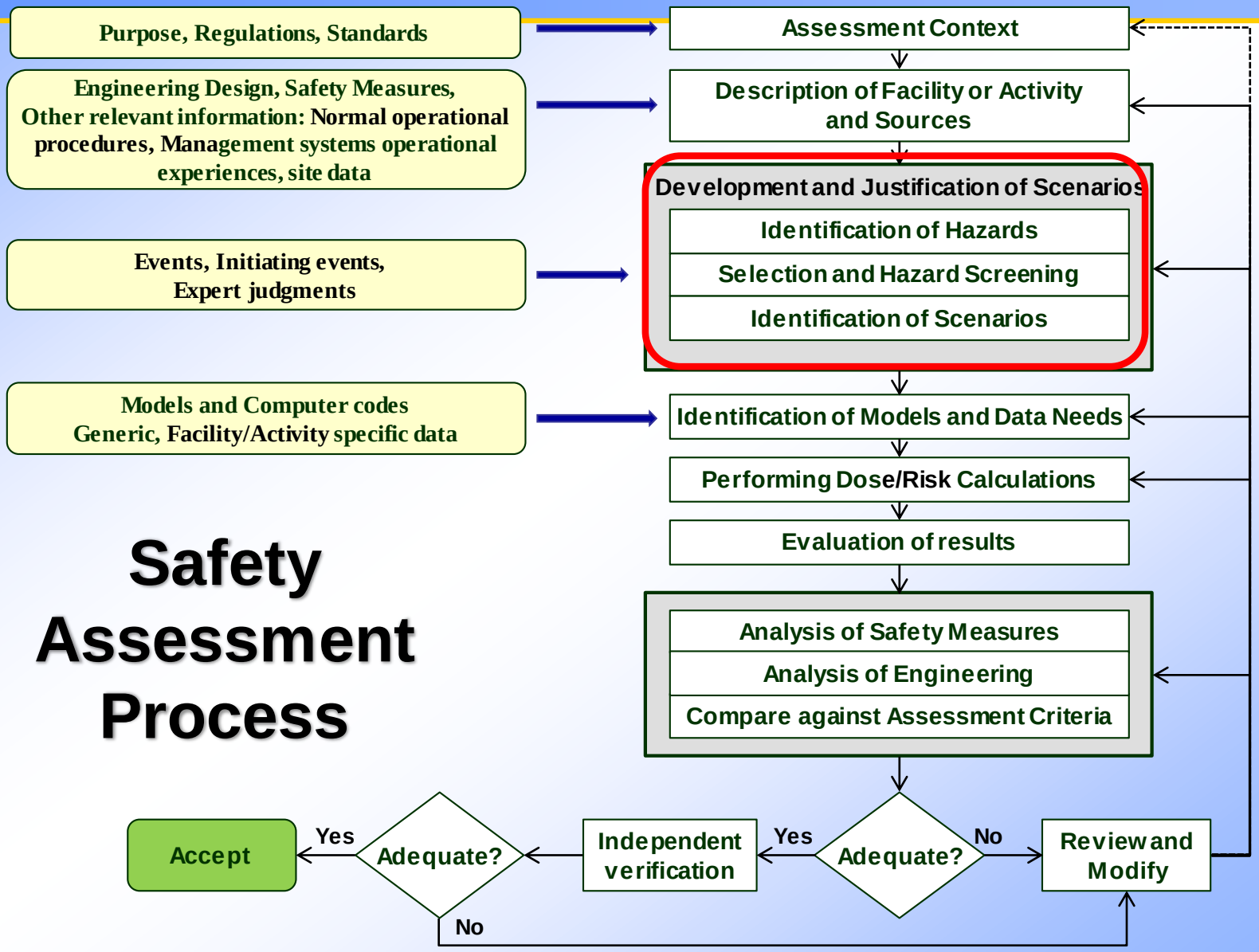
International Atomic Energy Agency

OBJECTIVE

To identify the key elements in the development of the safety assessment:

- Assessment context. Safety criteria and end points.
- Description of the facility or activity
- Development and justification of scenarios

Safety Assessment Process



Safety Assessment Process

Key terms used

- **Scenario**
  - A hypothetical sequence of processes and events that can lead to impacts (e.g. human exposure, environmental contamination), and
  - is one of a set devised for the purpose of illustrating the range of future behaviours and states of a facility or activity, for the purposes of evaluating a safety case

- **Reference Scenario**
  - Normal evolution scenario, design scenario, base case scenario, central scenario;
  - Benchmark scenario against which the impact of alternative scenarios can be compared – often the most likely scenario

Key terms used

- **Alternative Scenarios**
  - Investigate the impact of scenarios that differ to a lesser or greater extent from the reference scenario
  - Assess uncertainties in the assumptions made in scenarios
  - Sensitivity analysis of the reference scenario

- **PIE (Potential Initiating Events)**
  - A **PIE** is a feature, event, process or other factor, that it may be necessary to consider in safety assessment.
  - This includes physical features, events and processes that could directly or indirectly influence the release and transport of radionuclides from the facility or subsequent radiation exposures to humans, plus other factors, e.g. regulatory requirements or modelling issues, that constrain or focus the analysis

Development and justification of scenarios

- **Scenario is a postulated set of conditions and/or events that can lead to impacts (e.g. human exposure, environmental contamination);**
- **Scenarios are to be developed in accordance with the safety context and should consider:**
  - ✓ *All relevant existing and potential hazards arising from facilities or activities;*
  - ✓ *Interrelation of hazards;*
  - ✓ *Evolution of hazards over the considered time frame.*

Development and justification of scenarios

✓ ***Scenarios are to be identified for:***

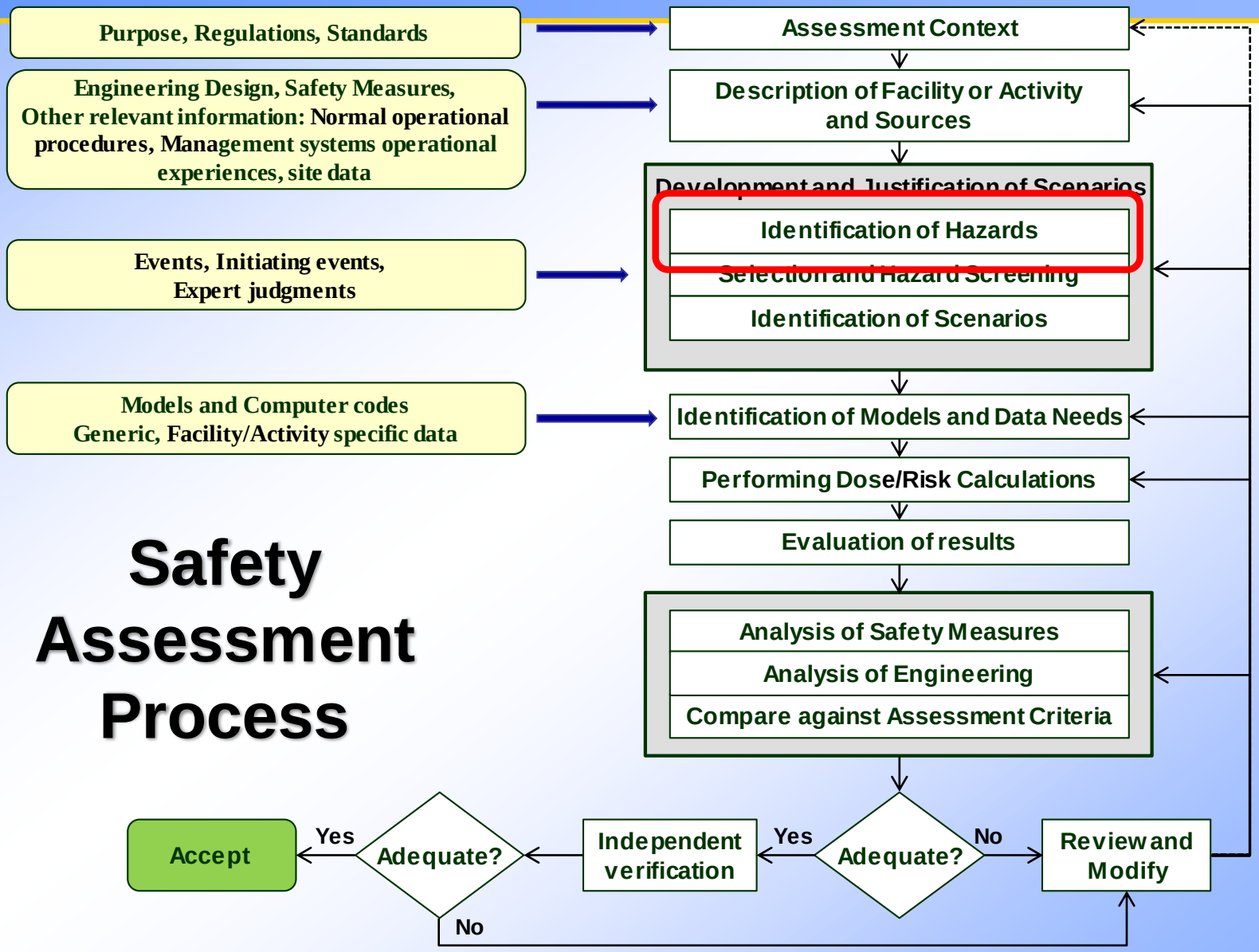
- *normal operation*
- *anticipated operational occurrences*
- *serious accidents*
- *post operational period*

Scenario development approach

Screening of PIEs

- **Reduce the number PIEs for detailed analysis**
- **Screen PIEs using well-documented screening criteria**
  - Assessment context
  - Facility or activity description
  - Probability/likelihood of occurrence
  - Consequence of occurrence
- **Transparent screening process**
- **Document the basis for rejecting a particular PIE**

Safety Assessment Process



Safety Assessment Process

Hazard identification

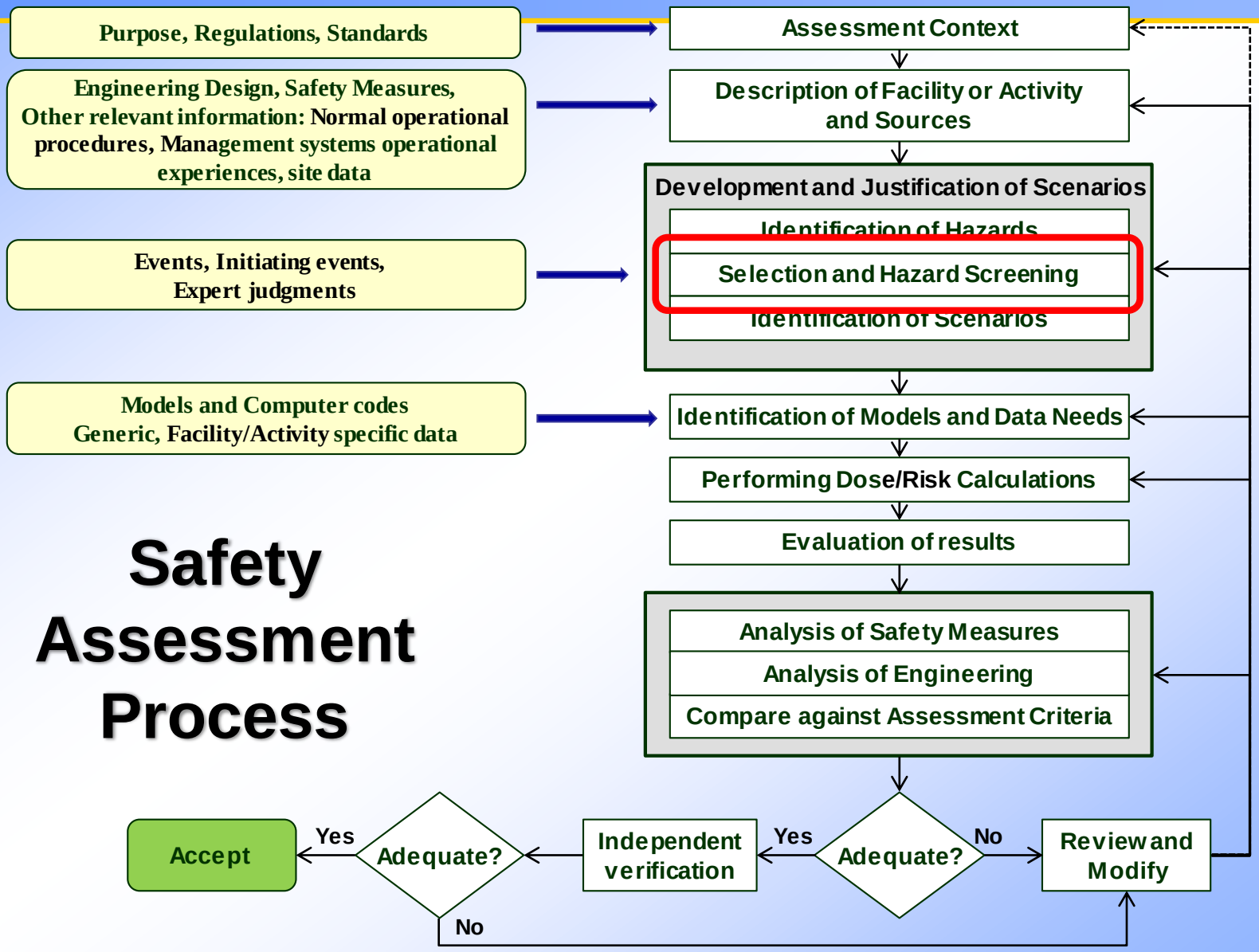
- A systematic approach to hazard identification, scenario development and hazard screening should be used;
- Following steps should be applied in an iterative manner:
  - ✓ *Identification of hazards;*
  - ✓ *Identification of activities / initiating events;*
  - ✓ *Identification of scenarios;*
  - ✓ *Hazard screening;*

Hazard identification

Hazards may arise from:

- ✓ *Inventory, activity, physical conditions and location of the radiation sources;*
- ✓ *Non-radiological hazardous materials (e.g. chemo-toxic, flammable) or physical conditions (e.g. high temperature, pressure);*
- ✓ *Management activities and processes;*
- ✓ *Software reliability;*
- ✓ *Etc.*

Safety Assessment Process



Safety Assessment Process

Hazards screening

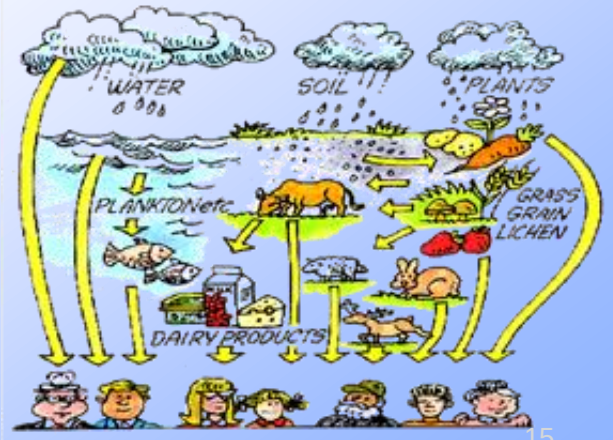
- ✓ Screening of hazards is performed in order to identify and direct efforts towards all significant and relevant hazards for the facility or activity;
- ✓ Hazard screening could lead to a reduced number of scenarios to be further assessed;
- ✓ Screening out means that the hazard associated impact is evaluated to be sufficiently low that do not needs any further assessment.

Hazards screening

- Qualitative screening of hazards which could be screened out:
  - ✓ lie outside the scope and/or objectives of the safety assessment, or
  - ✓ cannot lead to consequences in excess of relevant criteria,
- Screening of hazards is performed by performing a conservative quantification (using simplified conservative assumptions and simple models) of the impacts and comparing the results with screening limits;

Hazards screening

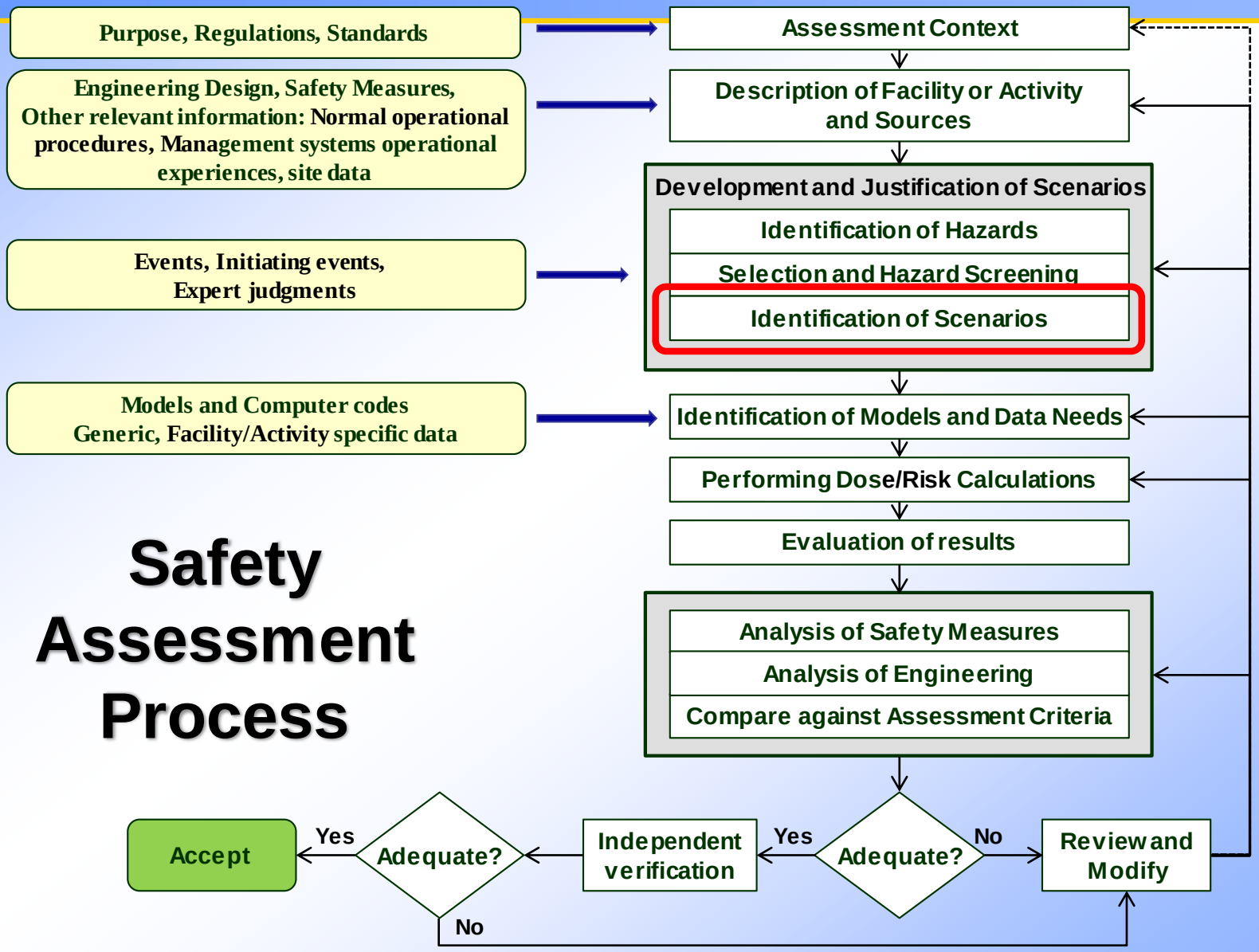
- ✓ Hazards should be quantified taking no benefit from any protective or mitigating safety measures to be used;
- ✓ However benefit from intrinsic (passive) features of the facility (e.g. walls for shielding, engineered safety features), which are not affected by the initiating event, should be taken into account;
- ✓ The hazard screening should involve consideration of all relevant exposure pathways to workers and to potentially affected members of the public.



Hazards screening

- ✓ Sometimes it is possible to group hazards, so that one bounding assessment of their consequences can be undertaken;
- ✓ Where hazards are eliminated or grouped, a justification for the approach should be included within the safety assessment;
- ✓ In subsequent safety assessments hazards screening justifications should be reviewed to check that they remain valid.

Safety Assessment Process



Safety Assessment Process

Identification of scenarios

- ✓ For new facilities or activities, a comprehensive identification and assessment of all events (activities) should be carried out;
- ✓ For modifications of existing facilities or activities, the assessment should focus on those events that could impact on the modification, either directly or indirectly;
- ✓ For facilities or activities, special attention should be given to human factor and technological procedures as this often can represent the main scenario generating component.

Identification of scenarios

- **Anticipated operational occurrences are those events**
  - Which exceed the bounds of normal operation and have the potential to challenge the safety of facility;
  - Which might be expected to occur at least once during the lifetime of facility;
- **Incidents and accidents have a lower frequency of occurrence than the anticipated operational occurrences:**
  - They would not be expected to occur during the lifetime of the facility but have to be considered in the design of the facility.

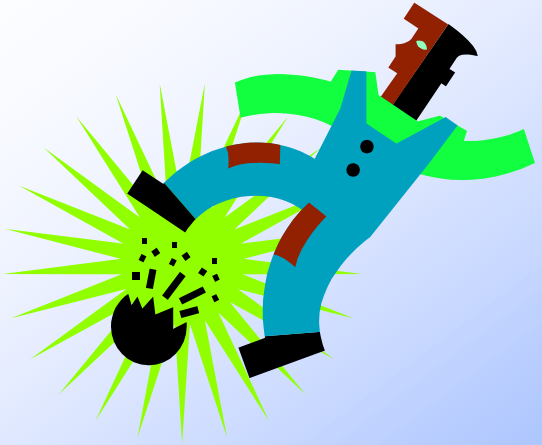
Identification of scenarios

Scenarios for normal operation should address:

- *All conditions under which the facility systems and equipment are being operated or activity is carried out as expected, with no internal or external challenges.*
- *Normal operation conditions includes all the phases of operation for which the facility is designed to operate (including start up and shutdown where appropriate) and maintenance over the considered time frame.*
- *The effects of variations in the input materials (feedstock, source material, receipts, etc.) on normal operations should be considered.*

Identification of scenarios

- **Incident or accident conditions are defined as accident conditions:**
  - ✓ *Against which a facility is designed;*
  - ✓ *For which the damage to the facility and the release of radioactive material would remain within defined acceptable levels;*



Identification of scenarios

- **Serious accidents** are those against which the facility is not explicitly designed to withstand.
- They may be considered in two general groups:
  - *Accidents which have a high enough probability of occurrence and severe enough consequences that it is advisable to give some prior consideration to possible corrective or remedial actions which could be taken should such an event occur.*
  - *Accidents which have a low enough probability of occurrence and not to warrant such consideration, even though the potential consequences could be very high.*

Identification of scenarios

- For the first group of accidents the assessment should aim to quantify a facility safety margin and demonstrate that a degree of defence in depth is provided;
- The facility design and operation should include measures to:
  - Prevent the escalation of events into serious accidents, control the progression of serious accidents and limit the releases of radioactive material by provision of additional equipment and accident management procedures;
  - Mitigate the potential radiological consequences by the provision of plans for on-site and offsite emergency response.

Identification of scenarios

- Accidents of the second group are usually screened out from further consideration, however a justification for such decision should be provided and included into safety assessment.

Initiating events

Identification of postulated initiating events (PIEs) and their evolution should be carried out using appropriate techniques and information on the:

- ✓ *Site;*
- ✓ *Design and operation of facility or activity;*
- ✓ *Operational experience;*
- ✓ *Feedback from other facilities or activities.*

Postulated Initiating Events (PIE's) :

- – *natural event,*
- – *human induced outside the facility*
- – *human induced inside the facility*

Initiating events

External initiating events.

- **Natural events:** adverse meteorological conditions (e.g. wind, snow, rain, ice, temperature, flood, lightning), earthquakes, biological intrusion;

- **Man-made events:** aircraft crashes (with or without subsequent fires), explosions, fires, loss of electrical power or other services, unauthorized access.

Initiating events

Internal initiating events at the facility or the site;

- ✓ *Fire, explosion, structural collapse, leakages or spillages, failures of ventilation, drop of heavy loads, failures of protective measures.*

Man-made initiating events;

- ✓ *Operator errors and violations, misidentifications performing incompatible activities.*