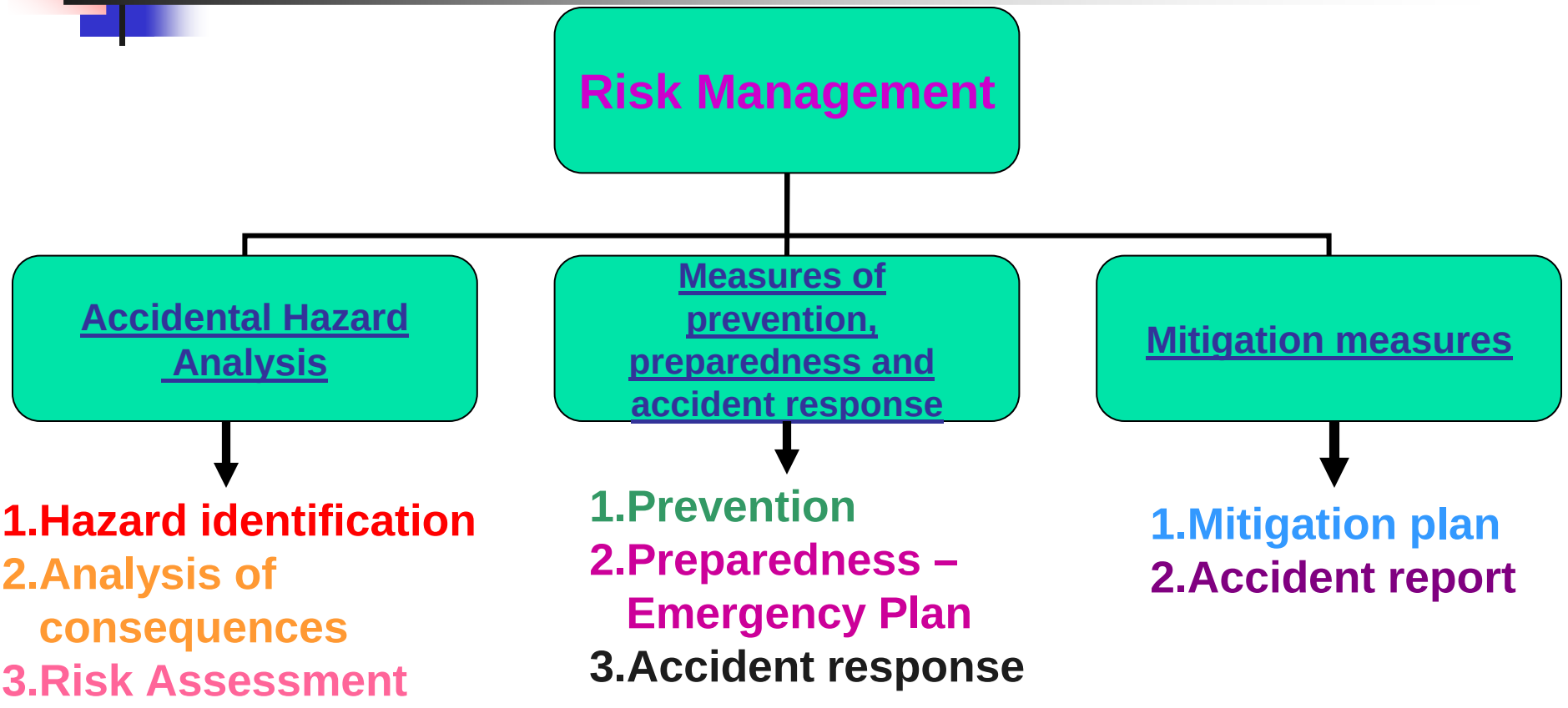

Case study Serbia
LPG storage

Content of the Study: Accident Hazard Assessment

- General documentation
  - information about individuals/legal entities involved in the preparation of SR
  - licenses, certificates
  - assignment of the case study
- Introduction
  - aim of the SR, regulations, instructions and recommendations used

Content of the Study: Accident Hazard Assessment



Accidental Hazard Analysis

I phase: Hazard identification

- Preparation - Team for Hazard identification
- Data collection
- Identification of possible hazard sources

II phase: Analysis of consequences

- Preparation - Team for Analysis of consequences
- Possible accident scenarios
- Modeling
- Analysis of vulnerability

III phase: Risk Assessment

- Assessment of the probability
- Assessment of possible consequences
- Risk evaluation

Measures of prevention, preparedness and accident response

I phase: Prevention

Set of measures and procedures which are taken in the establishment in order to reduce possibility and limit consequences of accident.

II phase: Preparedness – Internal Emergency Plan

III phase: Accident response

Procedures for accident response, intervention units, scheme for accident response

Background information
LPG storage

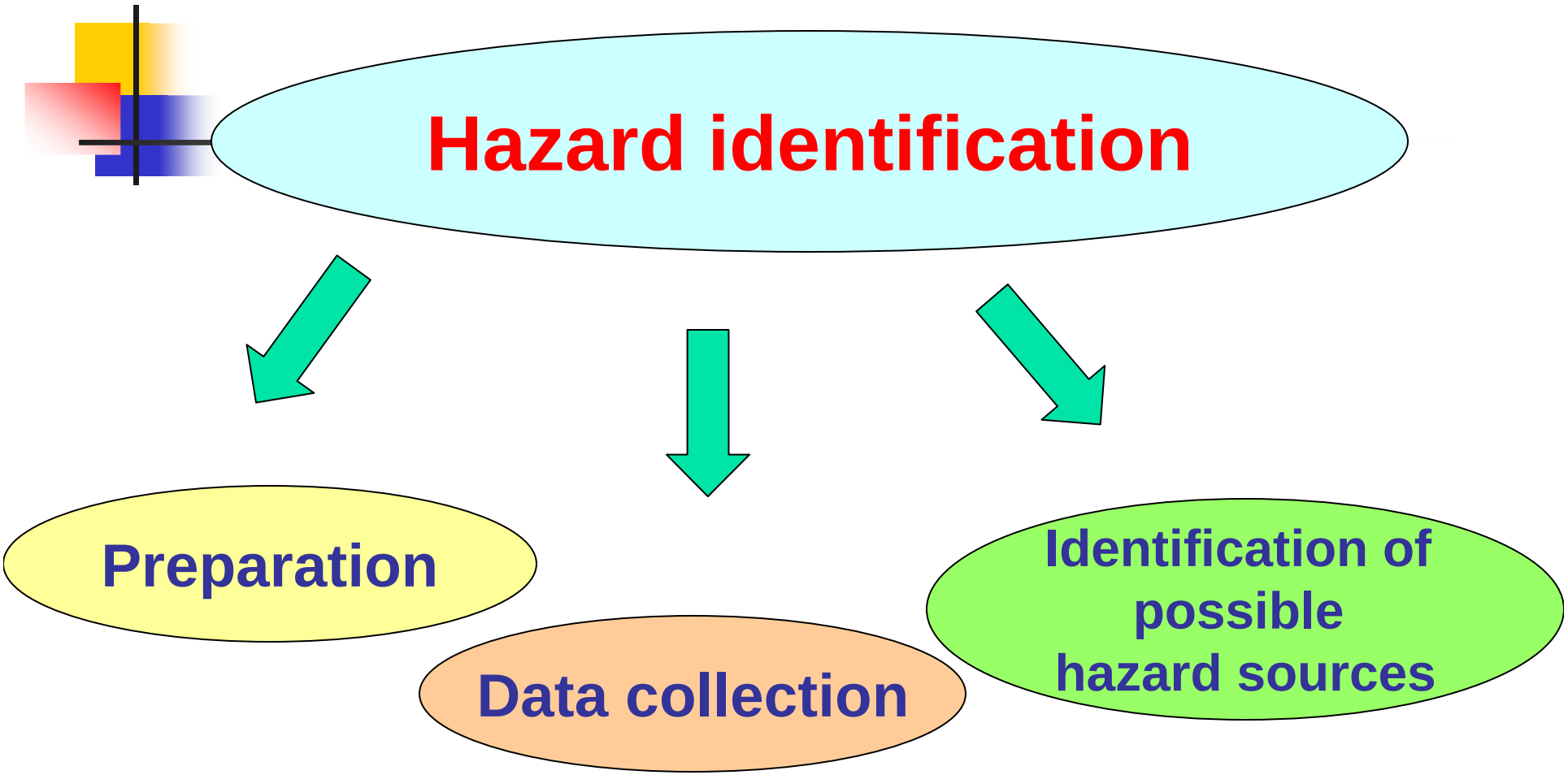
- 4 big spherical tanks for butane, each of 1000 m^3 (total 4000 m^3)
- 7 spherical tanks for propane, each of 600 m^3 (total 4200 m^3)
- 2 big cylindrical vertical tanks for natural gasoline (mixture of pentanes and higher hydrocarbons), each of 2700 m^3 (total 5400 m^3)
- 2 tanks for LPG, each capacity of 60 m^3 (total 120 m^3)
- loading via pipelines
- distribution via road and rail tankers

Butane tanks

Propane tanks

Natural gasoline tanks

LPG tanks


Hazard identification
Preparation
Data collection
Identification of possible hazard sources

Accidental Hazard Analysis

Hazard identification

- 1.1 Preparation - team for Hazard identification

  Team includes experts from the establishment and external experts

- 1.2 Data collection
  - data about storage (name, address, telephone, manager, number of employees)
  - technical documentation used for preparation of the Study
  - purpose of the establishment
  - description of the site and its environment
  - meteorological, geological, hydrological conditions
  - description of installations in the storage

1.2 Data collection

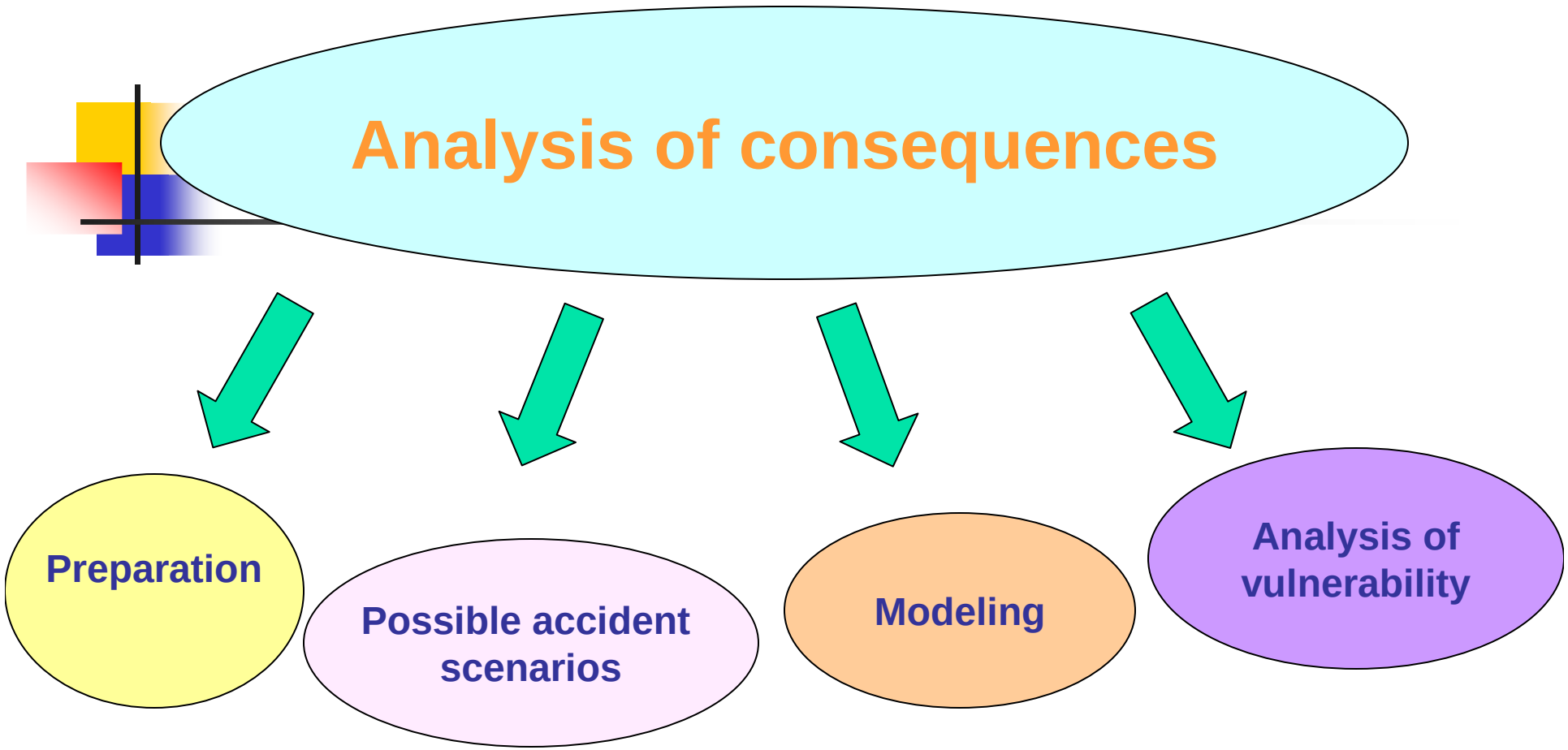
- description of the main activities/processes:
  - Filling of tanks via pipelines
  - Storage
  - Unloading from tanks to road and rail tankers
  - Distribution

1.2 Data collection

- description of dangerous substances:
  - inventory of dangerous substances: propane, butane, LPG and natural gasoline
  - chemical name, CAS number, IUPAC name, empiric formula, risk phrases
  - physical, chemical, toxicological, ecotoxicological properties
  - reactions relating e.g. to construction material
  - flammable and explosive characteristics
  - maximum capacity of storage facilities

1.3 Identification of possible hazard sources

- checking of 'critical points' of the processes/activities, especially possible hazard sources in the installations
  - fire and explosion, conditions under which they occur, event tree analysis
  - historical data on accidents


Analysis of consequences
Preparation
Possible accident scenarios
Modeling
Analysis of vulnerability

Analysis of consequences

2.1 Preparation - Team for Analysis of consequences

2.2 Possible accident scenarios

- Accident during loading
- Pipeline failure
- BLEVE of storage vessels

2.3 Modeling

- using program ALOHA
- List of accident scenarios:

1. gas releasing during loading of gas from storage tank into road tanker

a) no burning, toxic effects

b) ignition leads to jet fire, thermal radiation

2. gas release from LPG tank due to valve damage; total content released

a) no burning, toxic effects

b) ignition leads to jet fire, thermal radiation

3. fire on LPG storage and BLEVE of LPG tank

2.3 Modeling

4. release from tanks (spherical tanks for propane and butane) due to valve damage

a) no ignition, toxic effects
b) ignition leads to jet fire, thermal radiation
c) BLEVE

5. leakage of natural gasoline from tank

a) no burning, evaporating puddle
b) burning, pool fire
c) BLEVE

6. combustion: toxic effects of carbon-monoxide

2.4 Analysis of Vulnerability

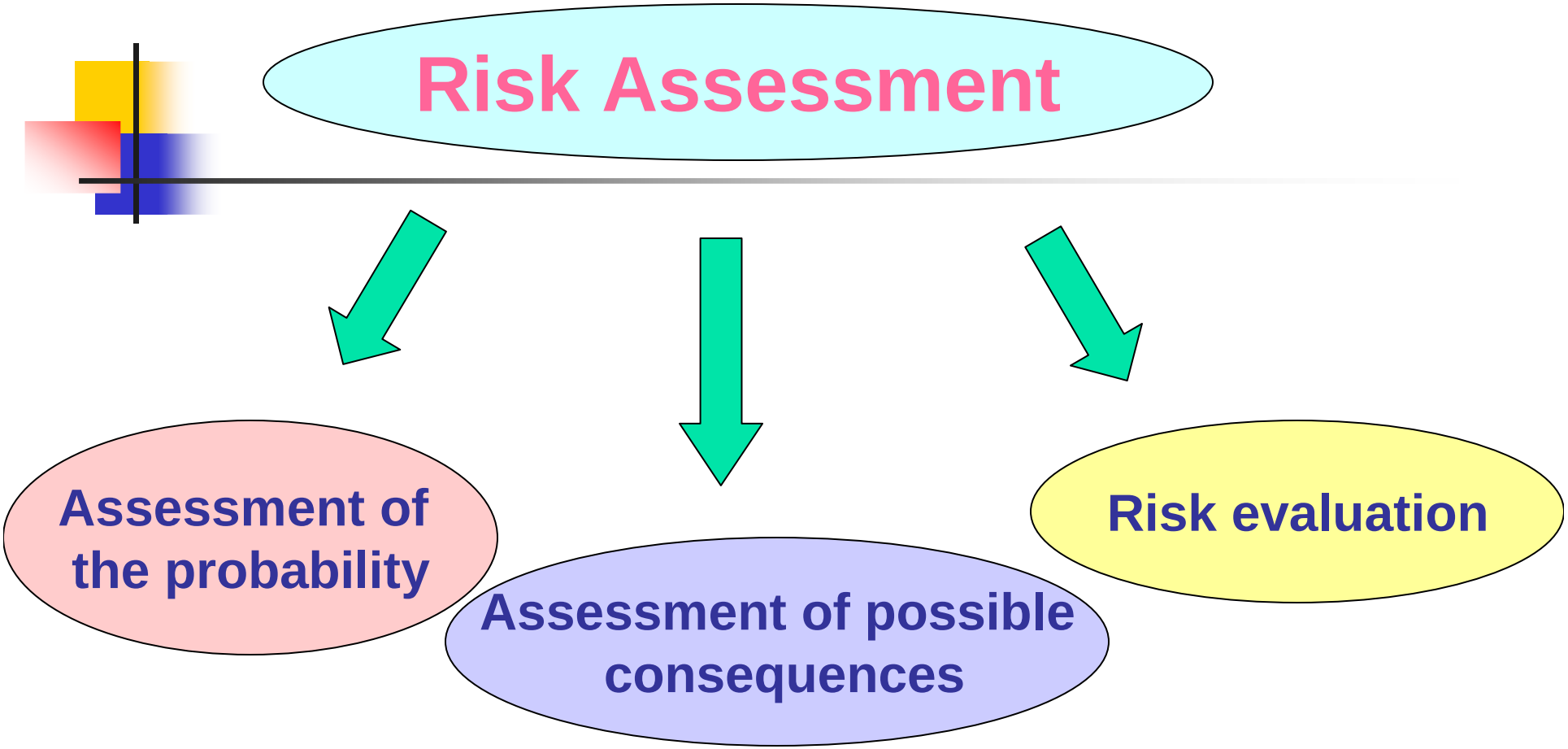
1. Identification of vulnerable area including maps
   - demographic data (number of employees, population density, schools, hospitals…)
   - data about surroundings (industrial, residential, communal, public areas)
   - data about protected natural goods (forests, waterpaths, agriculture areas...)

2. Level of accident based on extent of consequences
   - I level (level of installation)
   - II level (level of establishment)
   - III level (municipality level)
   - IV level (regional level)
   - V level (international level)

2.4 Analysis of Vulnerability

3. Assessment of vulnerable area

- Assessment of dispersion of gases
  - concentration used: IDLH, MAC, $LC_{50,}$ ERPG, TEEL...
- Assessment of consequences from explosion
  - for men: primarily cause – blast force, secondary cause – hazardous fragments
  - for buildings
- Assessment of consequences from fire
  - Level of thermal radiation (kW/m^2)
  - Toxic effects of combustion
  - Overpressure (blast force)
- Assessment of health effects
  - dose, toxicity, synergistic effects…
- Assessment of consequences for the environment


Risk Assessment
Assessment of the probability
Assessment of possible consequences
Risk evaluation

3.1 Assessment of the probability

Assessment of the probability is done on one of the following ways:

1. historical approach – based on information about similar accidents worldwide
2. analytical approach – based on hazard identification
3. combination of 2 approaches

- Probability can be **great, medium and small**

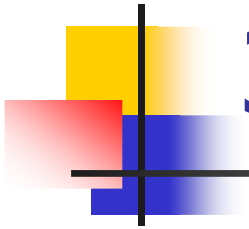
3.2 Assessment of possible consequences

- Possible consequences for man and environment are assessed as follows:

1. negligible
2. significant
3. serious
4. major
5. extensive

Assessment of possible consequences

indicators	Consequences				
	Negligible	significant	serious	major	extensive
Fatalities			1-5	6-20	>20
Number of injured, intoxicated		1-10	11-50	51-200	>200
Wild animals	0,1	0,1-1t	1-2t	2-10t	>10t
Domestic animals	0,5	0,5-10t	10-50t	50-500t	>500t
Fishes	0,5	0,5-5t	5-20t	20-100t	>100t
Contaminated area		1-10ha	10-100 ha	1-5 km^2	>5 km^2
Damage of accident (millions of RSD)	<0,02	0,02-0,2	0,2-2	2-10	>10



3.3 Risk evaluation

- **Negligible risk**
- **Minor risk**
- **Medium risk**
- **Major risk**
- **Extensive risk**

Risk is quantified based on assessment of probability and consequence assessment

Risk Quantifying

Probability	Possible consequences				
	negligible	significant	serious	major	extensive
small	negligible risk	minor risk	Medium risk	major risk	extensive risk
medium	minor risk	Medium risk	major risk	extensive risk	extensive risk
great	Medium risk	major risk	extensive risk	extensive risk	extensive risk

Risk Acceptability

- Risk is acceptable if it could be managed under certain conditions regulated by regulations (implementation of appropriate safety, technical, organizational measures…)

Appendices

- Annex I – Data about establishment
- Annex II – Data about dangerous substances
- Annex III – Inventory of all dangerous substances in the establishment (name, place in the process, quantities)
- Annex IV – Copy of approval on technical documentation regarding firefighting measures, issued by Ministry of Interior
- Annex V – Copy of approval on Fire Protection Plan, issued by Ministry of Interior
- Maps, Schemes, Diagrams

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