295557 - 295EQ033 - Risk and Safety at the Chemical Industry

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering
Academic year: 2018
Degree:
ECTS credits: 6  Teaching languages: English

Teaching staff
Coordinator: Pastor Ferrer, Elsa
Others: Planas Cuchi, Eulalia
         Agueda Costafreda, Alba

Prior skills
Calculus, basic chemistry and thermodynamics

Teaching methodology
- Regular classes
- Hands-on workshops
- Project based learning
- Case studies
- Seminars

Learning objectives of the subject
After this course, the students should be able to identify the risks associated to smart chemical factories and related installations; to evaluate the effects and consequences of severe accidents; to quantify and analyse technological risks.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>34h</th>
<th>22.67%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>20h</td>
<td>13.33%</td>
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<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>96h</td>
<td>64.00%</td>
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</table>
# 295557 - 295EQ033 - Risk and Safety at the Chemical Industry

## Content

<table>
<thead>
<tr>
<th>Introduction to technological risk management</th>
<th>Learning time: 4h</th>
</tr>
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<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td>- Introduction to accidental environmental impact</td>
<td></td>
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<tr>
<td>- Risk: definition, types and metrics</td>
<td></td>
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<tr>
<td>- Risk tolerability</td>
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<tr>
<td>- Accidental scenarios at the chemical industry</td>
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<tr>
<td>- Risk analysis structure</td>
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</table>

**Specific objectives:**
To understand the concept of risk. To have a general overview of the type of accidents that can occur at the chemical industry. To have a clear picture of the different activities involved in risk assessment and management at the chemical industry.

<table>
<thead>
<tr>
<th>Hazards identification</th>
<th>Learning time: 13h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 9h</td>
</tr>
<tr>
<td>- Hazards identification techniques: definition and types</td>
<td>Practical classes: 4h</td>
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<tr>
<td>- Hazardous materials at the chemical industry</td>
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<tr>
<td>- Historical Analysis</td>
<td></td>
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<tr>
<td>- Hazard &amp; Operability (HAZOP)</td>
<td></td>
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<tr>
<td>- Hazard Identification (HAZID)</td>
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<tr>
<td>- Fault trees and event trees</td>
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</tbody>
</table>

**Related activities:**
- Laboratory session 1: HAZOP workshop
- Laboratory session 2: Fault Trees and Event Trees workshop

**Specific objectives:**
To apply risk identification techniques. To identify and understand hazards associated to chemical substances.
## Source term

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
</table>
| - Introduction to source terms calculations  
- Flow of liquid through a hole in a tank  
- Flow of gas or vapour through a hole  
- Evaporation of a liquid from a pool  
- General guidelines for source term calculations in QRA |

### Specific objectives:
To know the main source term models and apply those with simplified hypothesis

<table>
<thead>
<tr>
<th>Learning time: 2h</th>
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</thead>
<tbody>
<tr>
<td>Theory classes: 2h</td>
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</tbody>
</table>

## Atmospheric dispersion

<table>
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<tr>
<th>Description:</th>
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</table>
| - Meteorological factors  
- Dispersion modelling: release types and models type  
- Gaussian models for neutral gases  
- Heavy gas dispersion  
- Consequence analysis  
- Vulnerability |

### Related activities:
- Laboratory session 3: Introduction to Aloha software  
- Laboratory session 4: Consequence and vulnerability analysis with Aloha software

### Specific objectives:
To quantify the effects and consequences of toxic releases

<table>
<thead>
<tr>
<th>Learning time: 10h</th>
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</table>
| Theory classes: 6h  
Practical classes: 4h |
### Runaway reactions

**Learning time:** 3h  
Theory classes: 3h

**Description:**  
- Historical analysis  
- Exothermicity  
- Risk analysis and process engineering  
- Study cases

**Specific objectives:**  
To understand the phenomena associated to runaway reactions. To know risk mitigation strategies in case of runaways.

### Fire Accidents

**Learning time:** 4h  
Theory classes: 4h

**Description:**  
- Types of fires  
- Flammability  
- Modelling: solid body model, pool fires, boilover, jet fires, fireballs, flashfires  
- Vulnerability

**Specific objectives:**  
To quantify the effects and consequences of fires

### Explosions

**Learning time:** 8h  
Theory classes: 6h  
Practical classes: 2h

**Description:**  
- Types of explosions  
- Blast and overpressure  
- Explosions modelling: vapour cloud explosions, Bleves vessel explosions, dust explosions  
- Vulnerability

**Related activities:**  
Laboratory session 5: Case study - Analysis of an LNG road tanker real explosion

**Specific objectives:**  
To quantify the effects and consequences of explosions
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## Quantitative risk analysis

<table>
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<td>Theory classes: 4h</td>
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<tr>
<td>Practical classes: 2h</td>
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### Description:
- Introduction to QRA: aim of the study and phases
- Standards in QRA
- Examples of simplified and complex set-ups

### Related activities:
Laboratory session 6: Simplified AQR of a real system

### Specific objectives:
To know the objectives and different parts of QRA. To apply QRA standards in a real system.

## Risk mitigation strategies

<table>
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<td>Theory classes: 4h</td>
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### Description:
- Functional safety
- Prevention and protection safeguards
- LOPA analysis

### Specific objectives:
To know the different functional safety strategies an layers of protection in chemical processes.

## Qualification system

- Partial exam 30%
- Final exam 40%
- Projects 30%

## Regulations for carrying out activities

Exams are all mandatory and all the documentation of the subject is allowed to be used during the exams. All evaluation elements are mandatory.

## Bibliography

### Basic: