



COLLEGE OF  
**ENGINEERING, ARCHITECTURE  
AND TECHNOLOGY**



**西南交通大学**  
Southwest Jiaotong University

# INTRODUCTION TO ENGINEERING (ENGR 1111)

Joint Bachelors Degree Program of Oklahoma State University & Southwest Jiaotong University

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## INTRODUCTION TO ENGINEERING

# Environmental Engineering Case Studies-I



# What Are Case Studies?

- A **case study** is a detailed study of a specific subject, such as a person, group, place, event, organization, or phenomenon.
- Case studies are stories that are **used as a teaching tool** to show the application of a theory or concept to real situations.
- Cases are narratives that present real-life scenarios/ problems and allow students to experience how professionals address problems encountered in the field.
- Case studies are a great way for first-year students to develop their research skills.
- A case study focuses on a single project for an extended period of time, which allows students to explore the topic in depth.



# What Are Case Studies?

- Cases have three main elements:

- ☐ (1) they are based on **real-life events** that allow students to experience problems they are not likely to encounter first-hand;
- ☐ (2) they **present** both **contextual & technical information** that is based on careful research and study;
- ☐ (3) they may present **no clear-cut solutions** to allow students to develop multiple perspectives



# Engineering case

- Within engineering, cases have been used since the 1950s with the first uses in chemical and civil engineering.
- Engineering cases are meant to enhance students' learning about engineering principles and practices by including the background and complexities of an engineering event.”

(Kardos & Smith, 1979)



# Case Study types

- There are **three** types of cases:
- **Micro cases** present dilemmas that individual engineers face in their daily lives and decisions.
- **Macro cases** involve societal issues that have the potential to impact the larger community
- **Exemplary cases** present situations that require individual(s) to take commendable actions to solve the problems

Harris (2003)





# Environmental Engineering Case Studies

- Environmental Disasters
  - Anthropogenic
    - Environmental pollution & pollutants originated by human activity
  - Naturally Occurring Disasters



# Environmental Engineering Case Studies

- Environmental Disasters

- Anthropogenic

- Bhopal: the Union Carbide gas leak
    - Chernobyl: Russian nuclear power plant explosion
    - Seveso: Italian dioxin crisis
    - The Great Smog of London
    - Major oil spills
    - Love Canal chemical waste dump
    - Baia Mare cyanide spill
    - European BSE crisis
    - Spanish waste water spill
    - Three Mile Island near nuclear disaster
    - Fukushima Nuclear Plant Disaster





# Environmental Engineering Case Studies

## ■ 1. Bhopal: the Union Carbide gas leakage

- December 3, 1984
- Bhopal, India

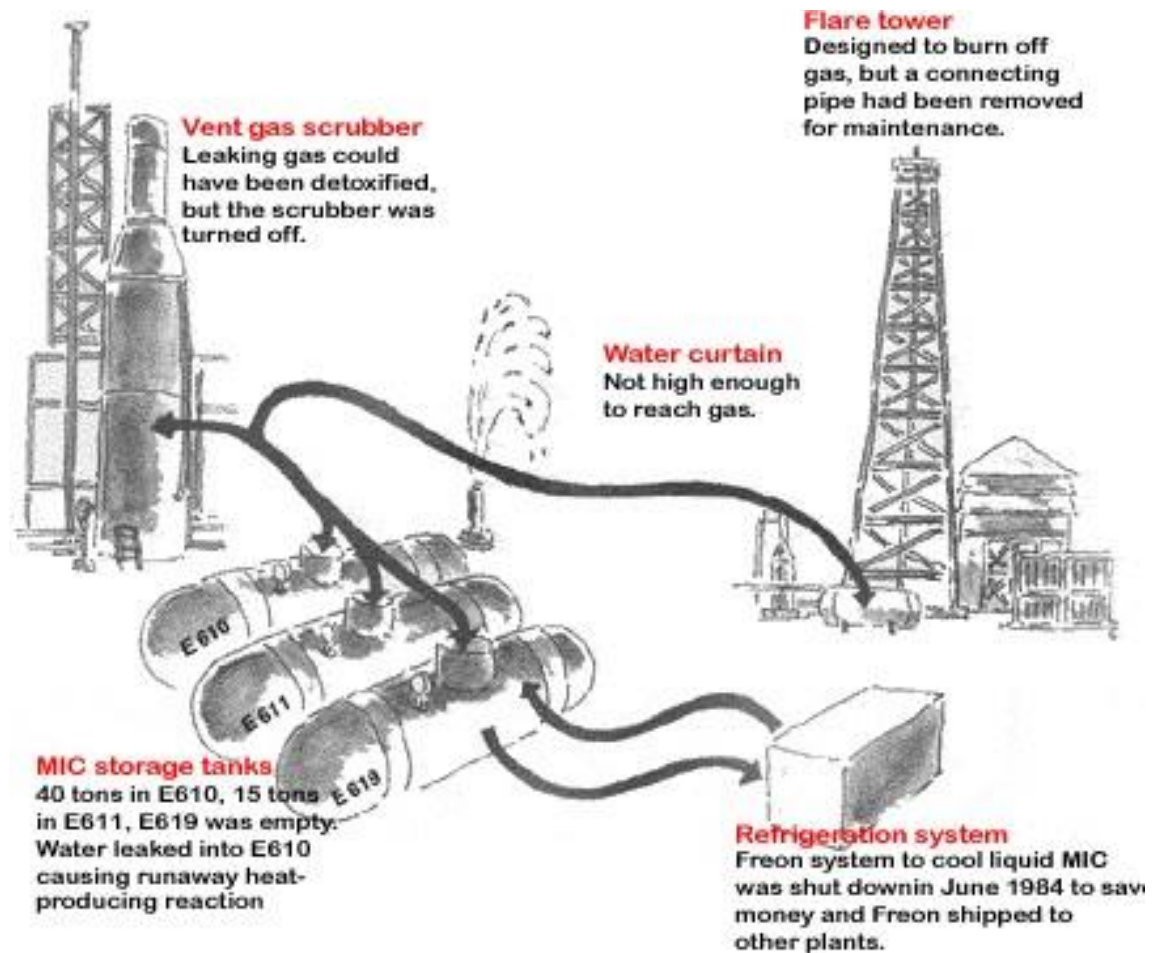
A poisonous gas cloud escaped from the Union Carbide India Limited (UCIL) pesticide factory

The cloud contained 15 metric tons of methyl isocyanate (MIC), covering an area of more than 50 square kilometers



# Environmental Engineering Case Studies

- Water entered MIC storage tanks
- Exothermal reaction large enough to open safety valves
- Scrubbers were turned off



# Environmental Engineering Case Studies

- **Neglect:**

- No valves present to prevent water from entering storage tanks
- Cooling installation and flaring installation that might have flared the gas were out of order
- Safety was low compared to other locations due to budget cuts



# Environmental Engineering Case Studies

## ■ Effects:

- Killed at least 4,000 local residents instantly
- Caused health problems for at least 50,000 people
- More than 15,000 people died in the years that followed
- More than 100,000 people still suffer chronic disease





# Environmental Engineering Case Studies

## ■ 2. The 1986 Chernobyl nuclear power plant accident

- April 26, 1986
- Ukraine (129 km from Kiev)



Tests were conducted on nuclear reactor 4 of the Chernobyl nuclear power plant that resulted in the security system being turned off

Errors in design and personnel judgement caused cooling water to start boiling

# Environmental Engineering Case Studies

Energy production increased to 10 times the normal level and temperatures reached more than 2000 °C, causing fuel rod melting and more cooling water boiling

Extreme pressures in cooling water pipes resulted in cracks, causing steam to escape

This steam caused an explosion, slamming off the roof of the building, starting a major fire and simultaneously forming an atmospheric cloud containing approximately 185 to 250 million curies of radioactive material



# Environmental Engineering Case Studies



# Environmental Engineering Case Studies

## ■ **Effects:**

- Killed 31 people instantly
- A zone of a 30 km radius was permanently evacuated
- The radioactive cloud covered Europe and reached the Netherlands
- The World Health Organization estimates that approximately 800,000 people have worked on restoring and cleaning after the accident





# Environmental Engineering Case Studies

## ■ Effects:

- deaths have occurred from radiation and other health problems
- Some sources place the death toll over 400,000 people
- Hundreds of people were diagnosed with radiation sickness.
- Increase in thyroid cancers, leukemia, birth defects, and genetic defects



# Environmental Engineering Case Studies

## ■ 3. Seveso: Italian dioxin crisis

- July 10, 1976
- Meda, Italy

An explosion occurred in a 2,4,5-trichlorophenol (TCP) reactor at the ICMESA chemical company

A toxic cloud containing high concentrations of TCDD (a highly toxic form of dioxin) was released into the atmosphere



# Environmental Engineering Case Studies

- **Effects:**

- Heavily polluted soils
- Led to the introduction of European regulation for the prevention and control of heavy accidents involving toxic substances – Seveso Directive



# Environmental Engineering Case Studies

## ■ 4. 1952 London smog disaster

- London, England
- December 1952-March 1953

Light winds and a high moisture content created ideal conditions for smog formation. Unusual cold caused additional coal combustion and many people travelled only by car, which caused the occurrence of a combination of black soot, sticky particles of tar and gaseous sulphur dioxide.





# Environmental Engineering Case Studies

Concentration of particulate matter in the air had reached 56 times its normal level.

Sulphur dioxide concentrations increased to seven times its peak level.

Sulphur dioxide reacted with substances in foggy droplets to form sulphuric acid, adding an intense form of acid rain to the process.

[Read more: https://www.lenntech.com/environmental-disasters.htm#ixzz7g5dq7MO4](https://www.lenntech.com/environmental-disasters.htm#ixzz7g5dq7MO4)



# Environmental Engineering Case Studies

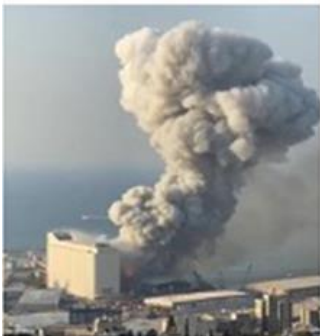
## • 5. Beirut Ammonium Nitrate explosion

- Beirut, Lebanon

One of the biggest non-nuclear explosions in history

- 4th August 2020

An uncontrolled fire in an adjacent warehouse ignited ~2,750 tons of Ammonium Nitrate (AN) stored in a warehouse at the port. The explosion was heard more than 250 km away. It caused 200 deaths and > 6,000 injured people while the 15 billion \$ in property damage is leaving an estimate of 300,000 people homeless.



# Environmental Engineering Case Studies

## Major ammonium nitrate explosions globally

Location	Year	Setting	AN in tons	Explosion root cause	Fatalities	Injuries
Beirut, Lebanon	2020	Port	2,750	Uncontrolled fire ignition	220	6,500
Texas City, USA	1947	Ship	2,086	Uncontrolled fire ignition	581	5,000
Tianjin, China	2015	Port	800	Uncontrolled fire ignition	165	798
Faversham, United Kingdom	1916	AN based factory	700	Uncontrolled fire ignition	115	
Oppau, Germany	1921	AN based factory	450	AN contamination with industrial explosives	561	1,952
New Brunswick, Canada	1947	AN based factory	400	Uncontrolled fire ignition	0	0
Toulouse, France	2001	Plant fertilizer	200	AN contamination with chloride	30	2,242
Tessenderlo, Belgium	1942	AN based factory	150	AN contamination with industrial explosives	189	900
Wayandra, Australia	2014	Transportation	56	Road traffic accident	0	8
Coahuila, Mexico	2007	Transportation	28	Road traffic accident	37	150
Barracas, Spain	2004	Transportation	25	Road Traffic Accident	2	5
Buzau, Romania	2004	Transportation	20	Road traffic accident	18	13
Oulu, Finland	1963	AN based Factory	10	AN contamination with industrial explosives	10	

# Environmental Engineering Case Studies

- **Major oil spills**

- Amaco Cadiz
- Piper Alpha
- Exxon Valdez
- Gulf War
- Tricolor



# Environmental Engineering Case Studies

## ■ Other

- - **1967** Liberian tanker Torrey Canyon spills 120,000 ton oil near Cornwall
- **1968** Witwater tanker spills 14,000 barrels of oil near Panama coast
- **1969** tanker Hamilton trader spills 4,000 barrels of oil in Liverpool Bay, England
- **1970** tanker Arrow spills 77,000 barrels of oil near Nova Scotia, Canada
- **1971** tanker Wafra spills 20,000 barrels of oil near Cape Agulhas, Africa
- **1972** tanker Sea Star catches fire after collision in Gulf of Mexico waste dump





# Environmental Engineering Case Studies

## ■ Other

- - **1974** Dutch tanker Metulla spills 53.,000 ton crude oil near South Chile
- **1976** Liberian tanker Argo Merchant spilled 29,000 square meters of oil near the Massachusetts coast
- **1976** Spanish tanker Urquillo spills more than 100,000 ton oil near Spain
- **1977** tanker Al Rawdatain spills 7,350 barrels of oil near Genoa, Italy
- **1977** tanker Borug spills 213,692 barrels of oil near the coast of Taiwan
- **1978** Brazilian Marina spills 73,600 barrels of oil near Sao Sebastiao, Brazil



# Environmental Engineering Case Studies

## ■ Other

- - **1979** Beteguese spills 14,720 barrels of oil near Bantry Bay, Ireland
- **1979** Ixtoc I exploratory well in Mexico blows out and spills 600,000 tons of oil
- **1984** Alvenus tanker grounds southeast of Cameron, Louisiana and spills 65,000 barrels of oil
- **1985** ARCO Anchorage spills 5,690 barrels of oil near the coast of Washington State, US
- **1986** unknown oil spill reaches the coast of Georgia (US) and is later appointed to the Amazon Vulture tanker
- **1989** Aragon tanker spills 175,000 barrels of oil near Madeira, Portugal



# Environmental Engineering Case Studies

## ■ Other

- - **1990** tanker American Trader grounds near Huntington Beach, California and spills 9,458 barrels of oil
- **1990** Cibro Savannah tanker catches fire and spills 481 square meters of oil
- **1990** Jupiter tanker catches fire in Bay City, Mexico and causes oil spill
- **1990** Mega Borg tanker catches fire and spills 19,000 square meters of oil near Galveston, Texas
- **1991** tanker Bahia Paraiso spills 3,774 barrels of oil near Palmer Station, Antarctica
- **1992** Greek tanker Aegean Sea spills 70,000 ton oil near Galicia



# Environmental Engineering Case Studies

## ■ Other

- - **1993** Bouchard B155 tanker spills 1,270 square meters of fuel oil after collision with 2 ships
- **1996** Liberian tanker Sea Empress spills 147,000 ton oil near Wales
- **1999** Maltese tanker Erika spills 30,000 ton oil near Brittany
- **2001** tanker Jessica spills 900 ton oil near the Galapagos Isles
- **2002** Bahamese Prestige spills oil near Galicia

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# Thank you