

**Department of Chemical Engineering  
West Virginia University**

**ChE 475 (Spring 2009)**

**Chemical Process Safety**

Time: Monday, Wednesday 3:00 - 4:50

Place: Room 449 Engineering Sciences Building

Instructor: John W. Zondlo  
Office: Room 415 ESB  
Phone: 293-2111 x 2409  
Office Hours: Wednesday 1 - 3 pm or by appointment.  
Please feel free to stop in and discuss any problems you are having.

Plus selected lectures by experts from the Morgantown branch of the National Institute of Occupational Safety and Health (NIOSH) and WVU Environmental Health and Safety (EHS)

Prerequisite: ChE 202, ChE 310 or consent

Required Text: Chemical Process Safety: Fundamentals With Applications, 2<sup>nd</sup> Edition by D.A. Crowl and J.F. Louvar, Prentice Hall, Englewood Cliffs, NJ, 2002.

Additional supplemental material will be given as handouts.

Additional texts and reference materials are available in the Chemical Engineering Library. (See attached list for some suggested references)

Course Description: The main focus of the course will be issues involving safety, health and loss prevention in the chemical process industry. You will be introduced to safety hardware, sources and prediction of toxic releases, potential harmful effects of chemicals in the workplace, as well as hazard identification. Awareness of these and other safety concerns will be raised so you can develop effective strategies for analyzing and evaluating the safety of chemical processes to reduce operating hazards.

The course will have three components:

- a) Classroom Lectures covering selected essential topics in the text.

- b) Discussion sections centered on strategies to identify and reduce potential hazards and accidents. A series of video tapes on a wide variety of topics will be used here.
- c) Short Projects done in small groups whereby skills learned in class can be applied to a typical health/hazard evaluation. Groups may also present case studies and/or slide seminars in class.

Course Grading:

Mid-term Exam	25%
Final Exam	35%
Homework	15%
Class Projects	<u>25%</u>
	100%

Course Objectives:

If you find a path with no obstacles, it probably doesn't lead anywhere. @

§ To obtain an understanding about how chemicals effect us physically and how hazards can be quantified.

B Industrial hygiene

B Toxicology

B Epidemiology

B MSDS Data

• To learn the basics of laboratory and plant safety procedures.

§ To learn about the release of chemicals and how to model it.

B Source Models ⇒ as chemicals leak out

B Dispersion Models ⇒ how the release spreads in the atmosphere

§ To understand the causes, effects and prevention of fires and explosions.

§ To gain an appreciation of the use and sizing of pressure relief valves.

§ To integrate class material with other chemical engineering areas and develop an awareness of laboratory and plant safety.

B Class Projects

B Laboratory Inspection

B Case Studies of Past Accidents



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**Course Syllabus**

- 1) Introduction
  - Overview
  - Some Case Studies
  
- 2) Chemical Hazards
  - Toxicology - how toxics effect us (biological organisms)
    - how they enter the body
    - how they are eliminated from body
  - Industrial Hygiene - how to prevent workers from being exposed to toxics in the work place -- Identification, evaluation and control of occupational conditions which can cause sickness and injury.
  
- 3) Release of Chemicals by Accidents in the Plant
  - Source Models -- prediction of how much is released and at what rate.
    - , flow of liquids and gases through holes
    - , evaporation of liquid from pools to atmosphere
  - Dispersion Models -- tells how a released substance spreads through adjacent areas (In plant and in atmosphere)
  - S Use of Models - mitigation and design
  
- 4) Fires and Explosions
  - What causes fires and Explosions -- fuel, ignition sources, how they spread
  - Design to Prevent Fires and Explosions
    - Inerting
    - Control Static Discharges and Buildup
    - Explosion-proof hardware
    - Ventilation
    - S Sprinklers
    - etc.
  
- 5) Pressure Relief Valves
  - Types and Location of Relief Valves
  - Sizing of Relief Valves
    - , Gas service, liquid service, or two-phase flow
  
- 6) Hazard Identification
  - HAZOP=s and Safety Reviews
  - Risk Assessment
  - Accident Evaluation

S      Inherently Safer Design

- 7)    Video Tapes on various aspects of laboratory and plant safety procedures

**ChE 475**  
**Fundamentals of Chemical Process Safety**  
**Some Suggested Resources**

- (1) D.A. Crowl and J.F. Louvar, Chemical Process Safety: Fundamentals with Applications, 2<sup>nd</sup> Edition (Englewood Cliffs, NJ: Prentice Hall Inc., 2002).
- (2) Brauer, R., Safety and Health for Engineers, 2<sup>nd</sup> Edition, (John Wiley & Sons, 2006).
- (3) Lees, F., Loss Prevention in the Process Industries (London, UK, Butterworths, 1980).
- (4) Bartlenecht, W., Explosions (New York, NY: Springer-Verlag, 1980).
- (5) Bodurtha, F.T., Industrial Explosion Prevention and Protection (New York, NY: McGraw-Hill Book Co., 1980).
- (6) Kletz, T., Process Plants: A Handbook for Inherently Safer Design, (Philadelphia, PA: Taylor & Francis, 1998).
- (7) J.F. Louvar and B.D. Louvar, Health and Environmental Risk Analysis, (Upper Saddle River, NJ: Prentice Hall PTR, 1998).
- (8) CCPS Books, AIChE, 345 East 47th Street, New York, NY 10017
  - , Guidelines for the Technical Management of Chemical Process Safety
  - , Guidelines for Chemical Process Quantitative Risk Analysis
  - , Guidelines for Process Equipment Reliability Data, with Tables
  - , Guidelines for Hazard Evaluation Procedures
  - , Guidelines for Use of Vapor Cloud Dispersion Models
  - , Guidelines for Safe Storage and Handling of High Toxic Hazard Materials
  - , Guidelines for Vapor Release Mitigation
  - , Student Problems: Safety, Health, and Loss Prevention in Chemical Processes (Problems for Undergraduate Engineering Curricula. Instructors Guide also available)
- (9) Treybal, R.E., Mass Transfer Operations, 3rd edition (New York, NY, McGraw-Hill Book Co., 1980).
- (10) McCabe, W.L., J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, 5th edition (New York, NY, McGraw-Hill book Co., 1993).
- (11) Perry, R.H. and D. Green, editors, Perry's Chemical Engineers' Handbook, 6th edition

(New York, NY, McGraw-Hill Book Co., 1984).

- (12) Bird, R.B., W.E. Stewart and E.N. Lightfoot, Transport Phenomena (New York, NY, John Wiley & Sons, Inc., 1960).