Pollution Prevention and Chemical Engineering
NATIONAL POLLUTION PREVENTION CENTER FOR HIGHER EDUCATION

Course Syllabi

- *Introduction to Pollution Prevention*
  William Budd, Washington State University
- *Industrial Pollution Prevention*
  Robert Counce, The University of Tennessee
- *Waste Reduction in Industry*
  Dale Denny, North Carolina State University
- *Industrial Waste Management*
  Marvin Fleischman, University of Louisville
- *Waste Reduction, Treatment, and Disposal*
  Marvin Fleischman, University of Louisville
- *P2, Waste Treatment, and Disposal*
  Marvin Fleischman, University of Louisville
- *Industrial Waste Reduction*
  David Kidd, University of Alaska - Anchorage
- *Design of Environmentally Benign Chemical Process Plants*
  Ronald G. Minet, University of Southern California
- *Advances in Polution Prevention: Environmental Management for the Future*
  Michael Overcash and Christine S. Grant, North Carolina State University
- *Pollution Prevention*
  Robert Pojasek, Tufts University
- *Hazardous Waste Management*
  Margrit von Braun, University of Idaho
- *Engineering Risk Assessment for Hazardous Waste Evaluations*
  Margrit von Braun, University of Idaho

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Pollution Prevention and Chemical Engineering
NATIONAL POLLUTION PREVENTION CENTER FOR HIGHER EDUCATION

Introduction to Pollution Prevention

William Budd
ES/RP 490/590 & 499/600, Spring 1993
Washington State University

Introduction to Pollution Prevention

ES/RP 490 (1 credit) + ES/RP 499 (2 credits)
ES/RP 590 (2 credits) + ES/RP 600 (1 credit)

M 1:10PM, W 1:10 - 5:00PM
Spring 1993

Objectives:

Environmental management in the United States, and in many other nations, is actively moving toward strategies of reduction and prevention of pollution. This movement represents a major shift in policy from a regulation/control model to a technical assistance and education model. Managers, both in government and the private sector, need to develop new skills which will allow them to identify opportunities for pollution prevention, develop strategies for effecting change in businesses, and linking those strategies to available technologies. Planning for pollution prevention is recognized as a vital component of this process.

The purpose of this course is to introduce students to the environmental, technical and legal aspects of pollution prevention (P2). Upon completion of this course, students will:

-be familiar with the national and state legislative mandates and their requirements for pollution prevention

-be exposed to the dimension of multi-media pollution prevention assessment and analysis

-understand the procedures and requirements for pollution prevention planning in Washington State.

Overview:

There will be two hours of lecture and three hours of field analysis/laboratory per week.

Evaluation will be based on various laboratory assignments, and laboratory (1) and class (1) examinations.

Graduate students will additionally be required to develop a research paper on a pollution prevention topic approved by the instructor. The initial list of topics include, but are not restricted to:

1. Analysis of potential waste reduction opportunities in the automotive repair industry. This would entail researching the different waste reduction strategies, analyzing how effective it would be for a shop to implement, cost effectiveness, and what should be a reasonable and achievable goal for reduction.

2. Economic analysis of waste reduction techniques for the automotive repair industry. Much of the waste reduction information has been developed for larger shops. Waste reduction savings at smaller shops may not be significant enough to provide incentives to reduce, especially if there are capital costs required to implement waste reduction. This project will quantify the real cost of implementing common waste reduction techniques, including training, capital costs, capabilities of new equipment, and productivity. Once costs are quantified, a model will be developed for comparing costs and benefits to answer questions concerning fiscal impacts and payback times.

3. Development of an assessment tool for small businesses. Many techniques have been developed for larger industries but prove to be ineffective when applied to smaller businesses.

Text:

The text for the class will be Pollution Prevention Planning: Guidance Manual for Chapter 173-307 WAC, Washington Reduction, Recycling and Litter Control Program, Publication #91-2. Copies will be made available to students in the first laboratory period.

A syllabus of other reading materials will be developed as necessary during lecture periods.

Introduction to Pollution Prevention

Topical Outline

Week	Lecture Topic
Jan 11	Introduction: Terminology and Benefits of P2 (Budd)
Jan 13	Federal Pollution Prevention Programs (Budd) Pollution Prevention Act 1990 Clean Air Act Amendments 1990 EPA Pollution Prevention Strategy EPA P2 Research Program
Jan 18	Federal Pollution Prevention Programs (con't) (Budd) 33/50 Program EPA Green Lights Program Other federal programs: DOD, DOE, U.S. Postal Service
Jan 20	State and local P2 Programs (Budd)
Jan 25	State and local P2 Programs (con't) (Budd)
Jan 27	Industrial P2 Programs (Budd)
Feb 1	Current Issues in P2 (Budd) Clean Technologies Measuring P2 Cost Effectiveness Incentives to Encourage P2 Barriers to P2
Feb 3	Current Issues in P2 (con't) (Budd) Life Cycle Analysis (LCA) Management and Business Product Design

Feb 8 Current Issues in P2 (con't) (Budd)
Ecological Product Development
Development of New Unit Operations
P2 Training and Education

Feb 10 Pollution Prevention in Washington: An overview

Feb 15 Preassessment review: Developing and using a facility history

Feb 17 P2 and Management: Building bridges for cooperation

Feb 22 Toxic materials and hazardous waste: Inventory and analysis

Feb 24 Toxic materials and hazardous waste: Seeking alternatives

Mar 1 Air emission assessment

Mar 3 Water use and discharges

Mar 8 Energy: Problems and analysis (Hinman)

Mar 10 Energy: Evaluation and response (Hinman)

Mar 15 SPRING BREAK

Mar 17 SPRING BREAK

Mar 22 Pollution prevention planning: Understanding the Washington process

Mar 24 Pollution prevention planning: Understanding the Washington process (con't)

Mar 28	Multi-media strategies: Analysis and the development of alternatives
Mar 31	Economics and P2: Evaluative models; building the case for pollution prevention (Budd)
Apr 5	Economics and P2: Evaluative models; building the case for pollution prevention (DOE speaker)
Apr 7	Pollution prevention planning: An assessment of case studies
Apr 12	Pollution prevention planning: An assessment of case studies
Apr 14	Field trip: Whitman County
Apr 19	Review and assessment of site visit
Apr 21	Field trip: Nelson Irrigation (Walla-Walla)
Apr 26	Review and assessment of site visit
Apr 28	Conspectus

Introduction to Pollution Prevention

Laboratory Sessions

Week	Project/Topic
Jan 13	Introduction to environmental management at WSU; environmental health and safety considerations (Hagihara)
Jan 20	Waste management game; analysis and review
Jan 27	WSU site visit; preliminary assessment
Feb 3	Continue with PA
Feb 10	Building systems models/team development of a flow model for WSU operation
Feb 17	Evaluation of toxic materials usage and hazardous waste
Feb 24	Evaluation of toxic materials usage and hazardous waste
Mar 3	Evaluation of air emissions problems
Mar 10	Assessment of water use and discharges
Mar 17	SPRING BREAK
Mar 24	Energy auditing
Mar 31	Economic evaluation and P2
Apr 7	P2 Plan Development
Apr 14	Whitman County Irrigation field trip
Apr 21	Nelson Irrigation field trip
Apr 28	Laboratory EXAM

Pollution Prevention and Chemical Engineering
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Industrial Pollution Prevention

R. M. Counce and R. J. Jendrucko
Chemical Engineering 581 / Engineering Science and Mechanics 581 / Environmental Engineering 581; University of Tennessee

Industrial Pollution Prevention (3 semester hours credit)

Chemical Engineering 581
Engineering Science and Mechanics 581
Environmental Engineering 581

Coordinators: R. M. Counce and R. J. Jendrucko

Description: Principles and practical aspects of industrial pollution prevention. Regulatory environment, pollution prevention strategies, economic analysis, life cycle assessment, process safety, case study: analysis of alternative waste management technologies.

Goals: The goal of this course is to incorporate pollution prevention into a typical approach to the analysis and design of industrial processes. The course focuses on topics such as environmental rules and regulations, opportunities and approaches to pollution prevention, analytical tools such as flow sheeting, economics, life cycle analysis and risk assessment and culminates in a relevant pollution prevention project. Numerous case studies and examples are presents in the course and speakers from industry and regulatory agencies are frequently utilized.

Textbook: Hazardous Waste Management (McGraw-Hill) by C. A. Wentz, New York (1989).

Supplemental Materials:

Waste Reduction Assessment and Technology Transfer (WRATT) Training Manual (2nd Ed) (University of Tennessee Center for Industrial Services) by Cam Metcalf (Editor-in-Chief), Knoxville (1989).

Pollution Prevention: Homework and Design Problems for Engineering Curricula, (Center for Waste Reduction Technologies, American Institute of Chemical Engineers) by D. T. Allen, N. Bakshjani and K. S. Rosselot, , New York (1992).

Prerequisites:

(1) graduate standing in engineering (2) consent of instructor

Topics:

1. Introduction
2. Environmental Legislation
3. Environmental Legislation - TSCA, RCRA, CERCLA & SARA
4. Hazardous Waste Characterization
5. Approaches to Pollution Prevention
6. Assessment of Pollution Prevention Opportunities
7. Life Cycle Assessment
8. Process Flow-Sheeting and Waste Tracking
9. Process Selection and Design for Pollution Prevention
10. Cost Estimating and Project Evaluation
11. Risk Assessment
12. Case Study in Pollution Prevention
13. Selected Topics in Pollution Prevention

Computer Usage: Several homework assignments and case study are sufficiently detailed so that computer usage is of obvious advantage.

Laboratory Projects: No lab is associated with this course.

Estimate ABET Category Content:

Engineering Science: 1.5 Credits or 50%
1.5 Credits of 50%

Prepared by: R. M. Counce Date: October 30, 1994

Pollution Prevention and Chemical Engineering
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Waste Reduction in Industry

Dale Denny
Chemical Engineering 598-O, Spring 1991
North Carolina State University

North Carolina State University
Chemical Engineering 598-O
Spring 1991

WASTE REDUCTION IN INDUSTRY

Instructor: Dale Denny

Schedule:

Week	Topic
January 14	What is Waste Reduction?
January 21	Developing a Waste Reduction Program in an Industrial Environment
January 28	Defining the Program, Audits and Site Assessment
February 4	Waste Reduction Options Definition and Evaluation
February 11	Product Modification, Materials Substitution, Process Modification, and Recycle, Documentation and Performance Monitoring
February 18	Class Presentations
February 25	Class Presentations
March 4	Spring Break
March 11	The Global Environment, Lifestyles and Public Attitudes,
March 18	Current Environmental Law, The Corporate Dilemma, Historical Environmental Control Approach
March 25	Current Environmental Law, Risk Assessment
April 1	Case Study Draft Due -- Preliminary Class Presentations
April 8	Float
April 15	Status Report --Case Studies
April 22	Case Study -- Class Presentations

Homework assignments will be made at the beginning of each week. Due dates will be variable due to the nature of the assignments.

There will be occasional short quizzes on assigned materials. There will be a final examination.

Grade Breakout:

Class Presentations	20%
Homework	20%
Case Study	50%
Final Exam	10%
Total	100%

Reference Materials:

1. Waste Minimization Opportunity Assessment Manual -- EPA/625/7-88/003

2. Waste Minimization Resource Manual -- 1989

    Chemical Manufacturers Association
    2501 M Street, N.W.
    Washington, DC 20037
    (202) 887 1100

3. Waste Minimization: Manufacturers' Strategies for Success -- 1989

    National Association of Manufacturers
    Publications Coordinator
    1331 Pennsylvania Avenue, N.W.
    Washington, DC 20004-1703

4. Pollution Prevention Benefits Manual

    Dr. Ronald T. McHugh
    US Environmental Protection Agency
    Office of Solid Waste
    Washington, DC 20460

5. Statistical Analysis for Decision Making -- Morris Hamburg

    Harcourt Brace Jovanovich Publishers
    757 Third Avenue
    New York, NY 10017

6. Carcinogen Assessment of Coke Oven Emissions -- EPA-600/6-82-003F

    US Environmental Protection Agency
    Office of Health and Environmental Assessment
    Washington DC, 20460

7. Health Assessment Document for Polychlorinated Dibenzo-p-Dioxins -- EPA/600/8-84/014F

    US Environmental Protection Agency
    Office of Health and Environmental Assessment
    Washington, DC 20460

8. Scientific American -- September 1989

9. David H. Sandler Sales Workshop

Sandler Sales Institute, Inc.
Greenspring Valley Road
Stevenson, Maryland 21153

10. Pollution Prevention Pays -- Instruction Manual

North Carolina Pollution Prevention Pays Program
3825 Barrett Drive
Third Floor
Raleigh, NC 27609

The course development and presentation was sponsored by

North Carolina Department of Waste Reduction
3825 Barrett Drive
Third Floor
Raleigh, North Carolina 27609

Gary Hunt, Director
(919) 571 4100

Pollution Prevention and Chemical Engineering
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Industrial Waste Management

Marvin Fleischman
ENVE 534, 1991
University of Louisville

ENVE 534 SPRING 1992
INDUSTRIAL WASTE MANAGEMENT

Jan. 15 Introductions & Organization

Overview of Environmental Activities in a Chemical Plant: Movie, "The Need to Know", CMA - Handout

Environmental Crimes: Video, "The Burial Ground" (Hazardous waste dumping) - Handout

Text: Ch 1, Questions 1,6

Jan. 22 "Overview of Environmental Regulations", Dave Fetter, Law Environmental
Handouts; Text, Chs. 3,4; Ch 3 - 2,3,4

Jan. 29 "Underground Storage Tanks", Tom Whitley, Evergreen Associates - Handout, Video: Tank Closure Without Tears: An Inspectors' Guide"

Toxicology - Video: Carcinogens, Anticarcinogens, and Risk Assessment", Bruce Ames
pp 6-8, 47, 65, 93-95
Ch5 -#5, 6

Feb. 5 "Environmental Law from a Public Advocacy Viewpoint", Tom Fitzgerald, Kentucky Resources Council

Types of Regulations & Standards - Performance (KPDES, MACT, BACT), Ambient Quality, Risk Based

Feb. 12 "Transportation and Diposal of Hazardous Wastes", Jerry McAdams, Lubrichem, Full Services Broker
Handout
pp 230-249, 250, 254-255, 256, 261, 263, 267-268, Handout, Ch 9- #s 3,5,7,
Ch 5 (thru p 96) -#s 1-6
DOT, 1990 Emergency Response Guidebook
TCLP Standards, Use of MSDS - Naptha as an example
Regulatory Concepts - Command & Control, Incentives, Permits, Fees, Taxes, New Source Performance Standards, Categorical Standards, Effluent Standards, Ambient Quality Standards, BAT, BDAT, MACT, Risk Based

Council on Economic Competetiveness
Superfund - NPL - Lees' Lane Landfill

Feb. 19 "Industrial Wastewater Pre-Treatment & Disposal to a POTW - OCPSF Standards & Treatment Methods", John Weil, Rhone-Poulenc (Biox, ChemOx, Air Stripping, Steam Stripping, Hyroxide Precipitation)

Handout, Text: pp 426-428, Ch7-Chemical, Physical, & Chemical Treatment
BOD & TSS Surcharges
Water Consumption, Effluent Discharge, & Rates, In-Plant Consumption, Reuse, & Evaporation
Waste Management Concepts - Dilute & Disperse, Concentrate & Confine

In the News - Lack of State Regulations Concerning Hazardous Waste Spills - No more stringent than, Clean to Background or Non-Detectable Concentrations

Comparative Risk Assessment of Environmental Problems - EPA Science Advisory Board Study (Handout)

Risk - Ch2, 2-#s 1-3

Feb 26 In the News - Burning of Toxic Waste, Trash to Steam Plant

"Environmental Liability", Rick Greenberg, Attorney - Handouts, Chs 3-6,

More on "Environmental Issues in General" - Property Transactions, Waste Oils, Air Emissions, Pollution Prevention, Life Cycle Assessment, Product Stewardship

Municipal Waste Water Treatment, Louisville Metropolitan Sewer District, Morris Foreman WWTP, Primary - Secondary (Oxygen Activated Sludge) Treatment & Sludge Handling

Mar 4 "Air Pollution Issues in Louisville - Urban Air Shed Model for VOCS & NOx, Clean Air Act, MACT, SO2 Offsets, Air Permits, George Abrahim, Law Environmental, Louisville - Handouts: List of High Risk Pollutants (HAPs); NOX Control, A Double Hitter: Ozone and Acid Rain Control

Interrelationships between various regulations dealing with hazardous materials - Life Cycle of a Chemical-TSCA, CERCLA, RCRA, CAA, CWA, HMTA, OSHA, etc. - Handout

In the News - Alternatives to Hazardous Waste Incineration; Louisville Garbage to Steam Plant; CFCs - Global Warming, HCFCs

Additional Issues/Concerns - Hazardous Waste Transport

Environmental Issues (cont.) - Industry Concerns:

Product Stewardship, Process Hazards Management, CMA Responsible Care Program, Chemical Capital Spending for Pollution Abatement Equipment,

Site Remediation, SuperFund - pp391-394, 396, 401-402, 404-406 (Seyour,IN), 420-424, Ch 14. #1,4
Superfund Problems - CEN, Chemecology

Mar 11 — Sheldon, McCollum, DuPont, Louisville - Site Remediation

Videos: "Beyond Business as Usual" (waste mgmt.)
"The Toxics Release Inventory: Meeting the Challenge"
"Let's Clean-Up America" - Marine Shale Processors
Handouts on all 3 videos

Mid term

Mar 18 — Spring Break

Mar 25 — In the News-"Christians Lack Proper Reverence for Nature" - Environmental Stewardship

Air Pollution - Definitions of Primary & Secondary Standards

<u>Hazardous Waste Characterization</u>
News Article - "Compromise reached on Cleanup Bill" - Clean up Standards & Lists for hazardous materials spills
Hazardous waste generator report - GE Appliance park
Handout, Text: RCRA, pp73-78, pp 88-98, Appendices B, C, D
Questions: Ch4 - 4, 5; Ch5 - 1 to 4

<u>Pollution Prevention</u>
Video: "Less is More: Pollution Prevention is Good Business", EPA, 23:13 - Handout
News Article - Senate Bill 296-Hazardous Waste Reduction
Handout: Types of Information Needed for Waste Minimization Assessment
Text: Ch 6 ,
Questions: Ch 6 - 1, 2, 5, 6

April 1 — Pollution Prevention, Pre-Site Visit Orientation, Sandy Kmiec, General Electric Appliance Park, "GE Appliances Dishwasher Operations, Applicance Park Building 3" - Handout

General Concepts of Pollution Prevention - Examples from WMAC Assessments

Handouts

April 8	Site Visit to GE - Dishwasher Manufacturing & Assembly & Wastewater Treatment Plant
April 15	Brainstorming: Pollution Prevention Assessment at General Electric
April 18	Field Trip: Outer Loop Landfill - Waste Management, Inc.- Voluntary
April 22	Pollution Prevention Concepts Remediation - Science vs. Risk Based Risk Assessment, Coburn-Forster-Kane Equation for Ambient CO Standards, Toxicity Text, pp 19-24, Questions 1,3 Text, pp 93-95
April 26	Tour of Morris Forman WWTP, Louisville-Jefferson County Metropolitan Sewer District
May 6	Final Exam

Environmental Issues and Priorities

Environmental Management at a Major Chemical Manufacturer

Environmental Liabilities and Crimes

Regulations and Regulatory Issues - RCRA, TSCA, CERCLA, SARA 313 (Toxics Release Inventory), Clean Air Act

Toxicology

Underground Storage Tanks

Air Pollution in Jefferson County

Industrial Wastewater Pretreatment

Toxic Substances Control Act

Hazardous Waste Transportation & Disposal

Environmental Audits for Land Acquisition

Hazardous Waste Characterization

Pollution Prevention

Municipal Solid Waste Disposal - Incineration, Landfilling

Waste Treatment Methodology

Emergency Response - Spills, Accidents

Modeling

Pollution Prevention and Chemical Engineering
NATIONAL POLLUTION PREVENTION CENTER FOR HIGHER EDUCATION

Waste Reduction, Treatment, and Disposal

Marvin Fleischman
ChE 694, Fall 1992
University of Louisville

File: Course.92

WASTE REDUCTION, TREATMENT, AND DISPOSAL
Fall 1992 - Semester

Text: Freeman, H., "Hazardous Waste Minimization, McGraw-Hill, 1990
USEPA, "Understanding the Small Quantity Generator: Hazardous Waste Rules", EPA/530-SW-86-019, Sept. 1986

8/25 Introduction
Video: Beyond Business as Usual
Reading: Ch 1 - Waste Minimization as a Waste Management Strategy in the United States; Ch 2 - Potential for Waste Reduction; Handouts

8/27 Hazardous waste characterization, Priority pollutants
Pretreatment standards for discharge to POTW
Video: Less is Better: Pollution Prevention Pays
Good Housekeeping, Segregation, Management Issues
Definition of Waste, Preferred Waste Management Hierarchy
Handouts
Reading: Ch3. Waste Reduction Techniques & Technologies; Handout

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9/1 Dave Fetter, Law Environmental, "Overview of Environmental Regulations", Handout

9/3 Went over Assignment on "Beyond Business as Usual"
Definitions and implications of Pollution Prevention, and Product Life Cycle Analysis

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9/8 In the News: EPA 33/50 Program, Burning used tires at a cement kiln-Thermal Processes, PCB ban & cleanup, Plastics recycling guide, Burying power plant flyash in coal suppliers landfill- Product Stewardship, GM Parts strike & impact on car manufacture-inventory control, just in time tradeoff

Reasons for P2, Benefits and Tradeoffs

9/11 **Guest Speaker:** Jerry Rockey, Heritage Environmental Services, "Off-Site Waste Reuse, Conditioning, Reclamation, Recycling, Treatment and Disposal" - Handout
Reading: Ch.3, Handout
Assignment: In the News

9/15 **In the News:** "The Recycling Bottleneck", Time Mag., 9/14/92, pp 52-54
"Residents Lash Out at Hazardous Waste Storage at Kosmos (Cement Kiln)
Synergies between Safety/Health & P2, Off-Site vs. On-Site Solvent Recycling

Overview: Waste Reduction Techniques/Technology
Reading: Ch3.

9/17 **In the News:** Acidic & Caustic Cleaning Fumes from Barrel

Recycling Company; Malling the Planet - Korean system of of material use with premium on durability & repair

Waste Reduction Techniques/Technology (cont.) - Chemical Plant Control Techniques, Raw Materials Purity, Process Simplification & Reliability, Case Study Example: Reducing Water Consumption in a Plating Rinsing Operation, Modification of Powder Addition Method to Dispersion Tank in Paint Formulation, Reduction of Dragout Losses from Rinsing
Assignments: Ch.3 - Handout: Everyday, common, household examples of P2 & application to manufacturing; **Problem:** Chemical Recovery from Plating Rinsewater

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9/22 **In the News:** US not immune to financial ill in Europe, Tokyo - Limits to Economic & Industrial Growth because of increasing product durability, repairability, recylability, emphasis on function & value over cosmetics, & impact on P2
Cleaning Emissions - Microwave destruction SOx & NOx in power plant stack gases

Waste Reduction Techniques/Technology (cont.) - Preventing Losses: Granary Operations in a Distillery; Additional General Approaches & Examples; Segregation & Recycling: Trash at a Steel Fabricator; Waste Exchanges; Broader & Philosophical Ramifications
Video: "Challenge to Innovative Pollution Prevention by Waste Minimization", 3M Co., 8:50

Video: "Down to Earth", Marine Shale Processors - Thermal Treatment/Recycling in a Rotary Kiln - Handout

9/24 **Field Trip:** Carl Petrus, Kosmos Cement, "Burning of Hazardous Wastes in a Cement Kiln", Lecture & Tour,
Handout: Acceptance Analytical Requirements (hazardous waste fuel)
Assignment: Should cement kiln be allowed to burn hazardous wastes? Why? Why Not? What are the Alternatives? What are the advantages of an integrated coal fired power plant & cement kiln (tie in with visit to LGE flue gas scrubber)

9/29 **Handout:** Characteristics of Companies with Excellence in Pollution Prevention
In the News: EPA drops new hazardous waste rule
Went over assignment on common, everyday, household, personal examples of waste minimization & pollution

prevention
Clean Air Act: Offsets, Trading, Banking, Selling of Emission Reduction Credits (SOx, Other Chemicals), Bubble Concept, Early Reduction Credits, 33/50 Program

10/1 **Field Trip:** "Power Plant Air Pollution Controls - Sulfur Dioxide Scrubbers", Tour of LGE Scrubber Systems at Cane Run Plant (lime & dual alkali), Mark Schmitt, 449-8802
Assignment: Related problems/questions
Handouts: FGD Control Technologies, Treatment/Disposal Alternatives, Lime Scrubber Chemistry, Flow Diagrams of Lime Scrubbing & Dual Alkali Processes

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10/6 **Waste Minimization Assessments: Videos:** Waste Minimization: An Introduction (16:10), Ca. Dept. of Toxics Substances Control; Waste Minimization Assessment Procedures (10:18), Ca. Dept. of Toxics Substances Control. **Reading:** Ch.4 - Implementing Waste Minimization Programs in Industry; Ch 5 - Waste Minimization Assessments.
Handouts: Study guides for videos & reading

10/8 **In the News:** RCRA Misinterpetations, Does RCRA Allow Innovative Technologies? (Remediation), Is US Recycling Policy Built on Faulty Ideas?
Case Study (Plating Rinsewater Assignment): Reducing Water Consumption Using High Pressure Spray Rinse, Nickel Sulfate by Plating Bath Rinsewater Recycle

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10/13 **Midterm exam - Part I** (take home) - descriptive
Additional household/everyday/personal/common P2 examples
In the News: PCB exposure from dismantling scrap transformers, IBM warns that chemicals used on chips may be a prenatal risk, Tons of Sewage Sludge my be shipped to mine

Case Study: Recovery of Nickel Plating Rinsewaters by Cold Evaporation

10/15 **Case Study:** Nickel recovery by reverse osmosis
Went over LGE assignment
Midterm - Part II (take home) - quantitative

10/20 Additional comments on Flue Gas Desulfurization
Chem. Eng, Sept. 1990, pp 125-127
In the News: US air improves, but still unfit for millons, Superfund & National Environmental Trust Fund
Waste Minimization Assessment Procedures
Handout, Ch.4 - Implementing Waste Minimization Programs in Industry; Ch 5 - Waste Minimization Assessments.

& study guide

10/22 **In the News:** Firm hit with biggest waste cleanup fine yet (CEN), Miscarraiges linked to two widely used glycols (CEN)
Corporate Environmental Policies - Quaker Oats
Waste Minimization Assessment Procedures - Preliminary to Site Visit - Definition of wastes
Handouts: Steps in Waste Min Assessment
Types of Information Needed
Waste Reduction Procedure

10/27 **Engelhard Assessment:** Pre-site visit
Annual Hazardous Waste Generator Report Review
Handout: Codes for Hazardous Waste Generator Reports

10/29 **Assessment:** Pre-site visit
Process/Product Description - Organic Pigments
Mike Campbell - Engelhard Employee, Class Student

11/3 Election Day - No Class

11/5 Legislative Authorities Affecting the Life Cycle of a Chemical
Class Project: Organic Pigment Process, Cadmium Pigment Process, Wastewater Pretreatment Plant - Mike Campbell, Stephanie Ellis, Engelhard, Students

11/10 1st site visit - Cadmium Salvage Plant, Wastewater Treatment Plant, Cadmium Pigment Plant, Organic Pigments Plant

11/12 Students went over site visit & brain stormed

11/17 "Wastes: To Burn or Not to Burn", CEP, July 1992, pp 53-58
Additional discussion on site visit

11/19 DuPont -Louisville Waste Minimization Program, Lisa Moyles, DuPont, Pollution Prevention Program, 569-2525

11/24 Went over midterm exam
In the News: Chemical firm to pay $125,000 fine for spill, Dumps at coal mines go largely unregulated
Toxics Release Inventory Reporting: Defining waste delays toxics inventory form, C&EN, June 8, 1992, pp 22-23
Class Project: Formation of student teams - Cadmium, Organics

11/26 Thanksgiving

12/1 **In the News:** Parkham Helps Auto Shops turn hazardous Waste into Profits (advertisement)
SARA 313 Reports: Engelhard 1991 TRI Report for 1991 - Cadmium Compounds, New Form R Reporting Requirements for Pollution Prevention, Determining a Production or Activity Index

12/3 State & Federal Regulatory Arena Concerning Pollution Prevention
EPA - Pollution Prevention Information Clearinghouse(PIES) Demonstration

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12/8 Bioremediation of Contaminated Soils & Groundwater, Jerry McCandless, The Evergreen Group, Louisville, KY

12/10 Last Class
Pollution Prevention in Chemically Reactive Systems
CMAs' Responsible Care Program
Draft reports submitted - Organic Pigments Manufacture, Cadmium Pigments Manufacture

12/17 **Classroom Final**
Draft reports returned prior to class with suggested correction, additions, modifications
Student Presentations of Reports
Revised reports submitted - After classroom final

Pollution Prevention and Chemical Engineering
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Pollution Prevention, Waste Treatment, and Disposal

Marvin Fleischman
Spring 1994
University of Louisville

Pollution Prevention, Treatment, and Disposal
Spring, 1994
(3Cr.; Tues & Thurs. 5:30-7;45PM)

Instructor: Marvin Fleischman, Department of Chemical Engin., University of Louisville, (502-852-6357, FAX:502-852-6357, email: m0flei01@ulkyvm.louisville.edu)

Text:
. "Facility Pollution Prevention Guide", EPA/600/R-92/088
. "Waste Minimization - Environmental Quality with Environmental Benefits", EPA/530-SW-90-044
. Louisville Courier Journal, Various news magazines, e.g., Time, Newsweek, etc.

Handouts: See detailed course schedule

References:
. Freeman, H., "Hazardous Waste Minimization", McGraw-Hill, 1990
. "Pollution Prevention: Homework & Design Problems for Engineering Curricula" AIPP, 1992
. Chemical Manufacturer's Association, "Designing Pollution Prevention into the Process - Research, Development, and Engineering
. Nemerow, N.L., Dasgupta, A., "Industrial and Hazardous Waste Treatment", Van Nostrand-Reinhold, 1991

References for assessment project at Paint and Coatings Manufacturing Facility (on reserve in library)
. USEPA, "Guides to Pollution Prevention: The Paint Manufacturing Industry", EPA/625/7-90/005
. Calif. Dept.of Health Services, "Hazardous Waste Minimization Assessment Checklist and Assessment Manual for Paint Formulators", May 1991
. Randall, P.M., "Pollution prevention methods in the surface coating industry", J. Haz. Matls., 29, 275-295, Elsevier, 1992
. Kirsch, F.W., Looby, G.P., "Environmental Research Brief: Waste Minimization Assessment for a Paint Manufacturing Plant", EPA/600/M-91/023, July 1991

Summary of Topics Covered

. Overview of Waste Management Approaches
. Definitions of Waste and General manufacturing waste categories/types
. Reasons for pollution prevention, benefits, tradeoffs, limitations, barriers, synergies
. Waste Management (Risk Reduction) Hierarchy (Product & Process)
. Definitions, concepts, and implications
  Pollution Prevention & Waste Minimization
  Recycling (Reuse, Reclamation, etc.)
  Other Related Concepts - Life cycle analysis, Industrial ecology, Sustainable development
. P2 Information Resources/Data Bases
. Pollution Prevention Regulatory Framework
  + Regulatory Approaches/Definitions
  + Overview of pertinent federal and state regulations - RCRA, SARA 313, Clean Air Act, Pollution Prevention Act

+ Reporting requirements & Permits
+ Waste characteristics, Lists

. Industrial Wastewater pretreatment for discharge to POTW
. Plant water balances, water conservation and reuse, quality surcharges, and lost product value
. Commercial waste management services - Heritage
. Thermal processes - Cement Kiln
. Pollution prevention techniques, technologies, approaches & examples - Product & Process, from design thru manufacturing
. Waste Reduction Measurements
. Prioritizing pollution prevention options
. Pollution Prevention Assessment Process
. Class assessment project (Courtalds Coatings)
. Total Quality Management
. Corporate and Trade Group Environmental and Pollution Prevention Programs - Elements of a Waste Minimization Program

Additional Topics Covered in Previous Semesters

. Pollution Prevention in Chemically Reactive Systems
. Flue gas desulfurization

Field Trips

Kosmos Cement Kiln, Louisville, KY
Courtalds Coatings, Plant 1, Louisville, KY - Part of class project

Simulation Exercise

Fun Factory

Problem Assignments

(Other assignments shown on detailed course schedule)

. Paint transfer efficiency, waste generation, & materials savings problem
. Estimating Hazardous Waste Constituents for Sewered Waste Notification Form (Minnesota)
. Reducing POTW surcharges (Biochemical Oxygen Demand)
. Recovery of Nickel Sulfate from Plating Bath Rinsewater and Water Conservation (Parts 9 & 10 as take home quiz)
. Evaporative Recovery of Copper from plating rinse waters, water reuse, and reduction of wastewater treatment plant costs
. Burning hazardous wastes in a cement kiln, Integrating cement kiln-coal burning power plant (to be graded as exam)
. Prioritizing pollution prevention options
. Form R Production Activity ratio
. Waste ratio

Class Assessment Project

Student teams writing qualitative waste minimization assessment report for a local paint manufacturer (Video tape of student oral group presentations available).

. In class coverage of company's environmental reports and permits
. "Process, Product, Waste and Emissions Overview of Plant", Presented by environmental manager of plant
. Plant visit
. Class brainstorming session (slides taken on plant visit and

shown in class)
. Questions and answer session with plant environmental manager
. Students allowed to communicate directly with plant manager
. Student rewrite of draft reports
. Final report and group presentations in class
(Some students did a waste prioritization on report similar to AICHE problem)

Other

. **Outside speakers** - Heritage Environmental Services, Kosmos Cement Plant, Law Environmental, General Electric Appliance Park, Industrial Engineering faculty member
. **Video tapes** - "Beyond Business as Usual" (Waste Management Hierarchy, Hazardous Waste Treatment & Waste Minimization); Safety-Kleen Video Network, "Parts Cleaner Services" and "New Castle Drum Shredder"; "Down to Earth" (Marine Shale Processors); Source Reduction Now; "Less is More: Pollution Prevention is Good Business"; "Waste Minimization: Introduction"; "Waste Minimization Assessment Procedures; 3M and the Environment, An Individual Effort"

Detailed Course Schedule

Jan. 11 Introduction, Organization, Student Introductions, Course Overview
Introduction to Waste Management Approaches
Video: Beyond Business as Usual (Waste Management Hierarchy, Hazardous Waste Treatment & Waste Minimization)
Assignment: Handout on video - **Hand in on 1/18?**
Handouts: Kentucky Partners newsletter; Course description and outline; Tentative syllabus; Acronyms, Abbreviations, and Such; Glossary; Summaries of Environmental Laws Administered by the EPA; Clean Air Programs
In the News: Not just polyester, recycled polyester is in fashion
Other: Need for course: Overhead of cartoon on conflicts between industry and environmental regulations, Administrator Browner: Pollution Prevention is Becoming EPA's Guiding Principle; Examples: 2 sided copying of handouts (increased labor); Printing on clean side of scrap computer paper & then copying or faxing wrong side; Super market - knotted plastic bag for fruits and vegetables hinders reuse of bag, not taking a bag for one item; Paunch washer/scalder - Rakvere (60C water to sewer, steam loss- energy & water, water and manure on floor, poor condition of equipment; Before and after - Engelhard pigments & Japanese rock garden

Jan. 13 Went over "Beyond Business as Usual" assignment
Assignment: Analysis of recent news article
Assignment: Waste definitions, Waste Management Hierarchy, Definitions (Ch1, EPA Manual)

-Jan. 18 No Class - Snow Day

Jan. 20 "

Jan. 25 **In the News:** 98 Cars required to have fume collectors (Phase out of service station pollution control nozzles & gasoline vapor recovery), Polluters would pay more - but get more help on rules (Increased cost of air permits, avoidance of permit or lower fees by implementing P2), KU proposes surcharge for environmental compliance (FGD pollution control, Command & Control vs. Incentives for SO2 Offsets)

Definitions & sources of waste & P2 opportunities (PPOs) - Examples (slides from assessments), Samples/Exhibits

- Raw materials in the door to wastes and products out the door
- CMA definition - Multimedia, Hazardous and non-hazardous wastes and releases
- Material inputs not incorporated into final product

  Unrecovered raw materials, Unrecovered products, Useful byproducts, Impurities in raw materials (% conversion, yield, paint transfer efficiency), Spent process material, cleaning waste, Packaging & container wastes
- Intrinsic, Extrinsic, Variable, & Fixed wastes
- Manufacturing definition of waste - Lost product, rework, Non value added material, e.g., packaging
- Importance of above in identifying PPOs - Waste audit

Handouts

Assignment: Paint transfer efficiency, waste generation, & materials savings problem

Jan. 27 **Reasons for pollution prevention/waste minimization**

Includes RCRA required certification of waste minimization programs at generators & TSD facilities **Slides:** Estonia meat packing plant rubbish disposal

Waste Management Hierarchy, Definitions, and Distinctions

- Risk reduction, Pollution prevention, Waste minimization, Source reduction, Recycling, Treatment, & Disposal, Hazardous & non-hazardous waste, Multimedia focus
- Pollution Prevention Act of 1990
- Waste oils
- Environmentally friendly design of products

  Exhibit: (Dissassembly, recyclability - Removable plastic spout from brandy bottle, Plastic deodorant dispenser

Handouts

Reading: EPA Guide: Ch. 1, Deciding on Pollution Prevention; Ch. 7, Designing Environmentally Compatible Products

Feb. 1 **P2 Benefits, Tradeoffs, Limitations, & Barriers**

(Examples from assessments)
. Avoided or reduced materials costs
. Reduced waste management costs
. Less regulatory burden
. Risk reduction
. Avoided or reduced pollution reduction/control
. equipment
. Intangible benefits
. Full cost accounting & payback
. Interactions with energy - Synergisms & tradeoffs
. Interactions with safety & health
. Wastes as raw materials
. **Tradeoffs** - Cost, Labor, Product Quality/Specifications, Customer Acceptance, Functionality vs. Cosmetics
. **Other barriers** - Economic, Regulatory, Institutional

Handouts
Reading: EPA Guide, Ch1., Ch. 2, Developing a Pollution Prevention Program, pp 23-26

Feb. 3 Jerry Racque, Heritage Environmental Services Inc., 473-0638, "Commercial waste management services" - Reuse, Recycling, Fuels Program, Treatment, Incineration, Landfill, Parts Washer Service - Hazardous, non-hazardous waste definitions
Handout: Company literature
Assignment: Weekly news abstract

Feb. 8 John Gonzalez, Louisville-Jefferson County Metropolitan Sewer District, "POTW Industrial Waste Pretreatment Program"(540-6913)
Handouts:
Assignments: Industrial Wastewater Pretreatment, Estimating Hazardous Waste Constituents for Sewered Waste Notification Form (Minnesota), Recovery of Nickel Sulfate from Plating Bath Rinsewater and Water Conservation (Parts 9 & 10 as take home quiz)

Feb. 10 **Assignment:** Weekly news abstract
In the News: "Overhaul of water law proposed", "Auto repairers want equal air pollution rules"
Other barriers (cont.)- Economic, Regulatory, Institutional (Examples: Lesco solvent recovery, Ichikoh paint wastes & hydroclone as a waste min. opportunity)
Commercial waste management services (cont.)
Recycling & liability, Hazardous waste derived from & mixture rules, Relationship between BTU content, metals, water, chlorine content & pumpability, and cost of disposal in a thermal program, and degree of solvent recovery vs. cost of still bottoms disposal, Use of MSDS for parts washer solvent and checking for SARA 313, Clean Air Act, and other listings
Video: Safety-Kleen Video Network, "Parts Cleaner

Services" and "New Castle Drum Shredder"
Handouts: Information sources (EPA hotlines), Hazardous Air Pollutants list, TCLP constituents and standards, EPA Hazardous Waste Lists and Characteristics

Case Study, Examples - Water, Wastewater

Feb. 15 **In the News:** Air board presses industry about smog control (VOCs, trading or selling pollution credits)
Paint Transfer Efficiency assignment (went over the assignment: waste & emissions generation as a function of transfer efficiency, solids content, solvent type; powder coatings; Benefits from improving transfer efficiency: savings, operating costs, payback, etc.)
Industrial wastewater pretreatment (went over previous handouts): Priority pollutants, categorical (technology based) standards, pretreatment standards, water quality standards, NPDES/KPDES permits, Basis for water & sewage charges (volume, quality surcharges, reuse, separate sewer meters)
Assignment/Exam (take home) - Industrial wastewater pretreatment; Recovery of Nickel Sulfate from Plating Bath Rinsewater Problem (Parts 9 & 10)

Feb. 17 **Industrial wastewater pretreatment** (cont.) - Went over take home quiz (Reasons for pretreatment), Potential conflicts between RCRA & Pretreatment Program, Pollution prevention as part of pretreatment program (textile-Cu bearing dye effluents as example), OCPSF Categorical Standards, Louisville MSD Pretreatment Program, Characterizing/Listing sewered hazardous waste streams & calculating hazardous constituents in waste streams (Previous assignment - Minnesota forms)
Assignments: Reducing POTW surcharge problems, Problem - Evaporative Recovery of Copper from plating rinse waters, water reuse, and reduction of wastewater treatment plant costs

Feb. 22 Steve Tucker, Law Environmental (588-5840, 588-5800), " Overview of Environmental Regulation"
Handouts: Major Environmental Protection Statutes, Air Toxics, EPA Definition of Pollution Prevention, Pollution Prevention Act of 1990, EPA Pollution Prevention Strategy

Feb. 24 **Video:** "Down to Earth" (Marine Shale Processors) - Part of Commercial Waste Management Services & Hazardous Wastes in a Cement Kiln (Thermal treatment for recycling of hazardous wastes/inert solid product made)
Handout: For video

Water Conservation Measures, Plant Water Balance & Justification for Separate Sewer Meter and Billing, Previous BOD surcharge assignment, Waste Reduction (BOD) Measures (to also account for lost product value)

March 1 Went over Ni plating rinsewater & Cu plating rinse water evaporation problems

March 3 Evaporative recovery of metals from plating rinsewaters (Cu, Ni), Recovery of metals from rinsewater by reverse osmosis - Reuse of metal bearing stream, Reuse of recovered water
In the News: Chemical plants must meet tougher EPA regulations (Clean Air Act, MACT for HAPs, VOCs)
Video: Source Reduction Now (MN Office of Waste Management)
Reading: EPA Manual; Ch.2 - Developing a Pollution Prevention Program, Ch 5 - Maintaining the Pollution Prevention Program

March 8 **Plant tour:** Kosmos Cement Kiln, Louisville, KY
Assignment (to be graded as exam, work in pairs): Burning hazardous wastes in a cement kiln, Integrating cement kiln-coal burning power plant (Ref. Nemerow, Industrial Waste Treatment)
Handouts: From Kosmos

March 10 Went over Ni recovery from rinse water assignment/quiz
Fun Factory Simulation exercise

March 15 Spring Break

March 17 "

March 22 **Examples:** Barrier to direct reuse - knotting plastic bags, Unrealized recyling/reuse opportunity - plastic bottle caps
In the News: Coal ash dumping in strip mines
Introduction to pollution prevention programs and assessments
Videos: "Less is More: Pollution Prevention is Good Business" (EPA); "Waste Minimization: Introduction" (Ca. Dept. Toxic Substances, 16:10); "Waste Minimization Assessment Procedures (10:18, Ca. Dept. Toxic Substances
Handouts: On videos
Reading: Assessment process - pp 18-21, Ch.3 - Developing and Implementing P2 Projects, Ch. 6 - Economic Analyis (also applies to previous coverage of benefits); **Pollution Prevention Programs** - Ch2- Developing a P2 Program, Ch. 5 - Maintaining the Pollution Prevention Program
Assignment: Prioritizing Pollution Prevention Options - AIPP

March 24 Cement kiln assignment due
Preassessment Methodology/Class Project
Report format

Certificate of Registration for Hazardous Waste Management
General POTW Discharge Permit
Air Emissions Inventory Statement, Certification of Data Accuracy
Operating Permit (Air)
TRI, Waste Generator Report, Assessment Process
Handouts: Portions of above permits for assessment project company, Report format, Assessment procedures
Assignment: Questions on EPA Facility Pollution Prevention Guide, Ch2 - Developing a Pollution Prevention Plan, Ch. 3 - Developing and Implementing Pollution Prevention Projects, Ch. 6- Economic Analysis of Pollution Prevention Projects

March 29 **Preassessment/Class Project**
Brent Fryrear, Manager, Environmental Health & Safety, Courtalds Coatings, "Process, Product, Waste & Emissions Overview of Plant 1"

March 31 AICHE problem on prioritizing P2 options due (teams)
Went over cement kiln assignment(graded)
Review of previous speaker's talk
1993 Hazardous Waste Generator Report for assessment plant
Formed assessment project teams
Handouts: For each group, sample report, waste gen. report & form Rs for plant
Assignments(graded): Hazardous waste generator report, Form R Production Activity ratio

April 5 Plant visit

April 7 Assessment Process, 5 step procedure
Discussion of plant visit, Views slide, Brainstorm, What we saw, Identify WM opportunities, Identify questions and additional information needed
Submit questions to Brent
Handouts: Notes from plant reps. class presentation, Instructor's review of prior plant information, Instructor's writeup of plant visit notes

April 12 Total Quality Management and ISO 9000, S. Alexander, Dept. of Industrial Engineering, University of Louisville
Handouts
Reading: Ch5 - Maintaining the Pollution Prevention Program
Assignment: Parallels between TQM and ISO9000, and Pollution Prevention programs
Assignment: Waste Ratio

April 14 Continue discussion of plant visit and questions and answers - Brent Fryrear
Students FAX questions to Brent

April 19 Paul Hosa, General Electric Appliance Park, "GE's Corporate Pollution Prevention Program"
Handouts:
Assignment: EPA Manual, Ch.5 - Maintaining the Pollution Prevention Program
3M Video: 3M and the Environment, An Individual Effort (13:10) - Handout

April 21 **Assessment Project:** Identification, brainstorm, and evaluation of waste minimization opportunities

April 26 **Draft assessment reports due**
Legislative Authorities Affecting the Life Cycle of a Chemical - TSCA, HMTA, CAA, CWA, RCRA, SWDA
Regulatory Concepts: Command & Control, Incentives, Technology Based Standards, Categorical Standards, Emissions Standards, Ambient Quality Standards
Went over Assignment on Ch.2 - Developing a Pollution Prevention Plan
3M Environmental Policy and P2 Program
CMA Responsible Care Program and Pollution Prevention Code
Product Stewardship
Additional Concepts, Interrelationships with Pollution Prevention and Waste Minimization, & Examples
Toxics Use Reduction
Life Cycle Analysis
Industrial Ecology
Sustainable Development

April 28 **Last Class**
Course Evaluations
WMAC Assessment Report at Courtalds Plant
Draft reports (reviewed) returned

May 5 Final Assessment Reports Due
Group presentations of assessment reports (videotaped)

(Some students did a waste prioritization on report similar to AICHE problem)
Slides taken on plant visit and shown in class

Pollution Prevention and Chemical Engineering
NATIONAL POLLUTION PREVENTION CENTER FOR HIGHER EDUCATION

Industrial Waste Reduction

David Kidd
Alaska Health Project, October 1991
University of Alaska–Anchorage

INDUSTRIAL WASTE REDUCTION

A three-credit university course curriculum
for environmental engineering

Course Content

This course serves as an overview of waste reduction concepts and applications in Alaska and the USA. The course covers waste reduction concepts, audits, programs, and technologies; waste disposal; regulations governing toxics use and disposal; worker safety and health; and background of the development of waste management/waste reduction in the USA. The course is divided into 15 weekly sessions, each two hours and forty minutes in length, for three graduate credits.

How to use this curriculum

This curriculum was originally produced in 1989. It does not reflect new regulatory developments at the state or federal level. Discussion of new and/or local regulation should be added by the instructor. Waste reduction information is used for examples and demonstration purposes, and may not be appropriate in all applications. For this reason, waste reduction examples would be best presented as options. Businesses or students interested in waste reduction should contact the waste reduction or pollution prevention organizations in their area.

Of the fifteen lessons in this curriculum, eleven are designed for in-class lecture by the instructor. The remainder are exam periods, student presentations, and a field trip. Each in-class lesson is organized by the following headings:

I. Reading
II. Instructor References
III. Objectives
IV. Class Activities
V. Homework

Acknowledgements

Support for development of this curriculum was provided in part under a cooperative agreement between Alaska Health Project and the Pollution Prevention Program of Alaska Department of Environmental Conversation funded by the Source Reduction Recycling Technical Assistance Grant (SRRTA) from the U.S. Environmental Protection Agency Office of Pollution Prevention. Additional support was provided by the Charles Stewart Mott Foundation. Dr. Robert E. Miller of the School of Engineering, University of Alaska Anchorage assisted in teaching the course in fall 1989.

INDUSTRIAL WASTE REDUCTION

Objectives

The students will:

1. Describe the magnitude and dangers of the waste/toxics problem in the country and state today, and describe the role of waste reduction in solving the problem.

2. List and describe the regulations governing toxics use and disposal.

3. Describe the waste reduction hierarchy, and list and explain the advantages of waste reduction.

4. Describe the steps used in conducting a waste reduction assessment of a facility.

5. Describe generic methods of reducing wastes in facilities, and apply those methods to specific examples.

6. Describe the basic principals of protecting workers from toxic exposures, and describe the relationship between these principals and waste reduction.

7. Describe the basic principles of process engineering, and apply those principles in making calculations for specific technologies.

8. Apply the waste reduction principles of product life extension, substitution, increasing efficiency, and in-plant recycling to oil management, solvent usage, coatings manufacture and application, rinsing, and chemical reaction-regeneration.

9. Describe the steps involved in setting up corporate and governmental waste reduction programs. Describe both the essential elements of these programs and potential problems that must be overcome.

Grading

The overall score for the course will be based on the following:

Homework: 30%
Project: 30%
Exams: 40%

Project

A technical paper is required. The paper can either be a research paper on some aspect of hazardous waste management or waste minimization; or it can be a waste audit report of a facility. The paper should be 8-10 pages, double spaced.

Text

Waste Reduction Assessment and Technology Transfer Training Manual 2nd Ed., (WRATT Manual) University of Tennessee, Center for Industrial Services, 1989

Supplemental Text

Hazardous Waste Minimization, Harry Freeman, McGraw Hill Publishing Company, New York, 1990

Handouts

Profiting from Waste Reduction In Your Small Business, David Wigglesworth, Alaska Health Project, 1988

Disposal Directory for Small Quantities of Hazardous Waste, Jim Sweeney, Municipality of Anchorage, Solid Waste Services, 1989

Understanding the Small Quantity Generator Hazardous Waste Rules, A Handbook for Small Business, EPA

A Manual for the Household Hazardous Materials Audit, Kristine Benson, Alaska Center for the Environment, 1987

Videos and Slides

Hazardous Waste Reduction Options for Oregon Businesses, Oregon Department of Environmental Quality

Less is More: Pollution Prevention is Good Business, EPA

Challenge to Innovation: Pollution Prevention by Waste Minimization, 3M Corporation

Pollution Prevention Pays, 3M Corporation

Waste Reduction and Waste Management Slides, Alaska Health Project

The Song of the Canary, 16mm film

References

Hazardous Waste Management, Charles Wentz, McGraw Hill Publishing, 1989

Hazardous Waste Small Quantity Generator Workbook, Intereg Group, Inc., Chicago IL 60646

The Layman's Guide to the Toxic Substances Control Act, EPA

Profit from Pollution Prevention, Pollution Probe Foundation, Toronto, Canada

Used Oil: Disposal Options, Management Practices, and Potential Liability, 2nd Edition, Government Institutes, Inc. 40 CFR, Parts 190 to 399

Alaska Job Hazard Recognition Program, Alaska Health Project

Artist Beware, Michael McCann, Watson-Guptill Publications, New York, 1979

Used Oil; Disposal Options, Management Practices, and Potential Liability, 2nd Ed., Nolan/Harris/Cavanaugh, Government Institutes Inc., 1989

Used Oil Management in Alaska, Alaska Health Project, 1989

Waste Reduction Audit Reports, Alaska Health Project (order form included in Appendix)

Pollution Prevention and Chemical Engineering
NATIONAL POLLUTION PREVENTION CENTER FOR HIGHER EDUCATION

Design of Environmentally Benign Chemical Process Plants

Ronald G. Minet
Winter 1995
University of Southern California

ChE 486 - Design of Environmentally Benign Chemical Process Plants

Course Syllabus

Instructor: Dr. Ronald G. Minet, Adjunct Professor
William Onstot, Teaching Assistant

Introduction:

The Chemical Engineering curriculum includes a Capstone Design class, Chemical Engineering 480 which reviews the various components of chemical engineering and combines them in a final design problem illustrating the application of various specialties to a realistic case which includes material and energy balances, equipment design and selection, capital and operating costs, economic considerations and optimization studies.

In the environment climate existing in the world today, the chemical engineer involved in process plant design must include detailed analysis of pollution control, effluent handling and hazard potential in the context of completing the design. Thus, the ChE 486 course describes a design course for chemical engineering seniors or graduate students which will equip them to become professional chemical engineers with the disciplines necessary to design an environmentally benign process plant.

Prerequisites for this course include knowledge of chemical process design, physical and organic chemistry, unit operations and economic analysis.

Texts used will include handouts from EPA and other sources and the texts used for ChE 480.

WEEK and TOPICS

1	1.0	Basic Environmental Considerations For Process Plants
	1.1	Proper Siting
	1.2	Environmental Impact Statement
	1.3	Appropriate Regulations: Federal, State, Local
	1.4	Process Plants And Environment As A System
	1.5	Life Cycle, Industrial, Ecology, Waste Audits and Emission Control
2	2.0	Sources Of Pollution, Hazard, Nuisance And Neighborhood Problems In Process Plant Designs
	2.1	Air, Water And Solid Wastes
	2.2	Hazards And Safety
	2.3	Compatibility With Natural Environments

WEEK and TOPICS

3	2.5	Application of analysis systems. Macroscopics, mesoscopic and microscopic pollution systems analysis
4	3.0	Review of Basic Design Procedure for Process Plants
	3.1	Overall Material Balances
	3.2	Basic Stoichiometry
	3.3	Overall Energy Balances
	3.4	Specific Sources Of Effluent Problems
5	4.0	Design Procedures To Minimize Effluents
	4.1	Internal Recycles
	4.2	Use Of Most Efficient Processes
	4.3	Selection Of Raw Materials
6	5.0	Minimizing Energy Requirements
	5.1	Second Law Of Thermodynamics Considerations
	5.2	Pinch Analysis For Heat Recovery
	5.3	Alternate Processing Strategy Using Heat Pumps, Waste Heat Recovery, Internal Use Of Waste Streams
7-11		Design Of A Selected Process Plant Using Advanced Environmentally Efficient Systems. The design project will be carried out by student groups using preselected industrial processes to arrive at improvements in overall environmental impact. this part of the course will count for 60% of the overall grade.
12	11.0	Analysis Of The Chemical Process Plant To Eliminate Potential Hazards From Improper Operation Or Equipment Failure
13	12.0	Study of Hazops Procedure Including The Use Of Computational Analysis On PC Programs
14	13.0	Economic Aspects Of Environmental Benign Design
15	14.0	Review And Finalization Of The Prepared Process Plant Design
16	15.0	Final Exam.

Textbook: Plant Design and Economics by Peters and Timmerhaus.
Selected publications of AIChE including Hazard Operations Analysis, Design of Pressure Safety Systems.
Conceptual Design of Chemical Process by J. M. Douglas.
Specific handouts for Federal, State and Local Regulation of Effluent Control.

Final Grade: Project: 60%, Homework and Occasional Quizzes: 10%, Final Exam: 30%.

ChE 486
Some Additional Notes

Week 1:

During the first week we will discuss basic environmental considerations for process plants. Included in these discussions will be those things which are needed for proper siting; the materials that are required to prepare a suitable environmental impact statement; some knowledge of regulations which will be required for guidance from the federal, state and local authorities; and in addition we will discuss how process plants and the environment in which the process plant has been placed behave as a closed system.

Week 2:

Sources of pollution hazards and nuisance as well as neighborhood problems that must be considered in process plant design will be discussed. Of course one of the major things to worry about are waste materials that would be coming out of the facility which might in some manner enter the surrounding air, groundwater, wastewater, and solid waste disposal requirements. This listing should take place early on in the design of the plant and in its first material balance consideration.

Once a suitable block diagram for the plant has been settled, a quick review should be made of the potential hazards and safety requirements for the unit. This would mean some kind of preliminary run through of the steps involved in the process and those areas where conceivably a hazard or a safety problem could occur.

We must also review the particular environment where the plant might be located. It is clear that if the plant is going to be located inside of an existing chemical or petroleum facility, the situation is significantly different than the case where the plant would be located on what is commonly called a "grassroots base" where there is no infrastructure or where the local existing infrastructure may not be designed for the presence of a chemical operating facility.

Weeks 3 and 4:

The basic design procedure which will be followed is similar to that used for the ordinary plant design course. The first step would be to prepare an overall material balance using the principles of stoichiometry and other requirements to make certain that we take into consideration all of the feedstocks and the products which would be coming from the facility. Once a basic stoichiometry has been made, overall material, block diagrams and energy balances can be prepared while doing this the specific sources of effluents which would be generated by this plant can be identified and listed.

Week 5:

Design procedures to minimize effluents. After the potential effluents have been identified, a review of the design should be undertaken to see if some of these effluents can be minimized or eliminated. For example, in case a plant is producing a byproduct material because of impurities in the feedstock, consideration should be given to using a more pure feedstock and thus minimize production of that particular byproduct unless the byproduct has an economic value. Sometimes it is possible to reduce effluents by providing internal recycles within the plant. Either gases, liquids, or solids can be recycled within the plant in order to reduce as many effluents as possible. Another practice that can be investigated is to determine the most efficient processes that can be used within the economic constraints of the process. A process which has a conversion level of 90% and a selectivity of 85% should be compared with another one that has a conversion level of 95% and a selectivity of, say 80% to see which one provides the best utilization of feedstock and minimizes the production of unwanted effluent.

Week 6:

Minimizing energy requirements. One of the major influences an operating plant has on the environment is due to the quantity of energy that must be consumed or disposed of. A review of the design of the plant taking into consideration second law thermodynamic considerations can sometimes reduce or pinpoint those areas utilizing or requiring the greatest consumption of energy. The heat recovery system can be subjected to pinch analysis to make certain that the most effective use of certain that the most effective use is being made of the energy which is input to the plant. Some modification of the organization of the heat exchange circuits frequently results in significant savings in overall energy requirements.

The study should include alternate process strategies making use of heat pumps, extensive waste heat recovery, and utilizing waste streams within the facility in order to provide a basis for the unit to operate in as efficient a manner as possible.

Week 7 - 11:

Detailed design of a selected process plant using advanced environmentally efficient systems. A specific project will be selected to be carried out by student groups using known preselected industrial processes. Once the basic process has been derived and the initial calculations carried out to determine overall economics and cost, the design will then be reviewed to minimize waste effluents and to minimize energy requirements. This particular part of the course will take at least 40% of the total time involved, but will account for at least 60% of the overall grade.

Week 12:

Having arrived at a basic design for the plant and having reviewed it for minimizing effluents: the design should then be investigated for hazards and for potential dangers which might arise if the plant were operated in an improper manner or if the plant should, for one reason or another, fail.

Week 13

The Hazops procedure will reviewed and there will be some use of computational analysis on PC programs.

Week 14:

The overall design will be reviewed from an economic point of view. Is the environmentally benign plant more expensive and less economic than the standard plant or when all things are taken into consideration is the economically benign design the most economical?

Week 15:

Will be taken up with the review and finalization of the prepared process plant design in the form of a report to be given to the department. These are specific references available including books and articles and the overall results of the study should be an understanding on the part of the student of the way in which a plant can be designed which is efficient, economic, and compatible with the environment to maximum extent that is feasible and by here we mean, by feasible, within the reasonable limits of cost and efficiency that will still allow the plant to operate in a successful manner.

ChE 486 Handouts

1. Pollution Prevention: Engineering Design at Macro, Meso and Microscales.
   D. T. Allen, page 251-323.

2. Life Cycle Design Guidance Manual.
   EPA Jan. 1993, G. A. Keoleian
   EPA/600/R-92/226 - Contact EPA, Cincinnati, OH 45268 (513) 569-7562 (free of charge)

3. Facility Pollution Prevention Guide
   EPA/600/R-92/088
   513-569-7562 ~~R&D~~ (free of charge)
   ~~513-569-7931~~

4. product
   Life Cycle Assessment: Inventory Guidelines and Principles, February ~~1993~~ 1992.
   EPA/600/R-92/245 (513) 569-7562 (free of charge)

5. Pollution Prevention for Chemical Processes.
   David Allen and Kirsten Rosselot.
   Hazardous Waste Research and Information Center
   One East Hazelwood Drive
   Champaign, Illinois 61820
   August 1994

Other References

1. New book by Allen - to be published in 1995 as yet untitled.

2. Application of Hazard Evolution Techniques to the Design of Potentially Hazardous Industrial Chemical Processes.
   H. R. Kavianian, *et al.*, Cal State, Long Beach, March 1992.

3. Sustainable Development by Design.
   Review of Life Cycle Design and Related Approvals.
   G. Keoleian and D. Menery.
   Air and Waste, Vol. 44, May 1994, 645-688

Pollution Prevention and Chemical Engineering
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Advances in Pollution Prevention: Environmental Management for the Future

Michael Overcash and Christine S. Grant
CHE 598 O, Spring 1993
North Carolina State University

Advances in Pollution Prevention:
Environmental Management for the Future
CHE 598 O: Spring 1993

Professors: Dr. Michael Overcash Dr. Christine Grant
Required Text: Course Notes and Supplemental handouts

A graduate level course for chemical engineers and non-chemical engineers focusing on the development of strategies for pollution prevention and waste minimization. Review of PP policies, regulation in addition to case studies to address the implementation of research in pollution prevention.

Course Objectives:

CHE 598 O focuses on the design of industrial processes which minimize or eliminate chemical waste production. The first part of the course will describe the regulations and the organization of current pollution prevention efforts. We will conduct case studies to illustrate the important aspects of these efforts. The second portion of the course will describe current research efforts in the area of waste minimization and pollution prevention. The third portion of the course will cover product life cycle analysis and the application of these ideas to the design of more efficient processes. The subsequent design of new processes and improvement of existing processes will be conducted using ASPEN ModelManager. In addition, there will be speakers from industry that will address the problems associated with pollution prevention.

Advances in Pollution Prevention:
Environmental Management for the Future
CHE 598 O: Spring 1993

Professors: Dr. Michael Overcash Dr. Christine Grant
Required Text: Course Notes and Supplemental handouts

Course Objective: Investigate the design of industrial processes which minimize or eliminate chemical waste production.

WEEK	TOPIC
1	Introduction
2	Regulations, Roadmap, Organization and Implementation of Pollution Prevention Concepts
3	Case Studies and Literature Review *Case Studies 1-3 should be done in groups of three. The final project must be done on an individual basis.
4	Research Topics I: Reactions and Trace Contaminants • Cyanide • Dioxin • Oxygenated Fuels
5-6	Research Topics II: Cleaning and Decontamination of Solid Surfaces • A Study of the Mechanisms and Kinetics Associated with the Reflux Cleaning of Chemical Processing Equipment • Non-Invasive Kinetic Studies of Metal Oxide Decontamination from Stainless Steel • Non-Invasive Kinetic Studies of Film Decontamination • Waste Minimization in the Removal of Flux Residues from Printed Wiring Assemblies • Gas-Phase Chemical Cleaning of Silicon Surfaces
7-8	Research Topics III: Volatiles/Fugitive Emissions • Fugitive Emissions • Carrier Reduction / Polyurethane Foam
9	Chemical Products
10-11	Life Cycle Analysis
12	Design Project / ASPEN
13	Project Report Presentations

In addition, there will one or two industrial speakers over the course of the semester to discuss various aspects of pollution prevention.

CHE 598 O: Advances in Pollution Prevention: Environmental Management for the Future
Detailed Course Schedule: Spring 1994

Lecture #	Topic/Handouts
1	Introduction/Syllabus/ Research Questionnaire
2	Eight Steps in Pollution Prevention (PP), Ethylene Oxide Process
3	**Environmentally Conscious Products: Guest Lecturer: Dr. Roger Sanwald, IBM, Research Triangle Park, NC**
4	EPA Regulations, Pollution Prevention History
5	Conducting a Waste Audit, Intro. to Printed Wiring Assemblies (PWA)
6	PWA Waste Audit, Flow Diagram: in class exercise
7	Pollution Prevention Decision Points: Course Notes
8	Total Quality Manufacturing, Research Topic 1: Reactions
9	Intro. to Pulp and Paper Technology/ Distribution of Case Study #1
10	Research Topic 1: Reactions
11	Case Study #1 Due: Class Discussion of Case/ Distribution of Case #2
12	**Test #1**
13	Research Topic 1: Reactions; Dioxin
14	Research Topic 2: Cleaning and Decontamination Processes Case Study #2 Due/Case # 3A Distributed
15/16	Research Topic 2: Cleaning and Decontamination Processes Case #3A due
17	Research Topic 3: Life Cycle Analysis **SPRING BREAK**
18/19	Research Topic 3: Life Cycle Analysis, Distribution of Final Project
20	**Developing a Site-Wide Waste Management Strategy: Guest Lecturer: Dr. Lisa Bullard, Eastman Chemical Company, Kingsport, TN** Case #3B due
21	Discussion of: Case #3, Eastman Lecture, Final Project, ASPEN
22/23	Research Topics 4: Volatilization, Final Project Phase 1 due
24	**Test #2**
25	Computer Aided Process Improvement for PP/ ASPEN
26	ASPEN Case Study, Discussion of Test #2
27/28	Final Project Presentations: Poster Format, Final Class Exit Interviews
29	Discussion of Final Projects, Summary of PP Research Efforts (e.g., NSF, EPA), Course Wrap-up, Final Evaluations

Case #1: **Pollution Prevention in Pulp and Paper Processing***
Case #2: **Polyurethane Foam Manufacturing***
Case #3: **Pollution Prevention in Cleaning Processes***
Final Project: Net Waste Reduction in Industrial Manufacturing and Life Cycle Analysis

Pollution Prevention and Chemical Engineering
NATIONAL POLLUTION PREVENTION CENTER FOR HIGHER EDUCATION

Pollution Prevention

Robert B. Pojasek
CE-194J, Spring 1993
Tufts University

Department of Civil/Environmental Engineering
TUFTS UNIVERSITY

CE-194J Pollution Prevention Spring 1993
Instructor: Dr. Robert B. Pojasek

COURSE DESCRIPTION

This course focuses on the interface between manufacturing and the environment. By manufacturing a product more efficiently, there will be less losses to the environment. Pollution prevention examines how a manufacturing firm can move away from end-of-the-pipe pollution controls as the only means of complying with stringent regulations. A process perspective is necessary to gain an understanding of chemicals use and process losses. Information presented in the course will provide a basis for developing and implementing techniques to reduce these losses at the source.

This is a "hands on" course where the student will learn by actually working on a pollution prevention project. In lieu of a final examination, the student will work in a small group to evaluate a designated facility which manufacturers paints, adhesives, or coatings (i.e., the industry classification chosen as the focus for this semester's course). Together they will prepare process flow diagrams, materials accounting summaries, description of all of the opportunities for pollution prevention, and a rank ordering of these opportunities. Each student in the group will then research one of the primary opportunities, conduct a feasibility study, and make recommendations for implementation.

In order to learn how pollution prevention programs are planned and implemented, each student will work in another small group to evaluate a designated firm's actual program. A confidentiality agreement will be negotiated in each case before the work is commenced. Each program will be evaluated in terms of the culture of that firm and not by comparing it to other firms' programs. The group will write a report describing the program and making recommendations to improve it. Each student will prepare an individual critical review of the program.

COURSE SCHEDULE

1. January 25, 1993 INTRODUCTION TO POLLUTION PREVENTION

Without dwelling extensively on the terminology and definitional problems that currently exist in this emerging field, some generic pollution prevention concepts will be presented. These concepts will include chemical use cycles, the waste management hier-

archy, sustainable development and the theories of loss control. Incentives and disincentives to the use of pollution prevention practices in industry will be examined along with pressures that have been brought to bear to induce facilities to place these practices in place. No attempt will be made to examine specific pollution prevention legislation or regulations.

2. February 1, 1993 MANUFACTURING AND MANAGEMENT

Emphasis in this course is placed on pollution prevention in manufacturing. All manufacturing categories have commonalities which, when recognized, allow the pollution prevention practioner to apply the concepts described in the previous section without regard to the type of firm. Besides examining manufacturing, the manner in which manufacturing is managed is a key to the successful implementation of pollution prevention. Analogous management programs (such as total quality management, just-in-time, and computer integrated manufacturing) will be discussed along with a model for manufacturing for competitive advantage.

3. February 8, 1993 CORPORATE POLLUTION PREVENTION PROGRAMS

One of the term papers will have the student explore how companies plan, operate, and sustain pollution prevention programs. An important key to a successful program is the recognition of the corporate culture. At various levels in the firm, this culture can vary somewhat depending on whether one looks at the corporate organization, business units/ divisions, facilities or departments in the facilities. There is also the issue of the impact of suppliers and customers in formulating a workable program to enhance competitiveness of the operation. Analogous programs such as total predictive maintenance will be examined to see how lessons learned will be applicable to pollution prevention programs.

4. February 17, 1993 MAPPING A MANUFACTURING PROCESS OR OPERATION (Wednesday)

Mapping is utilized to help develop a picture of the process or operation being examined. Resolving the differences between the way different people see the process and what is actually happening is a valuable activity. A variety of mapping and other visualization techniques will be evaluated along with analogies to road maps and electrical schematic diagrams. Using process flow diagrams to help understand process functionality is at the heart of the descriptive approach to pollution prevention assessments. A variety of exercises will be utilized to develop suitable map preparation skills.

5. February 22, 1993 CONDUCTING A FACILITY ASSESSMENT

To conduct a successful pollution prevention assessment one must learn to become a good EXPLORER. Utilizing prescriptive tools (i.e., checklists, worksheets, and questionnaires) for conducting assessments have many problems associated with them. Process flow diagrams and materials accounting must be an important component of the assessment. The difference between materials accounting and materials balances will be explained. It is

important that the facility assessment identify all the losses from the operations or process steps. All ancillary and intermittent operations must be identified and incorporated into the assessment.

6. March 1, 1993 IDEA TOOL BOX

Total quality management and other management programs employ a number of tools to define and understand the problems as well as to gather information for the feasibility study. Every loss identified in the assessment is an opportunity not to have the loss. To describe the opportunity and to qualify which opportunities are most important, a variety of tools can be utilized. They include: brainstorming, storyboarding, mind mapping, cause and effect diagrams, Pareto process, root cause analysis and computerized simulation models. Examples will be utilized from process equipment cleaning and chemical transfer/mixing operations.

7. March 8, 1993 ANALYZING INFORMATION

An ARTIST takes information gathered from the assessment and draws pictures with it. Graphical techniques will be utilized to present the data from the above steps. If the pollution prevention practitioner can utilize the tool box to discover trends and get at the root cause of the problems, they can begin to derive alternatives for each primary opportunity and develop the information necessary for screening and evaluation which takes place in the feasibility study. Above all, one must resist the search for the "right" answer.

8. March 15, 1993 THE FEASIBILITY STUDY

Conducting the feasibility study is like being a JUDGE. Considering the specifics in each case is important. Criteria for screening alternatives will include effectiveness, implementability and cost. A more detailed analysis of the primary alternatives will consider engineering, economics and institutional considerations. The need for bench and pilot testing must be determined at this time. All this activity will help establish a successful implementation program.

----------SPRING BREAK----------

This break provides an opportunity to work on the term papers. Four lectures will be given over the next two weeks to familiarize the student with the major categories of alternatives that are often considered in a pollution prevention feasibility study.

9. March 29, 1993 OPERATING PRACTICES/MATERIALS SUBSTITUTION

Good operating practices are often referred to as the "low hanging fruit" of pollution prevention. These are the easiest alternatives to implement and may often lead to the largest increments of reduction. Materials substitution is most frequently utilized by industry to move from listed regulated materials to unlisted materials. There are many cases where the substitute has either shifted the media into which the loss was transferred or was later

deemed toxic after more detailed tests were conducted. Dematerialization is another form or materials substitution that will be covered. **TERM PAPER ON COMPANY P2 PROGRAM DUE.**

10. April 5, 1993 TECHNOLOGY/RECYCLE-REUSE-RECOVER

Technology can range from equipment modification and process automation to quantum leaps in the manner in which an item is manufactured. Industrial ecology is a term used to examine the concept of recycling. There is often an overlap between recycling and treatment. Each of these considerations occupy a lower status on the waste management hierarchy covered in the first class. Sham recycling and off-site operations will be examined along with the practice of waste exchange.

11. April 12, 1993 IMPLEMENTATION

Implementing the primary alternative selected in the feasibility study is often like being a good WARRIOR. Instead of fighting to get something implemented, teamwork, program integration and a good feasibility study should help facilitate project and program implementation.

12. April 19, 1993 No Class

This break will provide an opportunity to complete the pollution prevention projects which are **DUE** at the next class.

13. April 26, 1993 DESIGN FOR X

It is always preferable to design pollution prevention into new processes and products. The X can stand for the following terms: environment, recyclability, disassembly, remanufacturability, reliability, durability, waste minimization, etc. These terms have been in use for a long time and are all related to one another. Life cycle analysis of products is also an old tool which has taken on new meaning by including environmental impacts of operations from the extraction of the raw materials to the ultimate disposition of the final product. This analysis can utilize the descriptive approach developed in this course and need not be prescriptive. **TERM PAPER ON POLLUTION PREVENTION PROJECTS DUE.**

14. May 3, 1993 COURSE WRAP-UP

Each of the important lessons learned about the manufacture of paints, adhesives and coatings will be utilized to design the coatings manufacturing facility of the future.

COURSE INFORMATION

Textbooks. There are four texts: "A Kick in the Seat of the Pants" by Roger von Oeck (ISBN 0-06-096024-8 pbk.); "21st Century Manufacturing" by Thomas G. Gunn (ISBN 0-88730-546-6); "Facility Pollution Prevention Guide", EPA/600/R-92/088, 1992; and "Guides to Pollution Prevention-The Paint Manufacturing Industry," EPA/625/7-90/005, 1990.

Additional reading materials will be handed out each week in class along with the homework assignments.

Reserve Reading. There will be materials placed each week in the reserve reading location of the departmental library. Usually these materials will provide supplementary information.

Homework. Homework must be completed by the start of each class. All homework must be TYPED with adequate spacing to make written comments in the class and by the instructor. It will be discussed in the class and collected with comments written by the student as a result of the class discussion.

Grading. Each student will receive a letter grade based on the following components:

1. Pollution Prevention Project-Term Paper = 40%
   Group Report = 25% of grade
   Individual Report = 75% of grade

2. Critical Review of Corporate Program = 30%
   Group Report = 33% of grade
   Individual Report = 67% of grade

3. Homework: Approx. six assignments = 20%

4. Classroom Participation = 10%

Class Schedule. Each class will begin promptly at 6:30 p.m. on the dates indicated above and will end at 9 p.m.

Office Hours. Dr. Pojasek will be available one hour before every class, i.e., 5:30 to 6:30 p.m. He is also available by appointment and by telephone during the normal business day at the following location: GEI Consultants, Inc.; 1021 Main Street; Winchester, MA 01890 (617) 721-4097 (voice mail). His fax number is (617) 721-4073.

Pollution Prevention and Chemical Engineering
NATIONAL POLLUTION PREVENTION CENTER FOR HIGHER EDUCATION

Hazardous Waste Management

Margrit von Braun
ES 475/575 & Engr 607, October 1990
University of Idaho

HAZARDOUS WASTE MANAGEMENT

SYLLABUS
(for live, microwave, video and NTU students)

Term: Fall 1990

University Course No: ES 475/575 (UI)
Engr 607 (ISU)
NTU Course No: ES 791-S

Course Title: Hazardous Waste Management

Instructor: Margrit von Braun, Chemical Engineering Dept.
University of Idaho, Moscow, ID 83843

FAX: 208-885-7462
Phone: 208-885-7838
Video/NTU Students: (Ask for Cathy) 800-824-2889 (outside Idaho)
800-632-8590 (in Idaho)

Telephone Office Hours: Mon/Wed 11:00 a.m. - 12:00 p.m. Pacific Time
Wed 2:00 p.m. - 3:00 p.m. Pacific Time

Live Office Hours: Tu/Thur 2:00 p.m. - 4:00 p.m. and by appointment

Course Days/Times Meet on Campus: Tu/Thur 7:30-8:55 a.m. Pacific Time

Texts:

Required: Selected Reading Materials (Instructor Packet)

Recommended: Standard Handbook of Hazardous Waste Treatment and Disposal. Harry M. Freeman. McGraw Hill, 1988.

A variety of additional course notes will be supplied by the instructor.

Prerequisites: Junior, Senior or Graduate standing in engineering or science. Applied Statistics.

Course Objectives/Description:

This course examines the management of hazardous wastes in the U.S. Following a review of the broad framework of toxic regulation, the course will focus on the management processes defined by the two major legislative acts, CERCLA/SARA and RCRA/HSWA. Special emphasis areas will include waste site characterization, risk assessment and waste minimization. Actual case studies will be provided.

Course Requirements:

Homework: To be assigned periodically.
Examinations: Two exams and a final.
Project: Term paper - details to be announced.

Please submit all homework and exams to Margrit von Braun, Department of Chemical Engineering, University of Idaho, Moscow, ID 83843. This will ensure rapid grading and return of your work. Also, include the NTU Course No. (if applicable) as well as the University Course No. on all homework and exams. You may Fax materials to save time.

The exams will primarily be take-home "projects". Closed book portions of exams may also be given. Reading assignments will be made throughout the course.

Class Attendance: Students are responsible for all material covered in class.

		Graduate	Undergraduate
Grading Policy:	Homework	10%	10%
	Two Exams	40%	40%
	Final Exam	25%	35%
	Paper	25%	15%

Course Outline:

A. Introduction
   1. Hazardous Waste Problem
      a. Scope
      b. Historical Perspective

B. Environmental Legislation
   1. Media Specific Laws (CWA, CAA, SDWA)
   2. Hazardous Waste Laws (TSCA, RCRA/HSWA, CERCLA/SARA)
   3. State Responsibilities
   4. EPA Structure and Organization

C. RCRA Process
   1. Definitions of Hazardous Waste
   2. Generator and TSD Requirements
   3. Land Ban Issues
   4. Resources and References

D. Superfund Process
   1. Site Ranking
   2. RI/FS to ROD
   3. Community Right to Know
   4. Toxic Release Inventory
   5. Case Studies
   6. Resources and References

E. Environmental Media Considerations
   1. Characterization and Sampling
   2. Focus on Specific Contaminants

F. Toxicological Principles
   1. Dose Response
   2. Toxic Effects
   3. Toxic Responses

G. Risk Assessment
   1. Exposure Mechanisms
   2. ARAR's
   3. SPHEM and RAG
   4. Historical Exposures
   5. Case Studies
   6. Data Sources, Resources, References on Toxicology and Risk Assessment

I. Waste Reduction
   1. Overview of Waste Minimization
   2. Benefits/Incentives/Barriers/Cost
   3. Basic Elements of Waste Minimization
   4. Implementation of Waste Minimization Program
   5. Waste Minimization Assessments
   6. Applications - Success Stories
   7. Resources & References on Waste Minimization

Pollution Prevention and Chemical Engineering
NATIONAL POLLUTION PREVENTION CENTER FOR HIGHER EDUCATION

Engineering Risk Assessment for Hazardous Waste Evaluations

Margrit von Braun
ES 404/504 & ENGR 599, Spring 1991
University of Idaho

Spring 1991
Engineering Risk Assessment for Hazardous Waste Evaluations
ES 404/504 (UI)
ENGR 599 (ISU)

Instructor: Margrit von Braun
Chemical Engineering Department
University of Idaho

FAX: 208-885-7462
Phone: 208-885-7838

Meeting Times: MWF 7:30-8:20 a.m.

Course Description:

The cleanup of hazardous waste sites is largely driven by an assessment of the risk to human health and the environment. This course examines risk assessment for quantitative and qualitative approaches to characterizing and controlling environmental pathways between contaminant hazards and the public. Engineers and scientists working in waste management will develop proficiency in and awareness of the theory and practice of toxicology, exposure assessment and risk characterization. Quantitative or mathematical models to make decisions about risks to humans or the environment will be used and evaluated. Case studies will be critically reviewed.

Prerequisites:

Required:
Senior or graduate standing in science or engineering. This status should include an introductory Biology course (UI Biol 201 or 100 or ISU BioS 120 or 599).

Recommended:
ES 475/575 (or ChE 470/570) Hazardous Waste Management

Textbooks:

Required:
Manahan, Stanley E. - Hazardous Waste Chemistry, Toxicology and Treatment. Lewis Publishers. 1990.

Recommended:
Paustenbach, Dennis J. - The Risk Assessment of Environmental Hazards. Wiley Interscience. 1989.

Course Outline:

I. INTRODUCTION

Overview of human health evaluations
Basic concepts in defining risk

II. BIOCHEMISTRY, CHEMISTRY, AND TOXICOLOGY OF HAZARDOUS MATERIALS

A. Basic Concepts of Biochemistry and Toxicology

Cell functions and defense mechanisms
Dose Response relationships
Non-carcinogenic responses
Carcinogenesis
Teratogenesis, Mutagenesis
Toxicity testing

B. Chemical Hazards and Classification

Properties of hazardous substances
Chemical Classes
Hazardous materials classifications

C. Chemistry of Inorganic Hazardous Wastes

Elements
Inorganic compounds
Organometallic compounds

D. Toxicology of Inorganic Hazardous Wastes

Elements
Inorganic compounds
Organometallic compounds

E. Chemistry of Organic Hazardous Wastes

Hydrocarbons
Organooxygen compounds
Organonitrogen compounds
Organohalide compounds
Organosulfur compounds
Organophosphorus compounds
PCB's, dioxins, asbestos

F. Toxicology of Organic Hazardous Wastes

Hydrocarbons
Organooxygen compounds
Organonitrogen compounds
Organohalide compounds
Organosulfur compounds
Organophosphorus compounds
PCB's, dioxins, asbestos

G. Medical Wastes

Biomedical wastes
Infectious wastes

III. SUPERFUND RISK ASSESSMENT

A. Hazard Identification

Data collection
Site characterization

B. Exposure Assessment

Pathways identification
Fate and transport parameters & assessments
Intake estimations
Historical considerations

C. Toxicity Assessment (Using EPA on-line databases)

Toxicity values for non-carcinogens
Toxicity values for carcinogens

D. Risk Characterization

Quantifying risks
Combining risks
Uncertainty assessments
Explaining risk
Site specific considerations

E. Radiation Risk Assessment

Principles of radiation protection
Key differences from chemical assessments

Required Manual:

EPA Risk Assessment Guidance for Superfund, Vol. I and II, March 1989.

Note! This document is in the UI library government documents and in the INEL library. It may be xeroxed; it is not copyrighted. If you prefer, xerox copies will be for sale at Kinko's in Moscow, at cost, approx. $30.00 and at IFCHE. (It costs $48 from NTIS).

Computer Facilities:

Access to a DOS-based (fully IBM compatible) personal computer for modelling and risk analyses using software packages on fate and transport.

Access to TYMNET, TELENET, InfoNet or CompuServe networks for using EPA on-line data bases.

Computer software and on-line accounts will be provided.

Although no computer language experience is specifically required, some computer experience is desirable. The ability to use LOTUS 1-2-3 or a similar spreadsheet program will also be helpful.

Course Requirements and Grading:

	G	UG	G-Video	UG-Video
Chemical Toxicity Review				
Presentation	10*		10**	
Paper	10	10	10	10
Case Study Critical Review				
Paper	10		10	
Risk Assessment Team Project	30	30	30	30
Midterm Exam	20	30	20	30
Final Exam	20	30	20	30

G = Graduate UG = Undergraduate

*Presentations will be made to the class and videotaped.
**Presentations will be made to the class and the instructor.