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Environmental Policy and Technology Project

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UKRAINE
Summary and Trip Report on Hazardous Waste Management Workshops

Donetsk, 15-16 & 20-21 February 1996

Delivery Order #09, Task U1

Prepared for:
U.S. Agency for International Development
Regional USAID Mission to Ukraine, Belarus & Moldova

Bureau for Europe & the New Independent States
Office of Environment, Energy & Urban Development
Environment & Natural Resources Division

Prepared by:
Ukraine, Belarus & Moldova Regional Office
Environmental Policy and Technology Project
For The New Independent States of the former Soviet Union

A USAID Project Consortium Led by CH2M HILL

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PREFACE

Under the 1992 Freedom Support Act, the United States Congress initiated a program to provide various forms of assistance to new independent states (NIS) of the former Soviet Union. Cooperative Agreements were signed between representatives of the U.S. government and each country in which assistance is to be undertaken. The U.S. Agency for International Development (USAID) was given the responsibility to coordinate all U.S. government assistance to the NIS under the Act.

Through competitive bidding, USAID awarded a multi-year contract to a team managed by CH2M HILL International Services, Inc. (CH2M HILL) to support implementation of an environmental assistance program to republics of the former Soviet Union. Under this contract, termed the Environmental Policy & Technology (EPT) Project, CH2M HILL is to assist USAID's missions in Moscow, Kyiv, and Almaty undertake a program to promote environmental improvements in the NIS. The USAID mission in Kyiv supports environmental, and other, assistance programs to Ukraine, Belarus, and Moldova. CH2M HILL established an office in Kyiv from which to perform services in these countries under the EPT Project.

This report was prepared as a contractually required deliverable under a contract between USAID and CH2M HILL. Although work on this report was conducted in cooperation with the assisted governments and USAID, the findings and recommendations are those of the CH2M HILL team. They do not necessarily represent official positions of the governments of the assisted countries nor of the United States of America.

The CH2M HILL team includes the following organizations:

- Center for International Environmental Law
- Clark Atlanta University/HBCUMI Environmental Consortium
- Consortium for International Development
- Ecojuris
- Environmental Compliance, Inc.
- Harvard Institute for International Development
- Hughes Technical Services Company
- International Programs Consortium
- International Resources Group, Ltd.
- Interfax Newsagency
- K&M Engineering
- Ogden Environmental and Energy Services Company
- Price Waterhouse
- World Wildlife Fund (US)

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NOTE ON TRANSLITERATION

Ukrainian personal and place names used in this report have been transliterated into the English language from the Ukrainian (not Russian) language, according to the modified Library of Congress standard adopted by many Western organizations and institutions, including the *Encyclopedia of Ukraine*, 5 volumes (University of Toronto Press, 1984-1993).

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ABBREVIATIONS, ACRONYMS & GLOSSARY

CH2M HILL	CH2M HILL International Services, Inc. (a U.S.-based international environmental engineering consulting firm)
DO	Delivery Order
EPT	Environmental Policy & Technology (Project). A USAID-funded program to provide environmental assistance to New Independent Republics of the former Soviet Union
MEPNS	Ministry of Environmental Protection & Nuclear Safety (of Ukraine)
MEPNS-DO	Ministry of Environmental Protection & Nuclear Safety, Donetsk Oblast
oblast	A government territorial-administrative unit in the former Soviet Union that is still in use following Ukraine's independence. A U.S. analogue would be something between a state and a county.
TIC	(EPT Project) Technical Information Center
USEPA	U.S. Environmental Projection Agency
USAID	U.S. Agency for International Development

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Section 1

INTRODUCTION

As part of a United States government bilateral assistance program, the U.S Agency for International Development (USAID) is supporting environmental management in Ukraine. Under direction from USAID, a consortium led by CH2M HILL International Services, Inc. (CH2M HILL), is implementing part of USAID's Environmental Policy & Technology (EPT) Project by undertaking various tasks that have been agreed to by representatives of the governments of both countries.

USAID authorized CH2M HILL to perform a series of tasks in Ukraine under Delivery Order (DO) #9. Task U1 (Donetsk Industrial Waste Management) includes a requirement for CH2M HILL to conduct a workshop in Donetsk on industrial waste management practices, in conjunction with the U.S. Environmental Protection Agency (USEPA).

A trip to Ukraine, including Kyiv and Donetsk, was undertaken by waste management engineer Tim Van Epp (of the EPT/Washington office) on behalf of the EPT Project between 10-22 February 1996. The purpose of this trip was to finalize workshop presentation materials, and present part of the workshop.

Under terms of the contract, CH2M HILL is required to submit a Summary Report on each workshop, and a Trip Report for travel by any U.S.-based professional to the NIS for project-related purposes. This document has been prepared to fulfill both these two obligations.

Section 2

RESULTS

The Workshop was held at the EPT Project's Technical Information Center (TIC) in Donetsk, a facility previously established as a component of Task U1 of DO #9. The Workshop was presented twice: for the first time on February 15-16, and then again on February 20-21, 1996.

Invitations were initially drafted by CH2M HILL, and forwarded by USAID/Kyiv to the Ministry of Environmental & Nuclear Safety, Donetsk Oblast office (MEPNS-DO). The head of MEPNS-DO, Dr. S. Kurulenko, then formally issued invitations to senior officials of selected industrial enterprises within the Oblast (see Appendix A for list of invitees and attendees). Attendees included technical department managers from various enterprises of coke, steel, non-ferrous, petrochemicals, and mining industry; university faculty; MEPNS-DO representatives; and three members of the Ukrainian Parliamentary taskforce on developing Waste Code regulations. Over 70 participants attended the Workshops, and a participant evaluation is presented in Appendix B.

The presenters of the Workshop were:

- Dr. S. Kurulenko - head of the MEPNS-DO
- Dr. N. P. Cheremisinoff - the EPT Project's Donetsk Industrial Waste Management task leader and resident advisor in Donetsk.
- Mr. Tim Van Epp, U.S.-based senior assistant to the EPT-Donetsk project
- Mr. G. Allen Farmer - head of USEPA Region IV's waste management branch
- Mr. D. McCurry - member of USEPA Region IV
- Mr. J. Johnson - member of USEPA Region IV
- Mr. K.Ewing - member of USEPA Region IV.

Photographs of the Workshop are included in Appendix C. An English-language version of viewgraphs/handouts used at the Workshop is presented in Appendix D. Russian-language versions were actually used for the viewgraphs/handouts. The Workshop was presented using sequential English-Russian translation.

There was a high level of interest expressed by many attendees in the technical aspects of hazardous solid waste management, and in the draft Ukrainian solid waste regulations which were included in part of the presentation. This level of interest was evidenced by numerous questions posed by attendees and in group participation problem-solving sessions which showed a high level of industry understanding of problems and management practices. This interest and interaction provided further evidence that both the content of material and the level of the technical content was proper for the audience.

A video tape of portions of the February 20-21 presentation was made and a copy is available for USAID to preview. Additionally, during one of the sessions, a local television station sent a reporter and taped a short segment of the conference, which was shown prior to the February 20-21 workshop.

At the conclusion of each Workshop, a formal evaluation was made by the attendees. The evaluation consisted of a one page questionnaire in which various questions and comments regarding the quality and usefulness of the program were solicited. A copy of the questionnaire is included in Appendix B. A summary of the results of the questionnaire is then given in the appendix. The evaluation indicated that the two sessions were both highly successful, but that the second presentation was more favorably received. This was attributed to the fact that the presenters felt that the first session was slightly less structured, and therefore served as a good dress rehearsal.

All attendees were provided with a Certificate of Completion, which appeared to be received as a good gesture among the participants.

Section 3

CONCLUSIONS

The Workshop appeared to have been extremely successful. For those who had previously been exposed to western concepts of environmental waste management practices, they had an opportunity for direct comparisons and contrasts with current Ukrainian draft regulations. For others, new concepts were introduced, and group discussions revealed a strong desire to incorporate many of the ideas and practices presented.

Conducting the Workshop at the TIC enabled enterprise and MEPNS-DO representatives an opportunity to preview some of the technical resources at their disposal. Numerous appointments were made for access to materials maintained at the Center, and several references were placed on-loan to selected enterprise managers, as well as to representatives from Ukraine's parliamentary commission who are drafting the current Ukrainian Waste Code regulations.

The Workshop's success also pointed to the desirability of presenting it to representatives from other industrial oblasts of Ukraine. Dr. S. Kurulenko (MEPNS-DO) indicated that enterprises outside the Donetsk region could greatly benefit from the Workshop. USAID/Kyiv may want to consideration funding such presentations, preferably to be held at the TIC.

Appendix A

LIST OF WORKSHOP ATTENDEES

Attendees: 15-16 February 1996

1. Heorhi Bily	--	Starobesheve SREP
2. Ivan Minaiev	--	State Administration of Environmental Safety in Donetsk oblast
3. Oleh Lytvyn	--	State Administration of Environmental Safety in Donetsk oblast
4.Halyna Borodai	--	State Administration of Environmental Safety in Donetsk oblast
5. Leonid Vasyliev	--	Donetsk Regional Environmental Inspectorate
6. Anatoli Panasenko	--	Donetsk State Technical University
7. Ivan Karahodov	--	State Administration of Environmental Safety in Donetsk oblast
8. Viktor Nazymko	--	Donetsk State Technical University
9. Mykola Pokryshov	--	Editorial Board of *Nash krai* (Our land) newspaper
10. Yuri Protasov	--	Chemical Plant, town of Horlivka
11. Yakiv Nikolaienko	--	Donetsk Chemical Reagent Plant
12. Serhij Lizenko	--	Stirol Company, town of Horlivka
13. Volodymyr Lytvynenko	--	Donetsk Regional Environmental Inspectorate
14. Volodymyr Shcherbyna	--	Donetsk Metallurgical Plant
15. Petro Redko	--	Donetsk Coke Chemical Plant
16. Anatoli Nazarenko	--	Makiivka Coke Chemical Plant
17. Yuri Pyliuhin	--	Kurakhivka SREP
18. Volodymyr Volovyk	--	Donetsk Energy Plant
19. Liudmyla Okhrymenko	--	Donetskhormash Corporation

20. Dmytro Halansky	--	Tochmash Plant
21. Volodymyr Lahunov	--	State Administration of Environmental Safety in Donetsk oblast
22. Gennadi Kliahin	--	Donetsk State Technical University
23. Hryhori Krechmer	--	Elektron Reagent Institute
24. Liubov Masych	--	Sylur Joint-Stock Company
25. Borys Panov	--	Donetsk State Technical University
26. Ivan Shmalko	--	Yasynuvata Coke Chemical Plant
27. Oleksandr Holbyn	--	Makiivka Coke Chemical Plant
28. Oleksandr Pasternak	--	Avdiivka Coke Chemical Plant
29. Iryna Poklad	--	Zuivka SREP-2
30. Serhij Vysotsky	--	Ukrenerhoproekt Institute

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Attendees: 20-21 February 1996

1. Volodymyr Turovych	--	Azovstal Integrated Iron-and-Steel Works
2. Oleksandr Smotrov	--	Illich Integrated Iron-and-Steel Works
3. Leonid Sebko	--	Yenakiive Integrated Iron-and-Steel Works
4. Halyna Berezkina	--	Dzerzhynsk Phenol Factory
5. Andrij Danyliuk	--	Vuhlehirsk SREP
6. Viktor Danylenko	--	Slaviansk SREP
7. Natalia Hresh	--	Khimprom Corporation
8. Heorhi Svystunov	--	Novokramatorsk Metallurgic Plant, town of Kramatorsk
9. Oleksandr Rybalko	--	Donbas Mine Board
10. Viktor Zenchenko	--	Zasiadko Mine
11. Ilona Kalabina	--	Abakumov Mine
12. Borys Malashevsky	--	Zasiadko Mine
13. Oleksandr Kariahin	--	Donetskvuhillia Corporation
14. Yevhen Matlak	--	Donetsk State Technical University
15. Volodymyr Rostovsky	--	Donetsk State Technical University
16. Oleh Tolstikov	--	Ministry of Environmental Protection and Nuclear Safety of Ukraine
17. Serhij Matvienko	--	Zhovtneva Central Concentrating Mill
18. Oleksandr Trusyliev	--	Selidovska Central Concentrating Mill
19. Viktor Chebotariov	--	Mospynska Central Concentrating Mill
20. Semen Etshtein	--	Vuzlivska Central Concentrating Mill
21. Nelia Horulko	--	Novotroitske Ore Administration, town of Volnovakha
22. Viktor Siroshtan	--	Sloviansk Armature and Isolator Plant

23. Volodymyr Kyian	--	Avtosklo Factory, town of Kostiantynivka
24. Valeri Synevych	--	Kostiantynivka Glass Works
25. Mykola Budin	--	Dontsement Joint-Stock Company
26. Ihor Kniazev	--	Azovmash Company, city of Mariupil
27. Oleksandr Shynkarenko	--	Ukrtsynk Plant, town of Kostiantynivka
28. Sviatoslav Kurulenko	--	State Administration on Environmental Safety in Donetsk oblast
29. Eduard Nikolaievych	--	State Administration on Environmental Safety in Donetsk oblast
30. Ena Kliucheva	--	State Administration on Environmental Safety in Donetsk oblast
31. Yuri Myshanov	--	the Donetsk City Executive Council
32. Volodymyr Kyrychenko	--	Ukrainian Scientific Center for Environmental Technology
33. Volodymyr Mishchenko	--	Ministry of Environmental Protection and Nuclear Safety of Ukraine
34. Borys Horlytsky	--	Ministry of Environmental Protection and Nuclear Safety of Ukraine
35. Volodymyr Pavlov	--	Donetskvuhlezbahachennia Corporation
36. Natalia Konyshcheva	--	Industrial Economics Institute
37. Larysa Bezzubko	--	Industrial Economics Institute
38. Petro Atamas	--	Mineral Resources Institute
39. Earl R. White	--	Economic Reform Program/Donbass
40. Oleksij Dudyk	--	Donbass Geological and Environmental Issues Institute
41. Vitali Sapronov	--	DIOS Institute
42. Ihor Balychentsev	--	DIOS Institute
43. Iryna Butorina	--	Coordinating Environmental Center

Appendix B

WORKSHOP EVALUATION

This appendix provides a copy of the Workshop evaluation form, followed by a summary of results of the evaluation.

Attendee Evaluation Form for Hazardous Waste Management Workshop

Please provide an evaluation of the workshop. Check the number which best describes your response to each question. 1=Poor, 2=Good, 3=Very good, 4=Excellent.

	QUESTION	1	2	3	4
1	The first day presentations can be rated as				
2	The second day presentations can be rated as				
3	The quality of the presentation materials was				
4	The quality of the Director's presentation can be rated as				
5	The quality of the EPA presenters overall can be rated as				
6	The quality of the CH2M Hill presenter can be rated as				
7	The overall use of the material to my enterprise is				
8	The overall use of the material to my specific job function				
9	The quality of the training room and facilities is				
10	The quality of the luncheons provided is				
11	The overall quality of the workshop is				

Your name:_____ Enterprise: _____
Date:_____ Location: _____

(WRITTEN COMMENTS AND RESPONSE SECTION)

1. Comments: What did you like about the workshop_____
_____
_____

2. What did you NOT like about the workshop_____
_____
_____

3. Did you feel the information obtained will assist your enterprise to better manage its waste problems? Yes No

4. Did you feel that you gained some insight into new waste regulations that are evolving in the Ukraine? Yes No

5. Would you recommend this workshop to other members of your enterprise?
Yes No

Summary of Evaluations for Hazardous Waste Management Workshop

Response rating: 1=Poor, 2=Good, 3=Very good, 4=Excellent.

	QUESTION	Average Ratings Feb.15-16	Average Ratings Feb.20-21
1	The first day presentations can be rated as	2.7	3.3
2	The second day presentations can be rated as	2.9	3.4
3	The quality of the presentation materials was	3.0	3.4
4	The quality of the Director's presentation can be rated as	3.2	3.6
5	The quality of the EPA presenters overall can be rated as	3.2	3.3
6	The quality of the CH2M Hill presenter can be rated as	2.9	3.3
7	The overall use of the material to my enterprise is	2.6	2.9
8	The overall use of the material to my specific job function	2.6	2.8
9	The quality of the training room and facilities is	3.0	3.4
10	The quality of the luncheons provided is	3.0	3.3
11	The overall quality of the workshop is	2.9	3.4

Summary of Comments

1. What did you like about the Workshop?

- variety of slides, systemic character of the seminar
- a lot of new information and data
- general atmosphere of the workshop
- presentation about the landfills
- useful recommendations that can be applied
- the way Workshop was conducted

2. What did you NOT like about the Workshop?

- more information on mining industry waste disposal is needed
- a lot of generalities
- no information on waste disposal licensing
- simplified approach to ecological problems
- it was very cold in the Center

3 Did you feel the information obtained will assist your enterprise to better manage its waste problem?

Number of YES Responses - 34
Number of NO Responses - 3

4. Did you feel that you gained some insight into new waste regulations that are evolving in the Ukraine?

Number of YES Responses - 22
Number of NO Responses - 14

5. Would you recommend this Workshop to other members of your enterprise?

Number of YES Responses - 24
Number of NO Responses - 3

Appendix C

PLATES

The following photographs show scenes from the workshop.

Plate 1: Opening remarks on 15 Feb 96 by Dr. S. Kurulenko (standing, center), head of the Donetsk Oblast office of the Ministry of Environmental Protection & Nuclear Safety

Plate 2: Overview of workshop and welcoming of attendees by Dr. N.P. Cheremisinoff, director of the EPT Project's Donetsk Office and Technical Information Center

Plate 3: Concepts of pollution prevention being presented by Mr. Tim Van Epp from the EPT Project's Washington, DC, office

Plate 4: Workshop attendees, together with a view of some reference materials at the Technical Information Center

HAZARDOUS WASTE MANAGEMENT WORKSHOP

A TWO-DAY PROGRAM ON CONCEPTS IN EFFECTIVE MANAGEMENT OF SOLID HAZARDOUS WASTES

****

Sponsored and Endorsed by the
Ministry of Environmental and Nuclear Safety

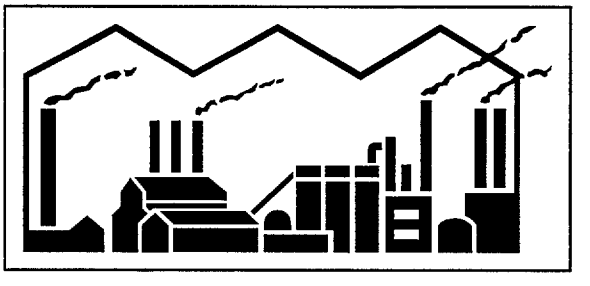
***

Funded by the
United States Agency for International Development

***

Prepared and Presented by
CH2M HILL International Services, Inc.

U.S. Environmental Protection Agency - Region IV



February 1996

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HAZARDOUS WASTE MANAGEMENT WORKSHOP

Workshop Outline

Introduction and Preface

Module I. What are solid hazardous wastes?

Module II. Assessing the effects of hazardous wastes.

Module III. Pollution Prevention.

Module IV. Recovery systems from waste disposal.

Module V. Hazardous waste treatment: technology overview.

Module VI. Waste management in the United States: An example of managing wastes.

INTRODUCTION AND PREFACE

Who are we?

Environmental Policy and Technology Project
Funded by
United States Agency for International Development
and Managed by
CH2M HILL International Services

What are we doing?

- Assisting the Donetsk Ministry of Environmental and Nuclear Safety on environmental problems.

How are we accomplishing this?

- Workshops to train on environmental management, risk assessment, environmental assessments, technologies for waste minimization and pollution prevention.
- Providing U.S. experts to consult with Ministry and enterprises.
- Establishing a Technical Information Center.
- Providing financial assistance in the form of equipment and instrumentation to address enterprise waste problems.

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USAID: ENVIRONMENTAL DEVELOPMENT IN UKRAINE

✓ Working with our Ukraine counterparts, USAID's Environmental Development program is designed to:

* minimize negative environmental impacts

* optimize economic and social outcomes, and

* generate **sustainable economic development** -- that is, **economic development that lasts**

- ✓ USAID has carefully selected qualified persons and organizations to implement its Environmental Development program in Ukraine

- ✓ CH2M-Hill are our primary implementors, with regional headquarters located in Kiev, and a resident manager located in each of Lviv and Donetsk.

- ✓ The United States Environmental Protection Agency also provides highly qualified implementors for USAID's Environmental Development program in Ukraine.

- ✓ USAID also coordinates with other donors and with The World Bank wherever possible to maximize the benefits to Ukraine of our environment program.

- ✓ We are proud to work as partners with our Ukrainian colleagues to demonstrate that sound environmental management advances economic development.

✓ USAID's Environmental Development program in Ukraine has four key strategies:

1. **institutional framework:** strengthening environmental institutions within government, the private sector, and the NGO community; addressing unintended environmental consequences (externalities) of national economic policies -- national policy work groups

2. **infrastructure for development:** building capacity within municipal governments and industry -- such as re-engineering the City of Lviv's water utility -- to create the necessary infrastructure for development

3. **sector synergies:** identifying opportunities to reduce waste and improve efficiency, as well as eco-efficient business development focusing on sound natural resource management

4. **international cooperation and biological resources:** advancing participation in international market opportunities and building capacity to meet obligations as signatory to international agreements and protocols

MODULE I
WHAT ARE SOLID HAZARDOUS WASTES?

The definitions vary based on:

- Country
- Regulations
- Industries

For the purposes of this workshop, solid hazardous wastes are characterized by --

Form:

- Bulk dry and semi-dry materials that may be dense, granular, or powdery in nature
- Concentrated discrete particulates that may be entrained or dispersed in process streams, liquid discharges
- Sludges, pastes and oily concentrates including greases

Property:

- Pose clear and present danger to human health by imposing threat of:
  - fire
  - explosion
  - carcinogen
  - uncontrolled chemical reactions

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DEVELOPING A PRACTICAL DEFINITION OF HAZARDOUS WASTE

- " 'Waste' is a moveable object with no direct use and is discarded permanently."

- " 'Hazardous' is toxic, flammable, ignitable, reactive, explosive, corrosive, radioactive, infectious, irritating, sensitive, bioaccumulative..." (and each of these has

WHAT A HAZARDOUS WASTE *IS NOT*

- **Not** wastes discharged directly into air or water
- **Not** just a solid waste or a subset of solid waste
  - high-strength liquids and hazardous solids mixed with water
  - hazardous liquids and gases disposed in containers
- **Not** radioactive or infectious
  - require much different management

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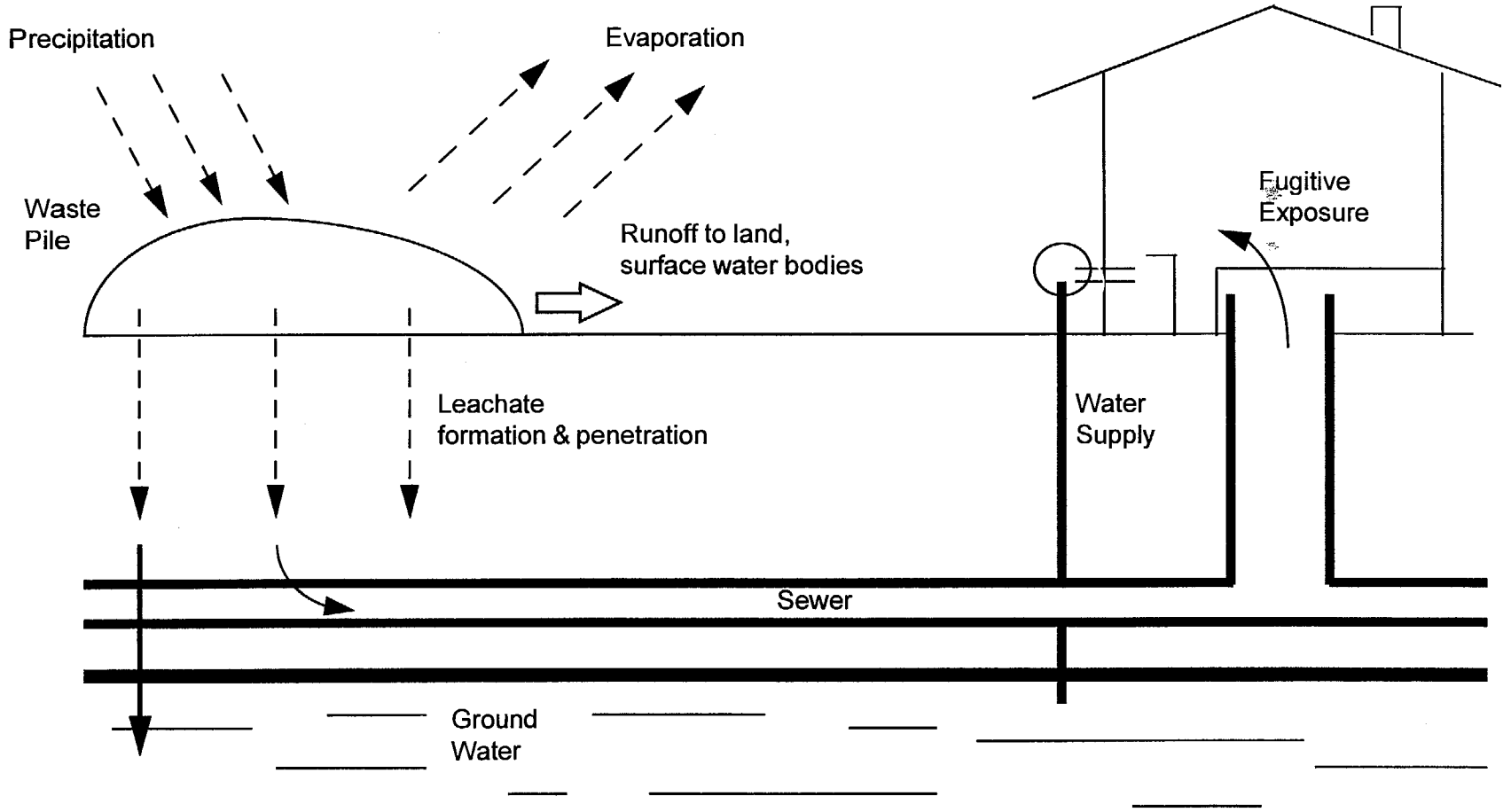
WHAT A HAZARDOUS WASTE *IS*

"**Hazardous wastes** mean wastes [solids, sludges, liquids, and containerized gases] other than radioactive and infectious wastes which, by reason of their chemical activity or toxic, explosive, corrosive, or other characteristics, cause danger or likely will cause danger to health or the environment, whether alone or when coming into contact with other waste..." (UNEP 1985, as modified by LaGrega, et al., 1994)

PATHWAYS BY WHICH SOLID HAZARDOUS WASTES MAY EFFECT RECEPTORS



INDUSTRIAL SOURCES OF HAZARDOUS WASTE

- Spent material
- By-products
- Treatment
- Commercial chemical products
  - Cleanup of process equipment
  - Failure to meet specifications
  - Accidental spills or leaks
  - Residue from containers
  - Outdated shelf life

SPECIAL RULES AND EXCLUSIONS

- Mixing/derived from
- Treatment residues
- Small generators
- Municipal wastewater
- Municipal wastewater sludge
- Mining waste
- Agricultural waste
- Contaminated media
- Recycled materials

DONETSK OBLAST INDUSTRY CATEGORIES IN ORDER OF WASTE GENERATION

- Coal mining (29.6)
- Ferrous metallurgy (27.6)
- Coking industry (9.1)
- Coal cleaning (8.1)
- Electric power generation (7.5)
- Public services (4.0)
- Construction/Building materials (3.3)
- Machine building (3.2)
- Chemicals & petrochemicals (1.5)
- Transportation (1.4)
- Refractory & flux (1.2)
- Non-ferrous metallurgy (1.2)
- Civil engineering (0.9)
- Miscellaneous light industries (0.8)
- Food (0.4)
- Agricultural (0.1)

( ) - % contribution to fines and penalties for waste/pollution discharges

TYPES OF DEFINITIONS AND BASES FOR CLASSIFICATION

- Testing against hazardous criteria
  - Specific standards and testing methods for each criterion
- Listing for specific reasons
  - By source -- specific industries and specific processes
  - By waste -- e.g., commercial chemical products, when discarded as wastes (off-spec, container and spill residues)
  - By substance -- listed individually or by class, based on concentration and volatility/leachability testing
  - By level of potential risk posed to human health and the environment, if managed improperly

PROBLEMS WITH DEFINITIONS AND CLASSIFICATION SYSTEMS

- Yes/No definitions apply same management requirements to all wastes in one of two categories regardless of many intermediate situations in reality
- Assessment of risks and optimal waste management methods depend on:
  - Types and degrees of hazards
  - Hazardous constituents, their concentrations, mobility, and other physical and chemical characteristics
  - Site-specific factors, e.g. potential migration pathways, exposure routes, dosages, mitigation measures
- Implementation of more realistic systems may be less practical

AN ENGINEERING CLASSIFICATION SYSTEM FOR HAZARDOUS WASTE

- Used for regional inventories of hazardous waste to study needs and feasibility of treatment, storage and disposal facilities

- Based on:
  - Waste form/phase
  - Organic/inorganic
  - Chemical class
  - Hazardous constituent versus treatment

ENGINEERING CLASSIFICATION SYSTEM FOR HAZARDOUS WASTE

Major category	Characteristics	Examples
Inorganic aqueous waste	Liquid waste composed primarily of water bu containing acids/alkalis and/or concentrated solutions of inorganic hazardous substances heavy metals, cyanide)	• Spent sulfuric acid from galvanizing • Spent caustic baths from metal finis • Spent ammoniacal etchants from manufacturing electronic compone • Rinse water from electroplating • Spent concentrates from hydrometallurgy
Organic aqueous waste	Liquid waste composed primarily of water bu containing admixtures or dilute concentration organic hazardous substances (e.g. pesticid	• Rinse water from pesticide contain • Washings of chemical reactors and formulation tanks
Organic liquids	Liquid waste containing admixtures or concentrated solutions of organic hazardous substances	• Spent halogenated olvents from me degreasing and dry cleaning • Distillation residues from productio chemical intermediates

ENGINEERING CLASSIFICATION SYSTEM FOR HAZARDOUS WASTE (CONTINUED)

Major category	Characteristics	Examples
Oils	Liquid wastes comprised primarily of petroleum-derived oils.	• Used lubricating oils from internal combustion engines • Used hydraulic and turbine oils from heavy equipment operations • Used cutting oils from machinery manufacture • Contaminated fuel oils
Inorganic sludges/solids	Sludges, dusts, solids and other non-liquid waste containing inorganic hazardous substances	• Wastewater treatment sludge from mercury cell process of chlorine production • Emission control dust from steel manufacture and smelters • Waste sand from coking operations • Lime sludge from coking operations • Dust from deburring of chromium parts in fabricated metal industry
Organic sludge/solids	Tars, sludges, solids and other non-liquid waste containing organic hazardous substances	• Sludges from painting operations • Tar residues from production of dyestuff intermediates • Spent filter cake from production of pharmaceuticals • Distillation bottom tars from production of phenols • Soil contaminated with spilled solvents • Slop oil emulsion solids

Source: Lagera, Buckingham, and Evans. Hazardous Waste Management, McGraw-Hill, Inc., 1994.

DEFINITIONS OF HAZARDOUS WASTE

	Austria	Canada	Denmark	France	Germany	India	Italy	Japan	Nether-lands	Southern Africa[1]	Spain	Sweden	Taiwan	UK	USA	Ukraine
Is there a legal definition?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	(1)	Yes	Yes	Yes	Yes	Yes	Draft
Purpose of definition																
Control over transport	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	Yes	No	Yes	Yes	No
Control over treatment/disposal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Type of definition																
List of waste	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	No	Yes	Draft
List of substances	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Draft
List of processes	No	No	No	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	No
Concentrations	No	Yes	No	No	No	No	Yes	No	Yes	No	No	No	Yes	No	Yes	No
Criteria	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	
Toxicity of waste	Yes	Yes	Yes	Yes	Yes	No	Yes	No		No	Yes	Yes	No	No	Yes	No
Toxicity of extract	No	Yes	Yes	Yes	No	No	No	Yes		Yes	Yes	No	No	Yes	Yes	No
Ignitability/ flammability	No	Yes	Yes	Yes	No	No	No	No		Yes	Yes	No	No	Yes	Yes	No
Corrosiveness	No	Yes	Yes	Yes	No	No	No	No		Yes	Yes	No	Yes	Yes	Yes	No
Reactivity	No	(5)	Yes	Yes	No	No	No	No		Yes	Yes	No	No	No	Yes	No
Special rules																
Mixing rule	Yes	(5)	Yes	Yes	Yes	No	Yes	No	Yes	No	No	No	No	No	Yes	No
Residue rule	No		Yes	Yes	No	No	No	No	No	No	No	No	No	No	Yes	Draft
Exclusions		(5)														
Small generators (2)	No		No	100 kg	No	No	No	Yes	No	No	No	No	No	No	100 kg	No
Wastewater	Yes		No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	(3)	No
Sewage sludge	Yes		No	No	No	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No
Mining waste	Yes		No	Yes	Yes	No	No	Yes	No	No	Yes	No	No	Yes	Yes (4)	Draft
Agricultural waste	Yes		No	Yes	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	Draft

(1) New definition in South Africa only.
(2) Quantity is that per month below which a producer is exempt from the regulations.
(3) Partial exclusion for wastewater treated exclusively in permitted treatment tanks. Wastewater treated in surface impoundments or lagoons is controlled as a hazardous waste.
(4) Mining waste excluded pending further study.
(5) Under consideration in 1992.

[1] In Tables 2-3 through 2-5, Southern Africa refers to the subcontinent south of the Kunene and Zambesi Rivers and comprises at least 17 sovereign states and several geopolitical areas.

[1] Adapted from Wilson and Forester.[60]

WHAT DOES THE UKRAINE NEED TO BEGIN MANAGING ITS WASTE PROBLEMS?

- Unified set of definitions of what constitutes a solid hazardous waste
- A modern waste classification system or set of criteria.
- Modern criteria for performing risk assessments
- An understanding and adoption or development of occupational exposure limits
- Industry cooperation and commitment to organizing, auditing and identifying wastes
- Development of a unified approach to managing wastes through establishment of environmental management system

UKRAINIAN CATEGORIES OF WASTE - DRAFT

CODE	CATEGORY DESCRIPTION	EXAMPLES
01	Residues and leftovers not otherwise defined hereafter	To be defined
02	Products which do not meet technical requirements or production conditions	Off-spec. products; example - subgrade steel
03	Products whose life time has expired	Solvents or catalysts with expired shelf life
04	Materials spilled or lost due to inadvertent actions	Contaminated products, materials, equipment, property resulting from spills; example - leaking underground storage tank
05	Products and materials polluted, diluted or used-up (spent) during production consumption	Cleaning residues, excess packaging materials, empty containers and drums
06	Products that are rejected or used (spent)	Accumulator batteries, spent catalysts
07	Materials that can no longer be used in manufacturing	Polluted or spent acids and solvents, spent heat treatment salts
08	Residues from manufacturing operations	Slag, cinders, vat residues

UKRAINIAN CATEGORIES OF WASTE - DRAFT (CONTINUED)

CODE	CATEGORY DESCRIPTION	EXAMPLES
09	By-products or concentrates resulting from pollution control operations	Slime from wet scrubbers, dusts from cyclones/baghouses/electrostatic precipitators, filtration cake
010	Scrap (leftovers) from metal finishing operations	Metal chips and filings, scale
011	Leftovers of raw materials derived from extraction and processing operations	Mine wastes, non-refined oils, concentrated slimes and sludges
012	Products or materials diluted with known hazards or carcinogens	Oils containing polychlorinated biphenyls (PCBs)
013	Materials, substances or product banned from use by legislation or government regulations	To be defined
014	Products, materials, packaging no longer considered usable	Garbage - household wastes, stationery, commercial wastes, general refuse, agricultural
015	Polluted materials, substances or products generated as a result of amelioration of polluted land	Petroleum contaminated soils resulting from leaking tanks
016	Materials, substances, products defined as wastes by manufacturer or exporter	To be defined

OPERATIONS WHICH LEAD OR MAY LEAD TO WASTES UTILIZATION ADDENDUM IIa OF THE LAW OF UKRAINE ON WASTES

(REGENERATION, RECYCLING, RECUPERATION, DIRECT RECURRENT OR ALTERNATIVE UTILIZATION)

CODE	OPERATION
R1	Utilization as fuel (except for direct incineration) or any other utilization to obtain energy.
R2	Regeneration (recuperation) of solvents.
R3	Regeneration (recycling) of organic substances, which are not used as solvents.
R4	Recycling of metals and their compounds.
R5	Utilization of other non-organic substances.
R6	Regeneration (recuperation) of acids and alkalis.
R7	Regeneration (recuperation) of components, which are used for fighting pollution (discharges).
R8	Regeneration (recuperation) of catalyst components.
R9	Repeated refining of used up oil products or other techniques of reutilization of used up oil products.
R10	Land farming (fertilization), which facilitates its utilization for agricultural purposes or improves the environment, including compost fertilization and other biotransformation processes.
R11	Utilization of leftover materials (wastes) generated as a result of performing operations R1 through R10.
R12	Exchange of wastes to be further subjected to operations R1 through R10.
R13	Accumulation and storage of materials subject to any operation listed in the Addendum.
R14	Other utilization techniques which are not defined above.

WASTE DISPOSAL OPERATIONS ADDENDUM IIb TO THE LAW OF UKRAINE ON WASTES

(WHICH ARE UNSUITABLE FOR UTILIZATION -RESTORATION, REGENERATION, RECYCLING, RECUPERATION, DIRECT REPEATED OR ALTERNATIVE UTILIZATION)

CODE	
D1	Storing on the ground (dumping) or under ground. For example, on dumping ground, etc..
D2	Placements for soil treatment (land amelioration).
D3	Pumping underground. For example, pumping wastes of appropriate consistency through bore-holes into salt domes or natural reservoirs.
D4	Dumping into bodies of water (as a rule into artificial ones). For example, placing of rare or slime-like wastes in foundation pits, ponds, accumulators, sedimentation pools, lagoons, etc.
D5	Placing in specially equipped land structures or polygons. For example, placing in separate compartments, which are closed at the top and are sealed off from one another as well as from the environment.
D6	Dumping of solid wastes into bodies of water except for seas and oceans.
D7	Dumping into seas or oceans including placing (burial) on the sea floor.
D8	Biological treatment not mentioned in other clauses of this Addendum and which results in generation of final compounds or mixtures which are subsequently disposed of by means of any operation indicated in the Addendum.
	* According to an article of the Law on Wastes, wastes must be disposed of by means of techniques, technological processes and operations which do not pose a threat to either public health or environment.

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WASTE DISPOSAL OPERATIONS
ADDENDUM IIb
TO THE LAW OF UKRAINE ON WASTES

WHICH ARE UNSUITABLE FOR UTILIZATION -RESTORATION, REGENERATION, RECYCLING, RECUPERATION, DIRECT REPEATED OR ALTERNATIVE UTILIZATION)

CODE	
D9	Physical and chemical handling which is not referred to in other clauses of this Addendum and which results in generation of final compounds or mixtures which are subsequently disposed of through any operation specified in this Addendum. For example, evaporation, drying, calcination, neutralization, precipitation, etc.
D10	Incineration (ashing) on land.
D11	Incineration (ashing) at sea.
D12	Permanent storing. For example, in special containers, mines, etc.
D13	Mixing prior to performing any operation specified in this Addendum.
D14	Repackaging prior to performing any operation specified in this Addendum.
D15	Storing pending any operation listed in this Addendum.
D16	Disposal methods other than listed above.

DISCUSSION TOPICS AND PROBLEMS

1. An enterprise has 50 underground storage tanks which it has used for many years to provide fuel oil for its furnaces. It is discovered that since these tanks are old and have been exposed to the surrounding soil and moisture, that many of them have corroded and leached. The surrounding soil and groundwater are found to be badly contaminated with hydrocarbons. For discussion--should this scenario be considered a solid waste problem and if so why?

2. For the leaking underground storage tank problem described above, what might the enterprise do to assess the extent of the damage to the environment? Discussion for group.

3. Besides a clear set of legal definitions and classification for solid wastes, what does your enterprise need in order to begin to manage its solid waste problems? Discussion for group.

MODULE II
ASSESSING THE EFFECTS OF HAZARDOUS WASTES

- Historical viewpoints
- General effects on health & the environment
- Toxicology and human risk factors
- The current Hazard Classification System
  - How it works
  - It's strengths and weaknesses
- Concepts and terms to include in developing new standards

HAZARDOUS WASTE
ANCIENT HISTORY

- Lead poisoning in the Roman Empire (2,000 years ago)
- Industrial Revolution - dramatic increases in population, industrial production, resource extraction and intensive agriculture
  - Hazardous constituents in wastes and products
  - Disposal in the environment
  - Exposure to humans and environment
  - First lead and mercury, then synthetic organic chemicals

HAZARDOUS WASTE
MODERN HISTORY OF MISMANAGED HAZARDOUS WASTE

- DDT -- U.S.
- Mercury -- Netherlands, Japan
- PCBs -- Taiwan, Japan, U.S.
- Seveso -- Italy
- Bhopal -- India
- Love Canal -- U.S.
- Other international examples

EVOLUTION OF HAZARDOUS WASTE SCIENCE

- Could not detect hazardous constituents with available analytical chemistry
- Did not know environmental persistence and mobility
- Did not know long-term consequences with available toxicology and epidemiology
- Short-term costs savings outweighed long-term impacts
- Analytical chemistry improved significantly to detect ppb, ppt, and ppq
- Then toxicology and epidemiology improved to reveal the human health and environmental impacts

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ENVIRONMENTAL EFFECTS

- Contaminated groundwater
- Contaminated surface water
- Reduced utility of lakes, streams, and wetlands
- Stress on animals and vegetation in contaminated areas
- Reduced diversity of species
- Depletion of resources
- Reduced quality of air

PERSISTENCE

- The tendency of a chemical to resist oxidation and degradation and to remain in the environment and possibly accumulate in the food chain.

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FACTORS THAT AFFECT CONTAMINANT TRANSPORT AND EXPOSURE

- Land use
- Physical setting
- Climate and weather
- Air dispersion
- Soil and groundwater

CONDITIONS AFFECTING CONTAMINANT TRANSPORT IN SOIL AND GROUNDWATER

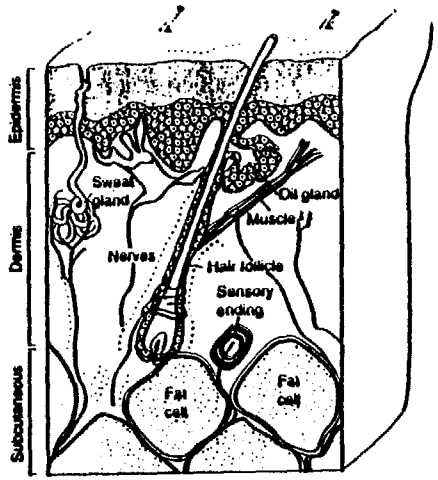
- Soil type
- Surface water
- Groundwater recharge
- Depth to groundwater
- Groundwater flow

HEALTH EFFECTS

- Birth defects and reproductive disorders
- Cancer
- Immune function disorders
- Kidney dysfunction
- Liver dysfunction
- Lung and respiratory diseases
- Neurotoxic disorders

ROUTE OF EXPOSURE

- Ingestion
- Absorption
- Inhalation



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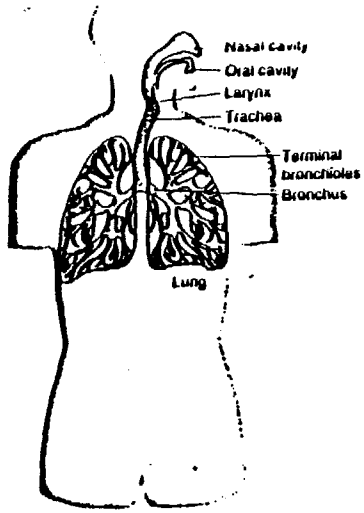
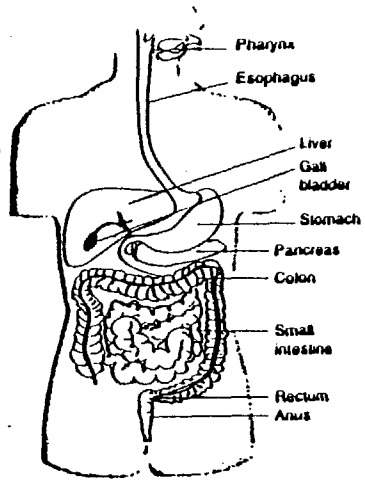


Inhalation



Ingestion

TOXICOLOGY

- What is toxicology?
  - Subject dealing with the averse effects caused by exposure of living organisms to chemical substances.
- What are limitations?
  - Findings and recommendations only partially derived from humans. Information largely based on experiments on animals.
  - Uncertainty/Lack of precision in:
    - Translating toxic responses between animal species
    - Extrapolating from high exposures used in animal studies to low-dose situations in general populations.
- Risk estimates can differ by orders of magnitude!

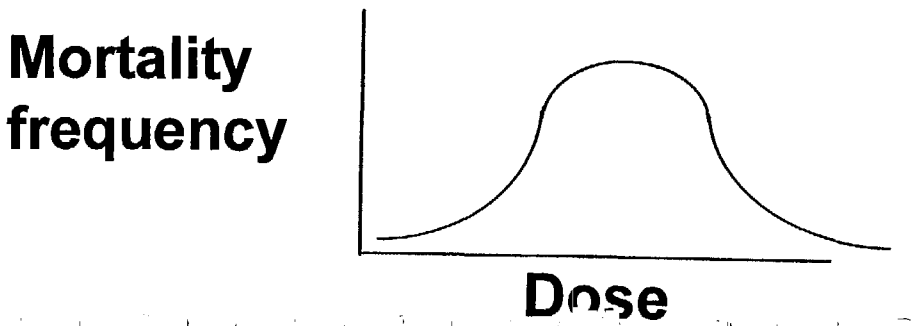
MECHANISMS OF TOXICOLOGY

- ACUTE
  - Chemical degradation of tissues
  - Localized inflammation
  - Lack of oxygen
  - Allergic reactions

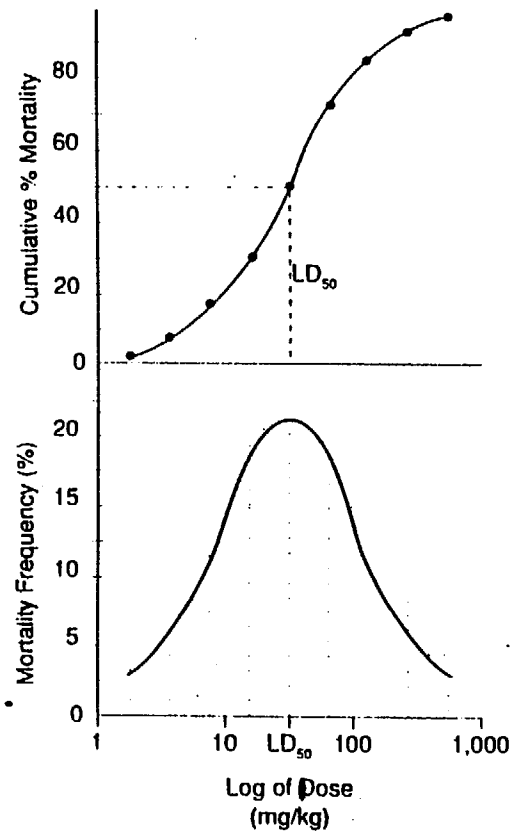
- CHRONIC
  - Agents that cause cancer
  - Agents that damage genes and chromosomes
  - Agents that cause adverse effects to the fetus

IMPORTANT TOXICOLOGICAL TERMS

- **Receptor -** Recipient or in some cases target organ that can be effected by a hazardous chemical.
- **Response -** The reaction of the recipient or target organ to over-exposure from a toxic chemical or waste. Degree of Toxic Action.
- **Dose -** The amount of chemical or its concentration that a receptor is exposed to over a length of time.
- **Dose-Response Relationship -** The frequency of a specified toxic end point among populations.



MEDIAN LETHAL DOSE



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EXAMPLE - ORAL LD_{50} IN RATS

Chemical	LD_{50}(mg/kg)
Ethanol	13,000
Table salt	3,800
Insecticides	2,800
Aspirin	1,500
Nicotine	50-60
Dioxin (TCDD)	0.02-0.05

EXPOSURE PERIOD

A Means of Characterizing Exposure:

Type Exposure	Time for Response
Acute	One day or less
Sub-acute	Ten days or less
Sub-chronic	Two weeks - seven years
Chronic	Seven years - lifetime

EXAMPLES OF ADVERSE EFFECTS FROM OVEREXPOSURE TO TOXIC CHEMICALS

Carcinogenic Chemical	Potential Carcinogenic Effects	Potential non-carcinogenic effects
Arsenic	Lung Cancer	Liver damage, lung fibrosis, neurological damage
Cadmium	Lung Cancer	Kidney damage, osteoporosis, anemia
Chromium	Lung Cancer	Bronchitis, liver and kidney damage
Organophosphorous pesticides		Neurotoxicity, systemic poisoning
Chlorinated organic compounds	Liver Cancer	Liver damage, neurological effects
Polychlorinated aromatic hydrocarbons	Lung cancer, stomach cancer, skin cancer	Liver damage, dermatitis

CLASSIFICATION OF TOXIC INDUSTRIAL WASTES-FORMER USSR

Approach

- Classifier data on toxic waste types organized into tables and alphabetically according to classes of toxicity.
- Based on a calculation of a Toxicity Index.

General Principles

- Probable impact of waste on environment and health
- Incorporates sanitary (health) exposure levels and toxicity parameters
- Attempts to account for toxicity effects through composition of mixed wastes
- Limited criteria for performing a Toxicity Class Assessment (a form of risk analysis)
- Toxicity Classes based on Admissible Concentrations (AC) of foreign chemical compounds in soil (U.S. equivalent terminology is Allowable Concentrations)

THE TOXICITY INDEX - USSR

$$K_i = AC/(S + C_b)_i$$

AC	=	Admissible (or Allowable) Concentration in Soil
S	=	Water Solubility Factor for a chemical species
C_b	=	Concentration of chemical component in the soil (tons per ton)
$_i$	=	Chemical species

TOXICITY INDEX CRITERIA - USSR

- Ki is calculated based on the 3 most important toxic components. Those chemical species are selected based on the lowest K_i values.
- Calculation Boundary Conditions:

$$K_i < K_{i+1} < K_{i+2}$$

$$2K_i \geq K_{i+2}$$

- Overall Toxicity Index for Solid Waste:

$$K_3 = 1/n^2\, 3K_i$$

where $n \leq 3$

- Round off K_3 to nearest first significant figure and apply Hazard Degree Classification Criteria

HAZARD DEGREE CLASSIFICATION CRITERIA--USSR

Toxicity Index, ΣK_i	Toxicity Class	Degree of Hazard
<2	I	Extremely Dangerous
2-16	II	Highly Dangerous
>16-30	III	Generally or Moderately Dangerous
>30	IV	Slightly Dangerous

IS THE HAZARD CLASSIFICATION CRITERIA (USSR) COMPARABLE TO OTHER SYSTEMS?

YES - One example is U.S. Department of Transportation (D.O.T.) safety regulations.

D.O.T. uses a criteria to assess how hazardous a material (not just waste) is.

These are Packing Group designations

PG Designation	Hazard Degree
I	Great Danger or Extremely Dangerous
II	Generally or Moderatly Dangerous
III	Minor or Slightly Dangerous

OTHER SECTIONS DEVISED BY MINISTRY OF HEALTH OF FORMER USSR

- Criteria for assessment of toxicity class for undefined Admissible Concentrations (AC) for soils, based on LD_{50}.
- Criteria for AC based on inhalation exposure to contaminated soils, based on LC_{50}.
- Criteria for estimating toxic concentration limits in overall quantities of toxic wastes. Using solubility data and toxicity indices.

[See Appendix for Details]

HUMAN HEALTH RISK ASSESSMENT CRITERIA: FORMER USSR

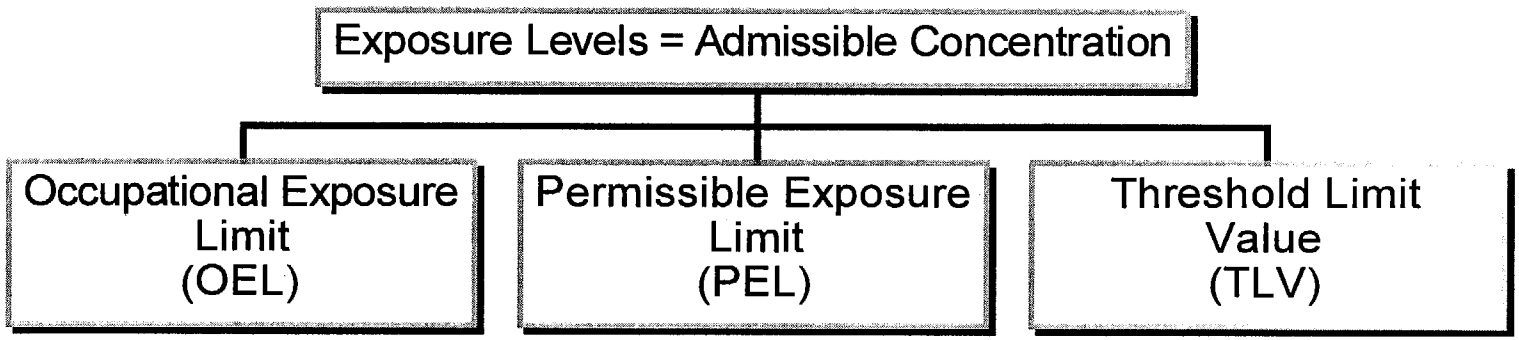
PROS

- Hazard or Risk Assessment based on individual toxicity indices
- Incorporates <u>some</u> well recognized toxicological concepts such as:
  - Lethal dose (LD_{50})
  - Lethal concentration (LC_{50})
  - Dose-Response Relationship

CONS

- Lacks many concepts that assess hazard from standpoint of the target organs that are at risk
- Lacks definition and guidance on acceptable criteria for different levels of exposure
- Not recognized by well established international agencies and countries with long-term environmental and health standards

IMPORTANT CONCEPTS & TERMS THAT HELP TO LIMIT RISKS



THRESHOLD LIMIT VALUE (TLV) AND SIMILAR TERMS DEFINE BOUNDARIES OR LIMITS TO EXPOSURE RISKS

EXAMPLES

- TLV - Based on time-weighted average
- TLV - Ceiling - Based on instantaneous exposure
- Short-Term Exposure Limit (STEL) - Based on 15 minutes or less

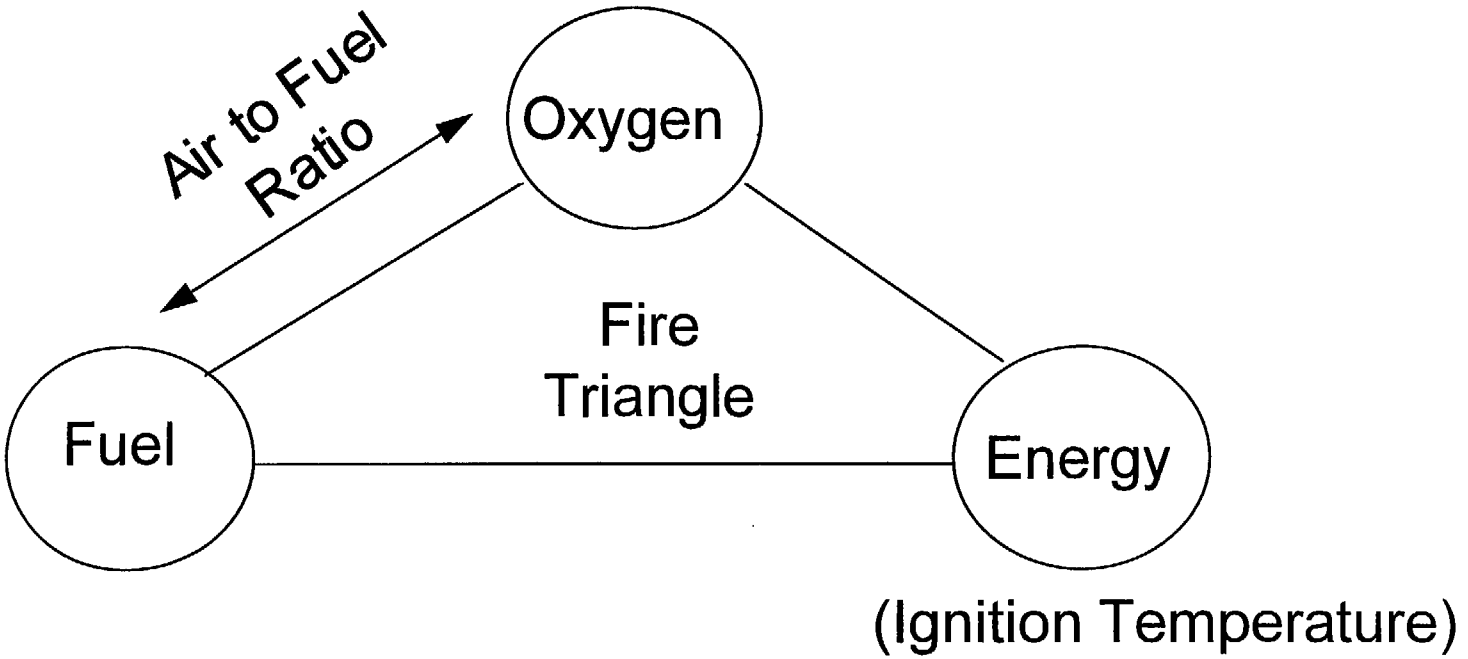
EXTREME DANGER LIMITS

IMMEDIATELY DANGEROUS FOR LIFE & HEALTH (IDLH)

- Exposure to an acute poison (example - H_2S)
- Entering an oxygen deficient atmosphere (< 19.5% O_2)
- Exposure to spontaneous combustion

CONCEPTS IN SPONTANEOUS COMBUSTION

Flash Point Temperature - Minimum temperature at which a mixture of flammable vapors forms in air.



AIR TO FUEL RATIO

FLAMMABILITY LIMITS = EXPLOSIVITY LIMITS

- Lower Explosion Limit (LEL)

Upper Explosion Limit (UEL)

	LEL	UEL
Gasoline	1.5	7.5
Air	98.5	92.5
	100.0	100.0

FLAMMABILITY RANGE

FR = UEL - LEL

EXAMPLES

	UEL	LEL	FR	HAZARD DESCRIPTION
Benzene	1.4	7.4	6.0	High
Methane gas	0.4	46.0	45.5	Extremely high
Hydrogen sulfide	4.0	72.0	68.0	Very high
Hydrogen	1	98	97	Extremely high
Kerosene	15	19	4.0	Low

DISCUSSION TOPICS AND PROBLEMS

1. Which are the main routes of exposure by which we can be exposed to chemical substances present in the environment?
2. The lethal dose or concentration of a certain substance is appreciably higher by inhalation than by ingestion. What conclusions can be drawn from this observation?
3. What are the differences between acute and chronic exposures, and how may these differences relate to acute and chronic health effects?
4. What does the term systemic poison mean and give examples?
5. What are some of the factors that can affect contaminant transport and exposure in the environment?
6. Explain what an exposure level is and why it is important to establish it for different chemicals.
7. What is the concentration range of oxygen which is considered safe and will sustain life?
8. List the elements of the fire triangle.
9. A 20,000-gallon above ground storage tank is used to store a hydrocarbon-based solvent. The vessel is one-third full of product. Discuss several scenarios that might cause this vessel to explode or catch fire.

PREFERRED WASTE MANAGEMENT OPTIONS IN PRIORITY ORDER

Priority No.	Waste Management Option
1	Pollution prevention (don't generate the waste)
2	Recycling, reuse, recovery
3	Treatment
4	Disposal

MODULE III
POLLUTION PREVENTION

- Around 1990 EPA began to implement the concept of pollution prevention.

- Pollution prevention means to make all reasonable efforts to either eliminate or reduce the production of wastes and the release of pollutants to the environment.

POLLUTION PREVENTION

For example:

- Treatment of a wastewater discharge may result in the creation of a sludge that is disposed on the land and which can cause pollution of the soil and possibly the groundwater.

- Treatment of the emissions from a smoke stack may result in a wastewater that pollutes a river or a lake.

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POLLUTION PREVENTION

The treatment for waste discharges was intended to prevent or minimize pollution of the air, water, and land. Sometimes efforts to control pollution in one area would create pollution in another area.

POLLUTION PREVENTION

From 1970 to 1990 the focus of environmental programs in the United States was to provide treatment for waste discharges to the environment. These discharges were:

- Smoke stack emissions to the air
- Wastewater discharges to rivers and lakes
- Solid and hazardous wastes dumped on the land

EXAMPLES - POLLUTION PREVENTION IN METAL FINISHING

(Typical Metal Finishing Industry Wastes)

Waste	Potential Hazard	Waste Stream	Process
Alkali (hydroxide)	Corrosivity	Wastewater	Cleaning, etching
Acid (nitric, sulfuric, hydrochloric, hydrofluoric)	Corrosivity	Wastewater	Cleaning, pickling, etching, bright dipping
Surfactants	Aquatic toxicity	Wastewater	Cleaning
Oil and grease	Aquatic toxicity	Wastewater, spent solvent	Cleaning
Cadium, zinc, nickel, cooper, other metals	Toxicity	Plating bath, drag-out, rinse water, spent filters, sludge	Plating
Perchloroethylene, trichloroethylene, other solvents	Inhalation, dermal	Spent solvent (liquid or sludge), air emissions	Cleaing
Cyanide	Toxicity	Plating bath, drag-out, rinse water, other wastewater	Plating, tumbling, stripping, heat treating, desmutting
Chromates	Toxicity	Plating bath, drag-out, rinse water, other wastewater, mist	Plating, chromating, etching
Water		Rinse water, drag-out, process bath, air emission (evaporation), cooling, water, boiler blowdown	Various

EXAMPLES OF PROCESS OPTIMIZATION TECHNIQUES FOR CLEANING AND DEGREASING

Cleaning Medium	Process Optimization Techniques
Conventional Solvents (Dip degreasing):	Eliminate need for
	Use less toxic solvents such as emulsion cleansers, aqueous solvents and abrasives
	Standardize solvent use - use the least number of different solvents possible in the facility
	Consolidate cleaning operation into one centralized degreasing operation
	Avoid contamination of solvent - Parts should be checked for undue contamination such as moisture before dipping
	Maintain equipment - Racks and barrels should be maintained so as not to introduce corrosion products (such as rust) into the solvent
	Careful solvent addition - adding even a small amount of the wrong solvent to a tank can render the entire batch useless
	Sludge removal - metal fines can catalyze reactions that lead to decomposition of the solvent. Continuous filtering is helpful
	Control evaporative losses - the location of the site for cleaning operations is very important for reducing evaporative losses. Avoid drafty and heated areas.

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EXAMPLES OF PROCESS OPTIMIZATION TECHNIQUES FOR CLEANING AND DEGREASING (CONTINUED)

Cleaning Medium	Process Optimization Techniques
	Reduce drag-out - drag-out refers to liquid that comes along on the part as it is removed from the tank. Methods for reducing drag-out include proper racking, increased drainage, and installation of drain boards
	Use counter-current cleaning - Parts should be passed through a series of cleaning tanks or compartments of increasing purity. Staging will reduce the amount of solvent use by maintaining solvent quality for a longer period
	Keep solvents segregated - for recycling, it is much easier to separate a solvent from its impurities than to separate two solvents
	Keep waste solvents as free from water, solids and garbage as possible
	Label the chemical content on each waste container
	On-site recycling - methods include gravity separation, filtration, batch distillation, fractional distillation, evaporation
	Offsite recycling
Vapor Degreasing	Limit entrance/exit speeds - Solution and vapors are lost from the tank when parts are removed too quickly
	Limit workload size - Use baskets having an area less than 50% of the degreaser opening to limit vapor drag-out due to piston effect
	Avoid work shock - work shock occurs when a heavy load is introduced into the degreaser resulting in the collapse of the vapor blanket and infiltration of air into the cleaning unit

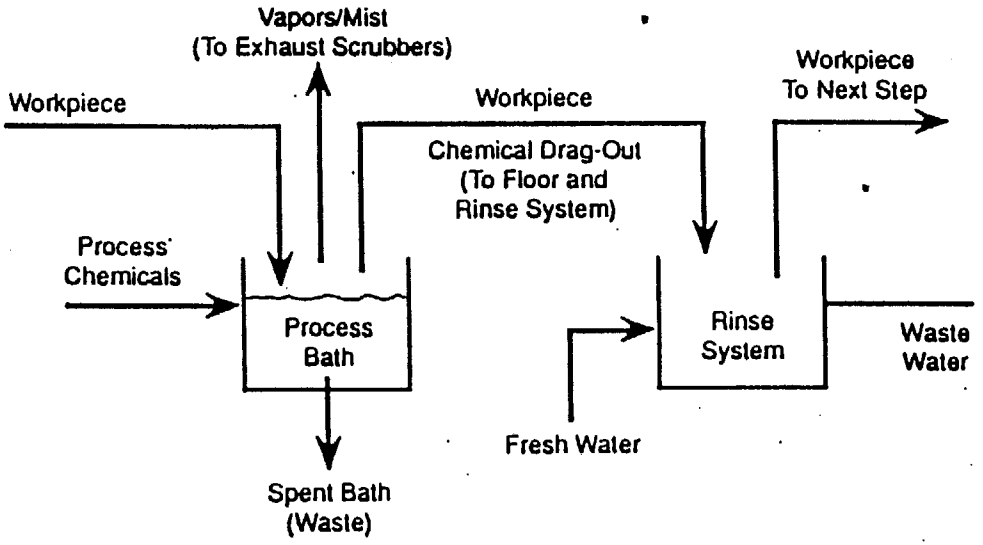
EXAMPLES OF PROCESS OPTIMIZATION TECHNIQUES FOR CLEANING AND DEGREASING (CONTINUED)

Cleaning Medium	Process Optimization Techniques
Vapor Degreasing:	Maintain temperature of solvent - The temperature of the solvent degreaser should be maintained at a level adequate for vapor production to ensure that the degreaser functions properly
	Allow sufficient time in the degreaser - Ensure that all parts have reached the temperature of the vapor degreaser so that condensation has ceased
	Spray only below the vapor zone - the spray pattern should be a solid stream, not a fine mist
	Maintain proper solvent level in sump - In addition to excessive water contamination, a major cause of chlorinated solvents going acidic is exposure of the heating coils to the solvent vapor
	Minimize vapor diffusion - Vapor diffusion results in air emissions
Aqueous Cleaners:	Maintain solution quality
	Conduct precleaning inspections - All parts entering tanks should be free of solvents and other cleaners
	Avoid unnecessary loading which can rapidly decrease cleaner efficiency
	Provide continuous heating
	Practice proper solution make up, mix thoroughly and heat to appropriate temperature

EXAMPLES OF PROCESS OPTIMIZATION TECHNIQUES FOR CLEANING AND DEGREASING (CONTINUED)

Cleaning Medium	Process Optimization Techniques
Aquous Cleaners:	Remove sludge and soils promptly
	Monitor cleaning solution strength
	Maintain equipment
	Reduce drag-out
	Use demineralized water
	Use counterflow rinsing
	Use spray rinsing - Rinsing efficiency can be increased by installing spray systems
	Install fog nozzels - these nozzels use much less water than conventional spray systems
	Employ closed loop systems
Abrasives:	Use a greaseless or water-based binder for buffing or polishing
	Control water level in mass finishing operations - Water level control is extremely important in order to achieve maximum efficiency in mass cleaning operations

TYPICAL METAL FINISHING PROCESS STEP



SUMMARY TABLE OF METAL FINISHING INDUSTRY WASTE

Waste	Potential Hazards	Waste Stream	Process
Alkali (hydroxide)	Corrosivity	Wastewater	Cleaning, etching
Acid (nitric, sulfuric, hydrochloric, hydrofluoric)	Corrosivity	Wastewater	Cleaning, pickling etching, bright dipping
Surfactants	Aquatic toxicity	Wastewater	Cleaning
Oil and Grease	Aquatic toxicity	Wastewater, spent solvent	Cleaning
Cadmium, Zinc, Nickel, Copper, Other Metals	Toxicity	Plating bath, drag-out rinse water, spent filters, sludge	Plating
Perchloroethylene, Trichloroethylene, Other Solvents	Inhalation, dermal	Spent solvent (liquid or sludge), air emissions	Cleaning
Cyanide	Toxicity	Plating bath, drag-out, rinse water, other waster	Plating, tumbling, stripping, heat treating, desmutting
Chromates	Toxicity	Plating bath, drag-out, rinse water, sludge, other wastewater, mist	Plating, chromating etching
Water	---	Rinse water, drag-out, process bath, air emission (evaporation), cooling water, boiler blowdown	Various

METAL TREATMENT/FINISHING
REPLACEMENT TECHNOLOGY CHARACTERISTICS

Replacement Technology	Conventional Technology	Replacement Status*	Surface Preparation Required	Operating Simplicity	Relative Capital Cost	Relative Operating Cost	EHS Risk
Chemical Vapor Deposition	Plating (electrolytic	P	Same	Better	Higher	Same	Lower
	Plating (electroless)	P	Same	Better	Higher	Same	Lower
	Cladding	P	More	Better	Higher	Higher	Same
	Anodizing	R	Same	Better	Higher	Same	Lower
Ion Beam Techniques	Plating (electrolytic)	P	Same	Better	Higher	Higher	Lower
	Plating (electroless)	P	Same	Better	Higher	Higher	Lower
	Cladding	R	More	Better	Higher	Higher	Lower
	Case hardening	C	More	Better	Higher	Higher	Lower
	Dip Galvanizing	R	More	Better	Higher	Higher	Lower
Plasma and Spray	Plating (electrolytic)	P	Less	Same	Higher	Same	Lower
	Plating (electroless)	P	Less	Same	Higher	Same	Lower
	Cladding	P	More	Same	Higher	Same	Lower
Evaporation	Plating (electrolytic)	R	More	Better	Same	Same	Lower
	Plating (electroless)	P	More	Better	Same	Same	Lower
	Cladding	C	More	Better	Higher	Same	Lower
	Dip/galvanizing	R	More	Better	Higher	Higher	Lower
Material Replacement	Chromating	C	Same	Same	Same	Same	Lower

EHS = Environmental Health and Safety
* P = Pilot, C = Commercial, R = Research

POLLUTION PREVENTION OPTIONS

Source Reduction:

- Using nonchelated process chemistries

- Reducing the volume of rinse water by:
  - Using spray rinse systems
  - Creating agitation in the rinse tank
  - Employing multiple use rinses for compatible processes
  - Using multiple stage counter-current rinse systems
  - Using conductivity controls and flow timers
  -
  - Extending the life of the process baths through:
  - Good housekeeping
  - Initiating electrolytic recovery or chemical treatment and filtration
  - Reducing drag-in
  - Using distilled, deionized , or reverse osmosis water
  - Properly maintaining racks
  - Using purer anodes and bags

POLLUTION PREVENTION OPTIONS (CONTINUED)

Source Reduction (continued):

- Reducing drag-out losses by:
  - Operating process baths at the lowest acceptable chemical concentrations
  - Operating process baths at higher temperatures
  - Withdrawing workpiece racks at a slower rate
  - Draining workpiece racks for longer periods
  - Capturing drag-out on a drainage board that drains back into the process tank
  - Adding wetting agents to process baths
  - Improving workpiece positioning
  - Recovering process chemicals in a drag-out tank and replenishing the process bath with the recovered solution
  - Spraying directly over the process tank

POLLUTION PREVENTION OPTIONS (CONTINUED)

Recycling and Resource Recovery:

- Reusing rinse water effluent
- Implementing material reuse techniques
- Regenerating spent process bath solutions
- Recycling process bath chemicals and rinse water solutions through use of chemical recovery technologies, including:
  - Evaporation
  - Reverse Osmosis
  - Ion exchange
  - Electrolysis
  - Electrowinning
  - Electrodialysis
- Recycling spent solvents by distillation
- Separating various waste streams for recycling, selective treatment, and batch treatment
- Implementing alternative treatment systems such as ion exchange, reverse osmosis, evaporation, and electrolysis.

EXAMPLES OF POLLUTION PREVENTION OPPORTUNITIES AT EGYPTIAN PLANTS

Name of Facility	Unit Operation	Pollution Prevention Option	Health & Environmental Benefits	Cost to Implement LE	Financial Benefits LE	Payback Period
MB	Surface preparation - Etching	Standardize the use of sulfuric acid, and eliminate the use inhibitor	Minimizes pollutant concentration in wastewater	0.00	1,000	immediate
MB	Surface preparation - General water use in plating areas	Change to non-continuous rinsing	Minimizes wastewater	0.00	2,500	immediate
MS	Surface preparation - Pickling	Reduce acid drag out from pickling tanks through increased acid drainage prior to rinsing	Reduces quantity of acid used. Reduces acidity of wastewater discharged.	0.00	14,600	immediate
MN	Surface preparation - Fluxing	Pump and filter flux bath	Reduces the generation of "hard zinc" sludge in the molten zinc baths. Reduce the on-site burning of fuel used to refine "hard Zinc." Reduce zinc losses by over-applying coating thickness.	13,000	32,000	Less than 5 months
MB	Electroplating	Purchase a Hull Cell for process control	Minimizes pollutant concentration in wastewater	500	6,400	1 month
MB	Electroplating - Nickel	Install a drain bar to reduce Nickel solution drag out	Minimizes pollutant concentration in wastewater	1,500	6,000	3 months
MB	Electroplating - Copper	Eliminate the use of copper cyanide	Eliminates the use of toxic substance	0.00	3,600	immediate

EXAMPLES OF POLLUTION PREVENTION OPPORTUNITIES AT EGYPTIAN PLANTS (CONTINUED)

Name of Facility	Unit Operation	Pollution Prevention Opportunity	Health & Environmental Benefits	Cost to Implement LE	Financial Benefits LE	Payback Period
MA	Painting	Switch from water curtain capture system for thermo-set paint to dry capture and recycle system	Eliminate s15,000 M^3 per year of topcoat and primer contaminated water; substantially reduces paint waste	340,000	169,000 (topcoat savings) 151,000 (primer savings)	13 months (topcoat 14 months (primer)
MA	Painting	Use high-solids paint along with special guns and drive systems to atomize paint	Reduces VOC emissions by 8.5 tons/year; reduce spaint consumption by 14 tons/year	100,000	692,000	3 months
MB	Painting	Monitor coating thickness	Reduces paint use or loss	20,000	65,000	4 months
MN	Galvanizing - Zinc	Leave the work pieces in the zinc tanks for less time. Purchase and use thickness gauges to help control the residence time in the zinc baths.	Reduces the consumption of zinc	100,000	2,000,000	1 month
MS	Galvanizing - Zinc	Recover zinc from solid waste of the galvanizing process. These wastes are: a) hard zinc, b) zinc ash, c) floor dusts	Reduces raw material usage (zinc). Minimizes waste zinc. Reduces worker exposure to zinc dust	485,000	725,000	up to 11 months

DISCUSSION TOPICS AND PROBLEMS

- Prepare a list of the waste problems you have in your facility today.
- Discuss with the group how your enterprise currently handles its wastes and give examples where you are applying or could apply pollution prevention practices.
- Allow about 15 minutes to prepare.

MODULE IV
SECOND PRIORITY:
RECYCLING, REUSE AND RECOVERY

- Valuable basic ingredients can be extracted from concentrated hazardous wastes using less energy and generating less pollution than processing virgin materials.
  - Spent solvent and waste oil reclamation
  - High-temperature metal recovery
- Energy can be generated by burning combustible liquid hazardous wastes
  - Spent solvents
  - Waste oils

WASTE OIL

Waste Oil = Used motor vehicle crankcase oils and spent machinery lubricating oils

U.S.. Example:

- 1.1 billion gallons generated each year
- 40% currently burned as fuel

ENVIRONMENTAL IMPACT OF WASTE OIL DISPOSAL

Major concern because of additives:

- Barium
- Magnesium
- Zinc
- Chromium
- Aluminum
- Sulfur
- Nitrogen
- Calcium
- Nickel
- Chlorinated HCs
- Phosphorous
- Lead Alloys
- Iron
- Molybdenum

WHAT ARE SPENT SOLVENTS?

- Waste Liquid Hydrocarbons (HCs)

- Used in Chemical/Pharmaceutical Processes
  - Reactions
  - Degreasing
  - Cleaning

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SPENT SOLVENTS RECOVERY

- Can be recovered via **filtration** and **distillation**
- Many become contaminated with organic residues (increases cost of recovery)
- Generally, only **non-halogenated** solvents are suitable as waste fuels for industrial boilers
- **Halogenated** solvents are poor fuels - require acid gas scrubbers which impacts energy savings

SOLVENT DISTILLATION

- Distillation separates a more volatile material from a less volatile material by a process of vaporization and condensation.

* Aqueous wastes boiled in a distillation unit condenses to a pure liquid; the pollutants remain in a concentrated residue.

- Applicability: Primarily chemical and petroleum industries. Liquid organics, including organic solvents and halogenated organics; the aqueous waste must be free flowing with a negligible solid content.

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TYPICAL SOLVENTS SUITABLE FOR WASTE FUEL BLENDING

Ethyl Acetate	Propionic Anhydride	3-Hexynol	Benzaldehyde
Acetone	Methyl Ethyl Ketone	Aniline	Benzylamine
Methanol	Dimethylaniline	Alcohol 2B	Acetonitrile
Ethyl Ether	Cyclohexyl Acetate	Isopropyl Ether	Butenol
Toluene	Dimethylformamide	Cyclohexane	Butyl Acetate
Hexane	Tetrahydrofuran	Diethylaniline	Isopropyl Acetate
Heptane	Cyclohexenylethylamine	Diethylamine	Ethyl Benzene
Xylene	Methyl Vinyl Ketone	Isobutyraldehyde	Dimethyl Malonate
Methyl Formate	Methyl Isobutyl Ketone	Butanol	Monobenzylamine
Ethyl Butenol	Dimethoxy Propane	Ethanol	Pyridine
Propionic Acid	Methyl Acetate	Acetic Acid	Triethylamine
Tetrahydrofuran	Methyl Benzyl Ether	Benzyl Alcohol	Butenediol
Dibenzyl Ether	Acetic Anhydride	Isopropanol	Cyclohexylethylamine

Source: Cheremisinoff & Cheremisinoff, Hazardous Materials and Waste Management, Noyes Publications, 1995.

LIQUID WASTE FUEL COMBUSTION

Examples:

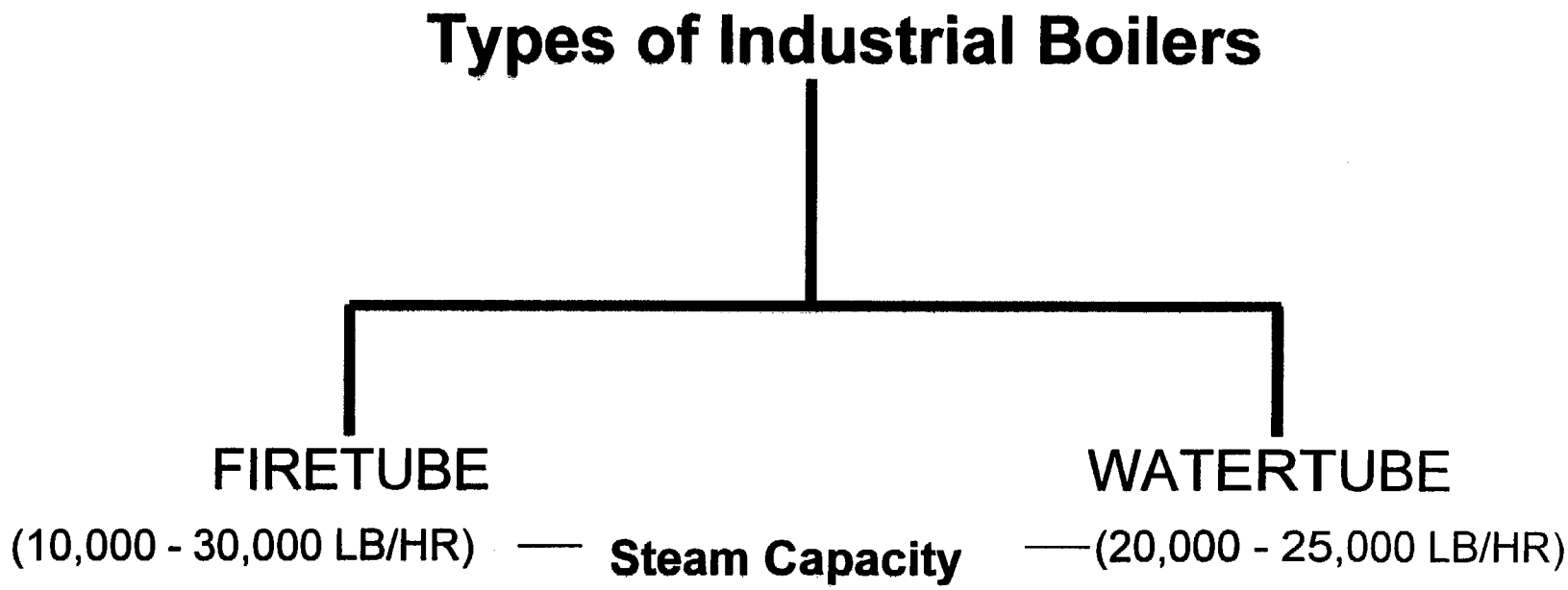
- Waste oils and spent solvents in industrial boilers

  (High cost of energy provides incentive for waste fuel combustion aimed at heat recovery in the form of steam generation)

Waste Oil/Solvent Combustion in Boilers =

Resource Recovery

TYPES OF INDUSTRIAL BOILERS



CAPITAL INVESTMENT ITEMS TO CONVERT BOILERS TO WASTE FUEL

- Liquid waste storage and feed systems
- Boiler modifications to accommodate waste fuels
- Engineering and permit fees to license boilers
- Air pollution instrumentation including continuous stack monitoring and recording
- Air pollution control devices

bd

HIGH TEMPERATURE METAL RECOVERY

- Waste is fed into a heating device where the metals and salts react with carbon to produce carbon dioxide and free metal. The high temperature destroys the organic compounds. The recovered metals can be used again in the industrial process. May produce a slag that has to be disposed of as a hazardous waste.
- **Applicability:** Intended to be used for wastes containing metal oxides and metal salts, including cadmium, chromium, lead, and nickel compounds.

MODULE V
HAZARDOUS WASTE TREATMENT: TECHNOLOGY OVERVIEW

Key Points To Be Covered:

- Treatment reduces waste volume, makes it less toxic, and/or immobilizes it
- There are many different treatment processes that can be used to treat a wide variety of wastes
- Treatment processes may be used separately or together in order to achieve maximum treatment of the wastes
- The treatment processes discussed here are a small sample of what is available

WHAT IS A TREATMENT?

- Any method, technique, or process designed to change the physical, chemical, or biological character or composition of any hazardous waste character or composition of any hazardous waste so as to neutralize the waste making it non-hazardous or less hazardous. Treatment can also be used to recover energy or material resources from the waste or make it safer to transport.

- Treatment reduces the volume of wastes, renders the wastes less toxic, or immobilizes them so they can be isolated fromt he environment.

- There are many different types of treatment processes.

TYPES OF TREATMENT

- Incineration
- Chemical
- Biological
- Recovery/Reclamation

INCINERATION

- Uses high temperatures (760^0 C - 1650^0 C) in a controlled environment to destroy primarily organic hazardous waste and reduce the volume requiring disposal

- Hazardous waste can be burned as a fuel or burned for destruction

- Incineration generates three residues:
  - Ash
  - Combustion gases
  - Wastewater

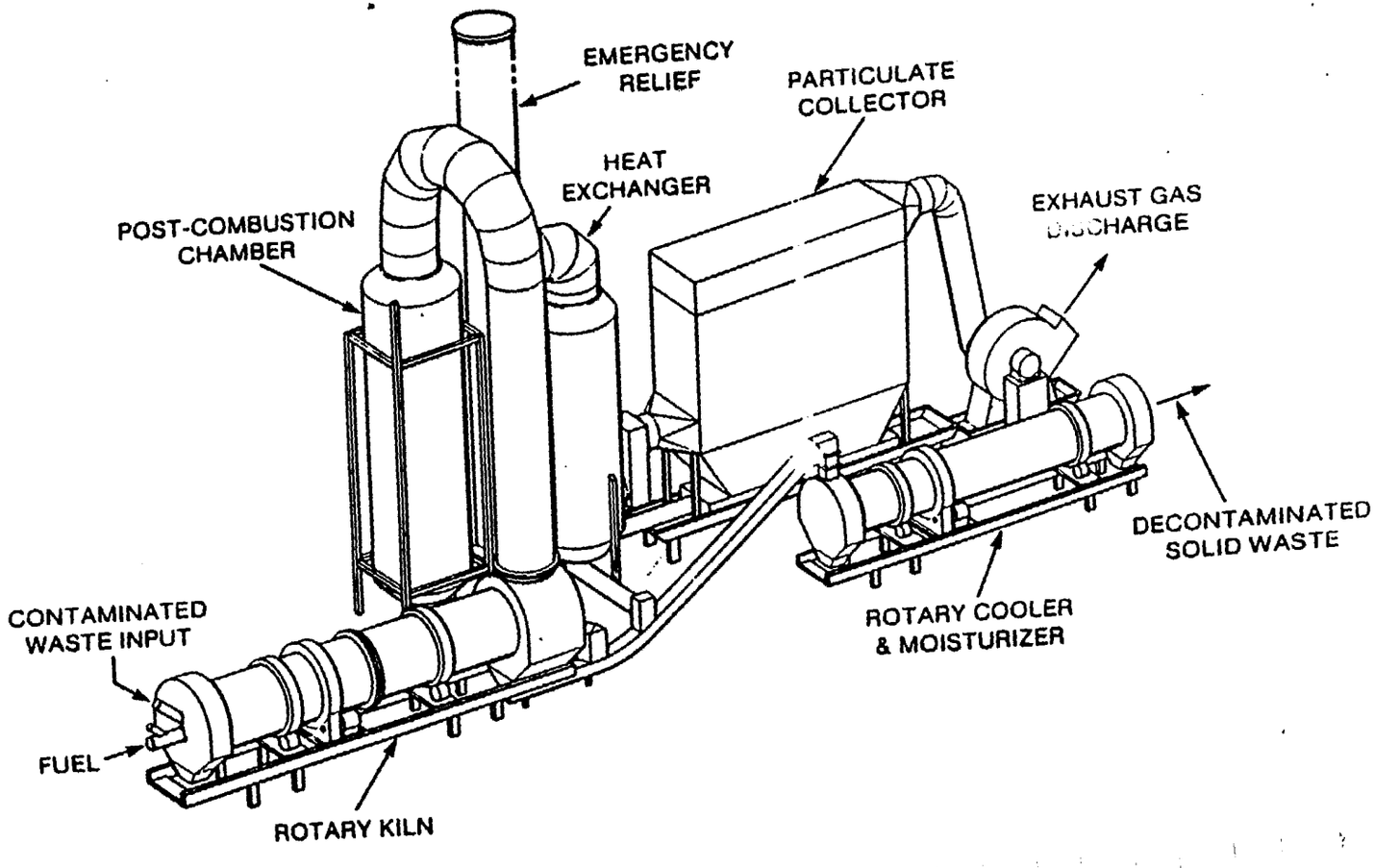
INCINERATION (CONTINUED)

- Some incinerators can burn only pumpable liquids while others can burn solids, sludges, and slurries

- Advantages
  - reduces the volume of waste requiring disposal
  - destroys moss organic compounds completely

- Disadvantages
  - some incinerators can accept only a specific type of waste
  - lead and mercury emissions can pose a serious problem if present in the waste

ROTARY KILNS



CHEMICAL TREATMENT

- Alters the wastes using techniques which render the wastes less hazardous or nonhazardous. Chemical treatment is especially applicable to waste acids or caustics.

- Two common types of chemical treatment:
  - Neutralization
  - Oxidation-reduction

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Chemical Treatment (continued)

- Neutralization
  - changes a solution's pH from acidic or alkaline to neutral;
  - can be used as a pretreatment for other processes;
  - applicable only for treating acidic or alkaline liquid waste.

- Oxidation-Reduction
  - oxidation widely used in treatment of inorganic cyanides; can be used to treat liquids, slurries, and sludges;
  - reduction used primarily to convert chromium IV to the less toxic chromium III; used to treat metal-bearing wastes, halogenated organic compunds, and pesticides.

BIOLOGICAL TREATMENT

- Biological processes using microorganisms (bacteria, fungi, yeast) have been used for many years to treat municipal and industrial waste water. Biological processes can also be used on selected hazardous wastes streams.

- Applicability: These methods are generally used with wastewater's and solids containing organic compounds.

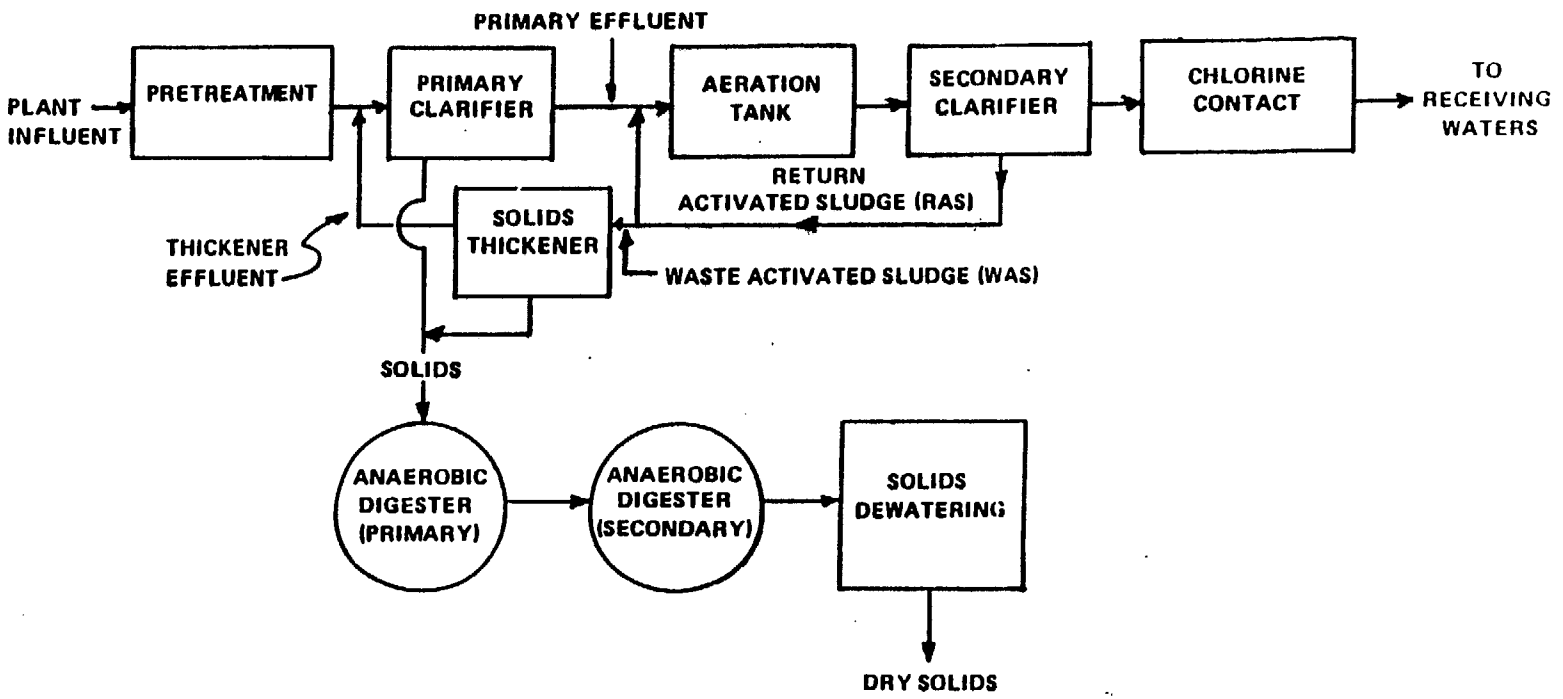
- Two common types of biological processes:
  - Aerobic digestion
  - Anaerobic

BIOLOGICAL TREATMENT (CONTINUED)

- **Aerobic digestion**
  - Uses microorganisms in presence of oxygen to oxidize organic molecules
  - Requires adequate levels of nutrients and oxygen
  - Used on aqueous wastes with low levels of non-halogenated organic

- **Anaerobic**
  - Organic matter reduced in oxygen-free environment
  - Can handle greater organic loads than aerobic techniques
  - Used on aqueous wastes with low to moderate organic levels; can treat certain halogenated organics

BIOLOGICAL TREATMENT (CONTINUED)



PHYSICAL TREATMENT

- Reduce the volume of wastes by removing the soluble and suspended hazardous components from the waste waters and sludges. May also make the waste immobile.

- Three common types of physical treatment:
  - Carbon adsorption
  - Flocculation
  - Solidification/stabilization

CARBON ADSORPTION

- Aqueous or vapor-phase wastes passes through a series of activated carbon beds where contaminants are adsorbed. Carbon beds must be replaced frequently orregenerated if the waste stream contains high organic concentrations.

- If waste stream contains suspended solids, oil and grease, or unstable chemical compounds, may have to pretreat waste stream prior to adsorption.

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CARBON ADSORPTION (CONTINUED)

- Removal efficiencies up to 99.99%. the major parameters influencing the effectiveness: pH, solubility, temperature, available surface area, and residence time.

- Applicability: Most frequently used for organic compounds. Certain inorganic compounds will also adsorb. Used in groundwater treatment systems, chemical spills, industrial wastewater treatment, and air pollution control systems.

FLOCCULATION

- Flocculants, such as alum and synthetic resin, added to the wastestream adhere to the suspended solids creating larger particles which drop out of suspension. Flocculants added under controlled pH to enhance sedimentation and precipitation. The extent of flocculation depends on waste flow rate and thoroughness of mixing.

- Applicability: Aqueous waste streams with colloidal solids. Especially effective on metal-bearing wastes. Not recommended for wastes that are viscous or high in organic contaminants.

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SOLIDIFICATION/STABILIZATION

- **Solidification:** Materials added to a waste produce a solid monolithic block with high structural integrity. May or may not involve a chemical bonding between the contaminant and the additive.

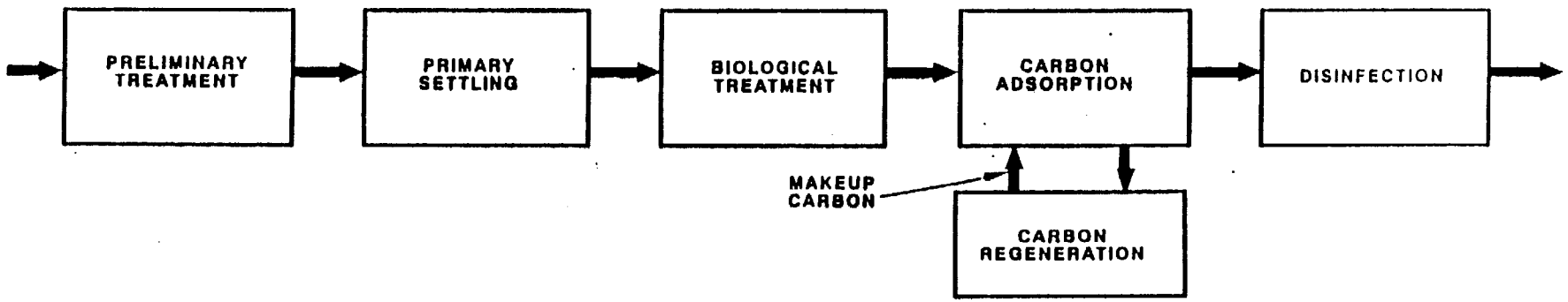
- Waste are mixed with a solidifying agent, or binder. The solidifying agent must be resistant to degradation. Waste and solidifying agent must be compatible so as not to become unstable and leach contaminants.

SOLIDIFICATION/STABILIZATION (CONTINUED)

- **Stabilization:** Chemical reaction converts waste to a more chemically stable form. The physical characteristics may or may not be improved or changed. No significant increase in volume.

- **Applicability:** Intended for sludges contaminated with certain organics, heavy metals, oils, and grease.

CARBON ADSORBTION (CONTINUED)



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STORAGE CONTAINERS

Provisions for Ignitable and Reactive Wastes:

Locate containers holding ignitable or reactive waste at least 15 meters from the property line of the facility.

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STORAGE CONTAINERS

Containment Systems:

- Use impervious liner materials to contain spills, leaks, or precipitation
- Provide sufficient containment system volume to contain 10% of the total volume of the containers or the volume of the largest container
- Specify procedures for removing liquids from the secondary containment system in a timely manner
- Constructed to prevent run-on from precipitation

STORAGE CONTAINERS

Inspections:

Conduct inspections at least once per week to look for leaking and deteriorating components of the containment system.

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STORAGE CONTAINERS

Maximum Stack height considerations:

- Type of container and waste
- Container condition
- Capabilities of equipment
- Use of pallets, plywood sheets, or racks when stacking
- Accessibility for inspection

STORAGE CONTAINERS

Management of Containers:

- Procedures to transfer wastes from containers in poor condition to containers in good condition
- Containers constructed of or lined with materials which will not react with and are otherwise compatible with the hazardous waste to be stored
- Keep containers closed except when necessary to add or remove waste
- Manage containers to prevent ruptures and leaks

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STORAGE CONTAINERS

Description of Container System:

- Maximum number and type of containers
- Construction materials
- Dimensions and usable volumes
- Markings and labels
- Container condition and age

STORAGE CONTAINERS

Definition:

- Portable device in which a hazardous material is stored, transported, treated, or disposed.
- Examples
  - Steel drums
  - Plastic containers
  - Fiber containers
  - Barrels
  - Kegs
  - Carboys

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STORAGE TANKS

Special provisions for Incompatible Wastes:

Do not place incompatible wastes in the same tank system.

STORAGE TANKS

Special Provisions for Ignitable or Reactive Wastes:

- Treat or render the waste inert before or immediately after placement in the tank system
- Store or treat waste to protect it from any material or condition that may cause it to ignite or react
- Provide additional buffer zone and spacing for flammable liquids

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STORAGE TANKS

Response to Leaks or Spills:

- Stop flow of waste immediately
- Remove and contain waste from the system
- Repair or close system
- Report spills and leaks

STORAGE TANKS

Inspection Schedules:

- Inspect tank systems on a routine basis to minimize the probability of accidental releases, the risk of fire, and exposure from such releases
- Visually inspect critical components and leak detection data daily
- Inspect the secondary containment system and cathodic protection system daily

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STORAGE TANKS

Corrosion Protection:

- Assessment of the potential of the soil to cause corrosion
- Assessment of the type and degree of corrosion protection necessary

STORAGE TANKS

Ancillary Equipment:

- Safeguards to prevent overfilling
- Safety cutoff or bypass system
- Venting system
- Pressure relief vents
- Piping
- Instrumentation

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STORAGE TANKS

Tank performance standards:

- Prevent explosion and implosion
- Prevent fire
- Prevent hazardous vapor emissions
- Prevent hazardous material spillage from overfilled vessels or transfer hose drainage

STORAGE TANKS

Tank design description:

- Shape, dimensions, and maximum capacity
- Age
- Materials of construction
- Type, size, and location of all pipes, manholes, and equipment
- Foundations, anchor systems, and frost heave considerations

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STORAGE TANKS

Secondary containment examples:

- External Liner
- Vault
- Double wall tank

STORAGE TANKS

Secondary containment and leak detection:

- Contain 100% of tank contents if a leak or spill occurs
- Prevent run-on of precipitation and migration of moisture into containment area
- Protect against formation and ignition of vapors within the containment area
- Install leak detection system to detect a failure of the primary or secondary containment systems

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STORAGE TANKS

Assessment:

- Determine if the waste is compatible with tank system
- Evaluate the tank system's structural integrity

STORAGE TANKS

Definition:

- Shell of tank provides enough support to maintain structural integrity when tank is free-standing
- Stationary
- Constructed primarily of non-earthen materials

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HAZARDOUS WASTE STORAGE FACILITIES

Types of hazardous waste storage facilities:

- Storage Tanks
- Storage Containers

TRANSPORTERS: SUMMARY

- Transporters should participate in the manifest system which allows the controlled tracking of hazardous wastes.
- Transporters should properly label containers and vehicles indicating the hazardous wastes contents.
- The United Nations Classification System is used for international trade. This classification system can be used to identify the contents of containers and vehicles. It provides basic emergency response information.

1017
2

1090
3

1993
3

PLACARDS ON CARRIERS

- Placards, or signs, should be placed on all motor vehicles, rail cars, and freight containers carrying either hazardous waste or hazardous materials (products).
- The diamond-shaped placard must contain the following information:
  - a graphic illustration of the hazard at the top of the diamond;
  - a one or two word description of the hazard in the center;
  - the United Nations four-digit specific chemical number; and
  - the United Nations one-digit class number.

DRAFT

LABELS ON CONTAINERS

The diamond-shaped label on each container should have the following information:

- a graphic illustration of the hazard at the top of the diamond
- a one or two word description of the hazard in the center of the diamond
- the United Nations one-digit class number.

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UNITED NATIONS HAZARD CLASSIFICATION SYSTEM

Examples of specific chemicals identified by four-digit numbers:

Number	Specific Chemical
1090	Acetone
1114	Benzene
2790	Acetic Acid
1935	Cyanide solutions
1832	Sulfuric Acid

UNITED NATIONS HAZARD CLASSIFICATION SYSTEM

Nine major classes of hazardous materials:

Number	Hazard
1	Explosives
2	Compressed gases
3	Flammable liquids
4	Flammable solids
5	Oxidizing materials
6	Poisons
7	Radioactive materials
8	Corrosives
9	Miscellaneous materials

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UNITED NATIONS HAZARD CLASSIFICATION SYSTEM

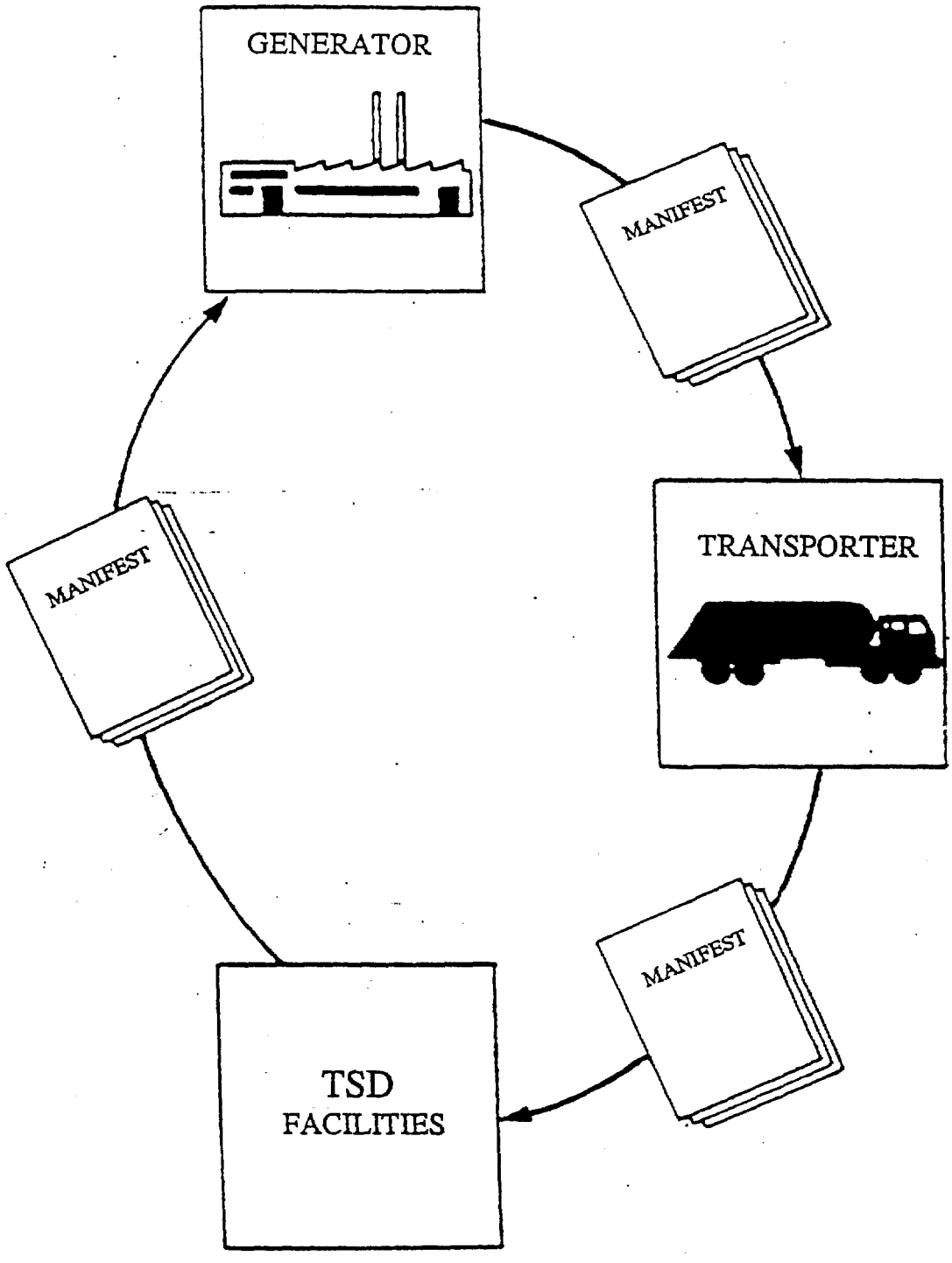
- This classification system is used for international trade.

- Classification system consists of two parts:
  - Hazardous materials are divided into nine major classes, as designated by numbers 1 through 9.
  - Specific chemicals are identified by four-digit numbers.

LABELING SYSTEM

- Each container of hazardous waste should be properly labeled prior to transportation off-site. The label identifies the contents of the container.
  - Provides Emergency Response Information

- Each <u>vehicle</u> carrying hazardous waste off-site should have a placard, or sign, indicating the hazardous waste it is carrying.


GENERATOR
MANIFEST
TRANSPORTER
MANIFEST
TSD
FACILITIES
MANIFEST

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MANIFEST (CONTINUED)

- Information in the manifest:
  - Identification of the generator, transporter, and treatment, storage or disposal facility;
  - description of the waste being transported;
  - quantities of the waste being transported;
  - address of the treatment, storage, or disposal facility where the waste is being sent

MANIFEST

- A document that is part of a controlled tracking system and allows the generator to track the movement of hazardous waste from the point of generation to the point of ultimate treatment, storage, or disposal.

- Part of a controlled tracking system. A copy of the manifest is retained by each person who has handled the waste.

WHAT IS A TRANSPORTER?

- Any person in the off-site transportation of manifested hazardous waste by highway, rail, water, or air

- A transporter should comply with the following:
  - identify themselves as a transporter
  - participate in the manifest, or tracking, system
  - take responsibility for any illegal discharges
  - take responsibility and assist in responding to spills in transit

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HAZARDOUS WASTE TRANSPORTERS

Key Points To Be Covered:

- Transporters participate in the hazardous waste manifest, or tracking, system
- Containers of hazardous wastes are labeled to identify contents
- Vehicles hauling hazardous wastes have a placard, or sign, to identify contents

RECORD KEEPING

- The types and amounts of each hazardous waste generated at the facility each year
- The types and amounts of hazardous wastes shipped to each off-site location each year
- These kinds of records will document the types of waste and quantities of waste that the company produced in a year and how the wastes were disposed

THE GENERATOR INSTITUTES MEASURES FOR:

- Preparedness and prevention
- Contingency plans
- Personnel training

ACCUMULATION

- A generator may accumulate (store) hazardous waste on-site prior to final treatment and disposal. However, perpetual storage to avoid final treatment and disposal should not be allowed.
- The waste should be placed in properly labeled tanks or containers.
- The date on which each period of accumulation begins should be clearly marked on each container or recorded for each tank.
- Storage should only be in tanks and containers that are sturdy and impervious.

THE MANIFEST

- Can be used when hazardous wastes are shipped off-site
- Constitutes a record of the shipment
- Provides a tracking mechanism

MAKE HAZARDOUS WASTE DETERMINATION USING:

- Physical and chemical data obtained from testing
- Knowledge of the process from which the waste is generated

RESPONSIBILITIES OF A GENERATOR

- Hazardous waste determination
- Proper packaging and labeling of wastes prior to shipment and use of manifests with each shipment
- Minimization of on-site accumulation
- Preparation of certain reports and keeping certain records

TYPES OF GENERATORS

- Chemical manufacturing plants
- Iron and steel plants
- Metal fabricators
- Electroplaters
- Vehicle maintenance and repair
- Mining operations
- Metal finishing and cleaning
- Food processing

DEFINITION OF A GENERATOR

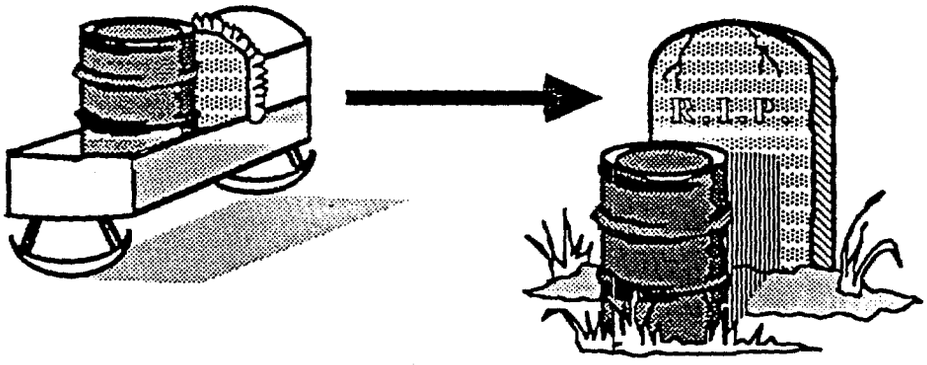
The company or facility who first produces or creates the hazardous wastes

GENERATORS

- Definition of a generator
- Types of generators
- Responsibilities of a generator
  - Waste determination
  - Waste tracking
  - Safe storage
  - Record keeping

Original RCRA Program Enacted in 1976

CRADLE → to → GRAVE
Control of Hazardous Waste



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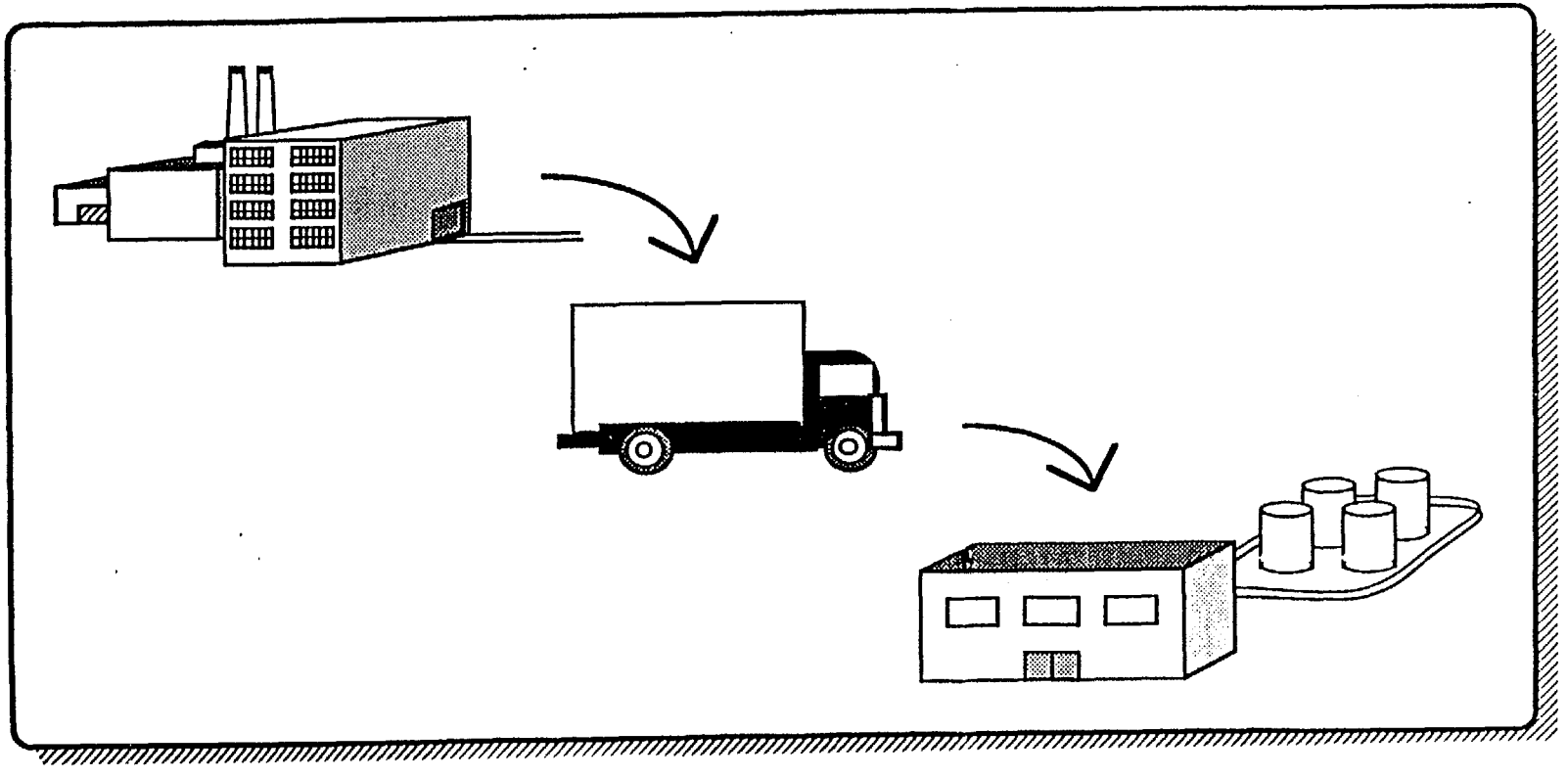
Cradle to Grave Control Meant

HW Generators → Transporters → Treatment, Storage, Disposal Facilities



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COMMENTS ON THE U.S. MANAGEMENT APPROACH

PROS

- Provides a complete history of a hazardous solid waste (Birth - Life - Death)
- Forces industry compliance - very effective in protecting human health and environment

CONS

- Regulations are complex and in some cases interpretive
- Waste definitions are not consistent
- Compliance based on fear - not incentives

CONCLUSIONS

- U.S. management approach not directly applicable to Ukraine, but
- Important elements are:
  - Record-keeping
  - Manifests
  - Labels
  - Placards
  - Waste codes
  - Emergency preparedness
  - Disposal facilities
  - Licensed transporters
  - Training
  - Reporting requirements

MODULE VI
WASTE MANAGEMENT IN THE UNITED STATES - AN EXAMPLE OF MANAGING SOLID WASTES

We will cover the U.S. management system and terminology for:

- Generators
- Hazardous waste transporters
- Hazardous waste storage facilities
- Waste disposal facilities

TREATMENT: SUMMARY

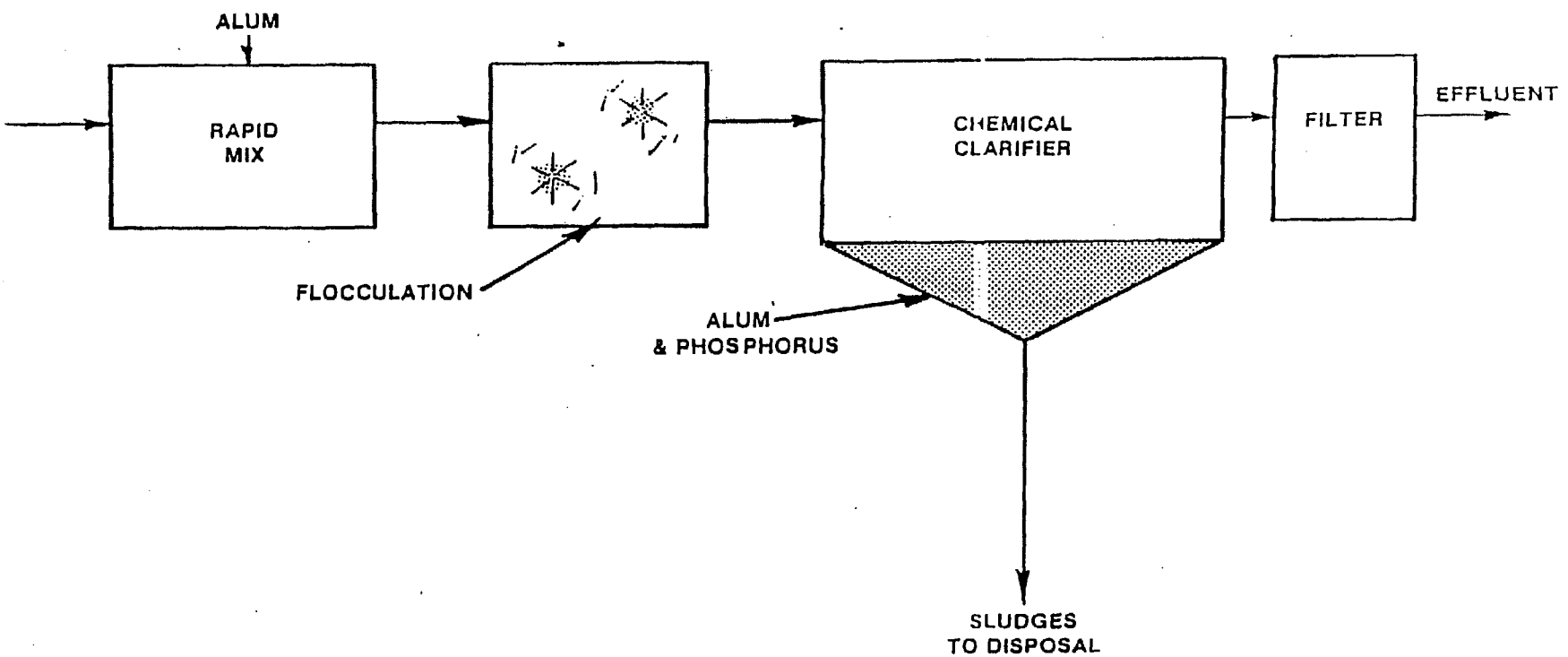
- Treatment should be used to reduce the volume of a waste, make the waste less toxic, and/or immobilize the waste
- Many different treatment processes exist to treat just about any type of waste
- Some treatment processes produce a hazardous waste which must also be treated
- Treatment can be less costly than disposal

WHAT IS NOT TREATMENT

- Dilution of hazardous wastes as a substitute for appropriate treatment is discouraged

- Substitution of a hazardous waste for an ingredient in a process, especially if the hazardous waste is less effective then the ingredient it is replacing

FLOCCULATION (CONTINUED)



STORAGE CONTAINERS

Provisions for Incompatible Wastes:

- Prevent leaks of incompatible materials from comingling
- Separate incompatible wastes by a wall or curb if they are in the same area or use overpack drums
- Do not place hazardous waste in an unwashed container that previously held incompatible waste

TYPICAL PROBLEMS AT STORAGE FACILITIES

- Deteriorating, damaged, or leaking tanks or containers
- Inadequate secondary containment
- Exceeding facility capacity for number of containers or volume of waste
- Poor maintenance of equipment or facility
- Storage of incompatible waste without enough separation

WASTE DISPOSAL FACILITIES

- Landfills

LANDFILLS

Types of Landfills:

- Municipal Solid Waste (receives household waste, commercial solid waste, and non-hazardous industrial solid waste)
- Hazardous Waste

LANDFILL REQUIREMENTS

Location Restrictions:

- Airports
- Floodplains
- Wetlands
- Fault Areas
- Seismic Impact Zones
- Unstable Areas

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LANDFILL REQUIREMENTS

Operating Criteria:

- Exclude hazardous waste using random inspections, training, and record keeping
- Cover waste with soil at the end of the operating day
- Control disease vectors such as rodents and insects
- Control explosive gases with routine monitoring and remedial measures
- Prohibit open burning at the landfill

LANDFILL REQUIREMENTS

Operating Criteria (continued):

- Control access to prevent illegal dumping and unauthorized vehicular traffic
- Control run-on and run-off of storm water in the landfill
- Prevent discharges that degrade surface water
- Prohibit disposal of bulk or non-containerized liquids
- Maintain complete records of the landfill operation

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LANDFILL REQUIREMENTS

Additional operating criteria for hazardous waste landfills:

- Must record on a map the exact location and dimensions of each cell, the contents of each cell, and the approximate location of each hazardous waste type within each cell.
- Ignitable or reactive wastes must be treated so they no longer have that characteristic, or must be handled and placed in containers that prevent ignition of the waste.
- Incompatible wastes must not be placed in the same cell.

LANDFILL REQUIREMENTS

Design Criteria:

- Liner
- Leachate collection
- Additional requirements for hazardous waste

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LANDFILL REQUIREMENTS

Design Criteria:

Liner -

Composite liner consists of flexible membrane liner (FML) over a layer of compacted soil with very low permeability

Leachate collection -

Leachate collection system is designed to remove and minimize the depth of leachate in the landfill

LANDFILL REQUIREMENTS

Additional design criteria for hazardous waste:

- Install two liners consisting of a top liner, for example a flexible membrane liner (FML), and a lower composite liner consisting of an FML over a thicker layer of low permeability compacted soil
- Install a leachate collection system over the top liner
- Install a leak detection and leachate removal system between the top liner and the lower composite liner

LANDFILL REQUIREMENTS

Ground-Water Monitoring and Corrective Action:

- Monitoring Systems
- Sampling and Analysis
- Detection Monitoring
- Assessment Monitoring
- Corrective Action

LANDFILL REQUIREMENTS

Monitoring systems:

- Yield representative samples of the uppermost aquifer
- Installed at the unit boundary
- Wells constructed with casing
- Last the life of the monitoring program

LANDFILL REQUIREMENTS

Sampling and Analysis:

- Sampling and analysis procedures
- Groundwater elevation, rate and direction of flow determination
- Establish background concentrations for constituents
- Statistical procedures

LANDFILL REQUIREMENTS

Detection Monitoring:

- Semi-annual monitoring
- Statistically significant increase over background triggers assessment monitoring program

LANDFILL REQUIREMENTS

Assessment Monitoring:

- Sample greater number of constituents
- Re-sample semi-annually
- Determine background and set groundwater protection standard for detected constituents
- Statistically significant increase over groundwater protection standard triggers assessment of corrective measures

LANDFILL REQUIREMENTS

Corrective Action:

- Characterize nature and extent of release
- Assess corrective measures
- Select remedy
- Implement remedy
- Remedy is complete when the groundwater protection standard is achieved for a three-year period

LANDFILL REQUIREMENTS

Closure:

Final cover must be designed to minimize infiltration and minimize erosion.

- Infiltration layer is a layer of low permeability soil and possibly a flexible membrane liner
- Erosion layer must be capable of sustaining native plant growth and preventing erosion

LANDFILL REQUIREMENTS

Post Closure Care:

- Maintain the final cover and containment systems
- Collect and manage leachate
- Groundwater monitoring
- Gas monitoring
- Lasts for 30 years