United States
Environmental Protection
Agency

Solid Waste And
Emergency Response
(OS-420) WF

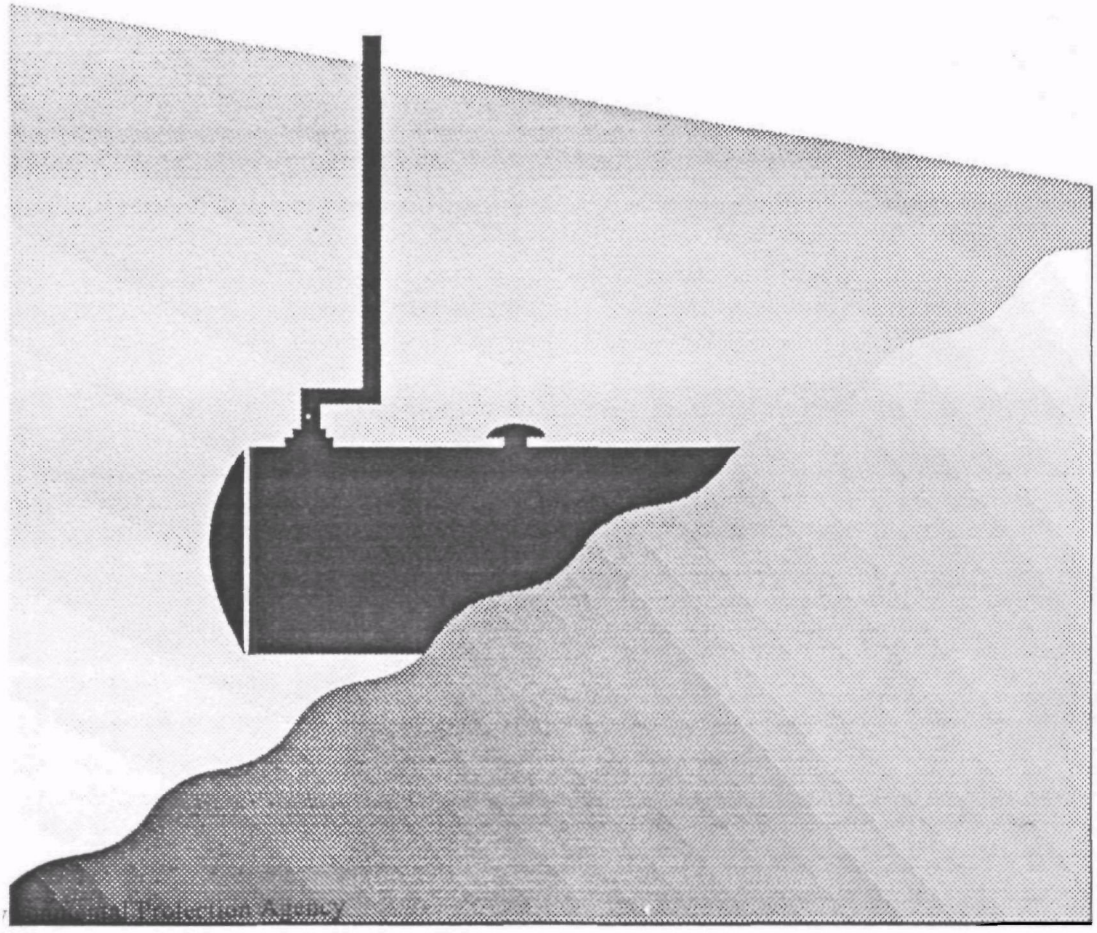
500/B-92/001a
April 1992

EPA

Introduction to Leak Detection

Understanding Federal Release Detection Requirements and Acceptable Release Detection Methods

Student Manual



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Contents

Contents

Contents

NOTES TO THE STUDENT

Welcome to "Introduction to Leak Detection."

This course presents State and local UST staff with a basic survey of Federal release detection requirements and acceptable methods of release detection. The course answers such questions as:

- What are the Federally accepted methods of leak detection?
- What are the requirements for monitoring USTs?
- What methods are used for leak detection in UST piping systems?
- What site characteristics should be considered when deciding on the proper leak detection method for a certain UST?
- What are the advantages and the limitations of the various leak detection methods?
- How do each of the methods compare in operation and maintenance?

These questions will be addressed by means of a variety of instructional methods: class lectures, slide presentations, large and small group discussions, question and answer sessions, and case study exercises.

CHAPTER ONE

BASIC LEAK DETECTION

This chapter will introduce you to the problem of leaking underground storage tanks, leak detection and what it accomplishes, and why leak detection is necessary. It will also provide an overview of several leak detection methods. The chapter will serve as an introduction for some participants, and as a review of the material for others with more experience. This information provides the background necessary for understanding the following chapters.

Lecture Notes	Student Notes
I. OVERVIEW OF LEAKING UNDERGROUND STORAGE TANK SYSTEMS (USTs)	**Slide 1:**
A. The problem	**Slide 1A (photo):**
1. Petroleum and chemicals are stored in underground storage tanks, many of which are vulnerable to corrosion.	**Slide 2:**
-- 84 percent of service station tanks are made of bare (unprotected) steel and are highly susceptible to corrosion.	**Slide 3 (graphic):**
-- 15 - 20 percent of petroleum tanks may be leaking, which means that hundreds of thousands of USTs may be leaking.	**Slide 4:**
2. Leaking tanks pose a threat to ground water. Releases from USTs into water supplies used for drinking and other purposes can endanger public health.	
3. The threat of leaking tanks is not limited to ground water. Other considerations are:	**Slide 5:**
-- Contamination of surface waters;	

Lecture Notes	Student Notes
– Fires and explosions; and – Toxic fumes that seep into homes and businesses. 4. Two components of gasoline, benzene and ethyl dibromide, are suspected cancer-causing agents.	
B. Releases	**Slide 6:**
1. Releases result from piping failure, spills and overfills, and tank corrosion.	
2. When a release occurs, product can: – Seep through the soil into the ground water; – Float on top of the water table; – Discharge into wells or surface water; and/or – Seep into underground structures (pipelines, utilities, lines, basements, etc.).	**Slide 7 (graphic):**
C. Uses and ownership of USTs	**Slide 8 (graphic):**
1. The largest percentage (39 percent) of regulated USTs are used in retail motor fuel businesses. 2. The second largest user of USTs (38 percent) is the non-retail motor fuel sector, such as rental companies and government agencies.	
3. Nearly 80 percent of all USTs used to store petroleum are owned and operated by gas stations and industry. Government and farmers each own about half of the remaining 20 percent. Farm tanks with a capacity of 1,100 gallons or less used for storing motor fuel for noncommercial purposes are not subject to Federal UST regulations.	**Slide 9 (graphic):**

Lecture Notes	Student Notes
II. LEAK DETECTION	**Slide 9A (photo):**
A. What does leak detection accomplish?	
1. Leak detection warns owners and operators of leaks in tanks and piping. Early warning enables owners and operators to take action to stop the escape of large amounts of the product into the environment.	**Slide 10:**
2. Leak detection can prevent ground-water contamination.	
B. Why is leak detection necessary for owners and operators of USTs?	**Slide 11:**
1. Detecting leaks is a good business practice.	
– Loss of product costs the owner/operator money.	**Slide 12:**
– Extensive releases can be very costly to clean up.	
– USTs that pollute a community's environment can cause public relations problems.	
2. Detecting leaks protects human health and the environment.	
– Leak detection helps prevent the contamination of ground water that may be used as drinking water. Half of the U.S. population relies on ground water as a source of drinking water.	
– Petroleum and chemicals stored in USTs can contaminate the soil, air and water with harmful effects to people, plants, and animals, particularly in farm production.	

Lecture Notes	Student Notes
-- Leaking tanks also can lead to explosions, fires, toxic fumes, and contaminated surface waters. 3. Detecting leaks can protect owners and operators against liability suits. -- Local residents and communities can take damage claims to court. 4. Detecting leaks is required by Federal, State, and local laws. -- UST regulations require preventing, detecting, and cleaning up leaks and spills.	

Lecture Notes	Student Notes
III. LEAK DETECTION METHODS	
Three types of methods detect leaks from tanks:	**Slide 13:**
— Internal monitoring:	
— Interstitial monitoring; and	
— External monitoring.	
In addition, piping has special leak detection requirements.	
A. Internal leak detection methods	
These methods monitor inside the tank to check for leaks, and frequently measure volume loss over time of test. There are four types of internal monitoring:	
1. Inventory control combined with tightness testing;	**Slide 14:**
2. Manual tank gauging;	
3. Automatic tank gauging; and	**Slide 15:**
4. Statistical inventory reconciliation.	
B. Interstitial leak detection methods	
These methods monitor the area between the tank and a containment barrier.	**Slide 16:**
C. External leak detection methods	
These methods use sensors to monitor the environment surrounding the tank for the presence of the leaked product. There are two types of external monitoring:	
1. Vapor monitoring; and	
2. Ground-water monitoring.	

Lecture Notes	Student Notes
D. Piping monitoring	
1. Requirements for pressurized piping and suction piping are not the same.	**Slide 17:**
– Compliance deadlines; and	
– Testing requirements.	
2. Pressurized piping must have automatic line leak detectors to prevent catastrophic releases.	
3. There are three types of leak detection for piping:	**Slide 18:**
– Tightness testing;	
– Interstitial monitoring; and	
– External monitoring.	

Lecture Notes	Student Notes
IV. OTHER SOURCES OF INFORMATION ON THE UST PROGRAM In addition to the materials in this manual, the UST program also has developed handbooks, slide shows, and video tapes on a wide range of topics to inform States, localities and regulated industries about the regulations and program requirements. Many of these materials may be of interest to you. Additional information sources have been provided for you on the next few pages of this manual, including publication and video order forms and a list of UST Regional and State contacts. In addition to these materials, the EPA RCRA/Superfund Hotline (1-800-424-9346) can assist you with specific questions about the UST regulatory requirements.	**Slide 19:**

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF UNDERGROUND STORAGE TANKS
PUBLICATIONS LIST

General Information

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Name: _____ Title: _____

Organization: _____

Street: _____

City: _____ State: _____ Zip: _____

Telephone: (_____) _____ - _____

Please return this form to:

U.S. Environmental Protection Agency
Office of Underground Storage Tanks
P.O. Box 6044
Rockville, MD 20850

Please send me the publications I have circled:

3	4A	4B	5	7
10	17	21	26S	32
39	40	42	49	73
74	84	88	92	

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Other Publications of Interest

TITLE / STOCK NO.	COST	AVAILABLE FROM
Basics for USTs: A Summary of the Regulations for Underground Storage Tank Systems Stock No. 055-000-00294-1	$2.50	**Superintendent of Documents** U.S. Government Printing Office Washington, D.C. 20402 (202) 783-3238 Visa and MasterCard accepted
Dollars and Sense: A Summary of the Financial Responsibility Regulations for Underground Storage Tank Systems Stock No. 055-000-00293-2	$1.25	
Cleanup of Releases from Petroleum USTs: Selected Technologies Stock No. 055-000-00272-0	$7.50	
Field Measurements: Dependable Data When You Need It Stock No. 055-000-00368-8	$5.50	
Petroleum Tank Releases Under Control: A Compendium of Current Practices for State UST Inspectors Stock No. 055-000-00295-9	$8.50	
Survey of Vendors of External Petroleum Leak Monitoring Devices for Use with USTs Stock No. 055-000-00277-1	$4.25	
Evaluation of Volumetric Leak Detection Methods for Underground Fuel Storage Tanks Volume 1. No. PB89-124333 paper/microfiche Volume 2. No. PB89-124341 paper/microfiche	 $39.00/$8.00 $81.00/$21.50	**National Technical Information Service** 5285 Port Royal Road Springfield, VA 22161 (703) 487-4600
Underground Storage Tank Corrective Action Technologies PB 87-171278 paper/microfiche	$31.00/$8.00	
Soil Gas Sensing for Detection and Mapping of Volatile Organics Catalog No. TO49	$35.00/ member $43.75/ non-member	**National Water Well Association** P.O. Box 182039, Dept. 017 Columbus, OH 43218 (614) 761-1711
Reg-In-A-Box personal computer (PC) software is an aid to understanding and working with the Federal UST regulations. Easy to use and available for PC-compatibles with hard disk drives. Not copy protected.	$5.00 plus shipping and handling	**Public Brand Software** 1-800-426-3475 (24 hours a day) (317) 856-7571 (in Indiana) Visa and MasterCard accepted
Volumetric Tank Testing (Summary of Edison Study on Internal Leak Detectors) Stock No. 625/9-89/009	Free	**Center for Environmental Research Information** 26 West Martin Luther King Drive Cincinnati, OH 45268-1072 (513) 569-7562

6/17/91 SPEC

Audiovisual Programs

VIDEOS

AVAILABLE FROM

"Straight Talk on Leak Detection"
(An introductory overview for owners and operators of underground storage tank systems on the leak detection methods available for complying with UST regulations [Total 35 minutes].)
Part 1: Straight Talk From Tank Owners. (Owners address the problems of UST compliance [5 minutes].)
Part 2: Straight Talk on Leak Detection with Joe Thursday (30 minutes).
Cost: $40.00 prepaid

"Doing It Right"
(Proper installation of underground tanks and piping for installation crews.)
Part 1: Tanks (24 minutes)
Part 2: Piping (16 minutes)
Cost: $16.00 prepaid

Environmental Media Center
P.O. Box 30212
Bethesda, MD 20814

OR CALL TOLL FREE:
1-800-522-0362
(301-229-1944 in Maryland)

Visa and MasterCard accepted

"Searching for the Honest Tank: A Guide to UST Facility Compliance Inspections"
(Covers major steps of UST inspections from protocols and equipment to enforcement and followup; from cathodic protection to leak detection. Although it is directed at inspectors, the video is also helpful to owners and operators [30 minutes].)
Video and Booklet Cost: $40.00 prepaid
Booklet Cost: $5.00 prepaid

"Tank Closure Without Tears: An Inspector's Safety Guide"
(Focuses on problem of explosive vapors and safe tank removal.)
Video and Booklet Cost: $30.00 prepaid
Booklet Cost: $5.00 prepaid

"What Do We Have Here? An Inspector's Guide to Site Assessment at Tank Closure."
(A three-part video on inspecting sites for contamination where tanks have been removed.)
Part 1: Site Assessment Overview (30 minutes)
Part 2: Field Testing Instruments at a Glance (14 minutes)
Part 3: Soil and Water Sampling at a Glance (7 minutes)
Video and Booklet Cost: $45.00 prepaid
Booklet Cost: $5.00 prepaid

New England Interstate Environmental Training Center
Attn: VIDEOS
2 Fort Road
South Portland, ME 04106

"A Question of When: Tank Installation for Inspectors"
(Tank and pipe installation with a checklist for inspectors [28 minutes].)
Cost: $32.85 prepaid

"In Your Own Backyard"
(What tank owners should require from installation contractors [22 minutes].)
Cost: $32.85 prepaid

TZ Communications
P.O. Box 332
Holbrook, MA 02343

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TZ Communications
P.O. Box 332
Holbrook, MA 02343

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SLIDES

AVAILABLE FROM

"Managing Underground Storage Tanks"
(Segments on all phases of tank management from inventory and installation to leak detection and clean up.) 185 slides, 27-page script, and 103 pages of graphics.

Cost: $120.00

National Audiovisual Center
Customer Services Section/WD
8700 Edgeworth Drive
Capitol Heights, MD 20743-3701
(301) 763-1891

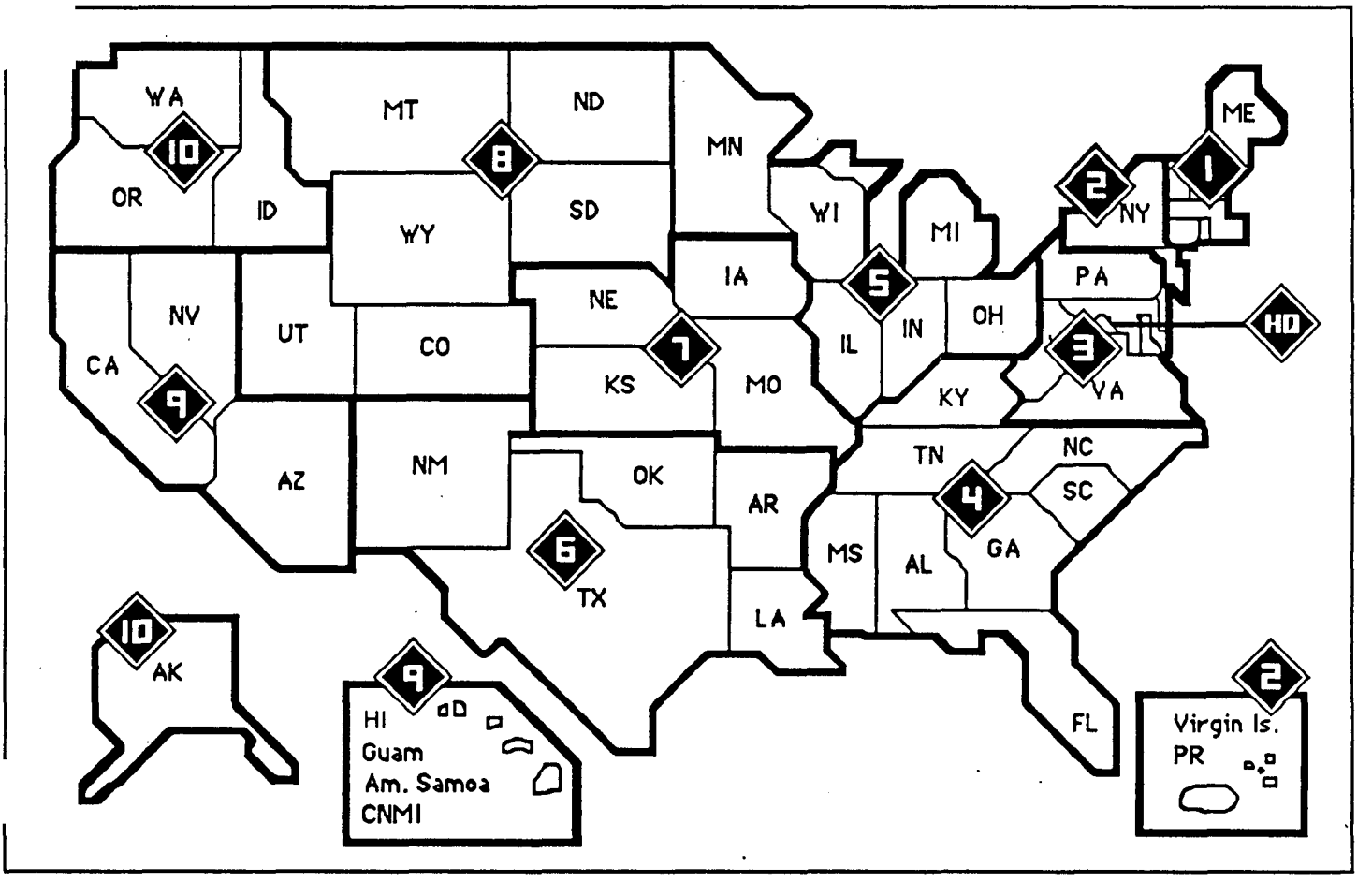
"Tank Talk: The New National Rules"
(A visual overview of the Federal rules for USTs - - technical standards and financial responsibility.) 70 slides, 20-page script, and 30-minute narrated audio tape.

Cost: $80.00

Capital Presentations
10 Post Office Road - Suite 2N
Silver Spring, MD 20910
(301) 588-9540

U.S. Environmental Protection Agency
Office of Underground Storage Tanks

Regional and State UST/LUST Program Contacts



EPA Regional UST Program Managers

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U.S. EPA, Region 1
JFK Federal Building
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Boston, MA 02203
617-573-9604
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Programs Branch
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New York, NY 10278
212-264-3384
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Atlanta, GA 30365
404-347-3866
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77 W. Jackson Blvd.
Mailcode: HRU-8J
Chicago, IL 60604
312-886-6159
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1445 Ross Avenue
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U.S. EPA, Region 9
75 Hawthorne Street
10th Floor, H-2-1
San Francisco, CA 94105
415-744-2079
FTS 484-2079

Joan Cabreza
U.S. EPA, Region 10
1200 Sixth Avenue
Mailcode: WD-139
Seattle, WA 98101
206-553-1643
FTS 399-1643

State UST/LUST Program Offices

AK UST/LUST CONTACT[2]
AK Dept. of Environmental Conservation
Contaminated Sites
410 Willoughby Avenue, Suite 105
Juneau, AK 99801-1795 907-465-5250

AL UST/LUST CONTACT
AL Dept. of Environmental Management
Ground-Water Section/Water Division
1751 Congressman W. L. Dickinson Dr.
Montgomery, AL 36130
UST: 205-271-7986
LUST: 205-271-7834

AR UST/LUST CONTACT[1]
AR Dept. of Pollution Control & Ecology
Regulated Storage Tank Division
P.O. Box 8913, 72219-8913
8001 National Drive
Little Rock, AR 72219-8913
501-562-6533

AZ UST/LUST CONTACT[2]
AZ Department of Environmental Quality
3033 North Central Avenue
Phoenix, AZ 85004 602-257-6984

CA UST/LUST CONTACT
CA State Water Resources Control Board
Division of Clean Water Program
2014 T Street
(P.O. Box 944212, Zip: 94244-2120)
Sacramento, CA 95814
UST: 916-739-4436
LUST: 916-739-4317

CO UST CONTACT
CO State Oil Inspection Office
1001 East 62nd Avenue, Room A1
Denver, CO 80216 303-289-5643

LUST CONTACT
CO Department of Health
Hazardous Materials & Waste Mgmt. Div.
Underground Storage Tank Program
4210 East 11th Avenue
Denver, CO 80220 303-331-4864

CT UST/LUST CONTACT[2]
CT Dept. of Environmental Protection
Underground Storage Tank Program
165 Capitol Avenue
Hartford, CT 06106 203-566-4630

DC UST/LUST CONTACT[2]
DC Environmental Regulatory Admin.
Underground Storage Tank Branch
2100 Martin Luther King Ave. S.E.
Suite 203
Washington, D.C. 20020
202-404-1167

DE UST/LUST CONTACT[2]
DE Dept. of Natural Resources &
Environmental Control
Underground Storage Tank Branch
715 Grantham Lane
New Castle, DE 19720 302-323-4588

FL UST/LUST CONTACT[2]
FL Dept. of Environmental Regulation
Tank Section
Twin Towers Office Building - Rm 403
2600 Blair Stone Road
Tallahassee, FL 32399-2400
904-488-3935

GA UST/LUST CONTACT[1]
GA Department of Natural Resources
Underground Storage Tank Mgmt. Prog.
4244 International Parkway, Suite 100
Atlanta, GA 30354 404-362-2687

HI UST/LUST CONTACT[1]
HI Department of Health
Solid and Hazardous Waste Branch
500 Ala Moana Blvd., Suite 250
Honolulu, HI 96813-4913 808-586-4230

IA UST/LUST CONTACT[1]
IA Department of Natural Resources
Henry A. Wallace Building
900 East Grand
Des Moines, IA 50319 515-281-8135

ID UST/LUST CONTACT[2]
ID Department of Health & Welfare
ID Division of Environmental Quality
1410 North Hilton
Boise, ID 83706 208-334-5860

IL UST CONTACT
IL Office of State Fire Marshal
Division of Petroleum & Chemical Safety
1035 Stephenson Dr.
Springfield, IL 62703 217-785-5878

LUST CONTACT
IL EPA, Bureau of Land
Div. of Remediation Mgmt., LUST Section
P.O. Box 19276
Springfield, IL 62794-9276 217-782-6760

IN UST CONTACT
IN Dept. of Fire and Services
Office of the State Fire Marshal
402 West Washington Street
Room C241
Indianapolis, IN 46204 317-232-2222

LUST CONTACT
IN Dept. of Environmental Management
Office of Environmental Response
2321 Executive Drive
Indianapolis, IN 46241 317-243-5110

KS UST/LUST CONTACT
KS Department of Health & Environment
Bureau of Environmental Remediation
Underground Storage Tank Section
Forbes Field, Building 740
Topeka, KS 66620-0001
UST: 913-296-1685
LUST: 913-296-1684

KY UST/LUST CONTACT[1]
KY Division of Waste Management
Underground Storage Tank Branch
18 Reilly Road
Frankfort, KY 40601 502-564-6716

LA UST/LUST CONTACT[2]
LA Dept. of Environmental Quality
Underground Storage Tank Division
P.O. Box 82178, 7290 Bluebonnet
Baton Rouge, LA 70884-2178
504-765-0243

MA UST CONTACT
MA Department of Public Safety
Underground Storage Tank Program
P.O. Box 490, East Street, Bldg. #5
Tewksbury, MA 01876 508-851-9813

LUST CONTACT
MA Dept. of Environmental Protection
One Winter Street
Boston, MA 02108 617-556-1044

MD UST/LUST CONTACT[1]
MD Department of Environment
Hazardous & Solid Waste Mgmt. Admin.
Underground Storage Tank Program
2500 Broening Highway
Baltimore, MD 21224 410-631-3442

ME UST/LUST CONTACT[1]
ME Dept. of Environmental Protection
State House - Station 17
Hospital Street, Ray Building
Augusta, ME 04333 207-289-2651

MI UST CONTACT
MI Department of State Police
Fire Marshal Division
P.O. Box 30157
Lansing, MI 48909 517-322-1935

LUST CONTACT
MI Department of Natural Resources
Leaking Underground Storage Tank Unit
P.O. Box 30028
Lansing, MI 48909 517-373-8168

MN UST/LUST CONTACT
MN Pollution Control Agency
Underground Storage Tank Program
520 Lafayette Road North
St. Paul, MN 55155-3898
UST: 612-297-8609
LUST: 612-297-8574

MO UST CONTACT
MO Department of Natural Resources
Water Pollution Control Program
P.O. Box 176
Jefferson City, MO 65102 314-751-6822

LUST CONTACT
MO Department of Natural Resources
Environmental Services Program
P.O. Box 176
Jefferson City, MO 65102 314-526-3349

1 = State has 1 person serving as both the UST and LUST Contact.
2 = State has 1 UST and 1 LUST Contact; both have the same address and telephone number.

State UST/LUST Program Offices

MS UST/LUST CONTACT[1]
MS Department of Environmental Quality
Bureau of Pollution Control
Underground Storage Tank Section
P.O. Box 10385
Jackson, MS 39289-0385
601-961-5171

MT UST/LUST CONTACT[1]
MT Dept. of Health & Environ. Science
Solid & Hazardous Waste Bureau
Cogswell Building - UST Program
Helena, MT 59620 406-444-5970

NC UST/LUST CONTACT[2]
NC Pollution Control Branch
Division of Environmental Management
Dept. of Env. Health & Natural Resources
441 N. Harrington St.
Raleigh, NC 27603 919-733-8486

ND UST/LUST CONTACT[1]
ND Department of Health
Division of Waste Management
Box 5520, 1200 Missouri Ave., Room 302
Bismarck, ND 58502-5520
701-221-5166

NE UST CONTACT
NE State Fire Marshal's Office
Flammable Liquid Storage Tank Division
246 South 14th Street
Lincoln, NE 68508 402-471-9465

LUST CONTACT
NE Dept. of Environmental Control
Groundwater Sect., Water Quality Division
301 Centennial Mall South, Box 98922
Lincoln, NE 68509-8922 402-471-4230

NH UST/LUST CONTACT[1]
NH Dept. of Environmental Services
Oil Compliance Section
Groundwater Protection Bureau
6 Hazen Drive, P.O. Box 95
Concord, NH 03301 603-271-3644

NJ UST/LUST CONTACT[2]
NJ Dept. of Environmental Protection
and Energy
Responsible Party Site Remediation
401 East State Street (CN-029)
Trenton, NJ 08625 609-984-3156

NM UST/LUST CONTACT[1]
NM Environment Department
Underground Storage Tank Bureau
P.O. Box 26110
1190 St. Francis Drive
Harold Runnels Building, Room N2150
Santa Fe, NM 87502 505-827-0188

NV UST/LUST CONTACT[1]
NV Dept. of Conservation & Natural Res.
Division of Environmental Protection
Capitol Complex
123 W. Nye Lane
Carson City, NV 89710 702-687-5872

NY UST/LUST CONTACT[1]
NY Dept. of Environmental Conservation
Bulk Storage Section
50 Wolf Road, Room 326
Albany, NY 12233-3520 518-457-4351

OH UST/LUST CONTACT[2]
OH Department of Commerce
8895 East Main Street
P.O. Box 687
Reynoldsburg, OH 43068
614-752-7938

OK UST/LUST CONTACT
OK Corporation Commission
Underground Storage Tank Program
Jim Thorpe Building
2101 North Lincoln Blvd.
Oklahoma City, OK 73105
UST: 405-521-3107
LUST: 405-521-6575

OR UST CONTACT
OR Dept. of Environmental Quality
Underground Storage Tanks
811 SW Sixth Avenue, 7th Floor
Portland, OR 97204 503-229-5733

LUST CONTACT
OR Dept. of Environmental Quality
UST Cleanup Program
811 SW Sixth Avenue, 9th Floor
Portland, OR 97204 503-229-6170

PA UST/LUST CONTACT[2]
PA Dept. of Environmental Resources
BWQM, Storage Tank Program
3600 Vartan Way, 2nd Floor
P.O. Box 8762
Harrisburg, PA 17105-8762
717-657-4080

RI UST/LUST CONTACT[1]
RI Dept. of Environmental Management
Underground Storage Tank Section
291 Promenade St.
Providence, RI 02908 401-277-2234

SC UST/LUST CONTACT
SC Dept. of Health and Environ. Control
Ground-Water Protection Division
2600 Bull Street
Columbia, SC 29201
UST: 803-734-5335
LUST: 803-734-5331

SD UST/LUST CONTACT[1]
SD Dept. of Environ. & Natural Resources
Division of Environmental Regulation
523 East Capitol
Joe Foss Building
Pierre, SD 57501-3181 605-773-3351

TN UST/LUST CONTACT[1]
TN Dept. of Environment & Conservation
200 Doctors Building
706 Church Street
Nashville, TN 37243-1541 615-741-4081

TX UST/LUST CONTACT[1]
Texas Water Commission
Petroleum Storage Tank Division
P.O. Box 13087, Capitol Station
1700 North Congress
Austin, TX 78711-3087 512-371-6200

UT UST/LUST CONTACT[1]
UT Dept. of Environmental Quality
Bureau of Solid & Hazardous Waste
Division of Environmental Response and
Remediation
1950 West North Temple
Salt Lake City, UT 84116 801-538-4100

VA UST/LUST CONTACT
VA State Water Control Board
P.O. Box 11143
Richmond, VA 23230-1143
UST: 804-527-5192
LUST: 804-527-5188

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802-244-8702

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Olympia, WA 98504-7600 206-438-7164

WI UST CONTACT
WI Dept. of Industry, Labor & Human
Relations
Bureau of Petroleum Insp. & Fire Protection
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Madison, WI 53702 608-266-7605

LUST CONTACT
WI Department of Natural Resources
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Madison, WI 53707-7921 608-267-7560

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UST/LUST Office
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Water Quality Division
Herschler Building, 4th Floor West
122 West 25th Street
Cheyenne, WY 82002 307-777-7781

1 = State has 1 person serving as both the UST and LUST Contact.
2 = State has 1 UST and 1 LUST Contact; both have the same address and telephone number.

State UST/LUST Program Offices

US TERRITORIES

UST/LUST CONTACT[1]
AS Environmental Protection Agency
Office of the Governor
American Samoa Government
ATTN: UST/LUST Program
Pago Pago, American Samoa 96799
684-633-2304

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Commonwealth of Northern Mariana Ids
Saipan, MP 96950 607-234-6984

GU UST/LUST CONTACT[1]
GU Environmental Protection Agency
IT&E
Harmon Plaza, Complex Unit D-107
130 Rojas Street
Harmon, Guam 96911 671-646-8863

PR UST/LUST CONTACT[1]
Water Quality Control
Environmental Quality Board
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Commonwealth of Puerto Rico
Santurce, Puerto Rico 00910
809-767-8109

VI UST/LUST CONTACT[1]
Environmental Protection Division
Dept. of Planning and Natural Resources
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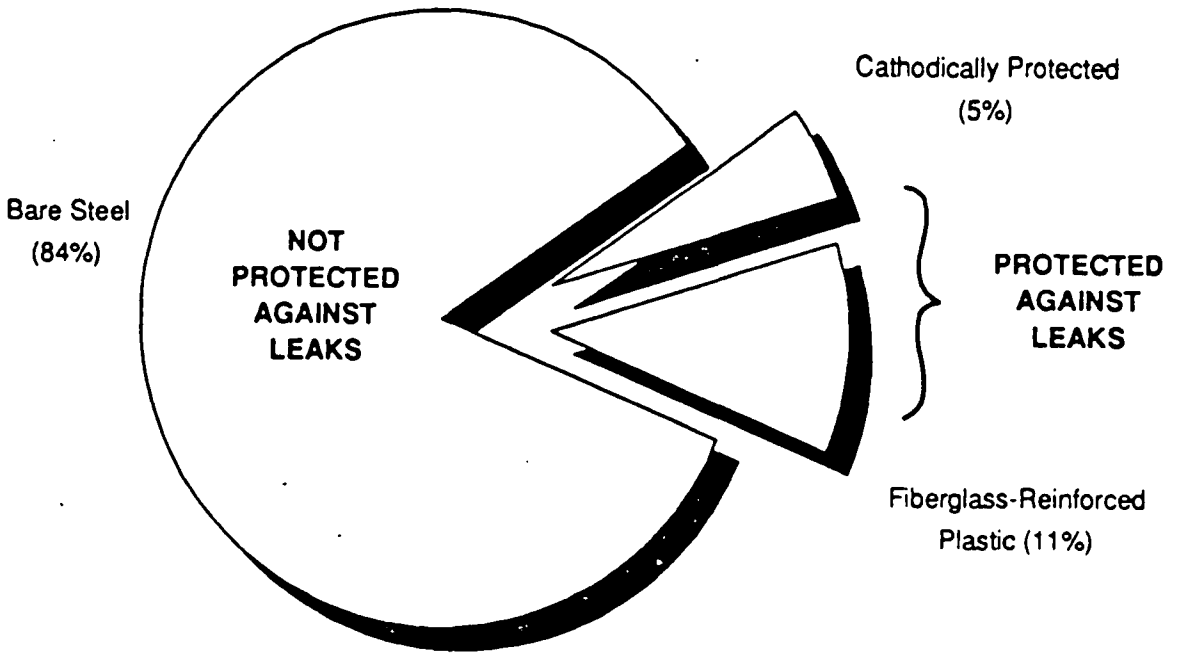
45A Estate Nisky
Charlotte Amalie
St. Thomas, Virgin Islands 00802
809-774-3320

1 = State has 1 person serving as both the UST and LUST Contact.
2 = State has 1 UST and 1 LUST Contact; both have the same address and telephone number.

SLIDE I-3

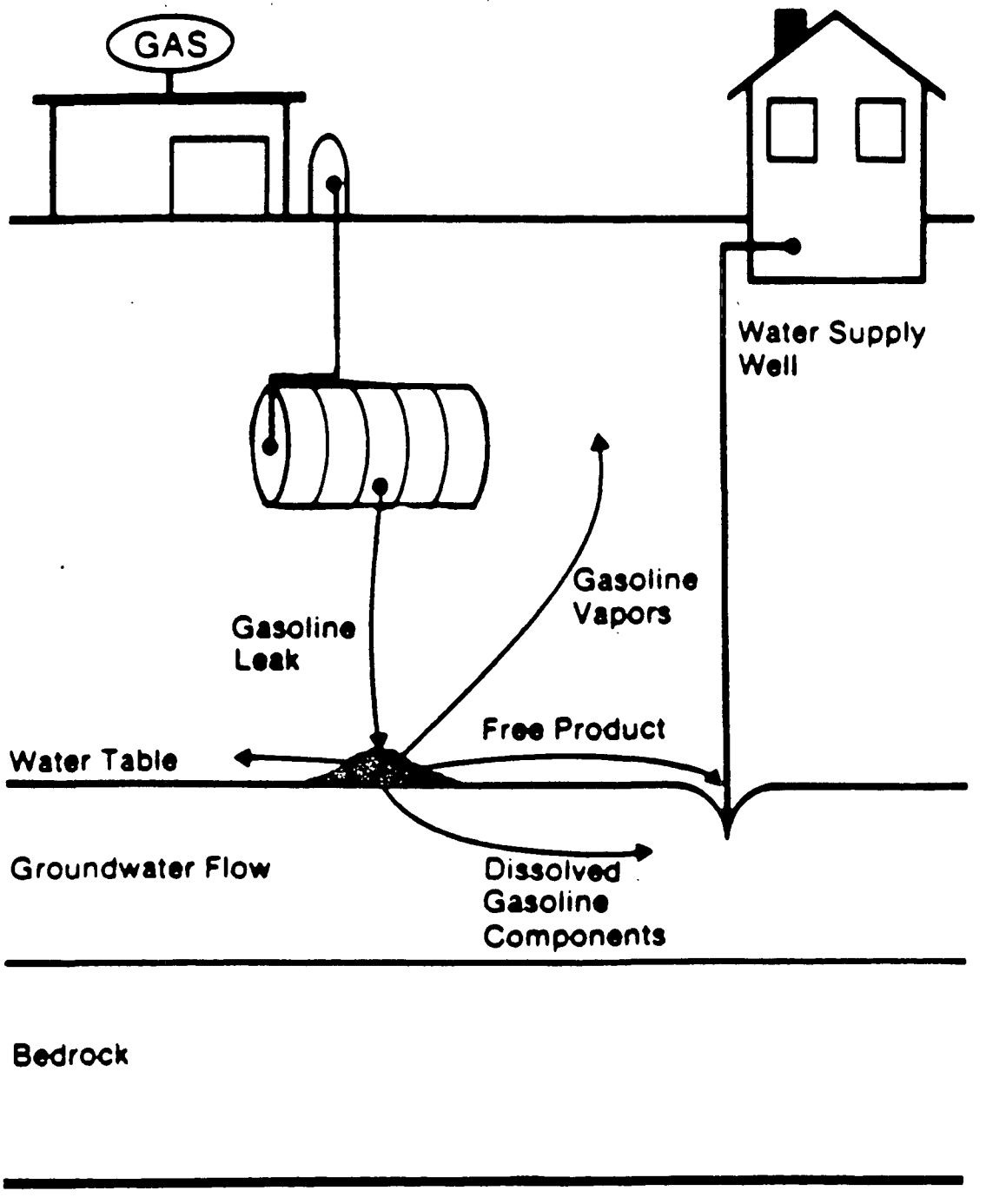
DISTRIBUTION OF TANK TYPES AT GASOLINE SERVICE STATIONS



Source: *Regulatory Impact Analysis. August 24, 1988.*

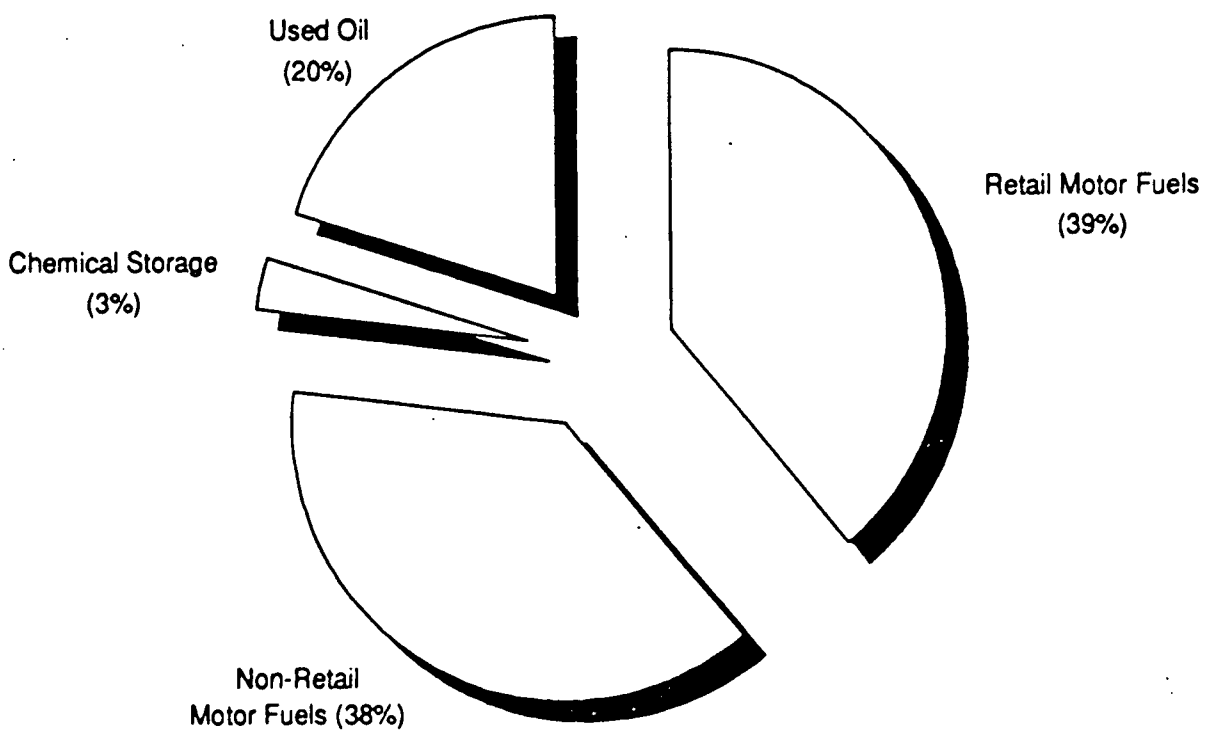
SLIDE I-7

WHERE RELEASED PRODUCT TRAVELS



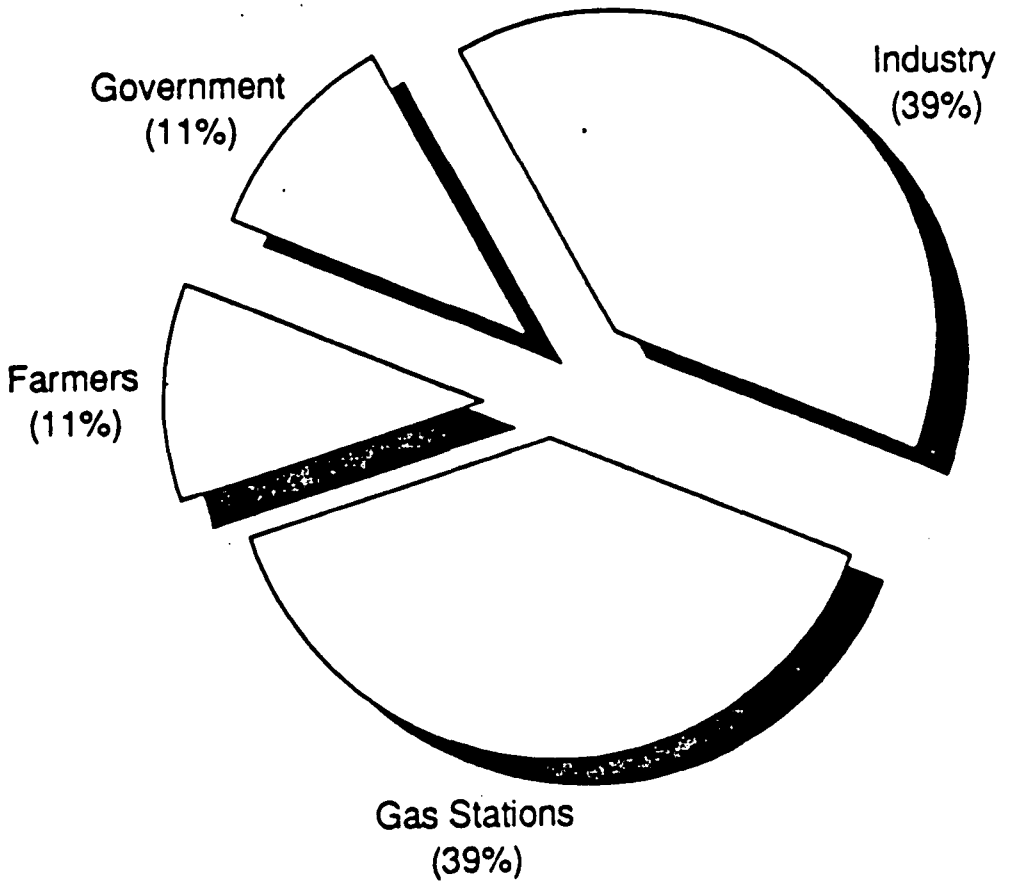
SLIDE I-8

USES OF REGULATED USTs



SLIDE I-9

OWNERSHIP OF USTs USED TO STORE PETROLEUM



CHAPTER TWO

UST WALK-THROUGH

This chapter will walk you through an underground storage tank (UST) system, including the tanks, the piping systems, and the product dispensers. The chapter will also introduce frequently used site terminology, such as excavation zone and water table. This information will serve as a background for following chapters on site characteristics and leak detection methods for tanks and piping systems.

Lecture Notes	Student Notes
Understanding the different parts of an UST system allows you to better evaluate the leak detection requirements and the various leak detection methods available. This chapter describes a typical UST system and each of its major components.	**Slide 1:**
I. WHAT IS AN UST?	**Slide 2:**
◂ Underground Storage Tank (UST) refers to a system storing petroleum products or hazardous substances. An UST system for motor fuel includes the tank(s), piping, and product dispensers. At least 10 percent of the combined volume of the tank(s) and associated piping must be underground for the system to be considered an UST system.	**Slides 3 and 3A (graphic and photo):**
Although multi-tank service station USTs are among the most common tank systems, and provide the basis for this course, it is important to recognize that there are several other systems, including used oil tanks, single-tank systems, farm tanks, and tanks without piping.	
◂ With the following exceptions, underground tanks must comply with Federal UST regulations:	**Slide 4:**
-- Farm or residential tanks of 1,100 gallons or less storing motor fuel for noncommercial purposes;	
-- Tanks storing heating oil for consumptive use on the premises where stored;	
-- Tanks holding 110 gallons or less;	

Lecture Notes	Student Notes
– Tanks on or above the floor of underground areas, such as basements or tunnels; – Septic tanks and systems for collecting storm water and wastewater; – Flow-through process tanks; – Emergency spill and overfill tanks; and – Surface impoundments, ponds, pits, or lagoons.	**Slide 5:**

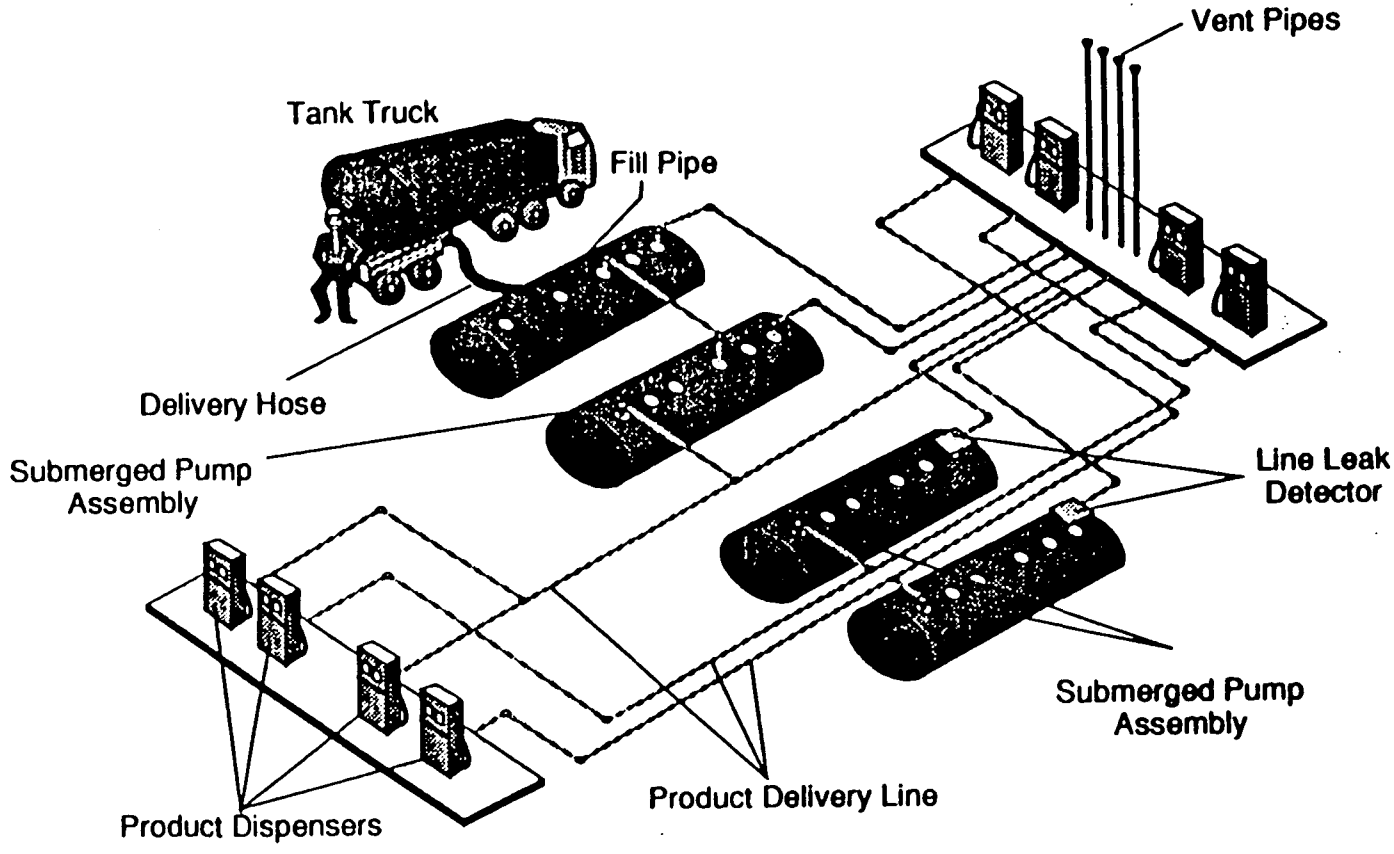
Lecture Notes	Student Notes
II. UST SYSTEM PARTS	
A. Tanks	**Slide 6:**
1. Typical retail tanks have a capacity of 2,000 to 12,000 gallons.	**Slide 6A (photo):**
– Older tanks typically hold 2,000-6,000 gallons.	
– Newer tanks generally hold 6,000-12,000 gallons.	
2. New tanks are generally constructed of cathodically protected coated steel, fiberglass-reinforced plastic (FRP), or a steel-fiberglass composite.	**Slide 6B (photo):** **Slide 6C (photo):**
B. Piping	**Slide 6D (photo):**
1. Product delivery lines connect the tanks and product dispensers.	
– Because delivery lines are generally installed near the ground surface and have many connections, leaks often come from delivery lines.	
2. Manifolded piping typically refers to a fueling system in which two or more dispensers are supplied with product via a piping system that is connected to one or more tanks. Manifolded systems have multiple connections and are thus particularly susceptible to piping failures.	
– An example of manifolded piping is a single submersible pump in an UST which supplies three separate dispensers.	

Lecture Notes	Student Notes
3. Vent pipes are routed from the tank to the surface as above-ground vents. – Vent pipes allow product fumes to be vented from the tank into the atmosphere, thus reducing the risk of explosion from volatile fumes under pressure.	**Slide 6E (photo):**
4. Fill pipes usually connect the underground tank to an above-ground fitting where a tank truck connects its transfer hose. – These pipes are used to fill the tank with the product. – Remote fills have the potential to leak.	**Slide 6F (photo):**
5. Vapor recovery lines are pipes that convey petroleum vapors back to the tank truck during off-loading or back to the UST during dispensing of product. In Stage II vapor recovery, there will be twice as much piping in the UST system because pipes run from dispenser back to tank.	**Slide 7:**
C. Product dispensers	
1. A pumping system draws or pushes product through the product delivery lines to a delivery hose, which dispenses the product.	
2. At retail stations, meters attached to product dispensers measure the volume of product dispensed from the UST system.	

Lecture Notes	Student Notes
D. The site 1. Excavation zone is the entire area that must be dug up in order to install an UST. 2. Backfill is any material used to fill in the excavation zone after the tank is in place. – Manufacturers' suggestions should be followed regarding the proper backfill to be used (generally, crushed rock, pea gravel, or sand). 3. Water table is the level where ground water will rest in porous soil conditions under normal atmospheric pressure.	**Slide 8:** **Slide 9 (graphic):** **Slide 10 (Review/Wrap Up):**

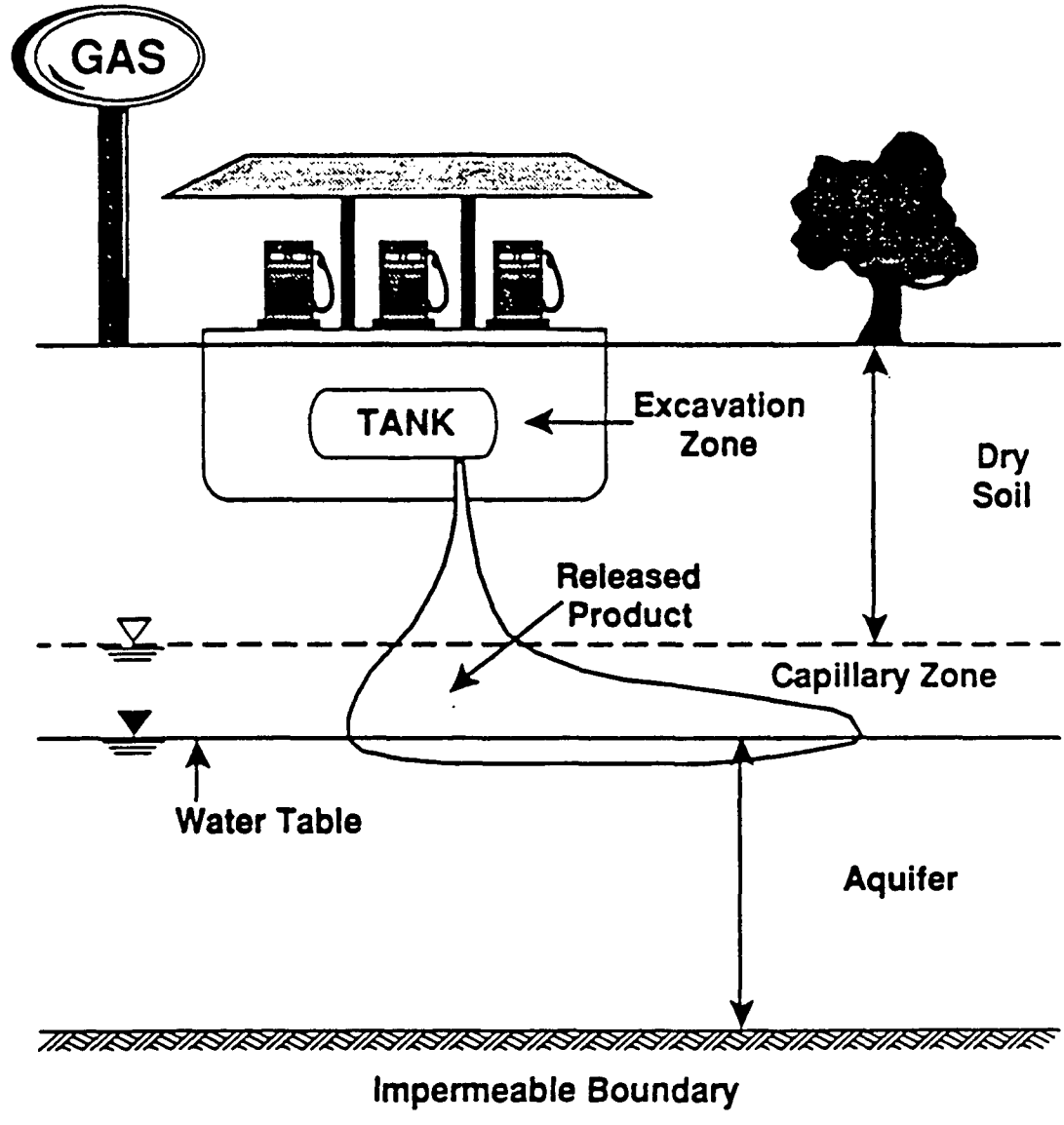
SLIDE II-3

TYPICAL RETAIL GASOLINE STATION



SLIDE II-9

SCHEMATIC OF A SUBSURFACE ENVIRONMENT



CHAPTER THREE

SITE CHARACTERISTICS

What are the important site characteristics that should be considered when selecting the proper leak detection method? This chapter will introduce you to relevant UST system characteristics, product characteristics, soil conditions, climatic factors, and geologic conditions. An understanding of these factors will help you assist UST owners and operators in making a more informed decision about the leak detection methods that can be used with particular UST systems.

Lecture Notes	Student Notes
Choosing the appropriate leak detection method for a particular UST system requires understanding how site characteristics can vary. The basic factors to consider when selecting a leak detection method fall into five groups: I. UST system characteristics; II. Product characteristics; III. Soil conditions; IV. Climatic factors; and V. Geologic conditions.	**Slide 1:** **Slide 2:**

Lecture Notes	Student Notes
I. UST SYSTEM CHARACTERISTICS	**Slide 3:**
A. Tank age (new vs. existing)	**Slide 4:**
1. New tanks are those installed after December 23, 1988. Existing tanks are those installed before December 23, 1988.	
2. Leak detection compliance deadlines differ for new and existing tanks.	**Slide 5 (graphic):**
3. Some leak detection methods can be used only for 10 years after installation of a new UST or upgrade of an existing UST.	
4. Some leak detection methods are better suited for new tanks, while others easily can be incorporated into existing tank systems.	
B. Tank size	**Slide 6:**
1. Certain leak detection methods <u>cannot</u> be used with tanks larger than a specified capacity.	
C. Piping system	**Slide 7:**
1. Types of piping systems	
– Suction piping systems use a vacuum to draw the product from the tank to the dispenser.	
– Pressurized piping systems use a pump at the bottom of the tank to push the product to the dispenser.	
2. Leak detection requirements for piping differ based on the type of piping system used.	

Lecture Notes	Student Notes
D. UST system size	**Slide 8:**
1. Number of tanks -- Some leak detection methods may be better suited or less costly than other methods for systems with many tanks.	
2. Extent of site area -- Some leak detection methods may be more effective or less costly for UST systems that cover a large area.	**Slide 9:**

Lecture Notes	Student Notes
II. PRODUCT CHARACTERISTICS **A. Types of stored product** Stored products fall into two general groups: petroleum products and some hazardous substances. 1. Petroleum products (major types): – Gasoline and blends; – Diesel fuel; – Aviation fuel; – Kerosene; – Heating oil; and – Used oil. 2. Hazardous substances: – CERCLA (Superfund) hazardous substances are subject to UST regulations. For example, ferric chloride, lead iodide, and zinc nitrate are hazardous substances. – CERCLA hazardous substances require secondary containment unless it can be proved that another method will work. *This course does not equip you to determine if other methods are sufficient.* – RCRA hazardous wastes are not subject to UST regulations because they are under different regulations. (See 40 CFR Parts 260-270 for hazardous waste regulations.)	**Slide 10:**

Lecture Notes	Student Notes
B. Characteristics of stored products	
Traits of different products may render certain leak detection methods inappropriate. Important characteristics include:	**Slide 11:**
– Solubility;	
– Density;	
– Viscosity;	
– Volatility;	
– Thermal effects; and	
– Compatibility with tank and piping materials.	
1. Solubility	**Slide 12:**
– Solubility is the ability of a substance to dissolve in or mix with another substance. For example, alcohol mixes more easily with water than oil does.	
– This characteristic is important to know because if the product mixes easily with water, some methods may not easily be able to detect its presence (for example, ground-water monitoring).	
2. Density	**Slide 13:**
– Density refers to the mass of a given substance per unit volume.	
– If the density of the product is higher than that of water, the product may sink beneath the ground-water surface and is not easily detectable. Therefore, ground-water monitoring is not allowed for these substances.	**Slide 14:**

Lecture Notes	Student Notes
3. Viscosity – Viscosity is a measurement of the ease with which a liquid flows (for example, molasses vs. water). – The degree of viscosity varies with changes in temperature. – A product's viscosity may affect which method is suitable (for example, whether tank testing can be conducted, ground-water monitoring is effective, automatic tank gauging can be used).	**Slide 15:**
4. Volatility – Volatility refers to how readily a substance will vaporize. – Volatility of the product may affect the use of certain leak detection methods. For example, a product must vaporize easily if it is to be detected in vapor monitoring wells.	**Slide 16:**
5. Thermal effects – Thermal effects refer to changes in product characteristics that occur in response to an increase or decrease in temperature. – Density, viscosity, and volatility are product characteristics that are affected by temperature. – For example, lower temperatures reduce the volatility of a product. As a result, vapor monitoring can be affected at sites storing a product that does not vaporize well at low temperatures.	**Slide 17:**

Lecture Notes	Student Notes
-- Temperature changes can affect the volume of a product. Monitoring methods that measure volume need to account for changes in volume created by temperature changes. 6. Compatibility -- Compatibility refers to the chemical effects stored products may have on tank materials. -- Certain fuel blends (methanol and ethanol) and hazardous substances may not be compatible with the tank and piping material or tank lining, causing them to degrade. -- A tank owner storing these materials should check with the manufacturer to ensure that they are compatible with the tank and piping.	

Lecture Notes	Student Notes
III. SOIL CONDITIONS: BACKFILL & SURROUNDING SOIL	**Slide 18:**
A. Relative porosity	**Slide 19:**
1. Relative porosity refers to a measurement of the extent to which a material (for example, soil or backfill) contains small spaces through which vapors or liquids can pass.	
2. Higher porosity backfill materials allow product vapors and liquids to pass through with greater ease.	
3. Methods that monitor the environment around the tank for signs of the leaked product require higher porosity backfills. New backfill that meets codes would meet porosity requirements. Older backfill needs to be tested for porosity to gauge whether porosity is sufficient for external methods to detect leaks quickly.	**Slide 20 (graphic):**
B. Hydraulic conductivity	**Slide 21:**
1. Hydraulic conductivity refers to a measurement of the rate at which a liquid (for example, water) can flow through a material such as soil.	
2. Some materials can have high porosities but low hydraulic conductivity; thus, both measurements should be considered.	
3. The presence of backfill materials with low hydraulic conductivity (for example, clay) generally precludes the use of leak detection methods that monitor the environment around the tank and piping.	

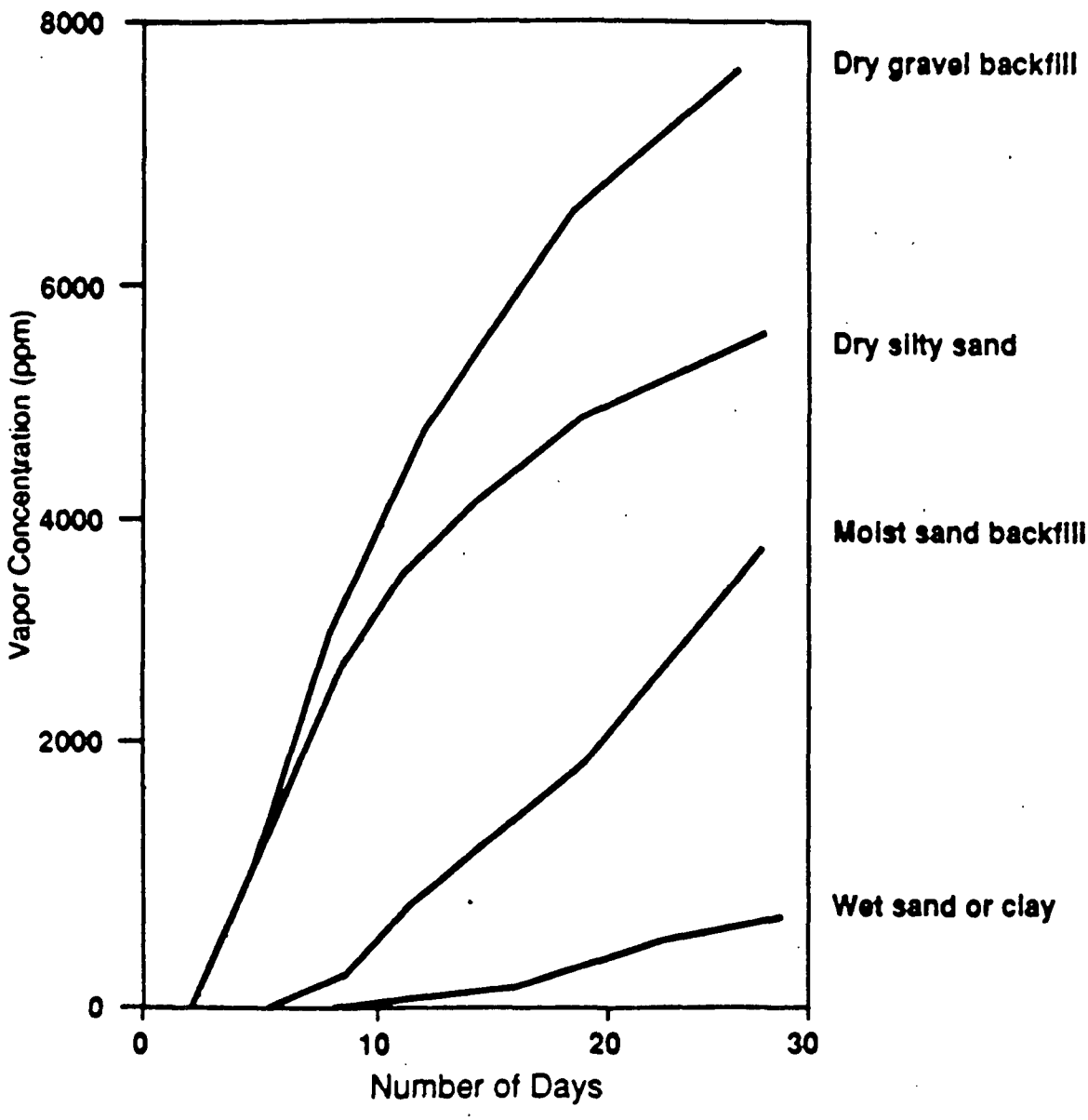
Lecture Notes	Student Notes
C. Contamination 1. Soil or backfill may be contaminated by past releases (for example, leaks, spills, or overfills). 2. Some methods of leak detection would sense this past contamination and inaccurately signal a current leak.	**Slide 22:**

Lecture Notes	Student Notes
IV. CLIMATIC FACTORS **A. Temperature** 1. Extreme temperatures or dramatic changes in temperature may affect the accuracy of certain leak detection methods, and may render other methods ineffective. **B. Rainfall** 1. Sites subject to heavy rainfall may experience significant changes in ground-water levels. -- Fluctuating ground-water levels may affect the accuracy of ground-water monitoring, and vapor monitoring.	**Slide 23:**

Lecture Notes	Student Notes
V. GEOLOGIC CONDITIONS	**Slide 24:**
A. Effects of ground water	**Slide 25:**
1. The level of ground water relative to the tank's product level and the location of the "hole" can affect both the rate and direction of a leak. If ground water is higher than the product level inside a tank, ground water will generally flow into the tank. If the product level is higher than the ground-water level, the product will generally flow out of the tank. By influencing both the rate and direction of a leak, the level and density of ground water relative to the level and density of the product in a tank can mask a leak. To detect leaks in this situation, monitoring devices need to be used that can detect water in the tank.	**Slide 26 (graphic):**
B. Important ground-water variables	**Slide 27:**
1. Depth of water table – The water table depth may affect the accuracy of vapor and ground-water monitoring.	
2. Large fluctuations in the water table levels affect the accuracy of vapor and ground-water monitoring methods.	
3. Gradient of ground-water flow – If the gradient is steep, and the monitoring wells are not properly placed, ground-water flow may bypass the monitoring wells and the release may not be detected.	
	Slide 28:

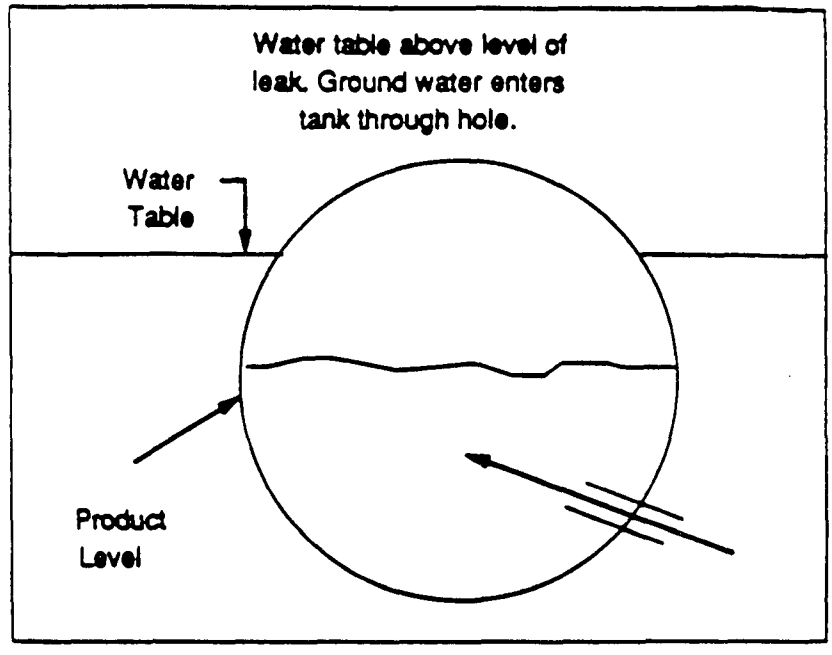
SLIDE III-20

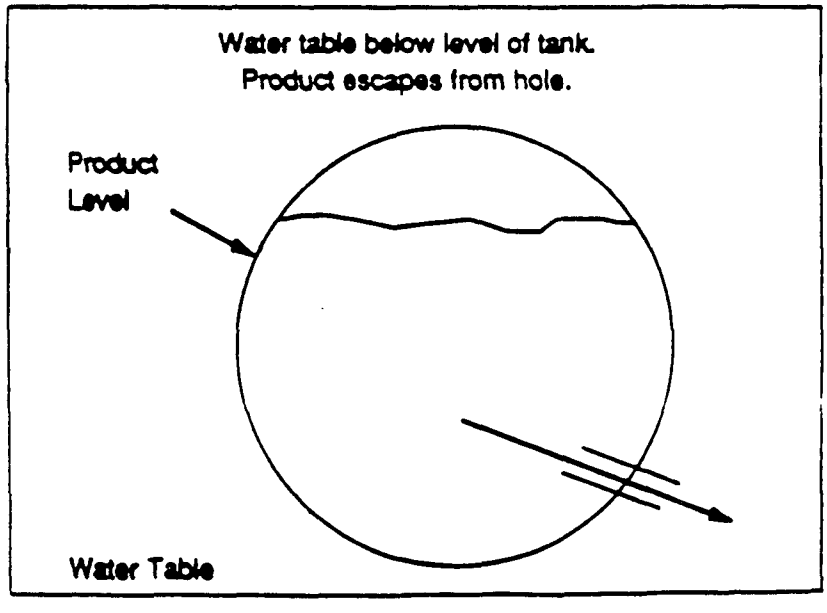
THE EFFECT OF SOIL CONDITIONS ON VAPOR CONCENTRATIONS AT A WELL



SLIDE III-26

THE EFFECT OF GROUND WATER ON THE RATE AND FLOW THROUGH A HOLE IN AN UST





CHAPTER FOUR

LEAK DETECTION METHODS FOR TANKS

How can you assist the owner or operator to select the right leak detection method for a specific UST? This chapter describes several methods that meet the Federal requirements for leak detection. This chapter's descriptions, considerations, and limitations noted for each system can help you assist owners and operators in choosing the best leak detection system for their particular facilities. The chapter is divided into three parts: Part I notes some general leak detection requirements, Part II deals with monthly monitoring methods, and Part III treats the temporary leak detection method of tank tightness testing and inventory control.

Lecture Notes	Student Notes
I. GENERAL LEAK DETECTION REQUIREMENTS	**Slide 1:**
A. Deadlines	**Slide 2:**
◂ 1. New tanks	
	Slide 2A (graphic photo):
– Tanks installed after December 23, 1988, must comply with UST leak detection requirements **when installed.**	**Slide 3:**
◂ 2. Existing tanks	
– Tanks installed before December 23, 1988, must comply with UST leak detection requirements according to the following timetable:	
	Slide 4:

Installation Date	Must Comply By
Before 1965*	December 1989
1965 - 1969	December 1990
1970 - 1974	December 1991
1975 - 1979	December 1992
1980 - 1988	December 1993

* Or if installation date is unknown.

Lecture Notes	Student Notes
B. Leak detection methods allowed	**Slides 5 and 6:**
1. New tanks require one of the following:	
— Monthly monitoring; or	
— Monthly inventory control with tank tightness testing every five years. This option can be used only for ten years after installation.	
2. Existing tanks require one of the following:	
— Monthly monitoring; or	
— Monthly inventory control and annual tank tightness testing. This option can be used only until December 1998; or	
— Monthly inventory control and tank tightness testing every five years. This option can be used only for ten years after a tank has been upgraded with spill/overflow prevention devices and corrosion protection.	
C. Requirements for probability of detection/probability of false alarm (PD/PFA)	**Slide 7:**
1. Some leak detection methods (tank or piping tightness testing, automatic tank gauging systems, statistical inventory reconciliation, and automatic line leak detectors) must be capable of detecting the leak rate or quantity specified for that method with a probability of detection (PD) of 0.95 and a probability of false alarm (PFA) of 0.05.	
There are two PD/PFA compliance deadlines:	
— By December 1990, automatic tank gauging systems, statistical inventory reconciliation, and tightness tests for tanks or piping must meet PD/PFA requirements;	
— By September 1991, automatic line leak detectors must meet PD/PFA requirements.	

Lecture Notes	Student Notes

However, methods permanently installed before the applicable compliance deadline are not required to meet the PD/PFA requirements.

D. Standard test procedures

EPA has developed standard test procedures (also known as protocols) that enable manufacturers of release detection methods and third-party evaluators of those methods to demonstrate that the methods can meet the Federal release detection requirements. Results form these highly technical testing procedures can be summarized on a short form provided with each test procedure. Having summarized test results, manufacturers can distribute the forms to tank owners and State and local regulators, who can use them to verify that the method being described meets EPA's release detection standards.

As of January 1992, EPA has published seven standard test procedures:

— Volumetric tank tightness test methods;

— Non-volumentric tank tightness test methods;

— Automatic tank gauging systems;

— Liquid-phase out-of-tank product detectors;

— Vapor-phase out-of-tank product detectors;

— Statistical inventory reconciliation methods; and

— Pipeline leak detection systems.

Your course instructor can tell you more about these published standard test procedures and how to get copies of them.

Lecture Notes	Student Notes
II. LEAK DETECTION METHODS: MONTHLY MONITORING	**Slide 8:**
Federal regulations describe five acceptable monthly monitoring methods: – Automatic tank gauging systems; – Manual tank gauging; – Secondary containment with interstitial monitoring; – Ground-water monitoring; and – Vapor monitoring.	
The following sections briefly describe each method, discuss the conditions suitable for a method's application, and point out the major factors owners and operators should consider when selecting a method.	**Slide 9:**
A. Automatic tank gauging systems (ATGS)	**Slide 9A (graphic photo):**
1. How ATGS work	**Slide 10:**
Automatic tank gauging systems continuously measure and record product level and temperature within the tank to determine the change in volume over time. If there is a significant loss of volume, then there may be a leak.	**Slide 10A (graphic photo):**
– Each tank is equipped with a probe to measure product level and temperature.	
– Underground wiring connects the tank with a monitor and microprocessor to record data read by probe:	**Slide 11 (graphic):**
- Product level;	**Slide 11A (photo):**
- Water level; and	**Slide 11B (photo):**
- Temperature.	**Slide 11C (photo):**

Lecture Notes	Student Notes
– A leak is indicated if recorded temperature changes cannot account for the measured volume change.	
– ATGS must be able to detect 0.2 gal/h release from any portion of the tank that routinely contains product.	
– ATGS have two modes, and the same equipment performs both operations:	**Slide 12:**
- Inventory control; and	**Slide 13 (graphic):**
- Leak testing.	
a. Inventory control mode	**Slide 14:**
– This mode automatically records activities of an in-service tank, including deliveries.	
- Product level and temperature readings are taken automatically and computer converts them to volume measurements.	
- ATGS operate in this mode whenever leak test mode is not being performed.	
– In most systems, a probe measures water levels in the bottom of the tank and converts to a volume, which is used in inventory control. The probe can also indicate a leak of ground water into the tank.	
– For most ATGS, on-site staff must manually record dispenser information.	

Lecture Notes	Student Notes
– Many systems have alarms to alert on-site staff of: - High and low product levels; - High water levels inside tank; and - Theft.	**Slide 15:**
b. Leak testing mode – Product level and temperature are measured generally at least two hours a month in out-of-service tanks, usually at night. The test can be set to last a given length of time. - The frequency of measurements and length of test is determined by the manufacturer to meet PD/PFA requirements and the regulatory performance standard of 0.2 gal/hr, and are programmed into ATGS. Generally, the longer the test is conducted, the higher the performance level of the test. - Test can be run with any level of product in the tank. - The temperature and product level readings are taken automatically.	**Slide 16:**
2. When automatic tank gauging systems are appropriate a. UST system characteristics – ATGS are used primarily on tanks smaller than 15,000 gallons.	**Slides 17 and 18:**

Lecture Notes	Student Notes
– ATGS cannot be used for piping.	
b. Product characteristics	
– To date ATGS used mostly with gasoline or diesel tanks because service stations have been the primary ATGS users.	
– If other products are to be tested, owner/operator should ascertain that ATGS meets regulatory performance standards when used with that product.	
c. Soil conditions	
– Use of ATGS is not restricted by soil type.	
d. Climatic factors	
– Wait at least six hours between delivery and testing to stabilize temperature differences between added product and product already in tank. The wait time may vary due to climate.	**Slide 19 (graphic):**
e. Geologic conditions	
– If the ground water is high enough to cover a hole in a leaking tank, a leak may be masked and water may enter the tank.	**Slide 20 (graphic):**
– Therefore, ATGS should have water sensors with alarms, so that they can monitor for an increase in water as well as a decrease in the level of product.	**Slide 20A (graphic photo):**

Lecture Notes	Student Notes
3. Considerations -- No product should be delivered to the tank for at least six hours before the monthly test, to allow the temperature to stabilize. -- No withdrawal should be made from the tank for a few hours prior to testing. Withdrawals disturb the stratified layers in the tank, which can lead to inaccurate test results. -- No product withdrawals or deliveries can be made during the monthly test which lasts one to six hours or more, depending on the manufacturers' recommendation. -- ATGS automation reduces time that employees must spend in monitoring leak detection. -- Inventory control and potential off-site monitoring features are attractive to some owners and operators. -- Tanks require a dedicated opening for the ATGS probe, making retrofit difficult in some cases.	**Slides 21 and 22:**
B. Manual tank gauging (MTG) 1. How MTG works MTG is a short-term test in a static (i.e., closed) tank. It cannot be used for tanks larger than 2,000 gallons. a. It differs from inventory control, which requires daily recording of volume in an active tank, and keeping track of additions and withdrawals.	**Slide 23:**

Lecture Notes	Student Notes
b. With MTG, weekly measurements of product levels are taken with a gauge stick inserted in the tank through the fill pipe.	**Slide 23A (photo):**
c. A test is conducted once each week and lasts at least 36 hours.	**Slide 24:**
d. The UST must not be in use between measurements (no product can be added or withdrawn during this test period).	
e. Four measurements must be taken:	
– Two at beginning of the weekly test; and	
– Two at end of the weekly test.	
f. A calibration chart specific to the tank is used to convert product level measurement into product volume.	**Slide 25 (graphic):**
g. The average of the final two measurements is subtracted from the average of the first two to obtain the change in product volume over time.	**Slide 26:**
h. The calculated product volume change is compared to weekly and monthly standards (below, in gallons). If the volume change exceeds these standards, the tank may be leaking. (The monthly figure is a simple average of the weekly measurements.)	**Slide 27:**

Lecture Notes	Student Notes

Tank Capacity (gal.)	Weekly Change (gal.)	Monthly Change (gal.)	Test Duration (hrs.)
Up to 550	10	5	36
551-1,000(64"x73")	9	4	44
1,000(48"x128")	12	6	58
If MTG is combined with TTT:			
1,001 - 2,000	26	13	36

2. When MTG is appropriate

   a. UST system characteristics

   - Only tanks of 1,000 gallons or less can use MTG as the only leak detection method for the life of the tank.

Slide 28:

   - Tanks between 1,001 and 2,000 gallons must combine MTG with tank tightness testing. This combined method can be used only for ten years following new tank installation or upgrade of existing USTs. Tank tightness tests must be performed annually for existing, non-upgraded USTs, and every five years for upgraded and new USTs. (USTs that have not been upgraded cannot use this combined method after December 1998.)

   - Tanks larger than 2,000 gallons cannot use MTG.

   - MTG cannot be used for piping.

   b. Product characteristics

Slide 29:

   - Not restricted to particular fuel types.

Lecture Notes	Student Notes
– Works best with heavier fluids (such as used oil and diesel) because they don't evaporate easily, are less sensitive to temperature changes, and can be seen more easily on the gauge stick.	
c. Soil conditions	
– Use is not restricted by soil type.	
d. Climatic factors	**Slide 30:**
– Ambient (surrounding) temperature changes may affect volume of stored product due to expansion and contraction of liquid. This is one of the reasons the test must last so long.	
– If temperature change is great, the testing period can be lengthened so that the beginning and ending gauge measurements can be taken at the same time of day.	
– Because this method does not account for temperature change, false alarms may occur in areas of extreme temperature variation.	
e. Geologic conditions	**Slide 31:**
– If the ground water is higher than product level in a leaking tank, it can exert pressure that can hide a leak from MTG.	
– Permanently high ground water may render this method inappropriate.	

Lecture Notes	Student Notes
3. Considerations	**Slide 32:**
– UST system must be removed from service at least 36 hours <u>every</u> week.	
– Equipment costs are very low.	
C. Secondary containment with interstitial monitoring	**Slide 32A (graphic photo):**
1. How secondary containment with interstitial monitoring works	**Slide 33:**
Secondary containment involves placing a barrier between the tank and its surrounding environment. The barrier may fully or only partially enclose the UST. Leaks are contained in the space between the tank and its secondary barrier. In addition, interstitial monitoring systems test for presence of released product in the space (interstice) between the tank and its outer containment barrier.	
a. Secondary containment may include:	**Slide 34 (graphic):**
– Concrete vault;	
– Double-walled tank;	**Slide 35 (graphic):**
– Tank with excavation liner; and	**Slide 36 (graphic):**
	Slide 36A (photo):
	Slide 36B (photo):
	Slide 36C (photo):
	Slide 36D (photo):
– Internal bladder.	**Slide 36E (photo):**
	Slide 36F (photo):
	Slide 36G (photo):

Lecture Notes	Student Notes
b. Fully enclosed systems include:	
-- Concrete vaults,	
-- Double-walled tanks, and	
-- Internal bladders.	
c. Partially enclosed systems may include:	
-- Excavation liners.	
-- In areas of heavy rainfall, liners should fully enclose the tank to prevent rainwater from sitting in the backfill and interfering with the monitoring equipment.	
d. Interstitial monitoring methods include:	**Slide 37:**
-- Electrical conductivity methods monitor changes in conductivity by differentiating between petroleum (nonpolar) and water (polar).	**Slide 38 (graphic):**
-- Pressure sensing methods apply either vacuum or pressure to the interstitial space. A leak is detected by changes in pressure.	
-- Liquid sensors detect the presence of a liquid by use of coated fibers or other materials that respond preferentially to liquid in the tank. Alternatively, there may be a pressure switch at the bottom of the interstitial space.	
-- Hydrostatic sensors monitor changes in the level of liquid in the interstitial space.	
-- Manual detection methods use product-finding paste on a dipstick to find liquid product in the interstitial space.	

Lecture Notes	Student Notes
– Vapor monitoring checks for presence of product fumes in the interstitial space.	
2. When secondary containment with interstitial monitoring is appropriate	
a. UST system characteristics	**Slide 39:**
– This method can be used for both tanks and piping.	
- Containment system for piping involves placing liner underneath or around piping to establish interstitial space, assembling a pipe within a larger diameter pipe, and double-walled piping.	
– Double-walled tanks are seldom larger than 20,000 gallons.	
- Larger tanks are very heavy and difficult to ship.	
– Excavation liners may be used around any size tank.	
– Secondary containment is impractical for existing tanks and piping, except when internal bladders are available for existing tanks.	
- Installation for existing tanks and piping requires substantial retrofitting.	
b. Product characteristics	**Slide 40:**
– Use of this method is unrestricted for all fuel types.	
c. Soil conditions	
– Use of this method is not restricted by soil type.	

Lecture Notes	Student Notes
d. Climatic factors	**Slide 41:**
-- This method can be used in all climatic conditions. However, in areas with heavy rainfall, a barrier system which fully encloses the tank should be used to prevent rain from interfering with the monitoring system. A tank liner that only partially encloses the tank may collect water, and therefore is not appropriate.	
e. Geologic conditions	
-- Tanks located in areas with high ground water should use a fully enclosed containment system.	
3. Considerations	**Slides 42, 43, and 44:**
a. Installation of secondary containment using liners requires even more careful attention by professional installers than other leak detection methods.	
b. Containment barrier used must be compatible with product stored.	
-- Exposure to product should not result in deterioration of barrier, which would release product into the environment.	
-- For standard petroleum products, such as gasoline and diesel fuel, most liners sold by reputable firms are compatible with product.	
-- For other products, nature of product and type of barrier must be considered to ensure an appropriate match.	

Lecture Notes	Student Notes
c. If a leak occurs, the barrier provides a degree of protection for surrounding environment against exposure. -- This aspect differentiates this method from others, which detect leaks but do not contain them. -- Lower corrective action costs associated with this method than with other leak detection methods.	
D. Ground-water monitoring 1. How ground-water monitoring works	**Slide 44A (graphic photo):**
Ground-water monitoring detects free product in monitoring wells. The monitoring wells extend from the ground surface to several feet below the lowest water table level. The leaked product travels through the soil and reaches ground-water wells and detection equipment.	**Slide 45:**
a. Monitoring wells -- Generally one to four wells per UST system will adequately detect leaks.	
-- Wells must be placed in, or near, backfill so that they can detect leaks rapidly.	**Slide 46 (graphic):**
-- To intercept free product the well screen must extend from the bottom of well to the highest point of the water table surface.	**Slide 47 (graphic):**
-- On-site staff must check wells at least monthly for presence of free product.	**Slide 48 (graphic):**

Lecture Notes	Student Notes
b. Manual devices for detecting free product	**Slide 49:**
– Grab samplers (bailers or buckets) collect liquid samples for visual inspection or on-site electronic analysis.	**Slide 50:** **Slide 50A (photo):** **Slide 50B (photo):**
– Chemical-sensitive pastes, attached to a weighted tape measure, are lowered into the well and change color when hydrocarbons are present.	**Slide 50C (photo):**
– Manual devices must be used at least once a month. Additional measurements need to be taken during the month.	
– Manual devices need to be able to detect 1/8 inch of free product.	
c. Automatic devices for detecting free product	**Slide 51:**
– These devices need to be able to detect 1/8 inch of free product.	
– Differential float devices contain two floats:	
- One float reacts only to liquids with density similar to water.	**Slide 52 (graphic):**
- One float responds only to liquids lighter than water.	
- Different float levels will trigger an alarm.	
– Product soluble devices:	**Slide 53 (graphic):**
- These devices are coated with material that degrades when exposed to hydro-carbons.	

Lecture Notes	Student Notes
– Thermal conductivity devices: - These devices measure heat loss when a floating probe contacts certain liquids. – Electrical conductivity devices: - These devices measure changes in electrical resistance that trigger alarms. – Automatic monitoring devices must be operated at least once a month. – Automatic monitoring devices are either permanently installed or placed in the well during each test.	**Slide 54 (graphic):**
2. When ground-water monitoring is appropriate a. UST system characteristics – This method can be used to detect leaks from tanks and piping. – This method may be used on any size tank. For larger systems, more wells are added. – This method may be retro-fitted, but installer must be careful not to puncture tanks or piping.	**Slide 55:**
b. Product characteristics – Product density must be lower than that of water. (Product must float on top of water.)	**Slide 56:**

Lecture Notes	Student Notes
– The product should not mix easily with water. (If it mixes, no free product layer will form.)	
– This method is most commonly used for gasoline and diesel fuels. (Alcohols and water-soluble chemicals are not appropriate.)	
c. Soil conditions	
– If this method is used alone, soil and backfill material between well and UST must be coarse and permeable (for example, sand or gravel) to allow released product to travel to wells.	**Slide 57:** **Slide 57A (photo):** **Slide 57B (photo):**
– Hydraulic conductivity of backfill material and soil between tank and monitoring well should be more than 0.01 cm/sec.	**Slide 57C (photo):**
– If national codes are followed for installation, the above requirements and conditions will have been met.	
d. Climatic factors	**Slide 58:**
– Very low temperatures may interfere with some monitoring devices. Ice can freeze monitors and interfere with product-soluble devices.	
e. Geologic conditions	**Slide 59:**
– Level of ground-water table	
- If this method is used alone, ground water must not be more than 20 feet below the surface.	

Lecture Notes	Student Notes
- Ideally, the ground water should be between 2 and 10 feet from the surface. – Fluctuations in water table level - If water level falls below or rises above the well screen, this method alone becomes insufficient to detect released product. – Gradient of ground-water flow - If the gradient is steep, the product may by-pass the monitoring wells. The most complete coverage would have wells installed on all sides of the site to intercept product and ensure release detection. – Fractures and cavities - Because free product tends to flow through fractures and cavities in the soil, wells that do not intercept these fractures and cavities will not detect free product. 3. Considerations a. Site assessment is required before installation. This involves: – Identification of soil type, ground-water depth and flow direction, and general geology of site.	**Slide 60 (graphic):** **Slide 61:**

Lecture Notes	Student Notes
– Identification of evidence of previous leaks that would falsely indicate a current release.	
b. Simple operation of detection devices.	
– On-site staff must take samples at least once a month.	
c. When installing monitoring wells, it is essential to avoid puncturing tanks or piping for UST or utility lines (such as gas, sewer, water, and electric).	
E. Vapor monitoring systems	
1. How vapor monitoring works	**Slide 62:**
Vapor monitoring systems check for presence of product fumes in the soil or backfill around tank. After a leaked material evaporates, its vapors travel through porous soil, and may be detected by vapor monitoring equipment located in monitoring wells.	
a. This method is operated either automatically or manually.	**Slide 63 (graphic):**
– Automatic systems incorporate a network of sensors that test for presence of vapors in monitoring wells.	**Slide 64 (graphic):**
– Manual monitoring systems collect air samples from wells surrounding tank to determine presence of vapors.	**Slide 65 (graphic):**

Lecture Notes	Student Notes
2. When vapor monitoring is appropriate	**Slide 65A (graphic photo):**
	Slide 65B (graphic photo):
a. UST system characteristics	**Slide 66:**
-- This method can be used for both tanks and piping.	**Slide 66A (graphic photo):**
-- This method can be installed as part of new or existing tanks and piping.	**Slide 66B (graphic photo):**
b. Product characteristics	**Slide 66C (graphic photo):**
-- Vapor monitoring must be used with products that vaporize readily. For example, gasoline, diesel fuel, and aviation fuels are appropriate, but fuel oils No. 4 or No. 6 are not.	**Slide 67:**
c. Soil conditions	**Slide 68:**
-- The backfill and soil around the tank must be porous enough to allow the vapors to reach the monitoring wells.	
-- For example, sand and gravel are porous materials. Clay is not porous and should not be used as backfill.	
-- Backfill and nearby soil must be clean and should not contain substances that will produce vapors.	**Slide 69 (graphic):**
-- Previously contaminated soil may lead to false readings, indicating releases.	
d. Climatic factors	
-- Temperature affects the volatility of released product. Sensors may need to be adjusted for extreme temperatures.	**Slide 70:**

Lecture Notes	Student Notes
F. Statistical Inventory Reconciliation (SIR) The five monthly monitoring methods described so far were all identified in the Federal regulations that became effective in December 1988. The regulations provided, however, that other release detection methods could be approved in the future if those methods could meet EPA's performance standards for release detection. In June 1990, EPA published a standard test procedure for an additional release detection method that is known as Statistical Inventory Reconciliation (SIR). SIR methods must be evaluated using EPA's standard test procedure or an equivalent procedure to prove they can meet EPA's release detection performance standards.	
1. How SIR works Statistical inventory reconciliation (SIR) analyzes inventory, delivery, and dispensing data collected over a period of time to determine whether or not a tank system is leaking.	**Slide 73A:**
a. Each operating day the operator measures the product level using a gauge stick or other tank level gauge. A calibration chart specific to the tank is used to convert product level into product volume.	
— The operator also keeps complete records of all withdrawals from the UST and of deliveries to the UST.	
— After data have been collected for the period of time required by the SIR vendor, this information is provided to the SIR vendor.	
b. The SIR vendor uses sophisticated statistical software to conduct a computerized analysis of the data that can identify if the UST is leaking.	
c. Every month, the SIR vendor reports the results of the analysis to the operator, who keeps monthly reports on file for at least 12 months.	

Lecture Notes	Student Notes
d. The Federal requirements for monthly release detection are met if the SIR analysis is performed every month, is capable of detecting release rates of at least 0.2 gallons per hour (with a probability of detection of 0.95 and a probability of false alarm of 0.05), and the monthly results are available at the UST facility. State and local requirements can be more restrictive.	**Slide 73B:**
e. Also, SIR can qualify as a tank tightness test if it meets the Federal requirements of detecting release rates of at least 0.1 gallons per hour with a probability of detection of 0.95 and a probability of false alarm of 0.05. (Tank tightness testing is discussed in section III.B below.) State and local requirements can be more restrictive.	
2. When SIR is appropriate	
a. UST system characteristics	**Slide 73C:**
— SIR procedures apply to fueling sites where the required measurements can be taken every operating day. It is not appropriate for unattended facilities, unless the required data can be retrieved remotely.	
— SIR systems may be used on tanks up to the capacity for which an individual SIR system is evaluated. SIR systems are generally not certified for use on tanks larger than 18,000 gallons.	
b. Product characteristics	
— SIR is generally not restricted by product type.	
c. Soil conditions	
— SIR is not affected by soil type.	
d. Climatic factors	**Slide 73D:**
— Changes in climate, especially temperature, affect the data used in SIR, so SIR vendors must take climatic factors into consideration in their procedures.	

Lecture Notes	Student Notes
e. Geologic conditions	
— Ground water around a tank may hide a hole or distort the data to be analyzed by temporarily reducing or preventing the product from leaving the tank. To detect a leak in this situation, the UST operator must check for water at least once a month.	
3. Considerations	**Slide 73E:**
— SIR can be used for tank and piping systems.	
— SIR should not be confused with other release detection methods that also rely on periodic reconciliation of inventory, withdrawal, or delivery data. Unlike manual tank gauging and automatic tank gauging systems (described earlier) or inventory control (described in the following section), SIR uses a sophisticated statistical analysis of data to detect releases. This statistical analysis can only be done by competent vendors of SIR systems.	
— The procedures used by the SIR vendor must be evaluated against EPA's standard test procedures (or an equivalent protocol) to confirm that the procedures are capable of meeting the Federal regulatory requirements regarding the detection of minimum release rates and the probabilities of detection and false alarm.	
— Tank level and meter readings should be taken carefully at the same time each operating day, at a time when no product is being delivered or dispensed. SIR does not require that the tank be out of service for extended periods.	
— Data can be transmitted to the SIR vendor on paper or by using computer modems or diskettes.	**Slide 73F:**
— SIR can identify problems other than leaking systems, such as miscalibrated meters, tilted tanks, and loss resulting from theft.	

Lecture Notes	Student Notes
— SIR requires minimal investment of staff time and equipment costs (usually involving a gauge stick and pastes that help identify product and water levels). The cost of services provided by SIR vendors compares favorably with the cost of other leak detection methods. — State and local governments can place restrictions on the use of SIR for compliance purposes.	

Lecture Notes	Student Notes
III. LEAK DETECTION METHOD: INVENTORY CONTROL & TANK TIGHTNESS TESTING	**Slide 74:**
Inventory control must be combined with tank tightness testing to meet the leak detection requirements. This combined method can be used only during the first ten years following the installation of a new UST or the upgrade of an existing UST. Existing USTs without upgrade cannot use this combined method after December 1998.	**Slide 74A (graphic photo):**
A. Inventory control	**Slide 75:**
1. How inventory control works	
Inventory control is a daily accounting system in which records of input and output of a product are compared to the measured product volume in an UST.	
– Inventory control is only acceptable as a leak detection method when used with periodic tank tightness testing.	
– Volume of product in the tank, deliveries, and sales are recorded daily.	
– Each month the owner or operator balances accounts of deliveries and product sold from the tank with daily volume measurements.	
– This method must be able to detect a monthly loss of 1.0 percent of flowthrough plus 130 gallons.	
– If overage or shortage equals or exceeds 1.0 percent of the tank's flow-through volume plus 130 gallons of product, the UST may be leaking.	

Lecture Notes	Student Notes
a. Daily tank gauging and reconciling	**Slide 76:**
– Each morning and evening (or after each shift) product level is measured with a gauge stick marked to one-eighth of an inch. This procedure should be conducted at regular intervals.	**Slide 76A (photo):**
– A gauge stick is inserted vertically through the fill pipe until it touches the tank's bottom.	**Slide 77:**
- Product-finding paste can be used to highlight the level on the gauge stick.	
– A calibration chart specific to the tank is used to convert product level into product volume. Similarly, water at the bottom of the tank is measured and accounted for in the reconciliation.	**Slide 78 (graphic):**
– Every day, product volume, withdrawals, and deliveries are recorded.	
b. Monthly reconciliation	
– At least monthly, daily data on product volume, and the amounts of product delivered to and withdrawn from the UST are reconciled.	**Slide 79 (graphic):**
– Daily overages and shortages that fluctuate randomly around zero are common for USTs without a leak.	

Lecture Notes	Student Notes
– If monthly overage or shortage is greater than or equal to 1.0 percent of tank's flow-through volume plus 130 gallons of product, the UST may be leaking.	**Slide 80:**
- If this overage or shortage occurs over two consecutive months, the owner or operator must report results to local implementing agency as a possible leak.	
c. Tank stock control	**Slide 81:**
– Dispensing meters must be correctly calibrated to local weights and measure standards to ensure accuracy of inventory control.	
– Product delivery volumes must be verified.	
– Unaccounted for additions and withdrawals (such as spillage or thefts) must be included in the reconciliation.	**Slide 82 (graphic):**
2. When inventory control is appropriate	
a. UST system characteristics	
– Any size tank is appropriate as long as inventory control can meet the performance standard of 1.0 percent of flow-through plus 130 gallons.	**Slide 83:**
– If the tank is not level you will need to create your own tank chart by adding increments of product and reading the corresponding level.	**Slide 83A (photo):**

Lecture Notes	Student Notes
b. Product characteristics	**Slide 84:**
– This method is effective for gasoline and diesel fuel and products that have similar viscosities and thermal properties.	
– If other products are stored, owner/operator should ensure that this method can be used satisfactorily with those substances.	
c. Soil conditions	
– Use is not restricted by soil type.	
d. Climatic factors	
– The ambient temperature should be noted when taking gauge readings. Inventory control is most accurate when performed at same time each day.	**Slide 85:**
– The temperature difference between newly-delivered product and product in tank limits accuracy of inventory control.	
– Temperature increase or decrease causes expansion or contraction of product, and may mask or imitate a leak.	
e. Geologic conditions	**Slide 86:**
– High ground water may interfere with measurement. If water level fluctuates, testing will be able to catch leak only during low water levels.	
– Inventory control may be inappropriate for areas with permanent high ground water.	

Lecture Notes	Student Notes
- If water level is high enough to cover a hole in the leaking tank, it can counteract outward pressure of stored product and mask a leak.	
– A monthly measurement using a gauge covered with water-finding paste must be taken to identify any water at bottom of tank.	
- If water level in the tank is over one-half inch, water must be removed.	
- Water volume should be accounted for in the reconciliation.	
3. Considerations	
a. Inventory control must be combined with periodic tank tightness tests. This combined method can be used for only ten years following installation of new USTs or upgrade of existing USTs.	**Slide 87:** **Slide 88:**
b. This method requires:	
– Daily product gauging;	
– Calibration of meters; and	
– Recording and monthly calculation of overage or shortage compared to total flow-through.	
c. Staff time is required every day, but doesn't require much time. Also, many facilities already practice inventory control.	
d. Small leaks may go undetected for a long period.	

Lecture Notes	Student Notes
e. This method is applicable only to metered storage tanks.	
f. Deliveries must be made through a drop tube that extends to within one foot of the tank's bottom.	
g. Inventory control results can be affected by variation in temperature, theft, tank tilt, and discrepancies in meter calibration, the tank calibration chart used, and delivery overages or shortages.	**Slide 89:** **Slide 90:**
B. Tank tightness testing	**Slide 91:**
Tank tightness testing identifies leaks in closed tank systems and must be performed annually in existing non-upgraded tanks and every five years in new or upgraded tanks. Tank tightness testing must be performed along with inventory control, but this combined method can be used only during the first ten years following installation of a new UST or upgrade of an existing UST. Neither method alone is an acceptable method of leak detection. The two types of tank tightness testing are volumetric and non-volumetric testing.	
1. How tank tightness testing works	
a. Volumetric testing	**Slide 92:**
– Changes in product level or volume in tank over several hours are measured precisely (in milliliters or thousandths of an inch).	**Slide 93 (graphic):**
– Changes in product temperature must also be measured in some methods to account for temperature-induced changes in product volume.	**Slide 93A (graphic photo):** **Slide 93B (photo):** **Slide 93C (photo):** **Slide 93D (photo):**

Lecture Notes	Student Notes
	Slide 93E (photo):
	Slide 93F (photo):
	Slide 94 (graphic):
– Tests are conducted either on partially filled or overfilled tanks.	**Slide 95 (graphic):**
- In a partially filled tank, test is conducted with the product level below the top of the tank. Because product level changes occur in a large surface area, small changes in volume create very small changes in product level.	
- In an overfilled tank test, the tank is filled until the product level reaches the fill tube or a standpipe located above grade. Because product level changes occur in a small surface area, small changes in volume cause large changes in level.	
– A net decrease in product volume during testing indicates a leak.	
b. Non-volumetric testing	**Slide 96:**
– Instead of monitoring for changes in product level or volume, these methods look for some other evidence of a leaking tank.	
– Acoustic testing methods use equipment that "listens" for the sound of air bubbling through a hole or the sound of turbulent product at a hole. This method may not work well where the water table is high or where the tank sits in mud.	

Lecture Notes	Student Notes
– Tracer methods add an easily detected liquid or vapor to the tank. The backfill surrounding the tank is monitored to see if the tracer escapes. c. General details – The test equipment is temporarily installed in the tank, usually through the fill pipe. – The tank must be taken out of service for duration of test. Tests may last 6-12 hours. – Test must be able to detect loss of 0.1 gallon per hour from any portion of tank that routinely contains product. – Some methods require that product in the tank be at a certain level before testing. - The owner or operator may have to add product from another tank on-site or purchase additional product. – If new product is added to tank to prepare it for testing, the test cannot be conducted until the temperature of the tank contents has stabilized. – Tank deformation and temperature in tank must be allowed to stabilize. – If product is added during the test to make fine adjustments in tank volume, tank contents must again be allowed to stabilize before the test can continue.	**Slide 96A (photo):** **Slides 97 and 98 (graphics):**

Lecture Notes	Student Notes
d. Application of test	
– A testing company performs tests.	
– Some methods require tester to make measurements and calculations by hand.	
– Some methods are highly automated and have computerized measurements and analysis.	
2. When tank tightness testing is appropriate	
a. UST system characteristics	**Slide 99:**
– Tightness tests can be used for both tanks and piping.	
– Tightness testing is primarily used for tanks smaller than 15,000 gallons.	
– If tank tightness testing is used for larger tanks, the owner/operator should make sure that the manufacturer or vendor has proof that it will meet the performance standard when used on larger tanks.	
– With automated tank tightness test methods, up to four tanks may be tested at one time.	
b. Product characteristics	
– To date this method has been used primarily in tanks containing gasoline, diesel, and light heating oils.	
– If other products are stored, the owner or operator should ensure that this method can be used satisfactorily with those substances.	

Lecture Notes	Student Notes
c. Soil conditions	
-- In volumetric testing, if the backfill allows the tank to "bulge," one may have to wait longer for tank to stabilize between filling the tank and beginning the test.	**Slide 100:**
d. Climatic factors	
-- In volumetric testing, wait at least six hours between delivery and testing to stabilize temperature differences between added product and product already in tank. The wait time may vary due to climate.	
- Temperature differences could cause differences in densities, which would result in different product capacitances.	
- Very cold weather will cool product in fill pipe. This cooler product drops into the tank, cooling the product below the fill pipe, and creates erroneous readings.	
e. Geologic conditions	
-- Ground-water level must be determined before this method is applied.	
-- Presence of ground water may mask an actual leak or slow the rate at which product is leaking.	
-- If water table is higher than location of hole in leaking tank, ground water exerts pressure on hole.	

Lecture Notes	Student Notes
– Water counteracts pressure exerted on hole by fluid in tank. This condition may mask or slow a leak. – This is particularly important with tank tightness testing due to the length of time between tests. A false reading may not be caught until the next test is performed. – The best methods can compensate for high groundwater levels if these levels are known prior to tank testing.	
3. *Considerations* a. Tightness tests must be used with inventory control method. This combined method can only be used for ten years following new UST installation or upgrade of existing USTs. b. Tank must be taken out of service during a test. c. Access problems may make it difficult to set up test equipment. Tester should be aware of layout of site beforehand. d. Permanent installation of equipment is unnecessary. e. Many different commercial methods are available. f. It is vital that tester follows proper testing methods.	**Slide 101:** **Slide 102:**

Lecture Notes	Student Notes
– Proper installation of double-walled piping is also very important, and requires a professional. – Piping monitoring can often be integrated with the tank monitoring system. – This is the only leak detection method that prevents product from entering the environment, thus reducing potential for cleanup costs.	
B. Ground-water monitoring	**Slide 39:**
1. How ground-water monitoring works a. Use of this method for piping is the same as its use for tanks, with the following exception: – Additional wells will be needed to monitor the area affected by piping.	
2. When is ground-water monitoring appropriate a. UST system characteristics – Can be used to detect leaks from tanks and piping. – May be used on any size piping run. For larger systems, more wells are added. – May be retrofitted. When retrofitting, installer must be cautious not to puncture piping. b. Product characteristics – Density must be lower than that of water. (Product must float on top of water.)	**Slide 40:**

Lecture Notes	Student Notes
– Product should not mix easily with water. (If it mixes, no free product layer will form.)	**Slide 41:**
– Most commonly used for gasoline and diesel fuels. (Alcohols and water-soluble chemicals are not appropriate.)	
c. Soil conditions	**Slide 42:**
– If this method is used alone, soil between well and piping must be coarse and permeable (for example sand or gravel).	
d. Climatic factors	**Slide 43:**
– Very low temperatures may interfere with some monitoring devices. Ice can freeze monitors and interfere with product-soluble devices.	
e. Geologic conditions	**Slide 44:**
– Level of ground-water table must not be more than 20 feet below the surface.	
- Ideally, the ground water should be between 2 and 10 feet from the surface.	
– Fluctuations in water table level	
- If water level falls below bottom of, or rises above the top of, the well screen, this method alone becomes insufficient to detect released product.	
– If there is a steep gradient of ground-water flow, the product may bypass the monitoring wells.	

Lecture Notes	Student Notes
– Because free product tends to flow through fractures and cavities in the soil, wells that do not intercept these fractures and cavities will not detect free product.	**Slide 45 (graphic):**
3. Considerations	**Slide 46:**
– Ground-water monitoring of underground piping can easily be integrated with a tank ground-water monitoring system.	
C. Vapor monitoring	
1. How vapor monitoring works	**Slide 47:**
a. Use of this method for piping is same as its use for tanks, with the following exceptions:	
– Monitoring wells do not need to be as deep as those used for tank monitoring.	
– When used for interstitial monitoring, horizontal slotted tubes at or below piping level may be used rather than conventional vertical wells.	
2. When vapor monitoring is appropriate	
a. UST system characteristics	**Slide 48:**
– This method can be used for both tanks and piping.	
– This method can be installed as part of new or existing tanks and piping.	
– May be retrofitted. When retrofitting, installer must be cautious not to puncture piping.	

Lecture Notes	Student Notes
b. Product characteristics	
– Vapor monitoring must be used with products that vaporize readily. For example, gasoline, diesel fuel, and aviation fuels are appropriate, but residual oil No. 6 (used oil) is not.	**Slide 49:**
c. Soil conditions	
– The backfill around the pipes must be porous enough to allow the vapors to reach the monitoring wells.	**Slide 50:**
– Backfill and nearby soil must be clean and should not contain substances that will produce vapors.	**Slide 51 (graphic):**
- Previously contaminated soil may lead to false readings, indicating releases.	
d. Climatic factors	**Slide 52:**
– Temperature affects the volatility of released product. Sensors may need to be adjusted for extreme temperatures.	
e. Geologic conditions	
– This method cannot be used in areas with heavy annual rainfall, extremely moist climates or high ground water.	**Slide 53:**

Lecture Notes	Student Notes
— The water fills spaces between the soil particles, preventing vapor from travelling through the soil. Vapors may also dissolve in the moisture before reaching the monitors.	
3. Considerations	**Slide 54:**
— Vapor monitoring for underground piping can easily be integrated with a tank vapor monitoring system.	
D. Statistical Inventory Reconciliation (SIR)	
The three monthly monitoring methods described so far were all identified in the Federal regulations that became effective in December 1988. The regulations provided, however, that other release detection methods could be approved in the future if those methods could meet EPA's performance standards for release detection. In June 1990, EPA published a standard test procedure for an additional release detection method that is known as Statistical Inventory Reconciliation (SIR). SIR methods must be evaluated using EPA's standard test procedure or an equivalent procedure to prove they can meet EPA's release detection performance standards.	
Chapter Four described the applicability of SIR to leak detection for tanks. Methods, applications, and considerations of SIR for piping systems are similar to those for tanks.	
1. How SIR works	
Statistical inventory reconciliation (SIR) analyzes inventory, delivery, and dispensing data collected over a period of time to determine whether or not a tank system is leaking.	**Slide 55:**
a. Each operating day the operator measures the product level using a gauge stick or other tank level gauge. A calibration chart specific to the tank is used to convert product level into product volume.	
— The operator also keeps complete records of all withdrawals from the UST and of deliveries to the UST.	

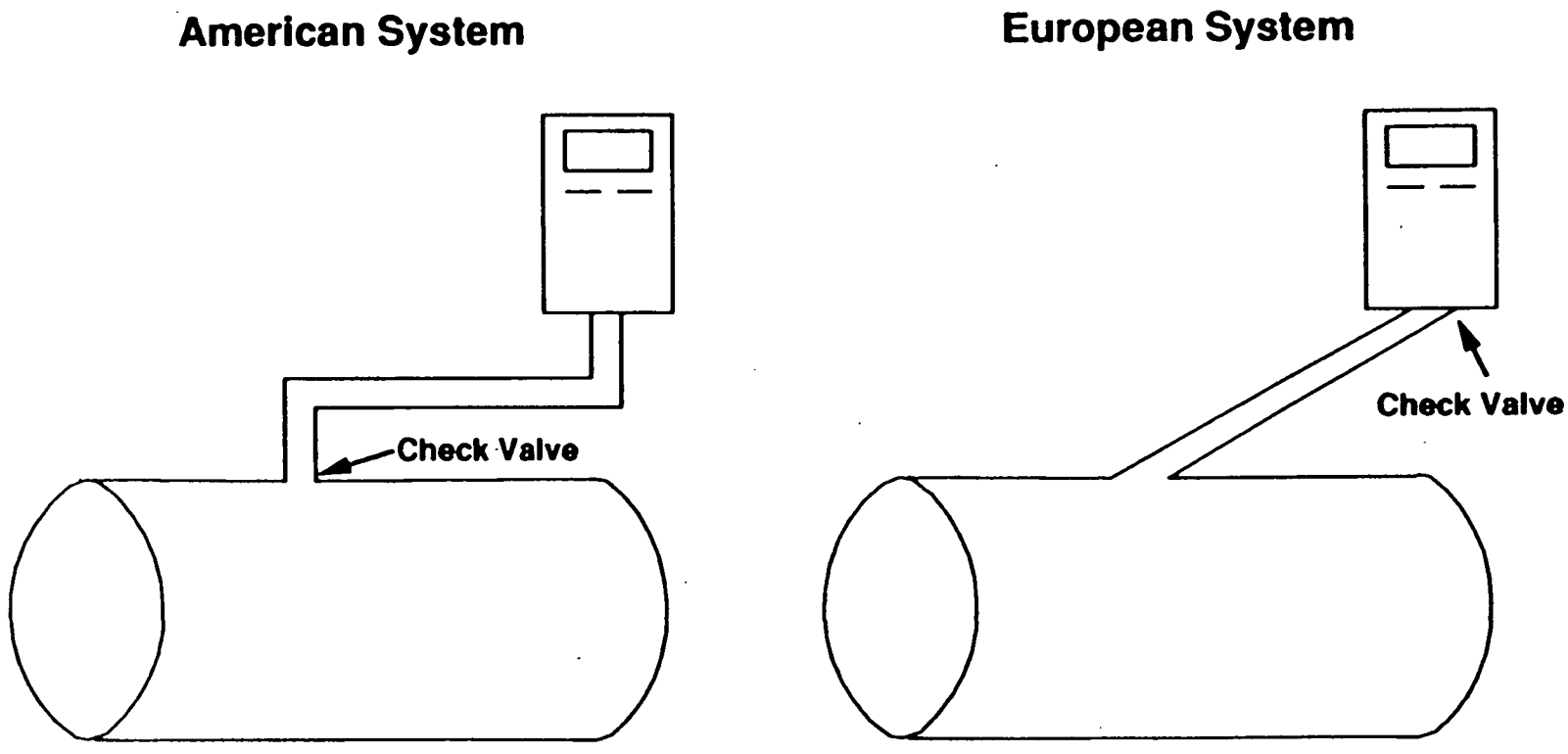
Lecture Notes	Student Notes
— After data have been collected for the period of time required by the SIR vendor, this information is provided to the SIR vendor.	
b. The SIR vendor uses sophisticated statistical software to conduct an analysis of the data that can identify if the UST is leaking.	
c. Every month, the SIR vendor reports the results of the analysis to the operator, who keeps monthly reports on file for at least 12 months.	
d. The Federal requirements for monthly release detection are met if the SIR analysis is performed every month, is capable of detecting release rates of at least 0.2 gallons per hour (with a probability of detection of 0.95 and a probability of false alarm of 0.05), and the results are available at the UST facility on a monthly basis. State and local requirements can be more restrictive.	
2. When SIR is appropriate	**Slide 56:**
a. UST system characteristics	
— SIR procedures apply to fueling sites where the required measurements can be taken every operating day. It is not appropriate for unattended facilities, unless the required data can be retrieved remotely.	
b. Product characteristics	
— SIR is generally not restricted by product type.	
c. Soil conditions	
— SIR is not affected by soil type.	
d. Climatic factors	
— Changes in climate, especially temperature, affect the data used in SIR, so SIR providers must take climatic factors into consideration in their procedures.	

Lecture Notes	Student Notes
e. Geologic conditions	
— SIR for piping is not affected by geologic conditions.	
3. Considerations	
— SIR can be used for tank and piping systems.	**Slide 57:**
— SIR should not be confused with other release detection methods that also rely on periodic reconciliation of inventory, withdrawal, or delivery data. Unlike manual tank gauging, automatic tank gauging systems, and inventory control (described earlier in Chapter Four), SIR uses a sophisticated statistical analysis of data to detect releases. This statistical analysis can only be done by competent vendors of SIR systems.	
— The procedures used by the SIR vendor must be evaluated against EPA's standard test procedures (or an equivalent protocol) to confirm that the procedures are capable of meeting the Federal regulatory requirements regarding the detection of minimum release rates and the probabilities of detection and false alarm.	
— Tank level and meter readings should be taken carefully at the same time each operating day, at a time when no product is being delivered or dispensed. SIR does not require that the tank be out of service for extended periods.	
— Data can be transmitted to the SIR vendor on paper or by using computer modems or diskettes.	**Slide 58:**
— SIR can identify problems other than leaking systems, such as miscalibrated meters, tilted tanks, and loss resulting from theft.	

Lecture Notes	Student Notes
— SIR requires minimal investment of staff time and equipment costs (usually involving gauge stick and pastes that help identify product and water levels). The cost of services provided by SIR vendors compares favorably with the cost of other leak detection methods. — State and local governments can place restrictions on the use of SIR for compliance purposes.	**Slide 59:**

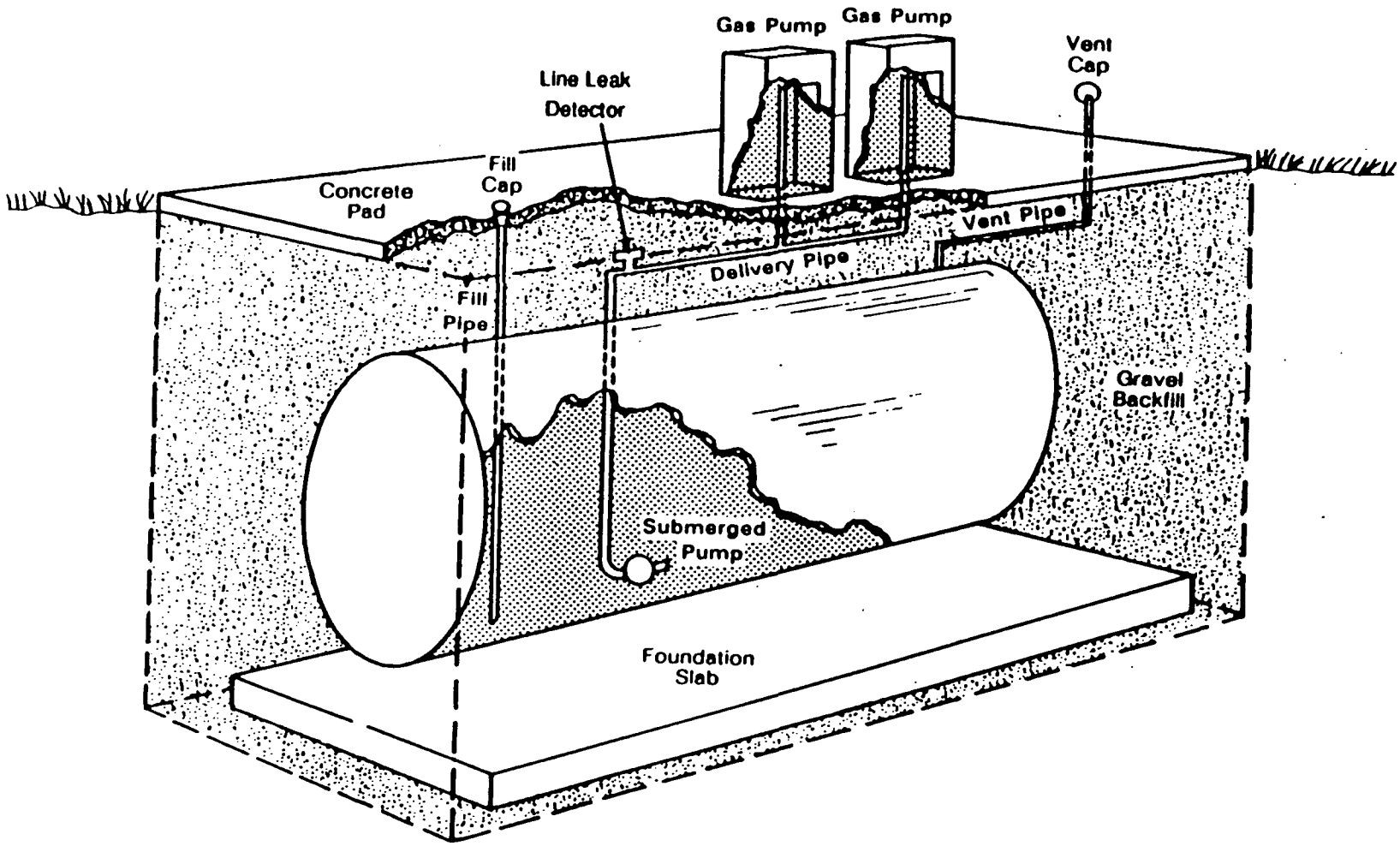
SLIDE V-5

AMERICAN AND EUROPEAN PIPING SYSTEMS WITH CHECK VALVES



SLIDE V-10

PRESSURIZED PIPING SYSTEM



GLOSSARY OF LEAK DETECTION TERMS

Ambient temperature -- Temperature of areas surrounding the tank site.

Atmospheric pressure -- The weight of overlying air at any given location.

Backfill -- The material used to fill in the excavation zone after the tank is in place. The best installation practice is to use sand or gravel as specified.

Check valve -- The valve found in suction piping systems that closes when product begins to flow backwards through the pipe.

Compatibility -- The ability of a tank and piping to be unaffected by stored product.

Contamination -- The remains, liquid or vapor, in soil or backfill of releases at a site.

Density -- The mass of a given substance per unit volume.

DNAPLs -- Dense non-aqueous phase liquids.

Excavation liners -- Flexible sheets of relatively impermeable substances (possibly made of various synthetic materials, such as high-density polyethylene, polyester elastomers, epichlorohydrin, and polyurethane) that separate the UST system and backfill from the native soil of the site.

Excavation zone -- The entire area that must be dug up in order to install an UST.

Fill pipes -- The pipes connecting the underground tank to an aboveground fitting where a tank truck connects its transfer hose.

Free product -- The leaked product floating on the water table surface.

Grab samplers -- The bucket or bailer used to obtain ground-water samples, from monitoring wells.

Hydraulic conductivity -- The measurement of the rate at which a liquid can flow through a particular material, such as soil.

Interstitial space -- The space between the wall of the tank or pipe and the secondary container or lining.

Inventory control -- A comparison of what is actually in the tank, based on measurement, to what should be in the tank, based on records.

Overages -- The amount by which volume measurement exceeds what is expected.

Overfill method -- A method used on tank tightness testing during which the tank is filled until the level of the product reaches the fill tube or a standpipe located above grade.

Performance standard -- The minimum sensitivity of a method as specified in the regulation.

Permeability -- A measurement of the ability of backfill or soil to permit liquids or gases to pass through.

Porosity – The measurement of the extent to which a material contains small spaces through which vapors or liquid can pass.

Positive displacement pump – The pump placed at or near the point of end use on suction piping systems; this pump creates a vacuum which draws product from the tank to the pump.

Pressurized piping systems – These systems use a pump at the bottom of the tank to push the product to the dispenser.

Product delivery lines – The piping that connects tanks and product dispensers (pumps).

Product-finding paste – Paste applied over a gauge stick to improve adherency of the product to the stick and prevent creepage. The pastes change color in the presence of product, and are applied in the area where one expects to see the product line, not on the entire stick.

Remote fill - Piping runs leading to a storage area for wastes, such as used oil, that are generally installed as an afterthought, which therefore, are prone to leaks.

Restrictors – Devices that keep the flow of product from the pump to the point of use below a certain gal/h rate.

Retrofit – The process of upgrading an UST system with new technologies and/or products.

Shortage – The amount that the volume measurement is below what is expected.

Solubility – The ability of a substance to dissolve in or mix with another substance.

Static tank system – A tank that is not in use; no product is added or removed.

Suction piping – The system uses a vacuum to draw the product from the tank to the pump.

Tank deformation – Expansions and contractions of the tank resulting from fluctuating temperatures of product within the tank and from the addition of product to the tank.

Thermal properties – Changes in product characteristics that occur in response to an increase or decrease in temperature.

Underground storage tank (UST) – A system used to store and dispense petroleum products. An UST system includes the tank(s), piping, and product dispensers. At least 10 percent of the combined volume of the tank(s) and associated piping must be underground for the system to be considered an UST system.

Vapor pockets – Vapor that becomes trapped in the manways, deadend piping, etc., after a tank has been filled to or above the top of the tank.

Vapor recovery lines – Pipes that carry vapors back to the tank truck during off-loading, or back to the UST during product dispensing.

Vent pipes – Pipes routed to the surface as aboveground vents.

Viscosity – The measurement of the ease with which a liquid flows.

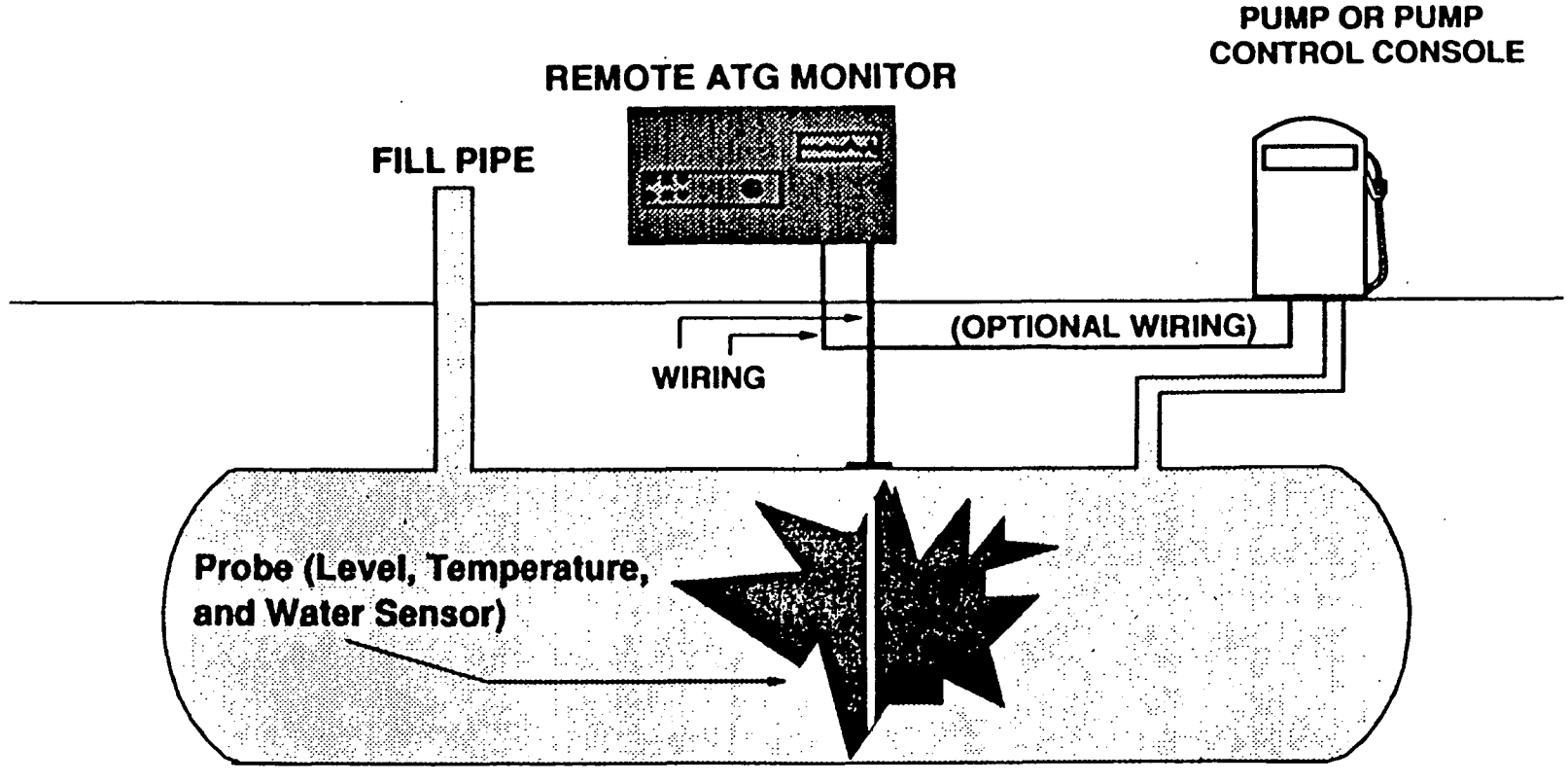
Volatility -- The measurement indicating how readily a substance will vaporize.

Water table -- The level where ground water will rest in porous soil conditions under normal atmospheric pressure.

Well screen -- The perforated or slotted area of a well that allows product to enter the well.

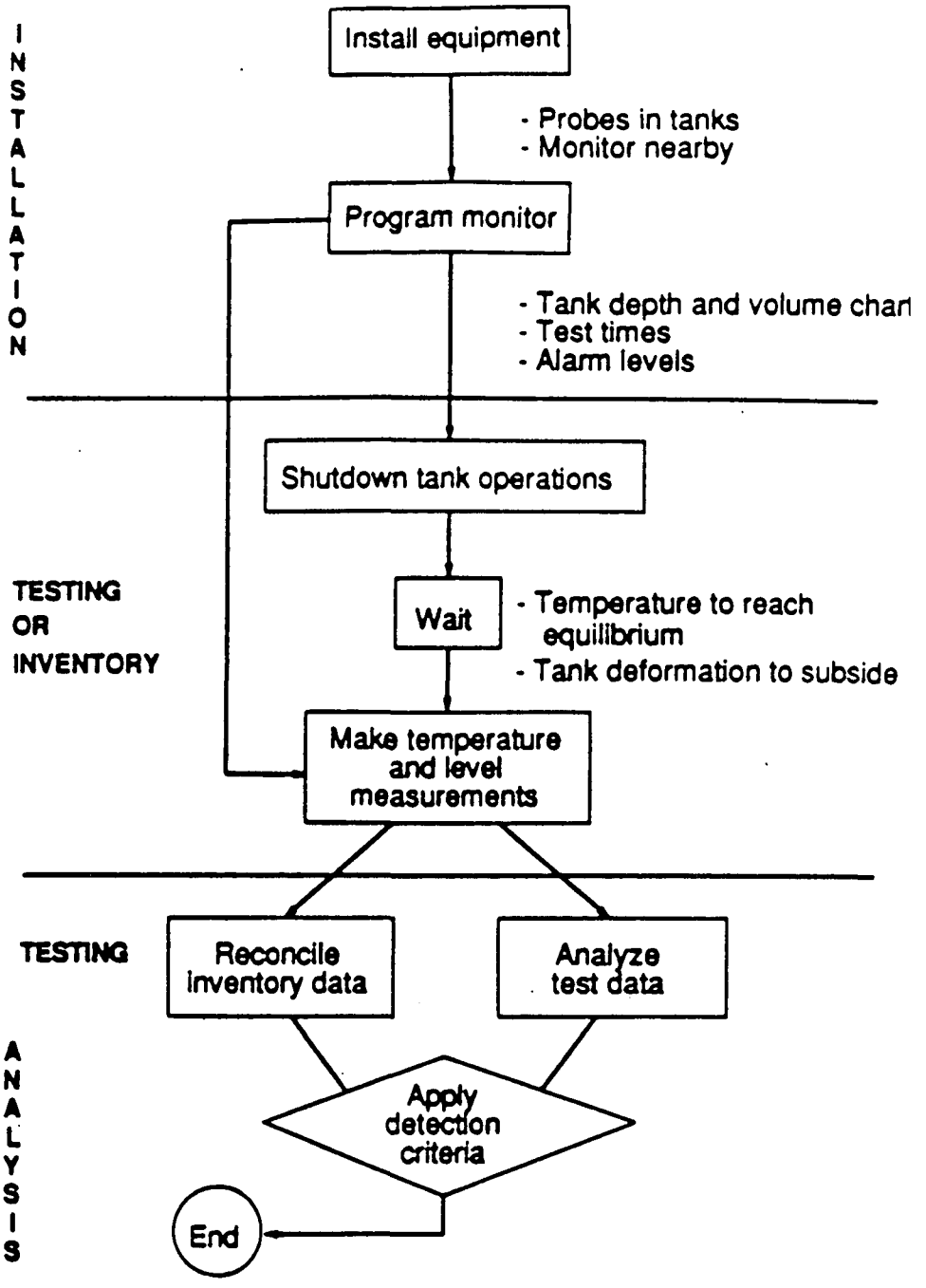
SLIDE IV-11

SCHEMATIC OF AN AUTOMATIC TANK GAUGING SYSTEM



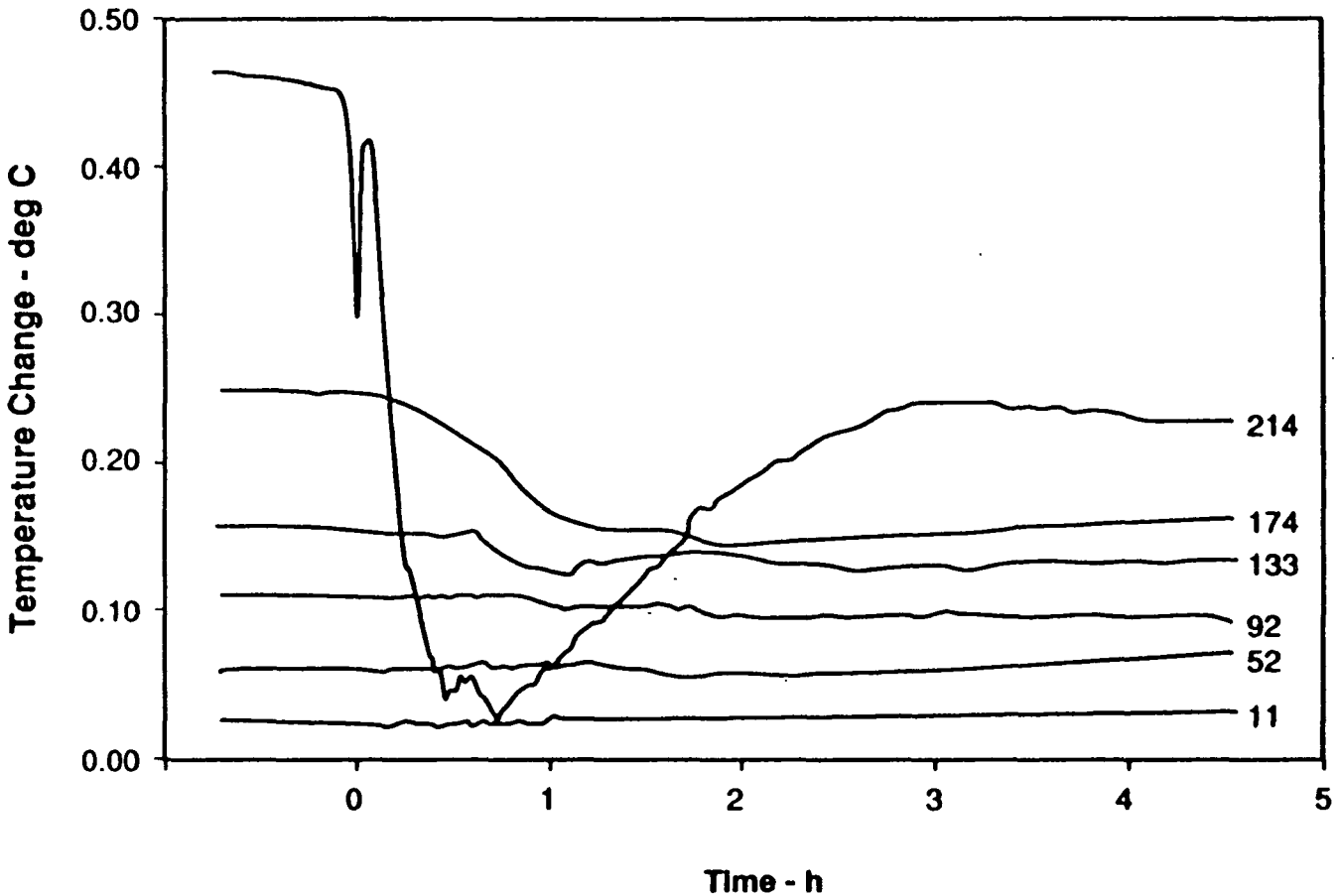
SLIDE IV-13

GENERAL PROCEDURE FOR ATGS



SLIDE IV-19

EFFECT OVER TIME OF TOPPING THE TANK WITH COLDER PRODUCT



SLIDE IV-25

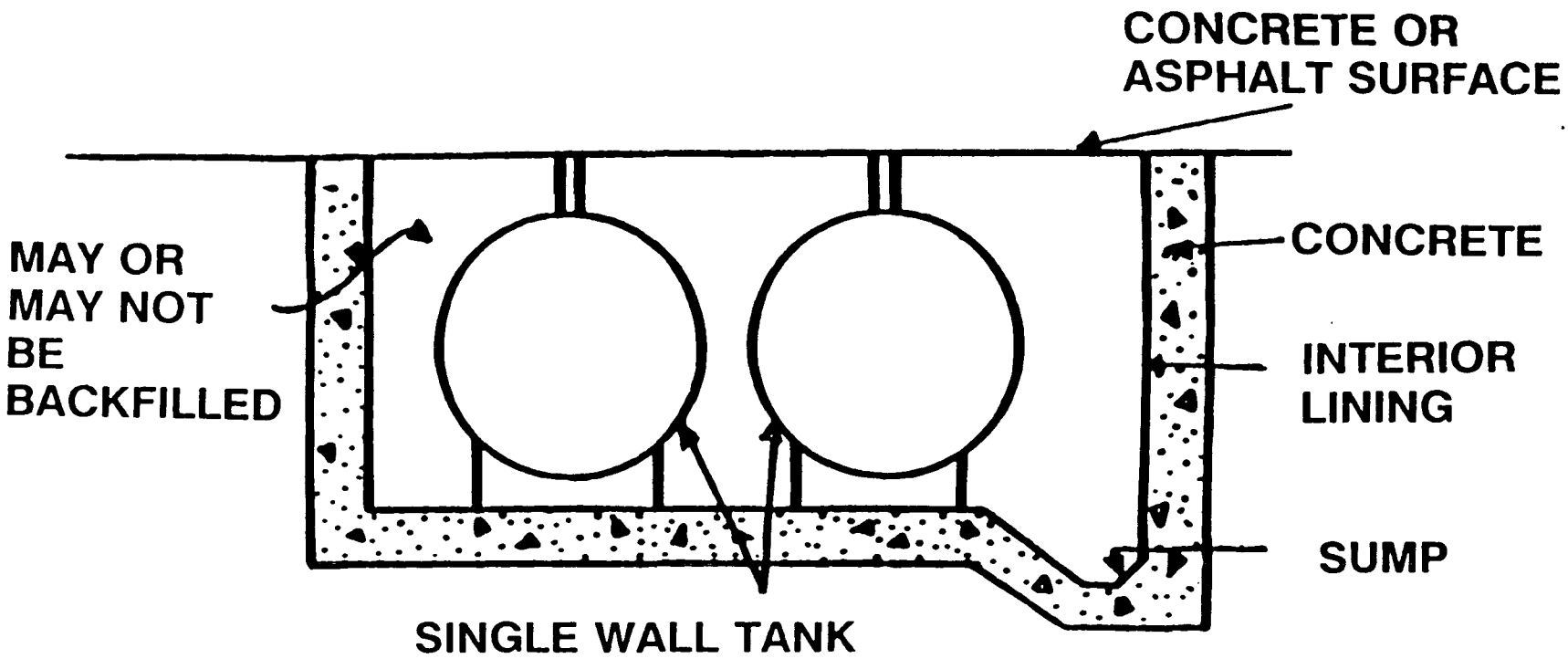
SAMPLE CALIBRATION CHART CONVERTING PRODUCT DEPTH TO GALLONS*

Tank Size / Depth in Inches	550 Gal. 49½" x 5'5"	1000 Gal. 49½" x 10'	1000 Gal. 64" x 6'	1500 Gal. 64" x 9'	2000 Gal. 64" x 12'
1	2	4	3	4	6
2	7	13	9	13	18
3	13	24	17	25	34
4	20	38	26	39	52
5	29	52	36	54	75
6	37	68	47	71	94
7	47	86	59	89	119
8	57	104	72	108	144
9	68	124	85	128	171
10	79	144	100	150	200
11	90	165	114	172	229
12	102	187	130	195	260
13	115	209	145	218	291
14	127	232	162	243	324
15	140	255	178	268	357

* Note that product depth in left column converts to gallons in the other columns.

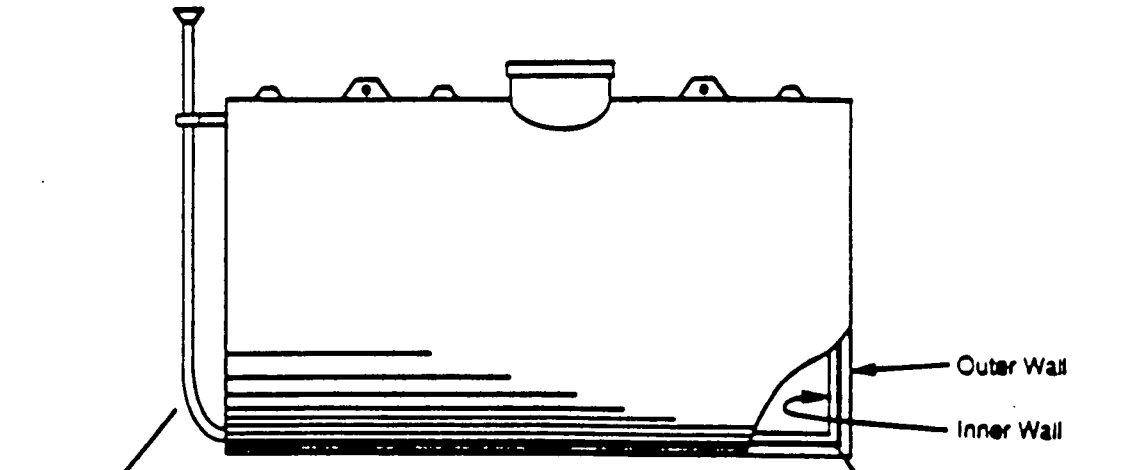
SLIDE IV-34

TANKS IN A CONCRETE VAULT

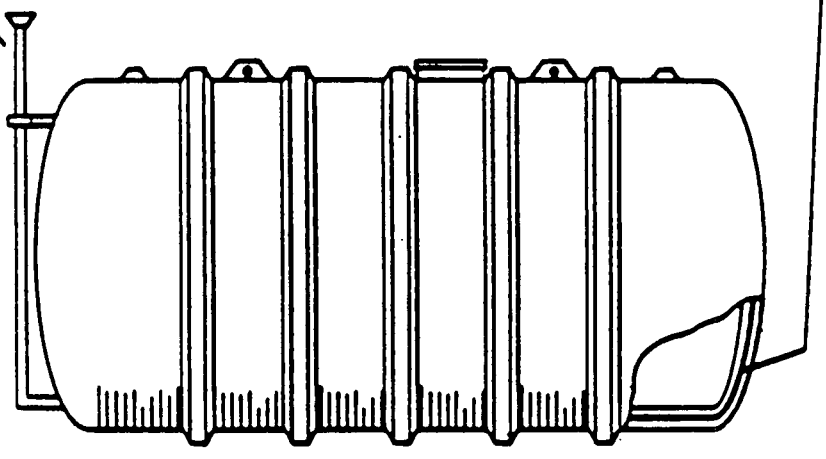


SLIDE IV-35

TWO DOUBLE-WALLED TANK CONFIGURATIONS



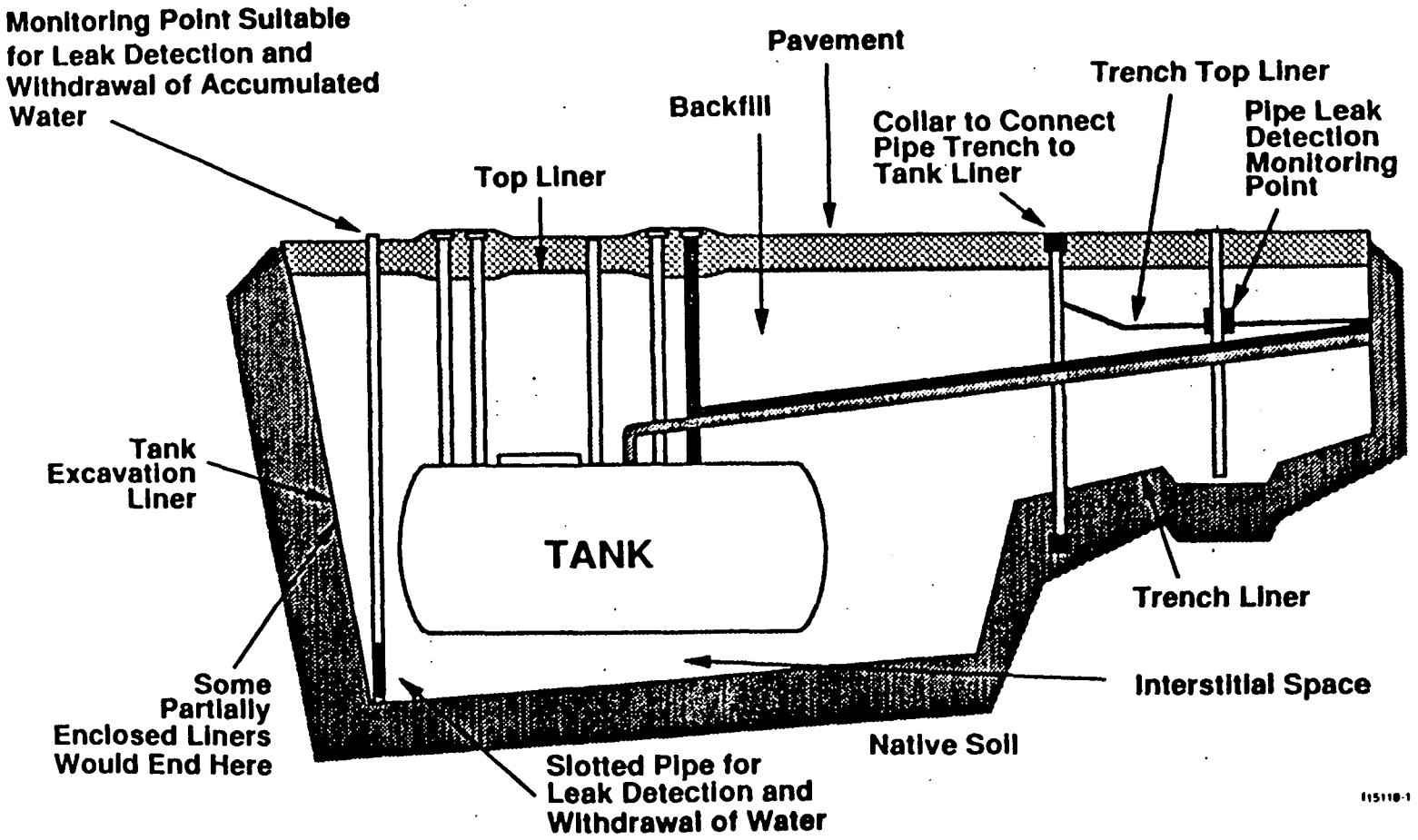
*Double-Walled Steel Tank



*Double-Walled FRP Tank

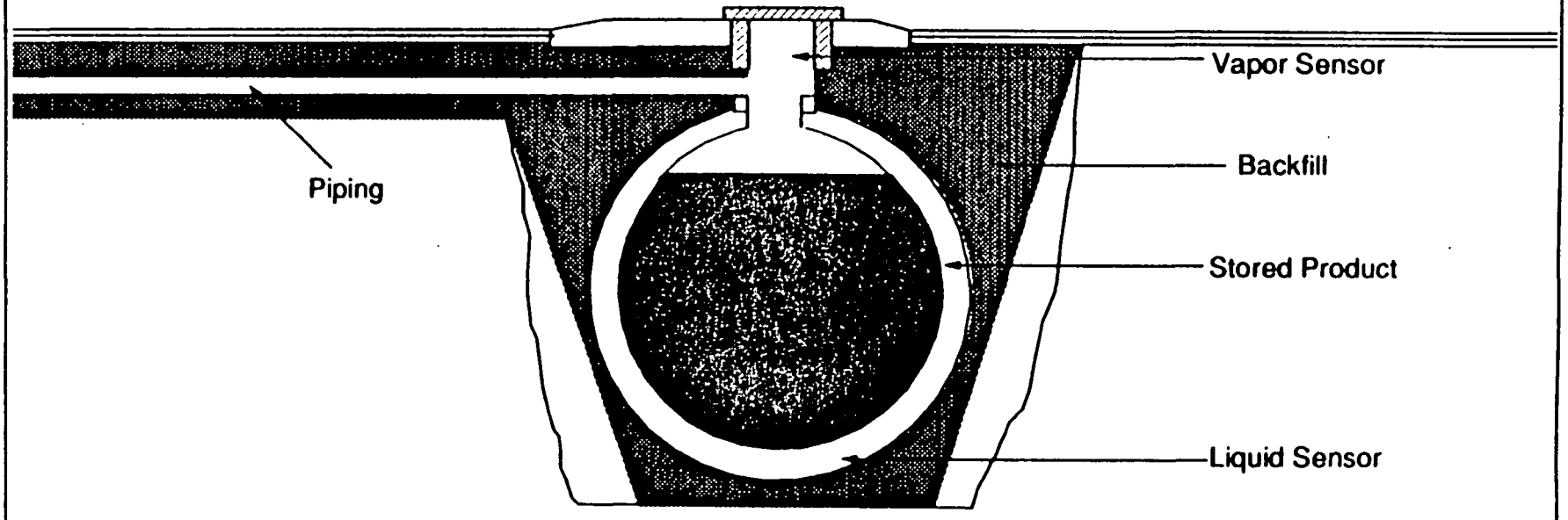
SLIDE IV-36

TANK WITH EXCAVATION LINER



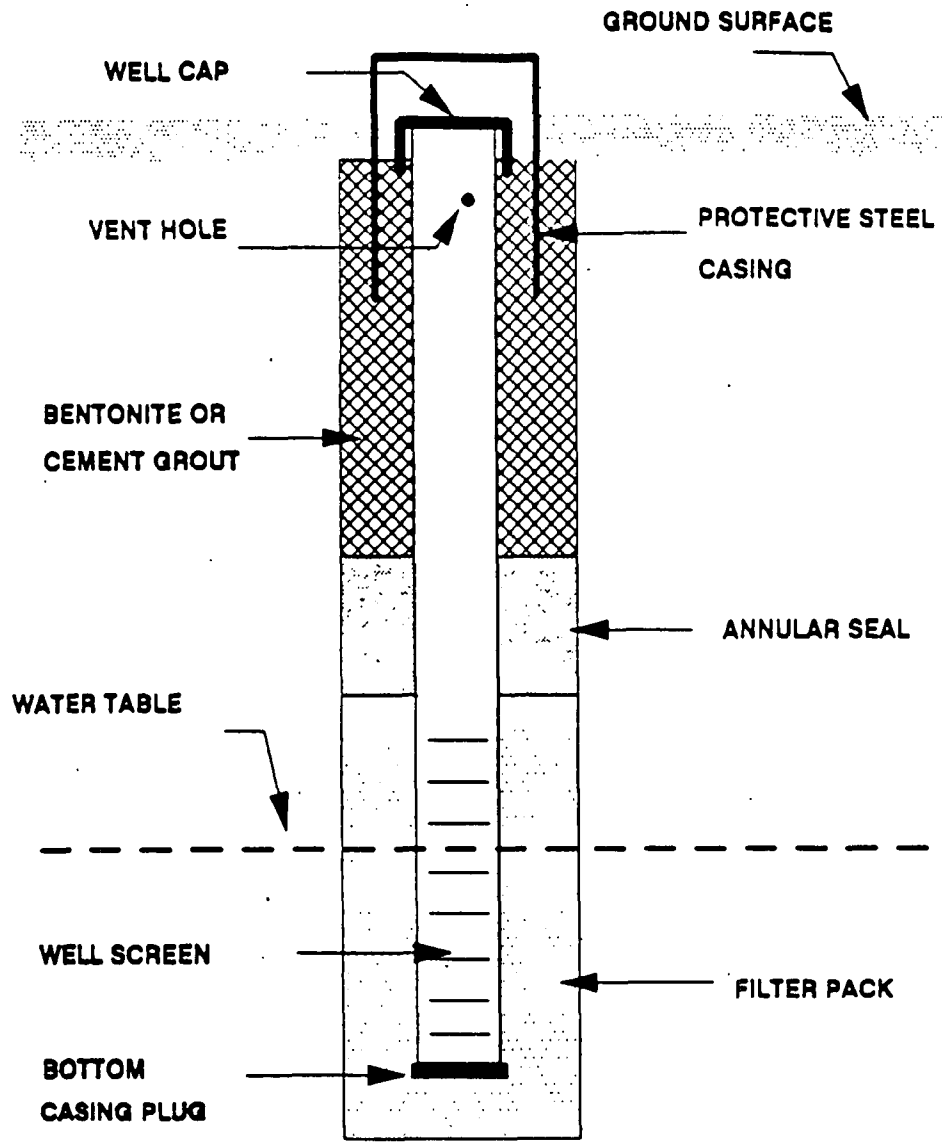
SLIDE IV-38

DOUBLE-WALLED TANK SHOWING PLACEMENT OF BOTH VAPOR AND LIQUID SENSORS



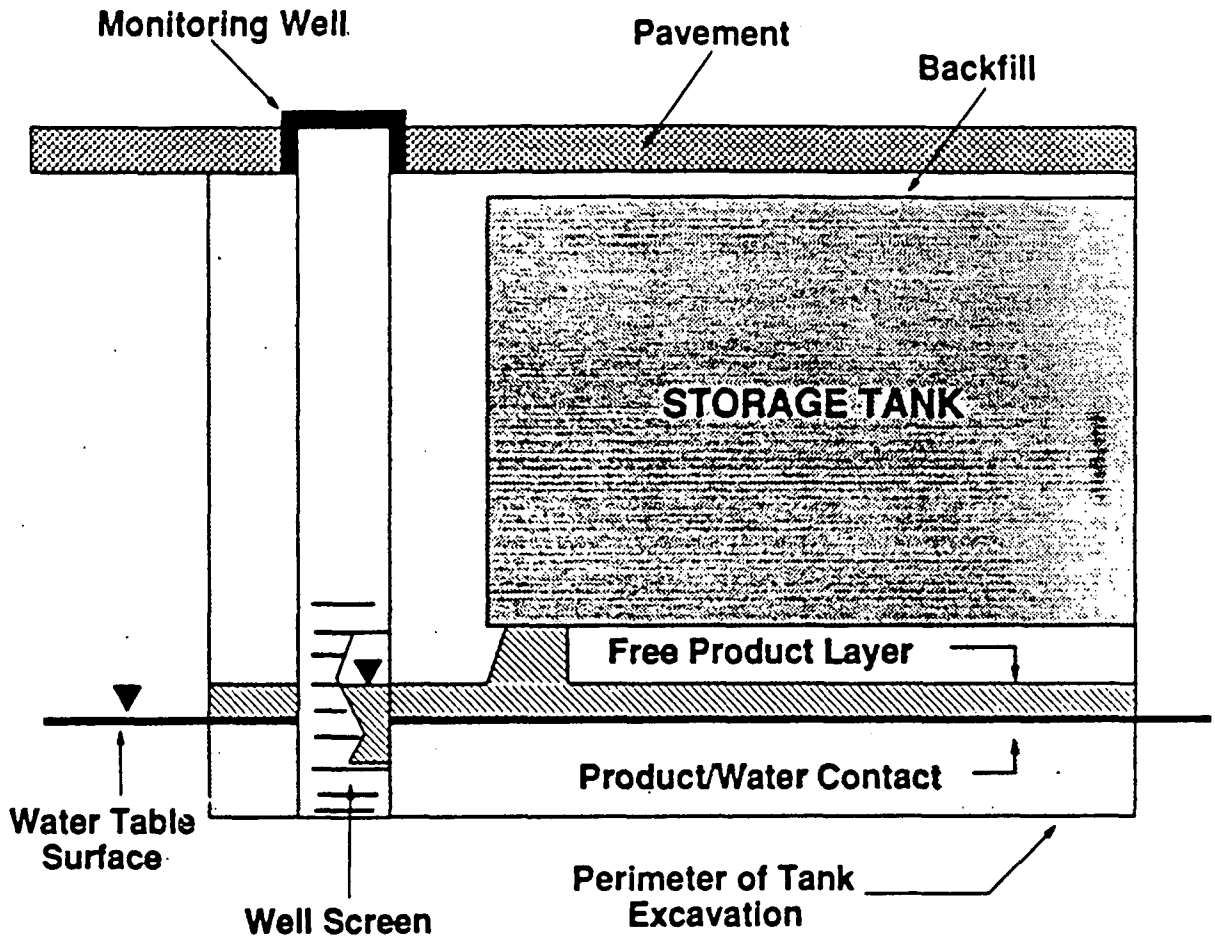
SLIDE IV-46

MONITORING WELLS WITH FILTER PACK



SLIDE IV-47

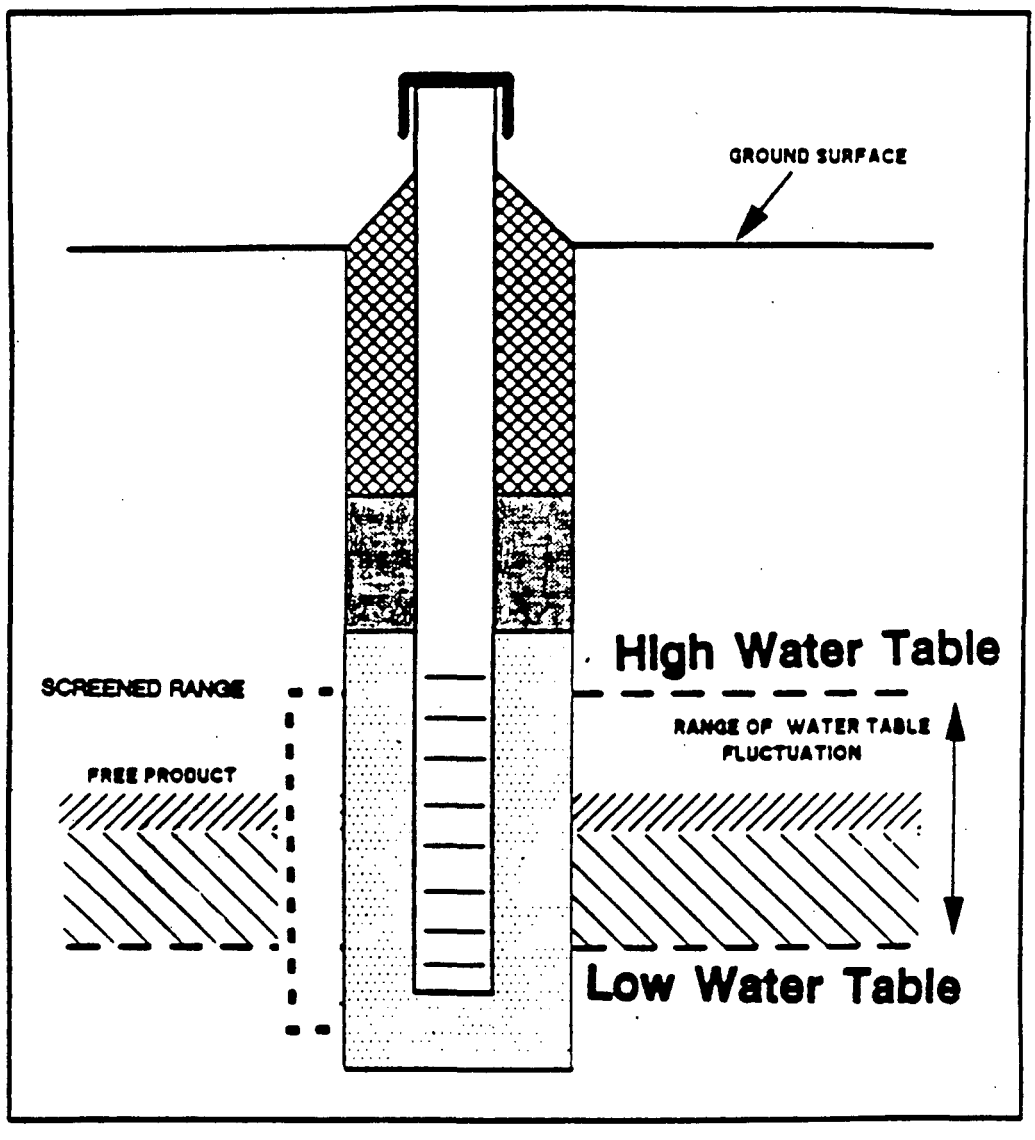
MONITORING WELL IN EXCAVATION ZONE



Monitoring wells installed in the excavation zone will quickly detect a release when the ground water table is within the tank excavation.

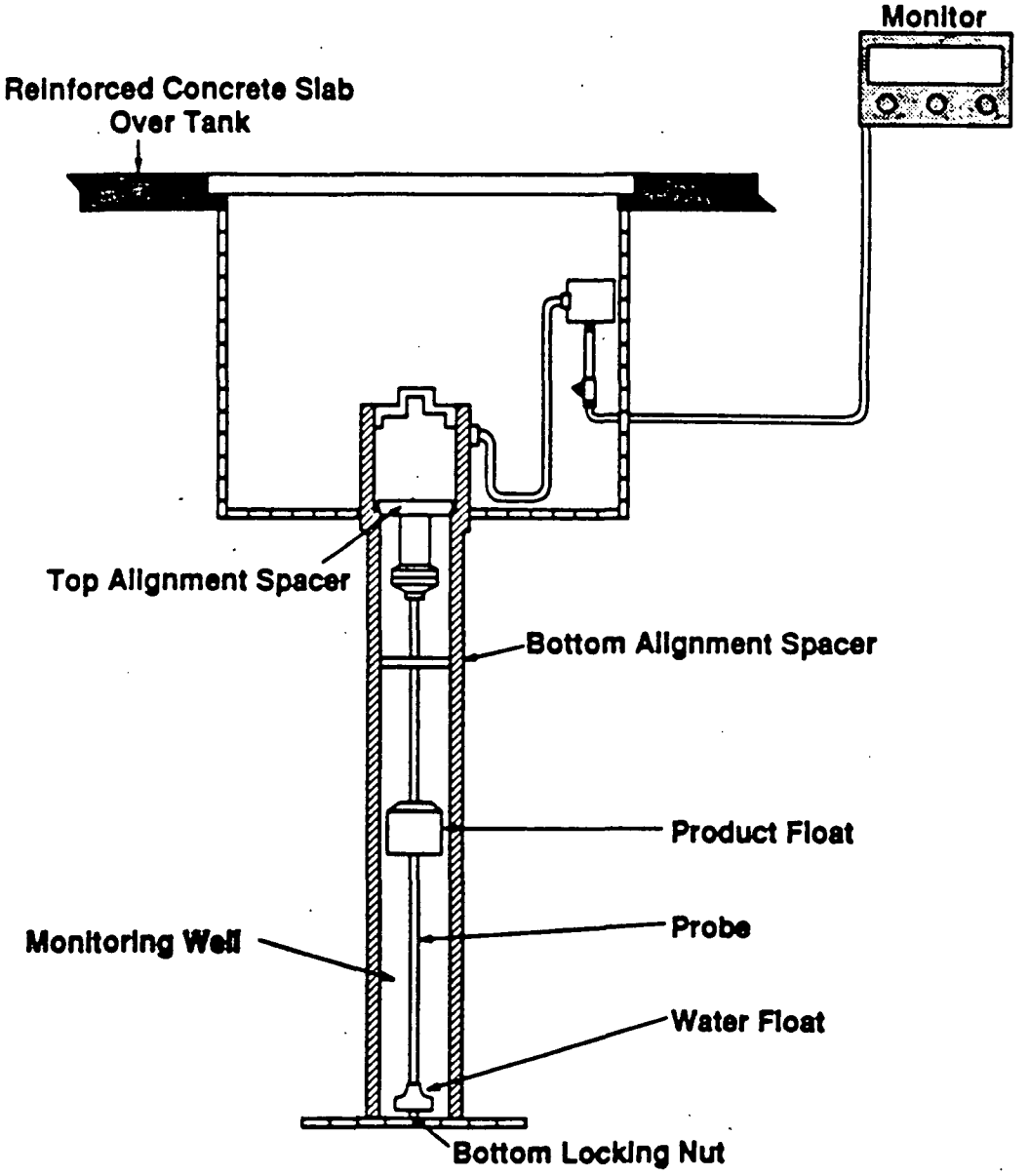
SLIDE IV-48

THE WELL SCREEN IS PLACED TO EXTEND OVER THE ENTIRE RANGE OF WATER TABLE FLUCTUATION



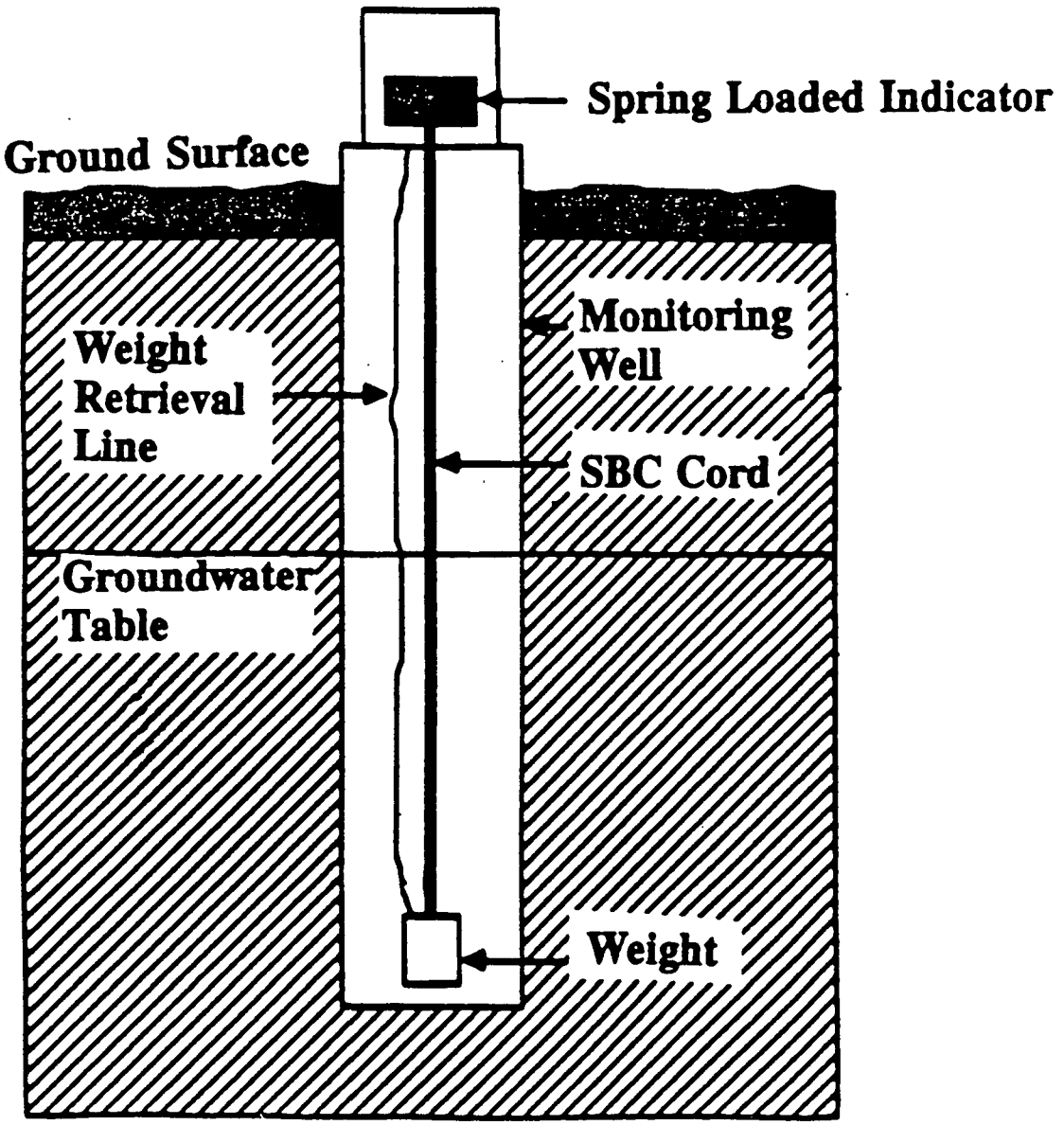
SLIDE IV-52

SCHEMATIC OF A DIFFERENTIAL FLOAT DEVICE



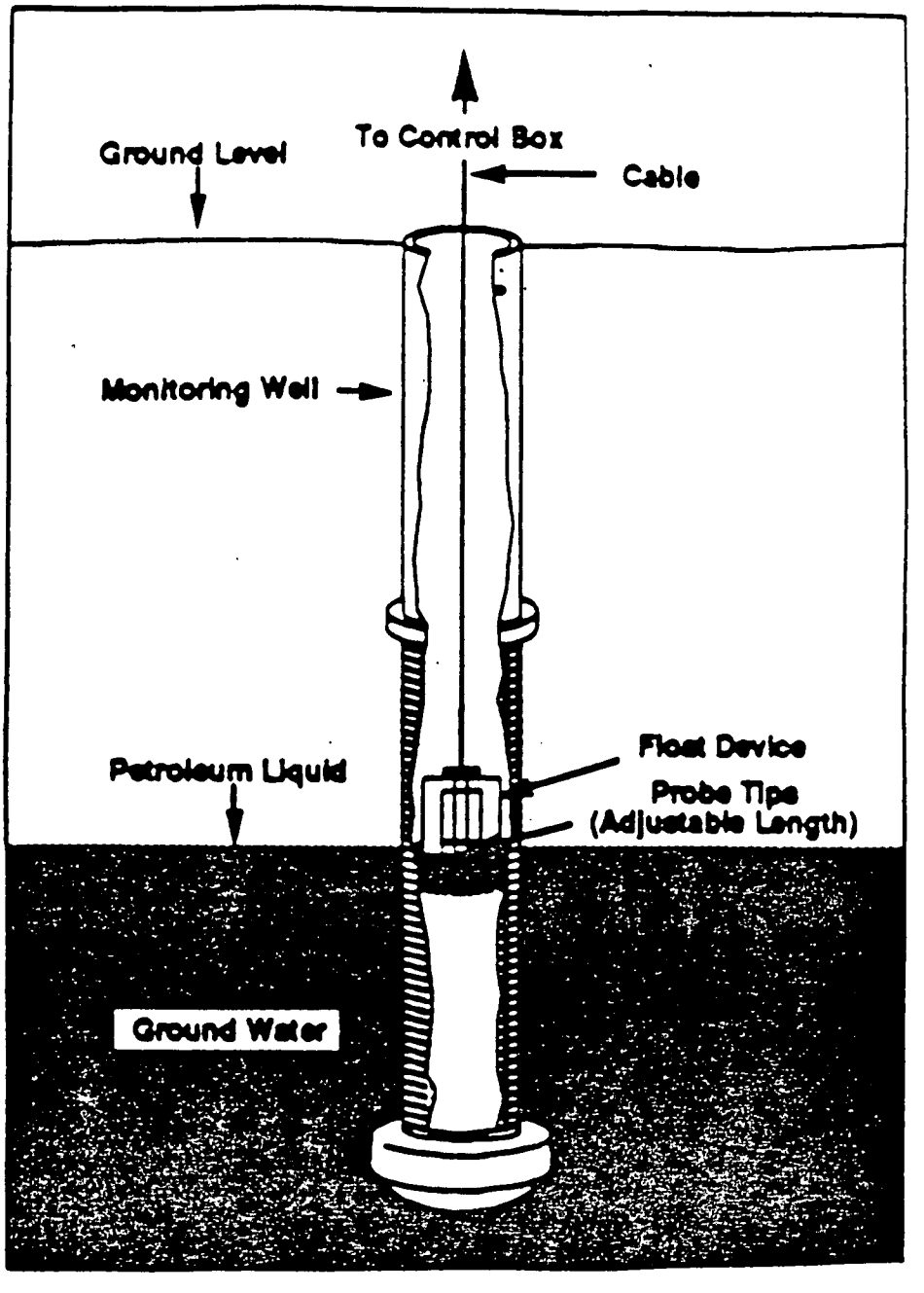
SLIDE IV-53

SCHEMATIC OF A MECHANICALLY ACTIVATED PRODUCT SOLUBLE DEVICE



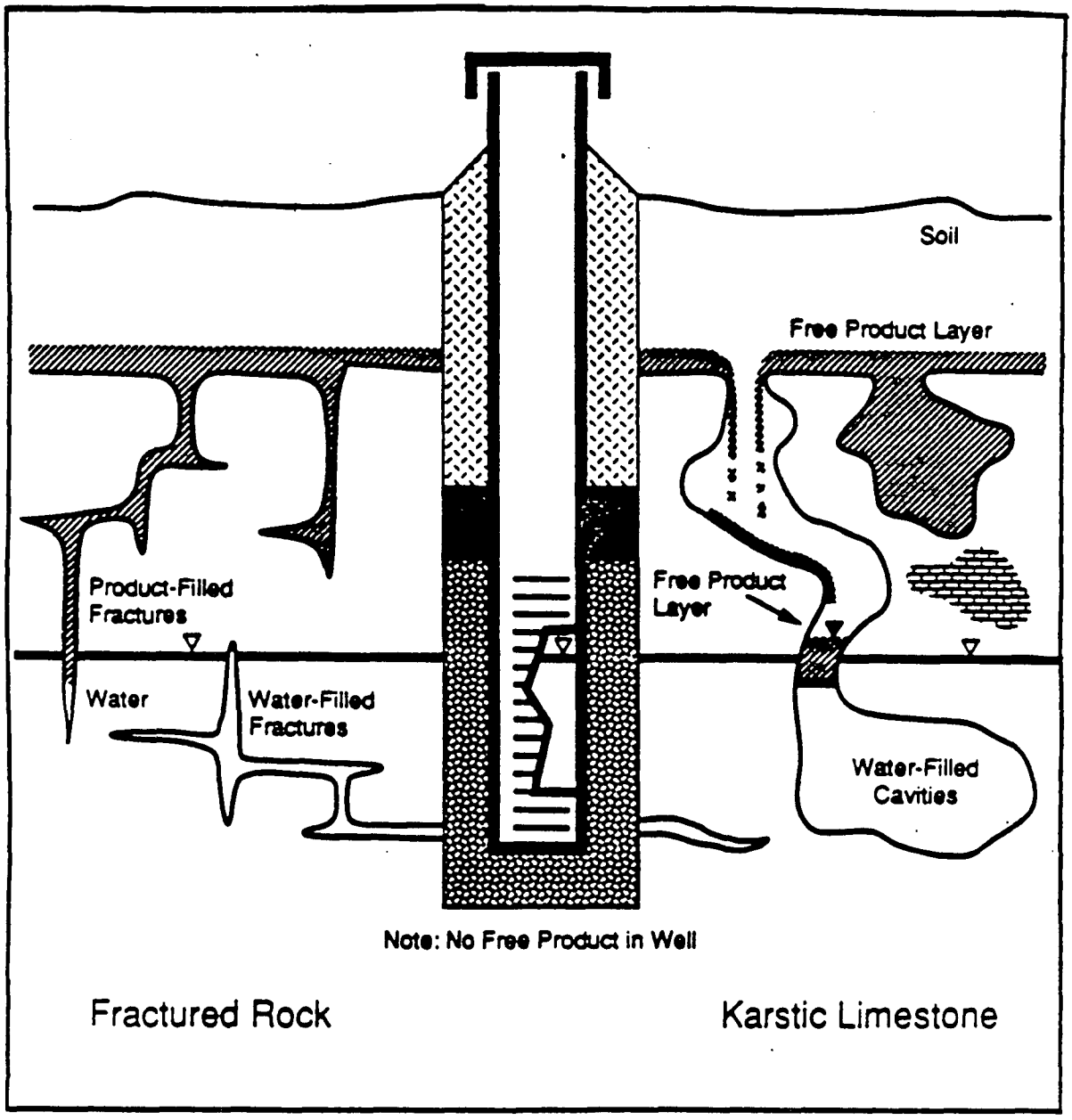
SLIDE IV-54

SCHEMATIC OF THERMAL CONDUCTIVITY DEVICE



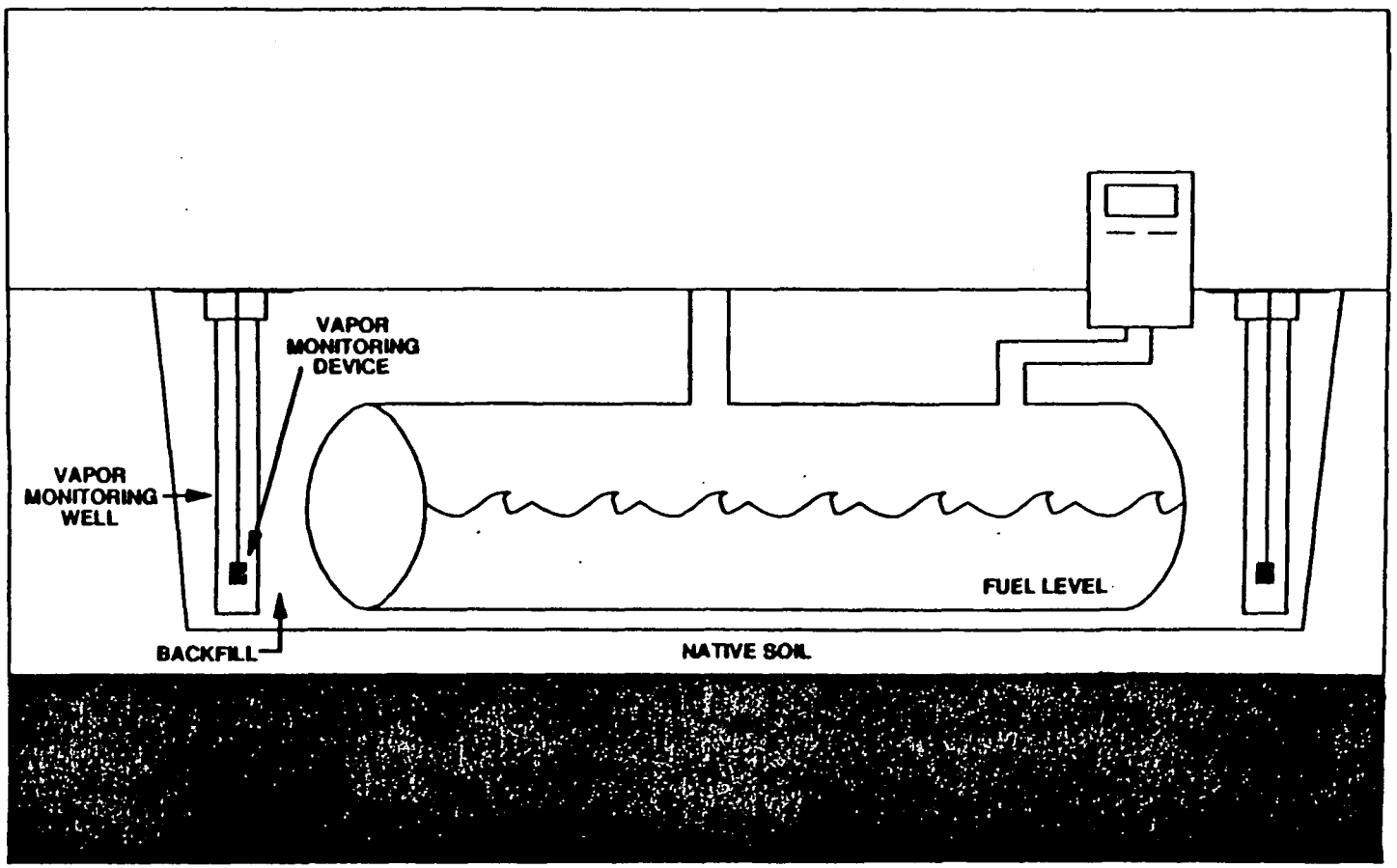
SLIDE IV-60

POORLY PLACED GROUND-WATER MONITORING WELL



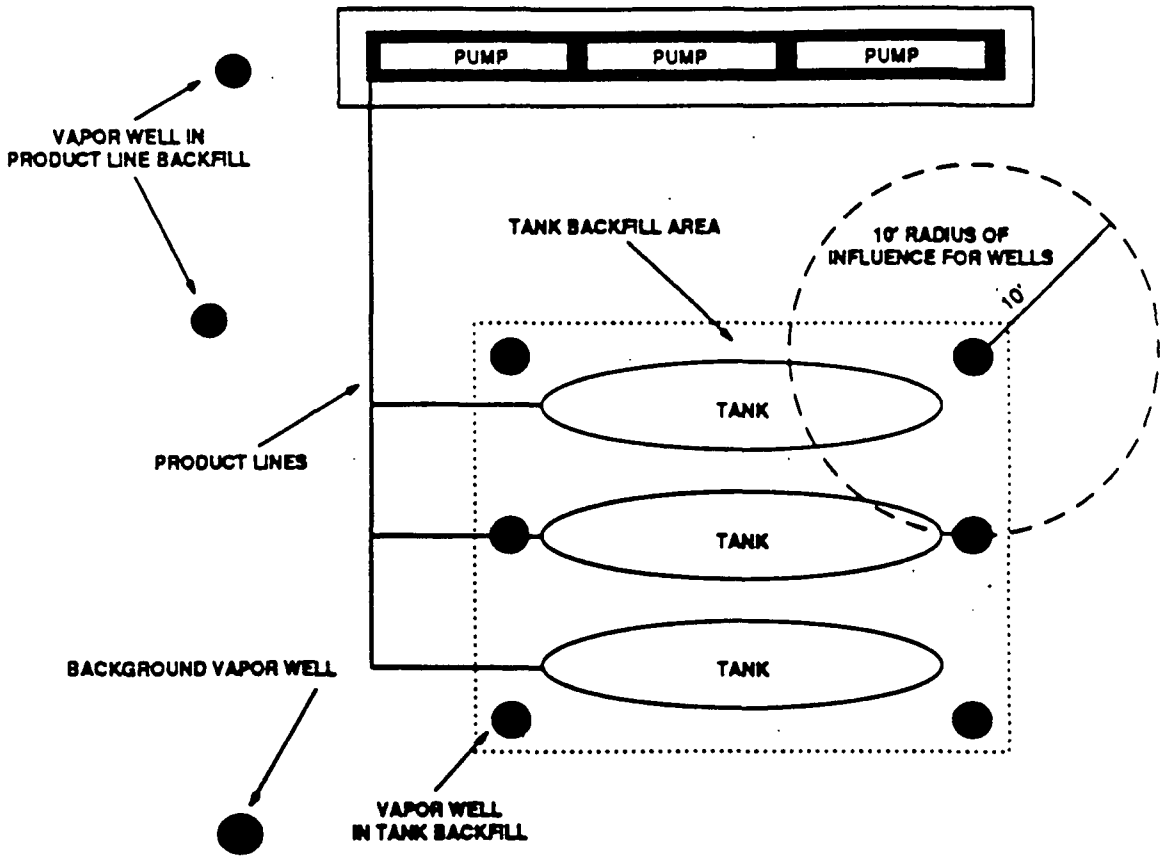
SLIDE IV-64

UNDERGROUND STORAGE TANK SYSTEM WITH VAPOR MONITORING WELLS



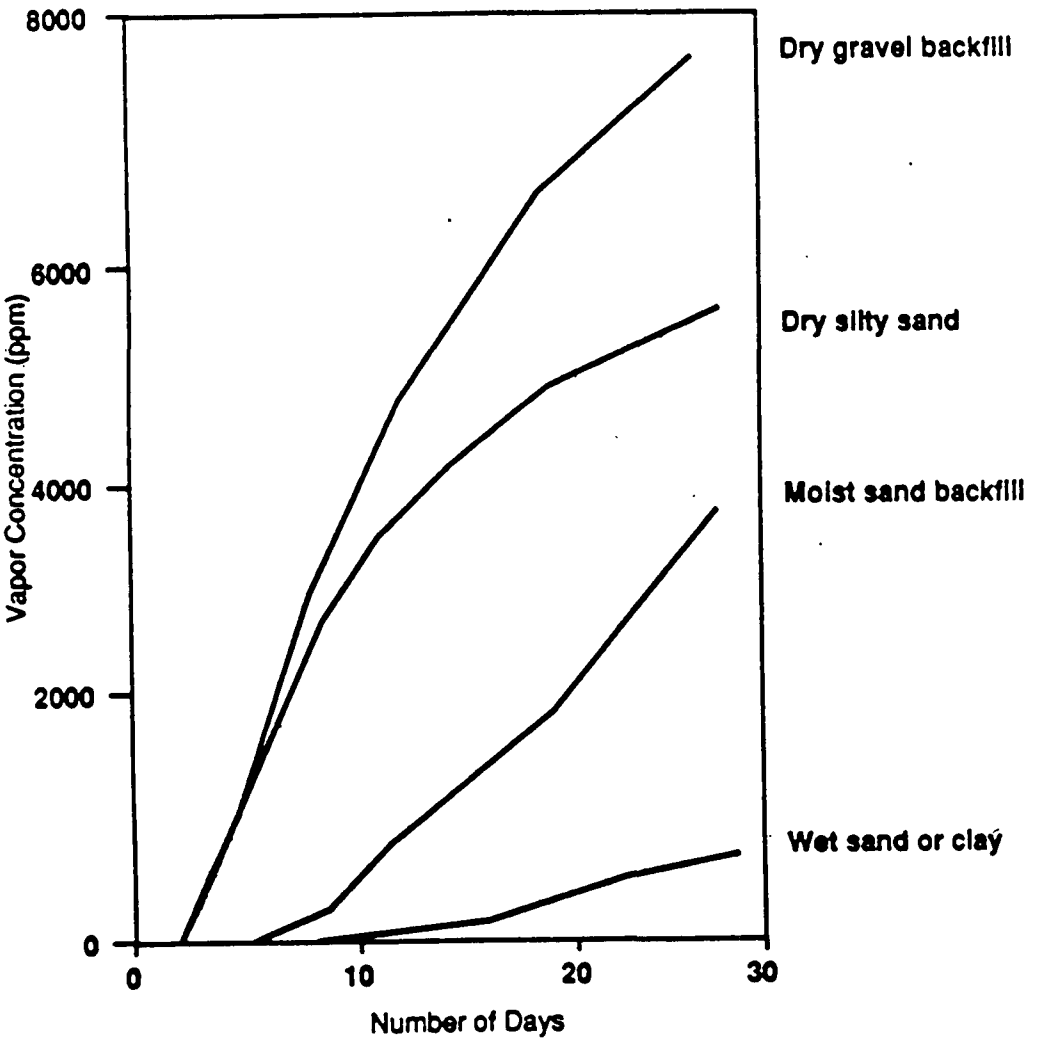
SLIDE IV-65

MAP VIEW OF TYPICAL UST SITE WITH VAPOR MONITORING



SLIDE IV-69

THE EFFECT OF SOIL ON VAPOR CONCENTRATIONS AT A WELL



SLIDE IV-78

SAMPLE CALIBRATION CHART CONVERTING PRODUCT DEPTH TO GALLONS*

Tank Size / Depth in Inches	550 Gal. 49½" x 5'5"	1000 Gal. 49½" x 10'	1000 Gal. 64" x 6'	1500 Gal. 64" x 9'	2000 Gal. 64" x 12'	2500 Gal. 64" x 15'	3000 Gal. 64" x 18'	4000 Gal. 64" x 24'
1	2	4	3	4	6	8	9	13
2	7	13	9	13	18	23	27	37
3	13	24	17	25	34	42	51	68
4	20	38	26	39	52	65	78	104
5	29	52	36	54	75	90	108	145
6	37	68	47	71	94	118	142	189
7	47	86	59	89	119	148	178	238
8	57	104	72	108	144	180	217	289
9	68	124	85	128	171	214	257	343
10	79	144	100	150	200	250	300	400
11	90	165	114	172	229	287	344	459
12	102	187	130	195	260	325	390	520
13	115	209	145	218	291	364	437	583
14	127	232	162	243	324	495	486	648
15	140	255	178	268	357	447	536	715

* Note that product depth in left column converts to gallons in the other columns.

SLIDE IV-79

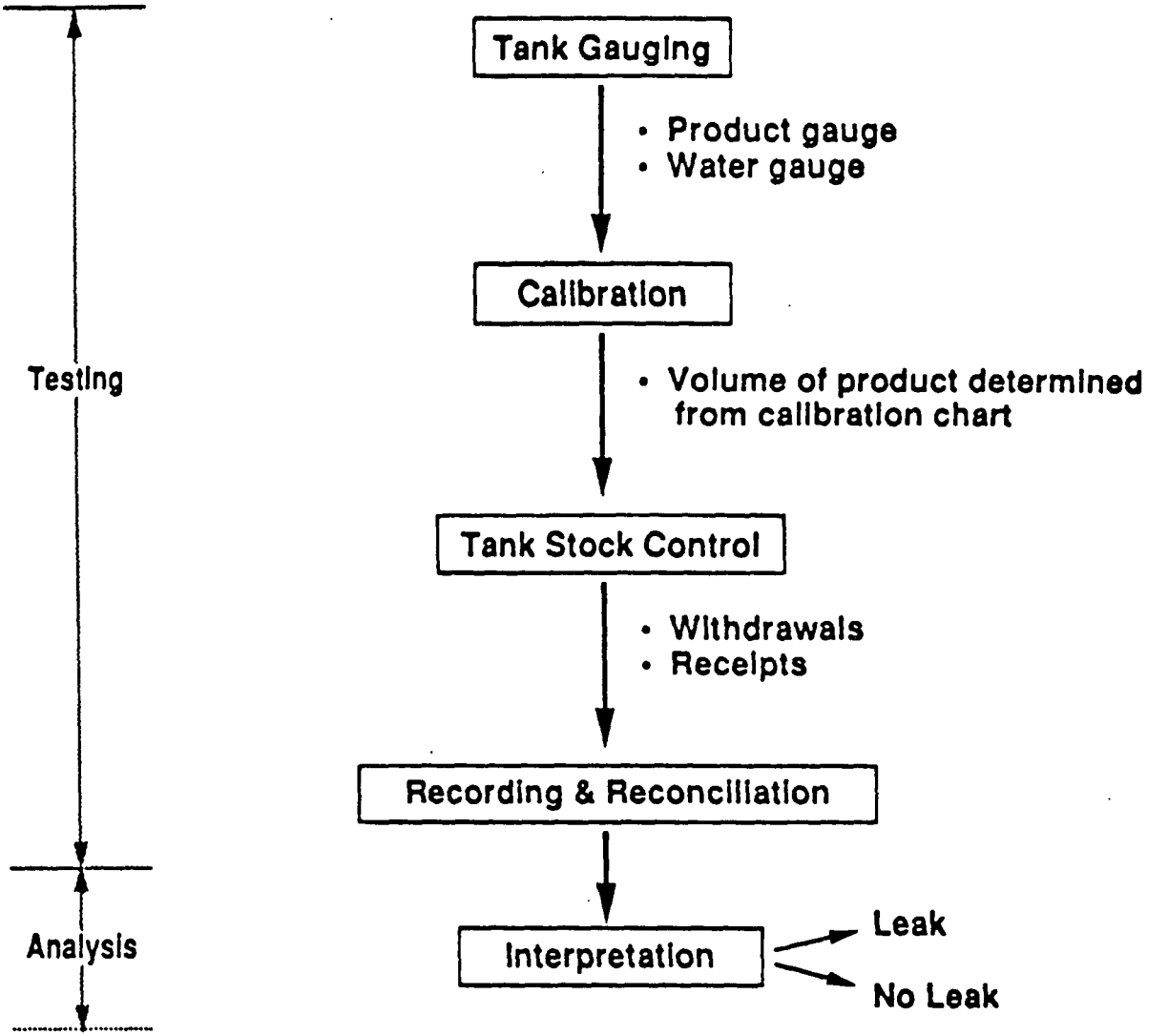
PART OF A MONTHLY RECONCILIATION FORM

LINE	DAY	REGULAR	UNLEADED
	1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9		
	10		
	11		
	12		
	13		
	14		
	15		
	16		
	17		
	18		
	19		
	20		
	21		
	22		
	23		
	24		
	25		
	26		
	27		
	28		
	29		
	30		
	31		
1	Cum. Over Total		
2	% Thru.		
3	Cum. Short. Total		
4	% Thru.		

Attention: The cumulative sum of monthly overages or shortages should not exceed 1.0% of the monthly throughput plus 130 gallons.

SLIDE IV-82

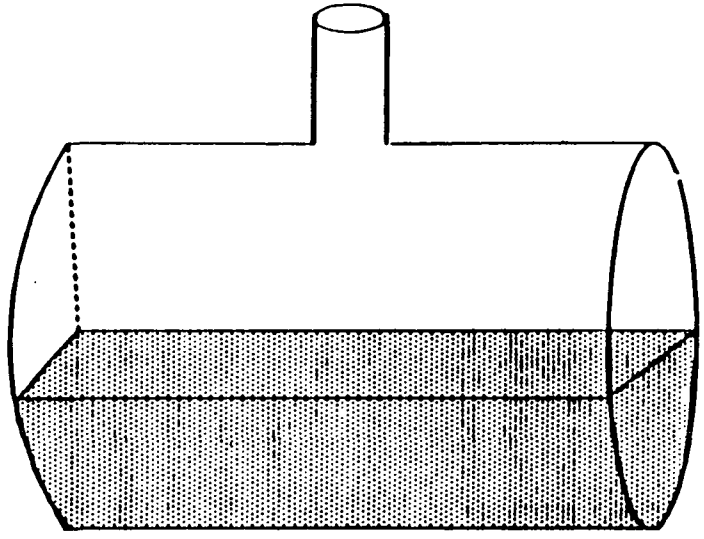
GENERAL PROCEDURE FOR INVENTORY CONTROL



SLIDE IV-95

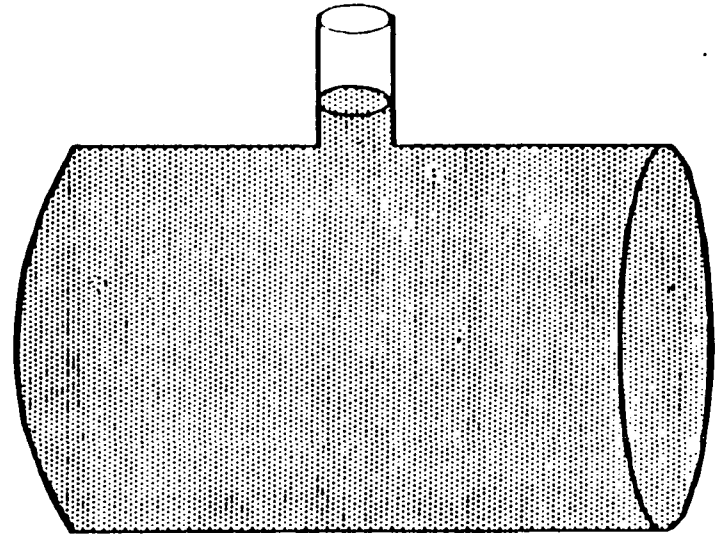
COMPARISON OF PARTIALLY-FILLED AND OVERFILLED TANKS

Partially-Filled Tank



Large volume changes produce only very small level changes

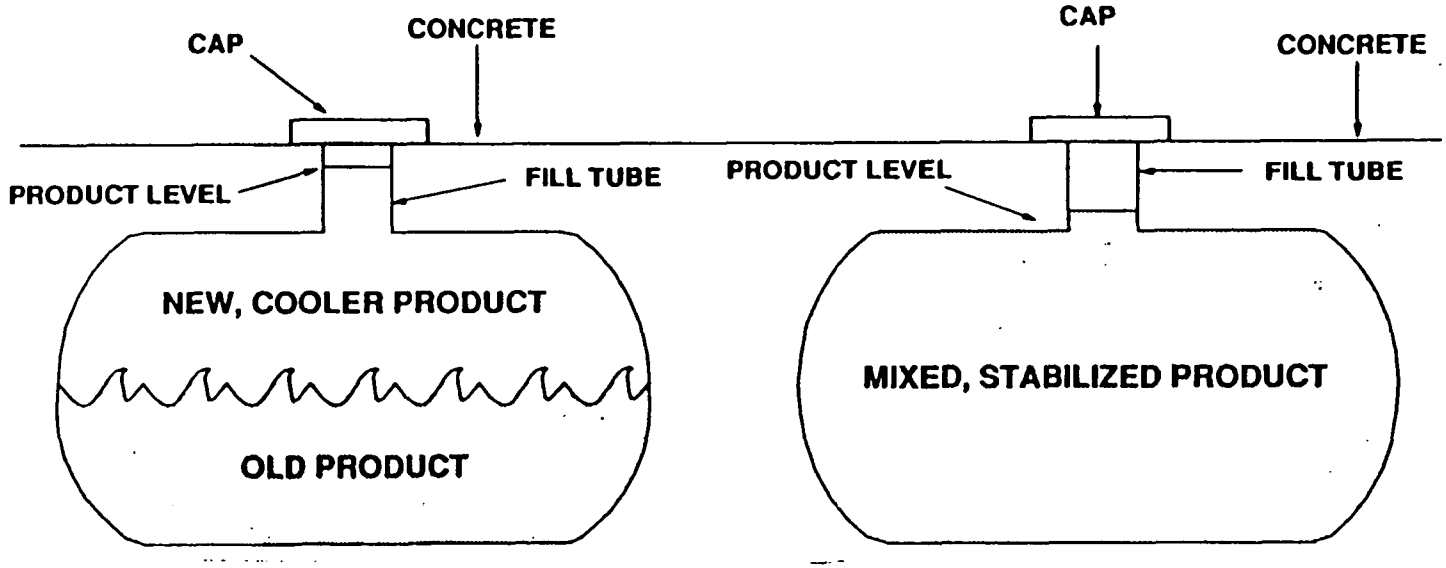
Overfilled Tank



A small volume change can produce a drastic level change

SLIDE IV-97

HOW TEMPERATURE CHANGES CAN BE MISTAKEN FOR A LEAK

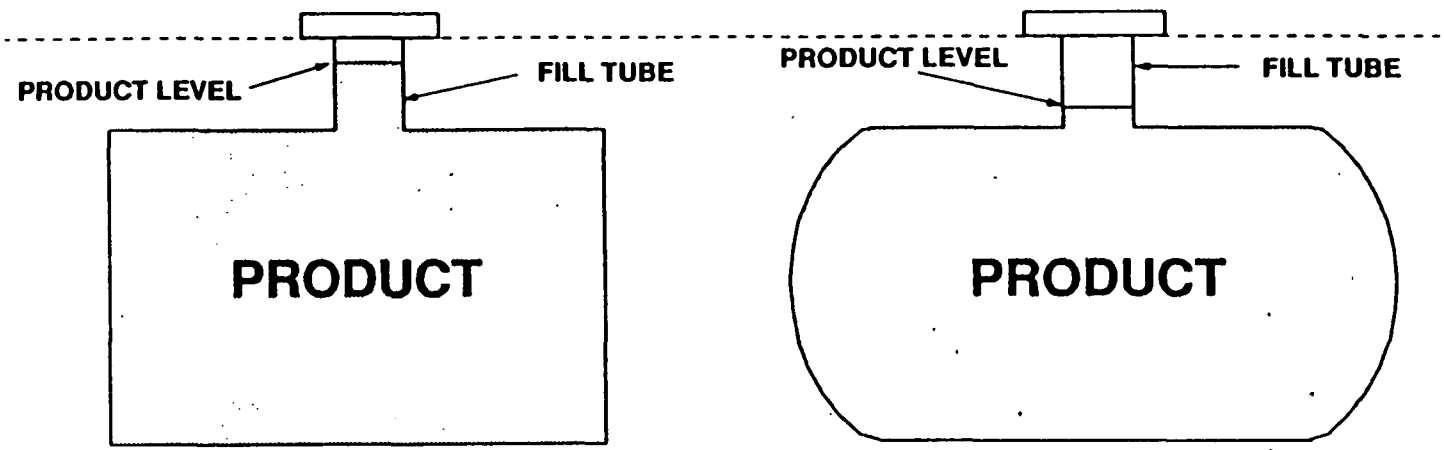


(A) A tank has just had additional product added.

(B) After several hours, product mixture has stabilized temperature, resulting in lower product level.

SLIDE IV-98

HOW STRUCTURAL DEFORMATION OF THE TANK CAN BE MISTAKEN FOR A LEAK



(A) An empty underground tank has just been filled with product

(B) In response to the pressure and/or temperature of the product, the ends of the tank begin to deflect (structural deformation), and the level of the product goes down.

CHAPTER FIVE

LEAK DETECTION METHODS FOR UST PIPING

How can you assist the owner or operator to meet the leak detection requirements for piping? This chapter presents detailed information about the two types of UST piping systems, pressurized and suction, and the requirements for piping monitoring and leak detection methods. This chapter covers types of line devices, line testing methods, and monthly monitoring methods.

Lecture Notes	Student Notes
I. UST PIPING	**Slide 1:**
The majority of UST leaks occur in the piping system. Two varieties of piping systems for product delivery are pressurized piping and suction piping.	**Slide 2:** **Slide 2A (photo):**
A. Pressurized piping systems	**Slide 3:**
1. A pump at the bottom of the tank pushes product through the delivery piping to the dispenser at positive pressure, usually around 28 to 32 pounds per square inch (psi).	
2. Very large releases can occur quickly because pumps continue to operate when piping is broken and force product through the hole or break.	
3. These systems are usually chosen for high volume sites because they deliver product quickly.	
B. Suction piping systems	**Slide 4:**
1. A positive displacement pump, at or near the point of end use, reduces the pressure at the dispensing unit, and atmospheric pressure pushes the product through delivery lines.	**Slide 4A (photo):** **Slide 4B (photo):**

Lecture Notes	Student Notes
2. When the pump is shut off or a leak in the lines occurs, suction is interrupted, and product flows back through the piping toward the tank. – Some product remains contained in the lines by one or more check valves within the pipe system. – At the point of a line failure, some product can not drain back into the tank and escapes into the environment.	**Slide 4C (graphic photo):**
3. Two general types of suction systems exist: – In the "European" system, the location of the check valve is immediately below the pump. Also, the slope of the piping will allow product in the piping to drain back into the tank when suction is released. – In the "American" system, the check valve is located at the top of the tank (angle check) or at the bottom of the suction line (foot valve). Both systems are used in the United States.	**Slide 5 (graphic):**
4. Suction piping systems deliver product slowly, so they are only used where speed of delivery is not a factor. These systems also require that the dispenser and tank are near each other.	

Lecture Notes	Student Notes
II. LEAK DETECTION FOR UST PIPING	**Slide 6:**
Federal regulations require that all UST piping systems that routinely contain product be tested for leaks. This may or may not include the vent lines, depending on the State requirements. Depending on the test method, piping may be tested separately or in conjunction with the tank.	
A. Deadlines	
1. Pressurized piping	**Slide 7:**
– New piping must comply with UST leak detection requirements **when installed.**	
– Existing piping must comply with UST leak detection requirements by **December 1990.**	
2. Suction piping	**Slide 8:**
– Leak detection is not required for either new or existing piping of the "European" type described earlier.	
– Other "American" suction piping types need to meet the following deadlines.	
- New piping must comply with UST leak detection requirements **when installed.**	
- Existing piping must comply with UST leak detection requirements according to the following timetable:	

Lecture Notes	Student Notes

Installation Date	Must Comply By
Before 1965*	December 1989
1965 - 1969	December 1990
1970 - 1974	December 1991
1975 - 1979	December 1992
1980 - 1988	December 1993

* Or if installation date is unknown.

Slide 9:

B. Requirements

1. Pressurized piping (new and existing)

Slide 10 (graphic):

- Each pressurized piping run must have an <u>automatic line leak detector</u> (LLD).

Slide 11:

- Pressurized piping must also have <u>one</u> of the following:
  - Monthly ground-water monitoring; or
  - Monthly vapor monitoring; or
  - Monthly interstitial monitoring; or monthly SIR;
  - Annual tightness test.

2. Suction piping

Slide 12:

- No leak detection is required if the suction piping is designed with:
  - Enough slope so that the product in the pipe can drain back into the tank when suction is released; and
  - Only one check valve, which is as close as possible beneath the pump in the dispensing unit.

Lecture Notes	Student Notes
— If a suction line does not meet all of these design criteria, one of the following leak detection methods must be used:	
— A line tightness test at least every three years; or	
— Monthly vapor monitoring; or	
— Monthly SIR;	
— Monthly ground-water monitoring; or	
— Monthly interstitial monitoring.	
C. Methods	**Slide 13:**
1. Automatic line leak detectors	
— Two types are currently available:	
- Automatic flow restrictor; and	
- Automatic shutoff device.	
2. Line tightness testing methods	**Slide 14:**
— Two general approaches are currently used:	
- Direct volumetric testing; and	
- Indirect tightness testing.	
3. Monthly monitoring methods	
— Four types exist:	
- Interstitial monitoring;	
- Ground-water monitoring;	
- SIR monitoring; and	
- Vapor monitoring.	

Lecture Notes	Student Notes
D. Requirements for PD/PFA	**Slide 15:**
1. Line tightness testing and automatic line leak detectors must be capable of detecting the leak rate or quantity specified for that method with a probability of detection (PD) of 0.95 and a probability of false alarm (PFA) of 0.05.	
There are two PD/PFA compliance deadlines:	
— By December 1990, tightness testing for piping must meet PD/PFA requirements;	
— By September 1991, automatic line leak detectors must meet PD/PFA requirements.	
However, methods permanently installed before the applicable compliance deadline are not required to meet the PD/PFA requirements.	
E. Standard test procedures	
As discussed earlier in Chapter Four, Section I.D., EPA has developed standard test procedures (also known as protocols) that enable manufacturers of release detection methods and third-party evaluators of those methods to demonstrate that the methods can meet the Federal release detection requirements. EPA published standard test procedures for evaluating pipeline leak detection systems in September 1990.	

Lecture Notes	Student Notes
III. AUTOMATIC LINE LEAK DETECTORS	
A. Automatic flow restrictors	
1. How automatic flow restrictors work	
– Restrictors, located at the pumps, monitor the line pressure and restrict flow if a possible leak is indicated.	**Slide 16:**
– When pressure in the pump delivery system drops below a preset threshold, commonly 1 to 2 psi, a test is automatically performed.	**Slide 17:**
– During the test product flows through line at 1.5 to 3 gal/h.	
– Line leak detectors must detect 3 gal/h release at 10 psi pressure, within 1 hour.	
– Leaks greater than 3 gal/h are indicated if more than 2 seconds are required to fully pressurize the line.	
– If test does not indicate a leak, normal flow is resumed.	
– Restrictors do not shut the system off entirely, but limit product flow to 3 gal/h.	
2. When automatic flow restrictors are appropriate	**Slide 18:**
– This method is used only in pressurized piping.	
– Most gas station USTs already have automatic flow restrictors (Red Jackets).	**Slide 18A (photo):**

Lecture Notes	Student Notes
3. Considerations – This method causes a slight lag in product delivery even when there is no leak. – At high altitudes or high temperatures, vapors are more likely to form in piping. This increases the amount of time required for product to reach operating pressure and may falsely indicate a leak. - If additional time is spent pressurizing the line, vapors will usually be reabsorbed into the liquid. – On-site staff may tamper with system to avoid delays in product delivery. – Requires little owner or operator involvement. – Tests can not be run while dispensers are in use. About five minutes between dispensings at the UST are needed for accurate testing. – Typical time between dispensings should be considered when selecting a method of piping leak detection.	**Slide 19:**
B. Automatic flow shutoff devices 1. How automatic flow shutoff devices work There are two different types of automatic flow shutoff devices: one system monitors for an increase in line pressure; the other monitors for a decrease in line pressure.	**Slide 20:**

Lecture Notes	Student Notes
a. Pressure increase monitor	**Slide 21:**
– The normal rate of pressurization in pipes is calculated when the testing system is set up.	
– When the pump is activated, the rate of increase in line pressure is measured.	
– It will take longer than usual for the piping to become fully pressurized if there is a leak.	
– If pressure does not rise quickly enough, the system automatically shuts down.	
– The level of automation varies from system to system.	
– Automatic flow shutoff systems are permanently installed.	
b. Pressure decrease monitor	**Slide 22:**
– System monitors line pressure over several minutes when dispenser is not in use.	
– If constant pressure can not be maintained or if pressure decreases more quickly than its normal rate, a leak is indicated, and the pump is shut down.	
– Generally, more than one test which indicates a leak is required before system shuts down.	
– The level of automation varies from system to system.	
– Such systems are permanently installed.	

Lecture Notes	Student Notes
2. When automatic flow shutoff devices are appropriate – This method is used for pressurized piping only. – Typical time between dispensings should be considered when selecting a method of piping leak detection.	**Slide 23:**
3. Considerations – Flow shutoff devices are subject to tampering if they are not locked or tamper-proofed in some way. – As with flow restrictors, tests cannot be run while dispensers are in use. At a minimum, about five minutes between dispensing at the UST are needed for accurate testing. - A longer interval between dispensings (up to one hour) is necessary to detect small leaks. – Automatic flow shutoff devices provide nearly continuous leak detection and require little time from staff.	**Slide 24:**

Lecture Notes	Student Notes
IV. LINE TIGHTNESS TESTS	**Slide 25:**
A. Direct volumetric line tightness test	
1. How direct volumetric line tightness tests work	**Slide 26:**
– The line is isolated from the tank, and is tested for its ability to maintain pressure.	
- A pressure loss indicates a potential leak.	
- The test must be able to detect a leak of 0.1 gal/h at 1.5 times the normal line operating pressure.	
– A hand pump or a dispenser and submerged pump is used to pressurize the piping leading back to the tank.	
– The amount of volume lost is determined in one of several ways:	
- If pressure decreases in the piping system, product is added to return pressure to original test level. The leak rate is estimated by measuring the amount of product added.	
- The volume of product lost over time is observed in an above-ground tube that is connected to pressurized piping.	**Slide 26A (photo):** **Slide 26B (photo):** **Slide 26C (photo):**

Lecture Notes	Student Notes
- A pressure gauge on the hand pump, or temporarily installed on the dispenser, can be used to indicate pressure change, which is converted to a leak rate. – If a 0.1 gal/h per hour leak rate is found, a leak is indicated.	
2. When the direct volumetric line tightness test is appropriate – This method can be performed alone or in conjunction with other monitoring methods. – With certain variations on tests, line tightness testing may be performed on both pressurized and suction systems.	**Slide 27:**
3. Considerations – The line must be shut down for several hours for the test. – This method requires no permanent equipment and can be performed along with tank tightness testing. – Test needs to be performed only once every three years for suction piping. Line tightness testing can be used as the only method of line leak detection for suction piping. – There are generally more problems with line tightness testing than with tank tightness testing. These problems are difficult to resolve due to poor fittings and gaskets, vapor pockets, bad check valves, etc.	**Slide 28:**

Lecture Notes	Student Notes
B. Indirect line tightness test	**Slide 29:**
1. How the indirect line tightness test works	
a. In an indirect line tightness test, piping is tested as a part of a full tank system test. Fluid loss over time in a closed tank and piping system is examined to determine presence of a leak. Procedures are the same as for tank tightness test with the following additions:	
– Overfill method must be used, so that piping as well as tank is full of product.	
– If test indicates a leak, tank is tested alone.	
– If no leak is found in tank, piping is assumed to be leaking.	
– If tank is leaking, separate test of piping must be conducted.	
2. When the indirect line tightness test is appropriate	**Slide 30:**
– This method must be done in conjunction with tank testing; tanks and piping might be on different test schedules, making an indirect test impractical.	
– With certain variations on tests, line tightness testing may be performed on both pressurized and suction systems.	
– If low pressure is put on piping, it is necessary to detect very small leaks to pass the pressure piping 0.1 gal/h test requirement.	

Lecture Notes	Student Notes
3. Considerations – This method must be performed as part of tank test; therefore, UST system must be shut down for at least several hours. – Requires no permanent equipment, and can conveniently be performed along with tank tightness testing. – Test must be performed only once every three years for suction piping. Line tightness testing can be used as the only method of line leak detection for suction piping. – There are generally more problems with line tightness testing than with tank tightness testing. These problems are difficult to resolve and are due to poor fittings and gaskets, vapor pockets, bad check valves, etc. – Indirect tests can only show that the entire UST system is leaking. Tanks and piping will have to be tested separately to identify the source of the leak.	**Slide 31:**

Lecture Notes	Student Notes
V. MONTHLY MONITORING METHODS	
A. Secondary containment with interstitial monitoring	**Slide 32:**
Methods, applications, and considerations of interstitial monitoring with secondary containment for piping systems are similar to those for tanks.	
1. How interstitial monitoring works	**Slide 33:**
a. Trench liners	
– Backfill and piping are placed in a lined trench.	
– The trench should be sloped away from the tank excavation to differentiate between tank leaks and piping leaks.	
– An interstitial monitor is placed between piping and the trench liner.	
b. Double-walled piping	**Slide 34:**
– Piping that carries the product is contained within a larger outer pipe.	
– The outer pipe usually drains to a sump that can be monitored for leaks. Other methods use an interstitial monitor placed between inner and outer piping.	
2. When secondary containment with interstitial monitoring is appropriate	
a. UST system characteristics	**Slide 35:**
– Can be used for both tanks and piping.	

Lecture Notes	Student Notes
– Secondary containment is impractical for existing piping, because it involves either excavating all piping runs and installing trench liners, or replacing existing piping with double-walled piping.	
b. Product characteristics	**Slide 36:**
– This method can be used for all types of fuels.	
c. Soil conditions	
– Use is not restricted by soil type.	
d. Climatic factors	**Slide 37:**
– This method can be used in all climatic conditions; however, in areas with heavy rainfall, a fully enclosed containment system should be used to prevent rain from interfering with monitoring system.	
e. Geologic conditions	
– In areas with high ground water, a fully-enclosed containment system should be used to prevent ground water from interfering with the monitoring devices.	
3. Considerations	**Slide 38:**
– Correct installation of trench liners is essential because piping trenches are narrow and long. To cover these areas requires piecing together small pieces of liner. Trained and experienced professionals can minimize the number of seams in the liner and ensure correct installation.	