(DRAFT)

United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park, NC

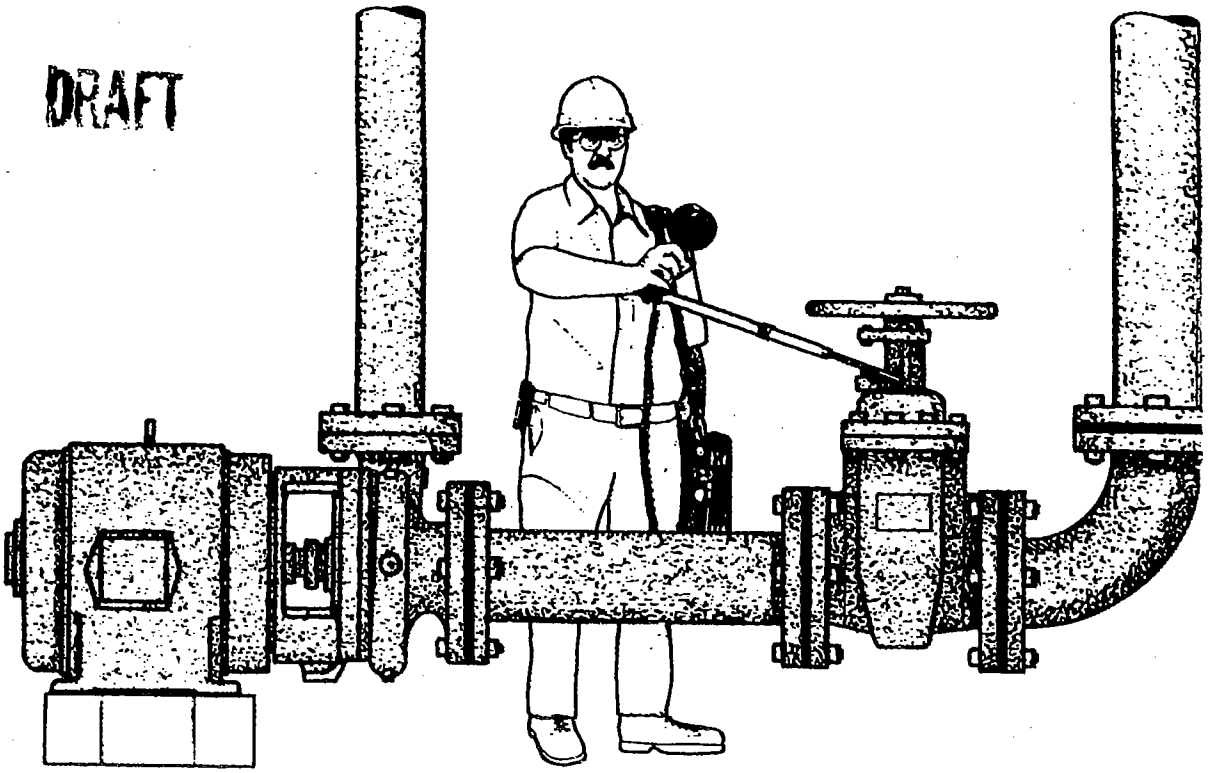
EPA

COURSE #380

DRAFT

INSPECTION TECHNIQUES FOR FUGITIVE VOC EMISSION SOURCES

DRAFT



Office of Air Quality
Clean Air
OAQPS
Planning and Standards

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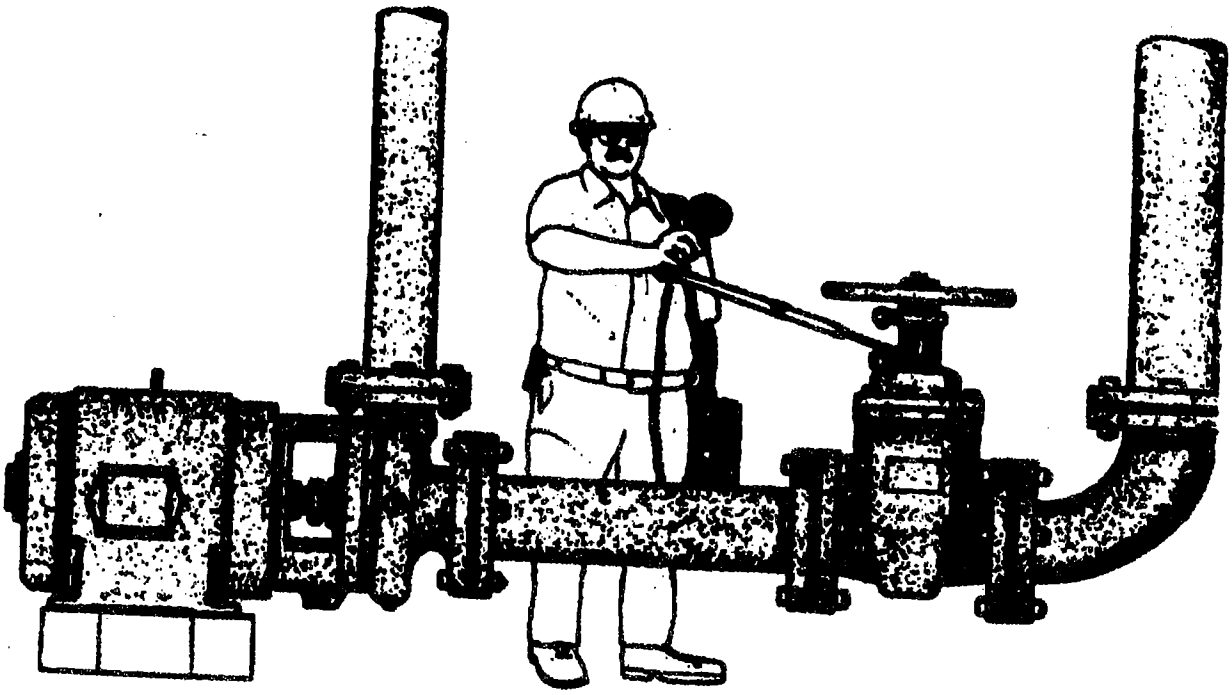

WORKBOOK

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U.S. Environmental Protection Agency
Air Pollution Training Institute (APTI)

Course #380
Fugitive Source Inspection

Workbook

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U.S. Environmental Protection Agency
Air Pollution Training Institute

Course #380
Fugitive Source Inspection

U.S. Environmental Protection Agency
Air Pollution Training Institute
Course #380

Fugitive Source Inspection

I. Course Description

As documented under various EPA regulations (NESHAP, NSPS, HON, and MACT), fugitive emissions of hazardous air pollutants (HAPs) from affected facility equipment must be monitored on a routine and continuous bases as part of a facility's leak detection and repair program (LDAR). In particular, these regulations specify Federal Reference Method (FRM) 21 as a procedure for identifying fugitive leaks of volatile hazardous air pollutant (VHAP) from valves, pumps, compressors, relief valves, connectors, flanges and various other pieces of equipment within a process. Equipment leak standards as identified in the regulations are designed to reduce volatile organic compound (VOC) and VHAP emissions from various components within the process.

These new regulations have placed the responsibility of fugitive emission reduction of VOCs and VHAPs on the source through their LDAR program. With these new programs comes the responsibility of agency personnel and inspectors to verify, inspect, and document the effectiveness of the source specific LDAR program to minimize emissions. Verification of a source LDAR program meeting compliance requirements may be accomplished through a level approach. Level I involves agency records review. Level II involves on site inspection of the LDAR program, observation of source personnel performing leak detection using portable VOC analyzers meeting FRM 21 requirements, and evaluation of the data acquisition system. Finally, Level III involves agency personnel performing leak detection using portable VOC analyzers meeting FRM 21 requirements.

This course is specifically designed for field inspectors who have the responsibility to evaluate compliance with EPA regulations involving source LDAR programs designed to minimize fugitive VOC and VHAP emissions from specific process equipment. The course briefly reviews applicable regulations and sources affected by those regulations, the type of flanges and valves and other process equipment covered by the regulations, and how EPA defines leaks. Specific to this course offering, a thorough review of FRM 21 will be presented, along with review of field portable instrumentation. Presentations and demonstrations will involve the operation, check-out, calibration, and maintenance of field portable VOC analyzers through approved checklist. In particular, field demonstrations associated with proper orientation and use of portable analyzers in evaluating fugitive emissions from plant process equipment as part of an agency fugitive leak inspection program will be documented. The participant will learn how to establish an agency fugitive leak inspection program, defining organization structure and responsibilities, equipment needs, selection, storage, calibration and maintenance, and standardized inspection techniques using audit checklists.

Major Topics

- Regulations addressing fugitive source emissions (NSPS/NESHAP/MACT/HON)
- Department of Justice findings
- Chemical and physical properties of fugitive emissions
- Applicable source categories of fugitive emissions
- Defining fugitive leaks
- Federal Reference Method (FRM) 21
- Survey of portable instrumentation
- Agency fugitive leak inspection program
- Source leak detection and repair program (LDAR)
- Day in the life of an Agency inspector
- Future tools for determining leaks at industrial facilities
    - -Smart LDAR source specific program
    - -Ring sensor/wireless communication LDAR program

II. Course Agenda

Attached is a draft agenda for EPA's Course #380 entitled: "Fugitive Source Inspection."

U.S. Environmental Protection Agency
Air Pollution Training Institute
Course #380

Fugitive Source Inspection

Day 1

8:00 AM Introduction

8:20 The Role of An Inspector in an Agency LDAR Program (SI 380 Video)

8:45 Chemical and Physical Properties of Fugitive Emissions

a. Chemical/Physical Properties
   - -Boiling Points
   - -Vapor Pressure

b. Defining HAPs into Categories
   - -Volatile
   - -Semi-volatile
   - -Particles

9:10 Regulations Associated with Fugitive Source Emissions

a. Clean Air Act Amendments of 1990, Title III HAPs
b. National Emission Standards for Hazardous Air Pollutants (NESHAP)
c. New Source Performance Standards (NSPS)
d. Hazardous Organic NESHAP (HON)
e. Maximum Achievable Control Technology (MACT)
f. LDAR Program (How Do The Regulations Fit In)

9:45 BREAK

10:00 Regulations (Cond't)

g. Recent Findings of the Department of Justice (Complaints Against Petroleum Refineries)
   - No Written Refinery-Wide Program!
   - Lack of Personnel Training!
   - No External or Internal Audit Program!
   - Lack of Documentation of Leak Definition and Repair!
   - Lack of LDAR QA/QC!

10:45 Potential Sources for Fugitive Emissions

a. Types of Valves, Flanges, and Pumps
(Cut-away of Valve Indicating Leak Areas)
b. Packing Materials for Valves, Flanges, and Pumps
c. Purging, Maintenance Reduction, and Packless Technologies

12:00 LUNCH

1:15 Refinery Operations and API Findings

a. **Analysis of Refinery Data**
b. **Distribution of Emissions by Component Category**
c. **Contribution of Total Emissions by Process Unit (High/Repeat Leakers)**

2:00 Tagging Techniques for Pumps, Valves, Flanges etc.
-Physical Tagging
-Tagless Leak Detection and Repair (Tagless LDAR)

3:00 BREAK

3:15 Federal Reference Method 21

a. **Organization**
b. **Applicability**
c. **Types of Detectors/ Weaknesses and Strengths**
d. **Performance Criteria**
   1. **Calibration Requirements**
   2. **Response Factors**
   3. **Retention Time**
g. **Method 21 Problems**

4:15 Laboratory Demonstration of Method 21/Performance Criteria (TEI/TVA Model 1000B)

4:45 Review of Day 1

5:00 Adjourn

U.S. Environmental Protection Agency
Air Pollution Training Institute
Course #380

Fugitive Source Inspection

Day 2

8:00 AM Introduction to Day 2(Questions/Answers/Review)

8:30 Survey of Portable Instrumentation

9:00 Portable Instrumentation
- a. Principle of Operation of Selected Types of Analyzers
- b. Using Field Portable Instruments (Operation, Check-out, Calibration, and Maintenance)
- c. Field Checklist for Operation of Portable Instrumentation

9:50 BREAK

10:00 Source LDAR Program (Seven Components)
- a. Plan the LDAR Program (In-house LDAR or Vendor?)
- b. Establish Monitoring Procedures and Component Identification
- c. Location Identification
- d. Establish Monitoring Procedures
- e. Establish Repair Procedures
- f. Data Collection and Analysis Procedures
- g. Data Management Software Selection

10:45 Data Management Software Packages
- a. Essential Technologies (FEMS)
- b. EC Systems (ORR LeakDAS)
- c. P3M

12:00 LUNCH

1:15 Performing an Agency Inspection for Fugitive Leaks
- a. Agency Program and The Role of the Inspector
- b. Organization Structure and Responsibility
- c. Inspection Techniques and Agency Audit Checklist (Demonstration of Agency Audit Checklist)
- d. Steps To A Successful Inspection
  - -Pre-inspection Activities
  - - On-Site Activities
  - -Post-Inspection Activities

e. **USEPA, Region 6 LDAR Inspector: The Real Story**
(Guest Speaker: David Duster, U.S. Environmental Protection Agency, Region VI, Houston, TX)

3:00 BREAK

3:15 Future Tools for Determining Leak Detection
a. CellNet Data Systems and Adsistor Ring Sensors (Video)
b. Smart LDAR (Laser Imaging Technology)
(Guest Speaker: Craig Weeks, U.S. Environmental Protection Agency, Region 6, Dallas, Texas)

4:15 Recordkeeping and Reporting Requirements for LDAR

4:45 Questions/Answers/Review

5:00 Course Adjourn

U.S. Environmental Protection Agency

Course #380

Fugitive Source Inspection

Course Objectives

"This course is specifically designed for agency personnel and field inspectors who have the responsibility to evaluate compliance with EPA regulations involving source LDAR programs."

Day 1

- Introduction
- Role of an Inspector in an Agency LDAR Program (Video)
- Chemical/physical properties of HAPs
- Regulations associated with fugitive source emissions
  - CAAA of 1990, NSPS, NESHAPs, HON

Day 1 (Cont'd)

- Potential Sources for Fugitive Emissions
- Refinery Operations and API Findings
- Tagging Techniques for Pumps, Valves, Flanges etc.
- Federal Reference Method 21 and Performance Criteria

Day 2

- Survey of Portable Instrumentation and Field Experience
- Source LDAR Data Program
- Data Management Software Packages
- Agency Inspection Program

Day 2 (Cont'd)

- Future Tools for Determining Leaks
  - Adsistor Technology
  - SMART LDAR
- Recordkeeping and Reporting Requirements
- Review/Course Closing

What Are Equipment Leak Standards?

- Federal and state regulations designed to reduce emissions from leaking process equipment. Regulations aimed at both volatile organic compounds (VOCs) and volatile hazardous air pollutants (VHAPs)

Why Are Equipment Leak Standards Needed?

- VOCs, NO_x, and sunlight produce ozone
- Ozone nonattainment is a serious problem
- Daily 8-hr standard (0.08 ppm)
- 158 non-attainment areas for all pollutants

Why Standards Needed

- Fugitive VOC regulations design to control VOCs to minimize atmospheric ozone production
- VHAPs are hazardous to human health
- Regulations designed to require sources to reduce emissions from leaking process equipment

Are Equipment Leaks Really Significant (1984-1989)?

Source Category	US Uncont. Emissions
Refineries	53,900 tons/year
SOCMIs	91,500 tons/year
Benzene	8,700 tons/year

Are Equipment Leaks Really Significant

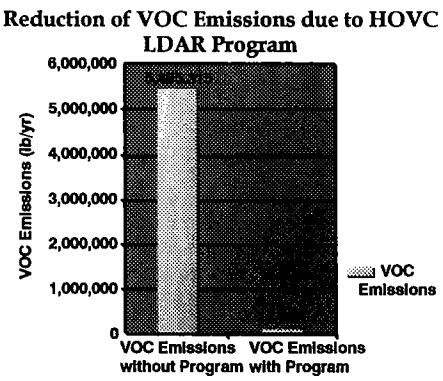
Source	US Uncont.	US Cont.	Percent Red.
Refineries	53,900	19,800	63
SOCMIs	91,500	40,700	56
Benzene	8,700	2,500	68

Effectiveness of HOVIC Leak Detection and Repair (LDAR) Program

Number of Components	35,832
Number of Monitoring Events in 1996	80,910
Program Costs (Man-hours/year)	13,220
Number of Leaking Components Identified in 1996	360

Calculated VOC Emissions 1996 If No Program In Place (Pounds/year)	5,495,315
Calculated VOC Emissions 1996 Using LDAR Program (Pounds/year)	16,910
Overall Percent Reduction of VOCs	99.78

Percentage of Leaking Components If No Program In Place	9.20
Percentage of Leaking Components Using LDAR Program	0.52



What Source Categories Are Regulated?

NSPS: SOCMI, petroleum refineries, onshore natural gas

NESHAP: Benzene, vinyl chloride

MACT: Technology-base approach to source categories

What Source Categories Are Regulated?

HON: Hundreds of affected facilities

State: SOCMI, HON, MACT, existing sources

What Kind of Equipment is Regulated?

- Pumps, valves, compressors, pressure relief devices
- Sampling connections, open ended valves and lines
- Flanges and other connectors, product accumulator vessels
- Agitators and closed vent systems

Regulating Equipment Leaks: Three Types of Standards

- Performance Standards
  - "No detectable emissions"
  - 95% control reduction

Regulating Equipment Leaks: Three Types of Standards

- Equipment Standards
  - Equipment specifications
  - Design specifications
  - Operational specifications

Regulating Equipment Leaks: Three Types of Standards

- Work Practice Standards
  - leak detection and repair (LDAR)
    - detect the leak
    - repair the leak

Similarities in the Standards

- Covered equipment (basically the same)
- Leak definition (10,000 ppm for all standards; HON 500 ppm)
- All use Federal Reference Method 21

Similarities in the Standards

- Repair/retest procedures (basically the same)
- Recordkeeping/reporting (basically the same)

Differences in the Standards

- Exemptions(type of compressor, location of plant, plant size)
- Definition of light/heavy liquid (NSPS/SOCMI vs. natural gas refineries)
- Component labeling (NSPS vs. NESHAPs)
- Monitoring frequency (Federal vs. State)

Definitions

- Affected facility
  - NESHAP: Each piece of equipment
  - NSPS/HON: Process unit
- Process unit: Used in NSPSs
  - Specific to the subpart: "Components assembled to produce intermediate or final products from petroleum...and can operate independently from the facility..."

Definitions

- In VOC service
  - Components must be in VOC service to be covered by NSPS
  - "...piece of equipment contains a process fluid that is at least 10 percent VOC by weight."

Definitions

- Gaseous/vapor service
  - "...means piece of equipment contains process fluid that is in gaseous state at operating conditions."

Definitions

- In light liquid service
  - Vapor pressure of one or more components > 0.3 kPa @ 20° C (0.043 mm Hg @ 68° F)
  - Total concentration of the pure components having a vapor pressure of > 0.3 kPa @ 20° C, > 20 percent by weight and the fluid is liquid at operating conditions

Definitions

- In heavy liquid service
  - If not in light liquid service or gas/vapor service
  - If % evaporated is 10 % or less at 150° C (Natural Gas Processing)

Definitions

- VHAP (NESHAP Std)
  - Applies to benzene and vinyl chloride
- In VHAP service (NESHAP Std)
  - 10 % by weight benzene (gas or liquid);
  - 10% by weight or volume for vinyl chloride
- In organic HAPs (HON)
  - 5% by weight total organic HAPs

Three Factors Affect Controlling Fugitive VOCs

- Monitoring interval
- Leak definition
- Repair interval

Agency Leak Detection and Repair Program

- Level 1: Pre-inspection activities
- Level 2: On-site review and walk-through
- Level 3: FRM 21 evaluation

Three Modes of Monitoring

- Direct component inspection
- Plume imaging technologies
- Remote detection technologies

The Day In the Life of An Agency Inspector (Video)

- Level I: Source Information, Preparation for Inspection, Review of Records
- Level II: Pre-Inspection Meeting, In-plant Records Review, Walk-through Inspection, Closing Conference
- Level III: FRM 21 Evaluation

Defining Hazardous Air Pollutants (HAPs)

Jerry Winberry
EnviroTech Solutions

Objectives

- Know how to classify hazardous air pollutants (HAPs) according to boiling point and vapor pressure
- Recognize compounds within the various classifications of HAPs
- Identify manufacturers of portable VOC monitors which can meet Federal Method 21 specifications

The Clean Air Act Amendments of 1990, Title III

- Now contains a list of 188 HAPs
- 56 % Defined as Volatile Organic Compounds (VOCs)
- 35 % Defined as Semi-volatile Organic Compounds (SVOCs)
- 9 % Defined as Non-volatile Organic and Inorganic Compounds

Compounds Classified to Different Categories According To:

- Vapor Pressure (in mm Hg at 25 °C)
- Boiling Point Temperature (°C)

Volatility Classification

- VOC: 0.1 to 380 mm Hg
- SVOC: 10^{-1} to 10^{-7} mm Hg
- NVOC: < 10^{-7} mm Hg

Example of HAPs in each Volatility Class

VP (0.1- 380 mm Hg)

VOC (85 HAPs)

- Benzene 76 mm Hg
- Xylene 5 mm Hg
- Hydrazine 16 mm Hg
- Hydrochloric acid 23 mm Hg

Example of HAPs in each Volatility Class

VP (10^{-7} to 10^{-1} mm Hg)

SVOC (66 HAPs)

- Benzidine 10^{-5} mm Hg
- Captan 10^{-6} mm Hg
- Phosphorus 10^{-2} mm Hg
- Mercury Compounds 10^{-3} mm Hg

Example of HAPs in each Volatility Class

VP (< 10^{-7} mm Hg)

NVOC (17 HAPs)

- 3,3'-Dimethoxybenzidine 10^{-13} mm Hg
- 4,4'-Methylenedianiline 10^{-10} mm Hg
- Asbestos Very Low
- Cadmium Compounds Very Low

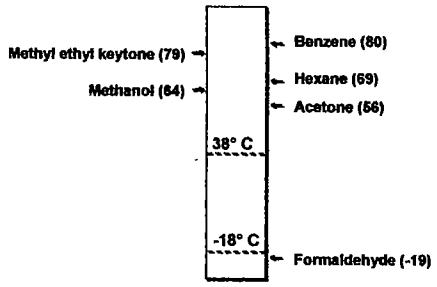
General Classification of HAPs

- Volatiles (VV/V) >10^{-1} mm Hg
  < 100 °C
- Semi-volatiles (SV) 10^{-1} to 10^{-7} mm Hg
  100-300 °C
- Particles (NV) <10^{-7} mm Hg
  > 300 °C

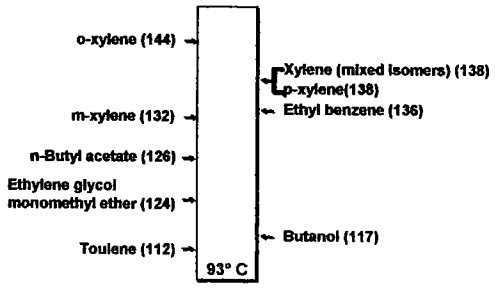
General Classification of HAPs

Classification	Vapor Pressure mm Hg	Boiling Point °C
Volatiles (VV/V)	$> 10^{-1}$	< 100°C
Semi-volatiles (SV)	10^{-1} to 10^{-7}	100 - 500°C
Particles (NV)	$< 10^{-7}$	> 500°C

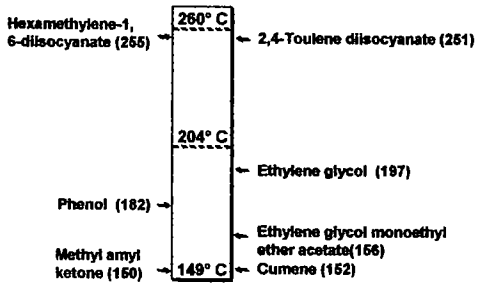
Boiling Points of Volatiles



Boiling Points of Semi-volatiles



Boiling Points of Semi-volatiles



Definitions

- In Gas/Vapor Service
  - "...means piece of equipment contains process fluid that is in gaseous state at operating conditions."

Definitions

- In VOC service (NSPS)
  - "...piece of equipment contains a process fluid that is at least 10 percent VOC by weight."

Definitions

- In Light Liquid Service if both of the following conditions apply:
  - Vapor pressure of one or more components > 0.3 kPa @ 20° C (0.043 mm Hg @ 68° F)
  - Total concentration of the pure components having a vapor pressure of > 0.3 kPa @ 20° C, > 20 percent by weight and the fluid is liquid at operating conditions

Definitions

- In Heavy Liquid Service
  - If not in light liquid service or gas/vapor service
  - If % evaporated is < 10 % at 150° C

Definitions

- In VHAP Service (NESHAP Std)
  - >10 % by weight benzene or vinyl chloride
- In Organic HAP (HON) Service
  - >5% by weight total organic HAPs
- In Vacuum Service
  - Operates at least 5 kPa below ambient pressure

Eight (8) Major Program Chemical Lists

- SOCMI list of chemicals (Subpart VV, 60.4890)
- HON list of chemicals/processes (Table 1 and 2)
- Clean Air Act Amendments of 1990 (CAAA of 1990), Title III Hazardous Air Pollutants (188 HAPs)
- CAAA of 1990, Title I photo-chemically active volatile organic compounds (VOCs)

Eight (8) Major Program Chemical Lists

- EPA's List of Urban Air Toxics (33 Air Toxics)
- EPA's List of Persistent Bioaccumulative Toxics (PBTs)
- EPA's Landfill Gases Compounds of Principle Concerns (COPCs)
- World Global Treaty of Dirty Dozen (12)

ATTACHMENT 1

LIST OF HAZARDOUS AIR POLLUTANTS

List of Hazardous Air Pollutants

CAS No.	Chemical name
75070	Acetaldehyde
60355	Acetamide
75058	Acetonitrile
98862	Acetophenone
53963	2-Acetylaminofluorine
107028	Acrolein
79061	Acrylamide
79107	Acrylic acid
107131	Acrylonitrile
107051	Allyl chloride
92671	4-Aminobiphenyl
62533	Aniline
90040	o-Anisidine
1332214	Asbestos
71432	Benzene (including benzene from gasoline)
92875	Benzidine
98077	Benzotrichloride (isomers and mixture)
100447	Benzyl chloride
92524	Biphenyl
117817	Bis(2-ethylhexyl)phthalate(DEHP)
542881	Bis(chloromethyl)ether
75252	Bromoform
106990	1,3-Butadiene
156627	Calcium cyanamide
133062	Captan
63252	Carbaryl
75150	Carbon disulfide
56235	Carbon tetrachloride
43581	Carbonyl sulfide
120809	Catechol
133904	Chloramben
57749	Chlordane
7782505	Chlorine
79118	Chloroacetic acid
532274	2-Chloroacetophenone
108907	Chlorobenzene
510156	Chlorobenzilate
67663	Chloroform
107302	Chloromethyl methyl ether
126998	Chloroprene
1319773	Cresols/Cresylic acid
95487	o-Cresol
108394	m-Cresol
106445	p-Cresol
98828	Cumene
94757	2,4-D, salts and esters
3547044	DDE
57147	1,1-Dimethyl hydrazine
334883	Diazomethane
132649	Dibenzofurans
96128	1,2-Dibromo-3-chloropropane
84742	Dibutylphthalate
106467	1,4-Dichlorobenzene(p)
91941	3,3-Dichlorobenzidene
111444	Dichloroethyl ether (Bis(2-chloroethyl ether)
542756	1,3-Dichloropropene
62737	Dichlorvos
111422	Diethanolamine
121697	N,N-Diethyl aniline (N,N-Dimethylaniline)
64675	Diethyl sulfate
119904	3,3-Dimethozybenzidine
60117	Dimethyl aminoazobenzene
119937	3,3'-Dimethyl benzidine
79447	Dimethyl carbamoyl chloride
68122	Dimethyl formamide
131113	Dimethyl phthalate
77781	Dimethyl sulfate
534521	4,6-Dinitro-o-cresol, and salts
51285	2,4-Dinitrophenol
121142	2,4-Dinitrotoluene
123911	1,4-Dioxane (1,4-Diethyleneoxide)
122667	1,2-Diphenylhydrazine
106898	Epichlorohydrin (1-Chloro-2,3-epoxypropane)
106887	1,2-Epoxybutane
140885	Ethyl acrylate
100414	Ethyl benzene
51796	Ethyl carbamate (Urethane)
75003	Ethyl chloride (Chloroethane)
106934	Ethylene dibromide (Dibromoethane)
107062	Ethylene dichloride (1,2-Dichloroethane)
107211	Ethylene glycol
151564	Ethylene imine (Aziridine)
75218	Ethylene oxide
96457	Ethylene thiourea
75343	Ethylidene dichloride (1,1-Dichloroethane)
50000	Formaldehyde
76448	Heptachlor
118741	Hexachlorobenzene
87683	Hexachlorobutadiene
77474	Hexachlorocyclopentadiene
67721	Hexachloroethane
822060	Hexamethylene-1,6-diisocyanate
680319	Hexamethylphosphoramide
110543	Hexane
302012	Hydrazine
7647010	Hydrochloric acid
7664393	Hydrogen fluoride (Hydrofluoric acid)
123319	Hydroquinone
78591	Isophorone
58899	Lindane (all isomers)
108316	Maleic anhydride
67561	Methanol
72435	Methoxychlor
74839	Methyl bromide (Bromomethane)
74873	Methyl chloride (Chloromethane)
71556	Methyl chloroform (1,1,1-Trichloroethane)
78933	Methyl ethyl ketone (2-Butanone)
60344	Methyl hydrazine
74884	Methyl iodide (Iodomethane)

List of Hazardous Air Pollutants (continued)

CAS No.	Chemical name
108101	Methyl isobutyl ketone (Hexone)
624839	Methyl isocyanate
80626	Methyl methacrylate
1634044	Methyl tert butyl ether
101144	4,4-Methylene bis(2-chloroaniline)
75092	Methylene chloride (Dichloromethane)
101688	Methylene diphenyl diisocyanate (MDI)
101779	4,4-'Methylenedianiline
91203	Naphthalene
98953	Nitrobenzene
92933	4-Nitrobiphenyl
100027	4-Nitrophenol
79469	2-Nitropropane
684935	N-Nitroso-N-methylurea
62759	N-Nitrosodimethylamine
59892	N-Nitrosomorpholine
56382	Parathion
82688	Pentachloronitrobenzene (Quintobenzene)
87865	Pentachlorophenol
108952	Phenol
106503	p-Phenylenediamine
75445	Phosgene
7803512	Phosphine
7723140	Phosphorus
85449	Phthalic anhydride
1336363	Polychlorinated biphenyls (Aroclors)
1120714	1,3-Propane sultone
57578	beta-Propiolactone
123386	Propionaldehyde
114261	Propoxur (Baygon)
78875	Propylene dichloride (1,2-Dichloropropane)

CAS No.	Chemical name
75569	Propylene oxide
75558	1,2-Propylenimine (2-Methyl aziridine)
91225	Quinoline
106514	Quinone
100425	Styrene
96093	Styrene oxide
1746016	2,3,7,8-Tetrachlorodi-benzo-p-dioxin
79345	1,1,2,2-Tetrachloro-ethane
127184	Tetrachloroethylene (Perchloroethylene)
7550450	Titanium tetrachloride
108883	Toluene
95807	2,4-Toluene diamine
584849	2,4-Toluene diisocyanate
95534	o-Toluidine
8001352	Toxaphene (chlorinated camphene)
120821	1,2,4-Trichlorobenzene
79005	1,1,2-Trichloroethane
79016	Trichloroethylene
95954	2,4,5-Trichlorophenol
88062	2,4,6-Trichlorophenol
121448	Triethylamine
1582098	Trifluralin
540841	2,2,4-Trimethylpentane
108054	Vinyl acetate
593602	Vinyl bromide
75014	Vinyl chloride
75354	Vinylidene chloride (1,1-Dichloroethylene)
1330207	Xylenes (isomers and mixture)
95476	o-Xylenes
108383	m-Xylenes
106423	p-Xylenes

List of Hazardous Air Pollutants

CAS No.	Chemical name
0	Antimony Compounds
0	Arsenic Compounds (inorganic including arsine)
0	Beryllium Compounds
0	Cadmium Compounds
0	Chromium Compounds
0	Cobalt Compounds
0	Coke Oven Emissions
0	Cyanide Compounds[a]
0	Glycol ethers[b]
0	Lead Compounds
0	Manganese Compounds
0	Mercury Compounds
0	Fine mineral fibers[c]
0	Nickel Compounds
0	Polycylic Organic Matter[d]
0	Radionuclides (including radon)[e]
0	Selenium Compounds

NOTE: For all listings above which contain the word "compounds" and for glycol ethers, the following applies: Unless otherwise specified, these listings are defined as including any unique chemical substance that contains the named chemical (i.e., antimony, arsenic, etc.) as part of that chemical's infrastructure.

[a]X'CN where X = H' or any other group where a formal dissociation may occur. For example KCN or $Ca(CN)_2$.

[b]Includes mono- and di-ethers of ethylene glycol, diethylene glycol, and triethylene glycol $R\text{-}(OCH2CH2)_n\text{-}OR'$ where

n = 1, 2, or 3

R = alkyl or aryl groups

R' = R, H, or groups which, when removed, yield glycol ethers with the structure: $R\text{-}(OCH2CH)_n\text{-}OH$

Polymers are excluded from the glycol category

[c]Includes glass microfibers, glass wool fibers, rock wool fibers, and slag wool fibers, each characterized as "respirable" (fiber diameter less than 3.5 micrometers) and possessing an aspect ratio (fiber length divided by fiber diameter) greater than or equal to 3, as emitted from production of fiber and fiber products.

[d]Includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100°C.

[e]A type of atom which spontaneously undergoes radioactive decay.

PAMS Target Volatile Organic Compounds

AIRS Parameter Code	Target Compound Name	AIRS Parameter Code	Target Compound Name
43203	Ethylene	43249	3-Methylhexane
43206	Acetylene	43250	2,2,4-Trimethylpentane (Isooctane)
43202	Ethane	43232	*n*-Heptane
43205	Propylene	43261	Methylcyclohexane
43204	Propane	43252	2,3,4-Trimethylpentane
43214	Isobutane	45202	Toluene
43280	1-Butene	43960	2-Methylheptane
43212	*n*-Butane	43253	3-Methylheptane
43216	*trans*-2-Butene	43233	*n*-Octane
43217	*cis*-2-Butene	45203	Ethylbenzene
43221	Isopentane	45109	*m/p*-Xylene
43224	1-Pentene	45220	Styrene
43220	*n*-Pentane	45204	*o*-Xylene
43243	Isoprene (2-Methyl-1,3-Butadiene)	43235	*n*-Nonane
43226	*trans*-2-Pentene	45210	Isopropylbenzene
43227	*cis*-2-Pentene	45209	*n*-Propylbenzene
43244	2,2-Dimethylbutane	45212	*m*-Ethyltoluene (1-Ethyl-3-Methylbenzene)
43242	Cyclopentane	45213	*p*-Ethyltoluene (1-Ethyl-4-Methylbenzene)
43284	2,3-Dimethylbutane	45207	1,3,5-Trimethylbenzene
43285	2-Methylpentane	45211	*o*-Ethyltoluene (1-Ethyl-2-Methylbenzene)
43230	3-Methylpentane	45208	1,2,4-Trimethylbenzene
43245	**1-Hexene***	43238	*n*-Decane
43231	*n*-Hexane	45225	1,2,3-Trimethylbenzene
43262	Methylcyclopentane	45218	*m*-Diethylbenzene
43247	2,4-Dimethylpentane	45219	*p*-Diethylbenzene
45201	Benzene	43954	*n*-Undecane
43248	Cylcohexane	43141	***n*-Dodecane***
43263	2-Methylhexane	43102	TNMOC
43291	2,3-Dimethylpentane	43000	PAMHC

* These compounds have been added as calibration and retention time standards primarily for the purpose of retention time verification. They can be quantitated at the discretion of the user.

federal register

Friday
April 22, 1994

Part V

Environmental Protection Agency

40 CFR Part 63

National Emission Standards for Hazardous Air Pollutants for Certain Source Categories; Final Rule

next semi-annual Periodic Report required by § 63.152(c) of subpart G of this part. If the leak remains unrepaired, the information shall also be submitted in each subsequent periodic report, until repair of the leak is reported.

(i) The owner or operator shall report the presence of the leak and the date that the leak was detected.

(ii) The owner or operator shall report whether or not the leak has been repaired.

(iii) The owner or operator shall report the reason(s) for delay of repair. If delay of repair is invoked due to the reasons described in paragraph (b)(3)(i) of this section, documentation of emissions estimates must also be submitted.

(iv) If the leak remains unrepaired, the owner or operator shall report the expected date of repair.

(v) If the leak is repaired, the owner or operator shall report the date of successful repair of the leak.

(c) An owner or operator is not required to meet the requirements in paragraphs (b)(1) and (b)(2) of this section if either of the conditions in paragraph (c)(1) or (c)(2) of this section are met.

(1) The heat exchange system is operated with the minimum pressure on the cooling water side at least 35 kilopascals greater than the maximum pressure on the process side.

(2) The once-through heat exchange system currently has an NPDES permit with an allowable discharge limit of less than 1 ppm.

§ 63.105 Maintenance wastewater requirements.

(a) Each owner or operator of a source subject to this subpart shall comply with the requirements of paragraphs (b) through (e) of this section for maintenance wastewaters containing those organic HAP's listed in table 2 of this subpart.

(b) The owner or operator shall prepare a description of maintenance procedures for management of wastewaters generated from the emptying and purging of equipment in the process during temporary shutdowns for inspections, maintenance, and repair (i.e., a maintenance-turnaround) and during periods which are not shutdowns (i.e., routine maintenance). The descriptions shall:

(1) Specify the process equipment or maintenance tasks that are anticipated to create wastewater during maintenance activities.

(2) Specify the procedures that will be allowed to properly manage the wastewater and control organic HAP emissions to the atmosphere; and

(3) Specify the procedures to be followed when clearing materials from process equipment.

(c) The owner or operator shall modify and update the information required by paragraph (b) of this section as needed following each maintenance procedure based on the actions taken and the wastewaters generated in the preceding maintenance procedure.

(d) The owner or operator shall implement the procedures described in paragraphs (b) and (c) of this section as part of the start-up, shutdown, and malfunction plan required under § 63.6(e)(3) of subpart A of this part.

(e) The owner or operator shall maintain a record of the information required by paragraphs (b) and (c) of this section as part of the start-up, shutdown, and malfunction plan required under § 63.6(e)(3) of subpart A of this part.

§ 63.106 Delegation of authority.

(a) In delegating implementation and enforcement authority to a State under section 112(d) of the Act, the authorities contained in paragraph (b) of this section shall be retained by the Administrator and not transferred to a State.

(b) Authorities which will not be delegated to States: § 63.102(b) of this subpart, § 63.150(i)(1) through (i)(4) of subpart G of this part, and § 63.177 of subpart H of this part.

TABLE 1 TO SUBPART F—SYNTHETIC ORGANIC CHEMICAL MANUFACTURING INDUSTRY CHEMICALS

Chemical name [a]	CAS No. [b]	Group
Acenaphthene	83329	V
Acetal	105577	V
Acetaldehyde	75070	II
Acetaldol	107891	II
Acetamide	60355	II
Acetanilide	103844	II
Acetic acid	64197	II
Acetic anhydride	108247	II
Acetoacetanilide	102012	III
Acetone	67641	I
Acetone cyanohydrin	75865	V
Acetonitrile	75058	I
Acetophenone	98862	I
Acrolein	107028	IV
Acrylamide	79061	I
Acrylic acid	79107	IV
Acrylonitrile	107131	I
Adiponitrile	111693	I
Alizarin	72480	V
Alkyl anthraquinones	008	V
Allyl alcohol	107186	I
Allyl chloride	107051	IV
Allyl cyanide	109751	IV
Aminophenol sulfonic acid.	0010	V
Aminophenol (p-)	123308	I
Aniline	62533	I
Aniline hydrochloride	142041	III

TABLE 1 TO SUBPART F—SYNTHETIC ORGANIC CHEMICAL MANUFACTURING INDUSTRY CHEMICALS—Continued

Chemical name [a]	CAS No. [b]	Group
Anisidine (o-)	90040	II
Anthracene	120127	V
Anthraquinone	84651	III
Azobenzene	103333	I
Benzaldehyde	100527	III
Benzene	71432	I
Benzenedisulfonic acid	98486	I
Benzenesulfonic acid	98113	I
Benzil	134816	III
Benzilic acid	76937	III
Benzoic acid	65850	III
Benzoin	119539	III
Benzonitrile	100470	III
Benzophenone	119619	I
Benzotrichloride	98077	III
Benzoyl chloride	98884	III
Benzyl acetate	140114	III
Benzyl alcohol	100516	III
Benzyl benzoate	120514	III
Benzyl chloride	100447	III
Benzyl dichloride	98873	III
Biphenyl	92524	I
Bisphenol A	80057	III
Bis(Chloromethyl) Ether.	542881	I
Bromobenzene	108861	I
Bromoform	75252	V
Bromonaphthalene	27497514	IV
Butadiene (1,3-)	106990	II
Butanediol (1,4-)	110634	I
Butyl acrylate (n-)	141322	V
Butylene glycol (1,3-)	107880	II
Butyrolacetone	96480	I
Caprolactam	105602	II
Carbaryl	63252	V
Carbazole	86748	V
Carbon disulfide	75150	IV
Carbon tetrabromide	558134	II
Carbon tetrachloride	56235	I
Carbon tetrafluoride	75730	II
Chloral	75876	II
Chloroacetic acid	79118	II
Chloroacetophenone (2-).	532274	I
Chloroaniline (p-)	106478	II
Chlorobenzene	108907	I
2-Chloro-1,3-butadiene (Chloroprene).	126998	II
Chlorodifluoroethane	25497294	V
Chlorodifluoromethane	75456	I
Chloroform	67663	I
Chloronaphthalene	25586430	IV
Chloronitrobenzene (m-).	121733	I
Chloronitrobenzene (o-).	88733	I
Chloronitrobenzene (p-).	100005	I
Chlorophenol (m-)	108430	II
Chlorophenol (o-)	95578	II
Chlorophenol (p-)	106489	II
Chlorotoluene (m-)	108418	III
Chlorotoluene (o-)	95498	III
Chlorotoluene (p-)	106434	III
Chlorotrifluoromethane	75729	II
Chrysene	218019	V
Cresol and cresylic acid (m-).	108394	III

TABLE 1 TO SUBPART F—SYNTHETIC ORGANIC CHEMICAL MANUFACTURING INDUSTRY CHEMICALS—Continued

Chemical name [a]	CAS No. [b]	Group
Cresol and cresylic acid (o-).	95487	III
Cresol and cresylic acid (p-).	106445	III
Cresols and cresylic acids (mixed).	1319773	III
Cumene	98828	I
Cumene hydroperoxide.	80159	I
Cyanoacetic acid	372098	II
Cyclohexane	110827	I
Cyclohexanol	108930	I
Cyclohexanone	108941	I
Cyclohexylamine	108918	III
Cyclooctadienes	29965977	II
Decahydronaphthalene.	91178	IV
Diacetoxy-2-Butene (1,4-).	0012	V
Diaminophenol hydrochloride.	137097	V
Dibromomethane	74953	V
Dichloroaniline (mixed isomers).	27134276	I
Dichlorobenzene (p-)	106467	I
Dichlorobenzene (m-)	541731	I
Dichlorobenzene (o-)	95501	I
Dichlorobenzidine (3,3'-).	91941	I
Dichlorodifluoromethane.	75718	I
Dichloroethane (1,2-) (Ethylenedichloride) (EDC).	107062	I
Dichloroethyl ether (bis(2-chloroethyl)ether).	111444	I
Dichloroethylene (1,2-)	540590	II
Dichlorophenol (2,4-)	120832	III
Dichloropropene (1,3-)	542756	II
Dichlorotetrafluoroethane.	1320372	V
Dichloro-1-butene (3,4-).	760236	II
Dichloro-2-butene (1,4-).	764410	V
Diethanolamine (2,2'-Iminodiethanol).	111422	I
Diethyl sulfate	64675	II
Diethylamine	109897	IV
Diethylaniline (2,6-)	579668	V
Diethylene glycol	111466	I
Diethylene glycol dibutyl ether.	112732	I
Diethylene glycol diethyl ether.	112367	I
Diethylene glycol dimethyl ether.	111956	I
Diethylene glycol monobutyl ether acetate.	124174	I
Diethylene glycol monobutyl ether.	112345	I
Diethylene glycol monoethyl ether acetate.	112152	I
Diethylene glycol monoethyl ether.	111900	I
Diethylene glycol monohexyl ether.	112594	V
Diethylene glycol monomethyl ether acetate.	629389	V
Diethylene glycol monomethyl ether.	111773	I
Dihydroxybenzoic acid (Resorcylic acid).	27138574	V
Dimethylbenzidine (3,3'-).	119937	II
Dimethyl ether	115106	IV
Dimethylformamide (N,N-).	68122	II
Dimethylhydrazine (1,1-).	57147	II
Dimethyl sulfate	77781	I
Dimethyl terephthalate	120616	II
Dimethylamine	124403	IV
Dimethylaminoethanol (2-).	108010	I
Dimethylaniline (N,N)	121697	III
Dinitrobenzenes (NOS) [c].	25154545	I
Dinitrophenol (2,4-)	51285	III
Dinitrotoluene (2,4-)	121142	III
Dioxane (1,4-) (1,4-Diethyleneoxide).	1239	III
Dioxolane (1,3-)	646060	I
Diphenyl methane	101815	I
Diphenyl oxide	101848	I
Diphenyl thiourea	102089	III
Diphenylamine	122394	III
Dipropylene glycol	110985	I
Di-o-tolyguanidine	97392	III
Dodecandedioic acid	693232	I
Dodecyl benzene (branched).	123013	V
Dodecyl phenol (branched).	121158585	V
Dodecylaniline	28675174	V
Dodecylbenzene (n-)	121013	I
Dodecylphenol	27193868	III
Epichlorohydrin (1-chloro-2,3-epoxypropane).	106898	I
Ethanolamine	141435	I
Ethyl acrylate	140885	II
Ethylbenzene	100414	I
Ethyl chloride (Chloroethane).	75003	IV
Ethyl chloroacetate	105395	II
Ethylamine	75047	V
Ethylaniline (N-)	103695	III
Ethylaniline (o-)	578541	III
Ethylcellulose	9004573	V
Ethylcyanoacetate	105566	V
Ethylene carbonate	96491	I
Ethylene dibromide (Dibromoethane).	106934	I
Ethylene glycol	107211	I
Ethylene glycol diacetate.	111557	I
Ethylene glycol dibutyl ether.	112481	V
Ethylene glycol diethyl ether (1,2-diethoxyethane).	629141	I
Ethylene glycol dimethyl ether.	110714	I
Ethylene glycol monoacetate.	542596	V
Ethylene glycol monobutyl ether acetate.	112072	I
Ethylene glycol monobutyl ether.	111762	I
Ethylene glycol monoethyl ether acetate.	111159	I
Ethylene glycol monoethyl ether.	110805	I
Ethylene glycol monohexyl ether.	112254	V
Ethylene glycol monomethyl ether acetate.	110496	I
Ethylene glycol monomethyl ether.	109864	I
Ethylene glycol monooctyl ether.	002	V
Ethylene glycol monophenyl ether.	122996	I
Ethylene glycol monopropyl ether.	2807309	I
Ethylene oxide	75218	I
Ethylenediamine	107153	II
Ethylenediamine tetraacetic acid.	60004	V
Ethylenimine (Aziridine).	151564	II
Ethylhexyl acrylate (2-isomer).	103117	II
Fluoranthene	206440	V
Formaldehyde	50000	I
Formamide	75127	II
Formic acid	64186	II
Fumaric acid	110178	I
Glutaraldehyde	111308	IV
Glyceraldehyde	367475	V
Glycerol	56815	II
Glycerol tri-(polyoxypropylene)ether.	25791962	II
Glycine	56406	II
Glyoxal	107222	II
Hexachlorobenzene	118741	II
Hexachlorobutadiene	87683	II
Hexachloroethane	67721	II
Hexadiene (1,4-)	592450	II
Hexamethylenetetramine.	100970	I
Hexane	110543	V
Hexanetriol (1,2,6-)	106694	IV
Hydroquinone	123319	I
Hydroxyadipaldehyde	141311	V
Isobutyl acrylate	106638	V
Isobutylene	115117	V
Isophorone	78591	IV
Isophorone nitrile	0017	V
Isophthalic acid	121915	III
Isopropylphenol	25168063	III
Linear alkylbenzene	___[d]	I
Maleic anhydride	108316	I
Maleic hydrazide	123331	I
Malic acid	6915157	I

TABLE 1 TO SUBPART F—SYNTHETIC ORGANIC CHEMICAL MANUFACTURING INDUSTRY CHEMICALS—Continued

Chemical name [a]	CAS No. [b]	Group
Metanilic acid	121471	I
Methacrylic acid	79414	V
Methanol	67561	IV
Methionine	63683	I
Methyl acetate	79209	IV
Methyl acrylate	96333	V
Methyl bromide (Bromomethane).	74839	IV
Methyl chloride (Chloromethane).	74873	IV
Methyl ethyl ketone (2-butanone).	78933	V
Methyl formate	107313	II
Methyl hydrazine	60344	IV
Methyl isobutyl carbinol.	108112	IV
Methyl isobutyl ketone (Hexone).	108101	IV
Methyl isocyanate	624839	IV
Methyl mercaptan	74931	IV
Methyl methacrylate	80626	IV
Methyl phenyl carbinol	98851	II
Methyl tert-butyl ether	1634044	V
Methylamine	74895	IV
Methylaniline (N-)	100618	III
Methylcyclohexane	108872	III
Methylcyclohexanol	25639423	V
Methylcyclohexanone	1331222	III
Methylene chloride (Dichloromethane).	75092	I
Methylene dianiline (4,4'-isomer).	101779	I
Methylene diphenyl diisocyanate (4,4'-) (MDI).	101688	III
Methylionones (a-)	79696	V
Methylpentynol	77758	V
Methylstyrene (a-)	98839	I
Naphthalene	91203	IV
Naphthalene sulfonic acid (a-).	85472	IV
Naphthalene sulfonic acid (b-).	120183	IV
Naphthol (a-)	90153	IV
Naphthol (b-)	135193	IV
Naphtholsulfonic acid (1-).	567180	V
Naphthylamine sulfonic acid (1,4-).	84866	V
Naphthylamine sulfonic acid (2,1-).	81163	V
Naphthylamine (1-)	134327	V
Naphthylamine (2-)	91598	V
Nitroaniline (m-)	99092	II
Nitroaniline (o-)	88744	I
Nitroanisole (o-)	91236	III
Nitroanisole (p-)	100174	III
Nitrobenzene	98953	I
Nitronaphthalene (1-)	86577	IV
Nitrophenol (p-)	100027	III
Nitrophenol (o-)	88755	III
Nitropropane (2-)	79469	II
Nitrotoluene (all isomers).	1321126	III
Nitrotoluene (o-)	88722	III
Nitrotoluene (m-)	99081	III
Nitrotoluene (p-)	99990	III
Nitroxylene	25168041	V

TABLE 1 TO SUBPART F—SYNTHETIC ORGANIC CHEMICAL MANUFACTURING INDUSTRY CHEMICALS—Continued

Chemical name [a]	CAS No. [b]	Group
Nonylbenzene (branched).	1081772	V
Nonylphenol	25154523	V
Octene-1	111660	I
Octylphenol	27193288	III
Paraformaldehyde	30525894	I
Paraldehyde	123637	II
Pentachlorophenol	87865	III
Pentaerythritol	115775	I
Peracetic acid	79210	II
Perchloromethyl mercaptan.	594423	IV
Phenanthrene	85018	V
Phenetidine (p-)	156434	III
Phenol	108952	III
Phenolphthalein	77098	III
Phenolsulfonic acids (all isomers).	1333397	III
Phenyl anthranilic acid (all isomers).	91407	III
Phenylenediamine (p-)	106503	I
Phloroglucinol	108736	III
Phosgene	75445	IV
Phthalic acid	88993	III
Phthalic anhydride	85449	III
Phthalimide	85416	III
Phthalonitrile	91156	III
Picoline (b-)	108996	II
Piperazine	110850	I
Polyethylene glycol	25322683	V
Polypropylene glycol	25322694	V
Propiolactone (beta-)	57578	I
Propionaldehyde	123386	IV
Propionic acid	79094	I
Propylene carbonate	108327	V
Propylene dichloride (1,2-dichloropropane).	78875	IV
Propylene glycol	57556	I
Propylene glycol monomethyl ether.	107982	I
Propylene oxide	75569	I
Pyrene	129000	V
Pyridine	110861	II
p-tert-Butyl-toluene	98511	III
Quinone	106514	III
Resorcinol	108463	I
Salicylic acid	69727	III
Sodium methoxide	124414	IV
Sodium phenate	139026	III
Stilbene	588590	III
Styrene	100425	I
Succinic acid	110156	I
Succinonitrile	110612	I
Sulfanilic acid	121573	III
Sulfolane	126330	II
Tartaric acid	526830	I
Terephthalic acid	100210	II
Tetrabromophthalic anhydride.	632791	III
Tetrachlorobenzene (1,2,4,5-).	95943	I
Tetrachloroethane (1,1,2,2-).	79345	II
Tetrachloroethylene (Perchloroethylene).	127184	I
Tetrachlorophthalic anhydride.	117088	III

TABLE 1 TO SUBPART F—SYNTHETIC ORGANIC CHEMICAL MANUFACTURING INDUSTRY CHEMICALS—Continued

Chemical name [a]	CAS No. [b]	Group
Tetraethyl lead	78002	IV
Tetraethylene glycol	112607	I
Tetraethylene-pentamine.	112572	V
Tetrahydrofuran	109999	I
Tetrahydronapthalene	119642	IV
Tetrahydrophthalic anhydride.	85438	II
Tetramethylene-diamine.	110601	II
Tetramethylethylenediamine.	110189	V
Tetramethyllead	75741	V
Thiocarbanilide	102089	V
Toluene	108883	I
Toluene 2,4 diamine	95807	II
Toluene 2,4 diisocyanate.	584849	II
Toluene diisocyanates (mixture).	26471625	II
Toluene sulfonic acids	104154	III
Toluenesulfonyl chloride.	98599	III
Toluidine (o-)	95534	II
Trichloroaniline (2,4,6-).	634935	III
Trichlorobenzene (1,2,3-).	87616	V
Trichlorobenzene (1,2,4-).	120821	I
Trichloroethane (1,1,1-).	71556	II
Trichloroethane (1,1,2-) (Vinyl trichloride).	79005	II
Trichloroethylene	79016	I
Trichlorofluoromethane	75694	I
Trichlorophenol (2,4,5-).	95954	I
(1,1,2-) Trichloro (1,2,2-) trifluoroethane.	76131	I
Triethanolamine	102716	I
Triethylamine	121448	IV
Triethylene glycol	112276	I
Triethylene glycol dimethyl ether.	112492	I
Triethylene glycol monoethyl ether.	112505	V
Triethylene glycol monomethyl ether.	112356	I
Trimethylamine	75503	IV
Trimethylcyclohexanol	933482	IV
Trimethylcyclohexanone.	2408379	IV
Trimethylcyclohexylamine.	34216347	V
Trimethylolpropane	77996	I
Trimethylpentane (2,2,4-).	540841	V
Tripropylene glycol	24800440	V
Vinyl acetate	108054	II
Vinyl chloride (Chloroethylene).	75014	I
Vinyl toluene	25013154	III
Vinylcyclohexene (4-)	100403	II
Vinylidene chloride (1,1-dichloroethylene).	75354	II

TABLE 1 TO SUBPART F—SYNTHETIC ORGANIC CHEMICAL MANUFACTURING INDUSTRY CHEMICALS—Continued

Chemical name[a]	CAS No.[b]	Group
Vinyl(N-)-pyrrolidone(2-).	88120	V
Xanthates	140896	V
Xylene sulfonic acid	25321419	III
Xylenes (NOS)[c]	1330207	I
Xylene (m-)	108383	I
Xylene (o-)	95476	I
Xylene (p-)	106423	I
Xylenols (Mixed)	1300716	V
Xylidene	1300738	III

[a] Isomer means all structural arrangements for the same number of atoms of each element and does not mean salts, esters, or derivatives.
[b] CAS Number = Chemical Abstract Service number.
[c] NOS = not otherwise specified.
[d] No CAS number assigned.

TABLE 2. TO SUBPART F—ORGANIC HAZARDOUS AIR POLLUTANTS

Chemical name[a,b]	CAS No.[c]
Acetaldehyde	75070
Acetamide	60355
Acetonitrile	75058
Acetophenone	98862
Acrolein	107028
Acrylamide	79061
Acrylic acid	79107
Acrylonitrile	107131
Allyl chloride	107051
Aniline	62533
Anisidine (o-)	90040
Benzene	71432
Benzotrichloride	98077
Benzyl chloride	100447
Biphenyl	92524
Bis(chloromethyl)ether	542881
Bromoform	75252
Butadiene (1,3-)	106990
Caprolactam	105602
Carbon disulfide	75150
Carbon tetrachloride	56235
Chloroacetic acid	79118
Chloroacetophenone (2-)	532274
Chlorobenzene	108907
2-Chloro-1,3-butadiene (Chloroprene).	126998
Chloroform	67663
Cresols and cresylic acids (mixed).	1319773
Cresol and cresylic acid (o-)	95487
Cresol and cresylic acid (m-)	108394
Cresol and cresylic acid (p-)	106445
Cumene	98828
Dichlorobenzene (p-)	106467

TABLE 2. TO SUBPART F—ORGANIC HAZARDOUS AIR POLLUTANTS—Continued

Chemical name[a,b]	CAS No.[c]
Dichlorobenzidine (3,3'-)	91941
Dichloroethane (1,2-) (Ethylene dichloride) (EDC).	107062
Dichloroethylether (Bis(2-chloroethyl)ether).	111444
Dichloropropene (1,3-)	542756
Diethanolamine (2,2'-Iminodiethanol).	111422
Dimethylaniline (N,N-)	121697
Diethyl sulfate	64675
Dimethylbenzidine (3,3'-)	119937
Dimethylformamide (N,N-)	68122
Dimethylhydrazine (1,1-)	57147
Dimethyl phthalate	131113
Dimethyl sulfate	77781
Dinitrophenol (2,4-)	51285
Dinitrotoluene (2,4-)	121142
Dioxane (1,4-) (1,4-Diethyleneoxide).	123911
1,2-Diphenylhydrazine	122667
Epichlorohydrin (1-Chloro-2,3-epoxypropane).	106898
Ethyl acrylate	140885
Ethylbenzene	100414
Ethyl chloride (Chloroethane)	75003
Ethylene dibromide (Dibromoethane).	106934
Ethylene glycol	107211
Ethylene oxide	75218
Ethylidene dichloride (1,1-Dichloroethane).	75343
Formaldehyde	50000
Glycol ethers[d]	
Hexachlorobenzene	118741
Hexachlorobutadiene	87683
Hexachloroethane	67721
Hexane	100543
Hydroquinone	123319
Isophorone	78591
Maleic anhydride	108316
Methanol	67561
Methyl bromide (Bromomethane)	74839
Methyl chloride (Chloromethane)	74873
Methyl ethyl ketone (2-Butanone).	78933
Methyl hydrazine	60344
Methyl isobutyl ketone (Hexone)	108101
Methyl isocyanate	624839
Methyl methacrylate	80626
Methyl tert-butyl ether	1634044
Methylene chloride (Dichloromethane).	75092
Methylene diphenyl diisocyanate (4,4'-) (MDI).	101688
Methylenedianiline (4,4'-)	101779
Naphthalene	91203
Nitrobenzene	98953
Nitrophenol (p-)	100027
Nitropropane (2-)	79469
Phenol	108952

TABLE 2. TO SUBPART F—ORGANI HAZARDOUS AIR POLLUTANTS—Continued

Chemical name[a,b]	CAS No.[c]
Phenylenediamine (p-)	10650
Phosgene	7544
Phthalic anhydride	8544
Polycyclic organic matter[e]	
Propiolactone (beta-)	5757
Propionaldehyde	12338
Propylene dichloride (1,2-Dichloropropane).	7887
Propylene oxide	7556
Quinone	10651
Styrene	10042
Tetrachloroethane (1,1,2,2-)	7934
Tetrachloroethylene (Perchloroethylene).	12718
Toluene	10888
Toluene diamine (2,4-)	9580
Toluene diisocyanate (2,4-)	584849
Toluidine (o-)	9553
Trichlorobenzene (1,2,4-)	120821
Trichloroethane (1,1,1-) (Methyl chloroform).	71556
Trichloroethane (1,1,2-) (Vinyl trichloride).	79005
Trichloroethylene	79016
Trichlorophenol (2,4,5-)	95954
Triethylamine	121448
Trimethylpentane (2,2,4-)	540841
Vinyl acetate	108054
Vinyl chloride (chloroethylene)	75014
Vinylidene chloride (1,1-Dichloroethylene).	75354
Xylenes (NOS)	1330207
Xylene (m-)	108383
Xylene (o-)	95476
Xylene (p-)	106423

[a] For all listings above containing the word "Compounds" and for glycol ethers, the following applies: Unless otherwise specified, these listings are defined as including any unique chemical substance that contains the named chemical (i.e., antimony, arsenic) as part of that chemical's infrastructure.
[b] Isomer means all structural arrangements for the same number of atoms of each element and does not mean salts, esters, or derivatives.
[c] CAS Number=Chemical Abstract Service number.
[d] Includes mono- and di- ethers of ethylene glycol, diethylene glycol, and triethylene glycol $R-(OCH_2CH_2)_n-OR'$ where:
n=1, 2, or 3;
R=alkyl or aryl groups; and
R'=R, H, or groups which, when removed, yield glycol ethers with the structure: $R-(OCH_2CH_2)_n-OH$
Polymers are excluded from the glycol category.
[e] Includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100 °C.

TABLE 3 TO SUBPART F—GENERAL PROVISIONS APPLICABILITY TO SUBPARTS F, G, AND H[a]

Reference	Applies to Subparts F, G, and H	Comment
63.1(a)(1)	Yes	Overlap clarified in §63.101, §63.111, §63.161.
63.1(a)(2)	Yes.	

EPA's List of 33 Urban Air Toxics

- Acetaldehyde
- Acrolein
- Acrylonitrile
- Arsenic Compounds
- Benzene
- Beryllium Compounds
- 1,3-Butadiene
- Cadmium Compounds
- Carbon Tetrachloride
- Chloroform
- Chromium Compounds
- Coke Oven Emissions
- 1,2-Dibromoethane
- 1,2-Dichloropropane
- 1,3-Dichloropropene
- Ethylene Dichloride
- Ethylene Oxide
- Formaldehyde
- Hexachlorobenzene
- Hydrazine
- Lead Compounds
- Manganese Compounds
- Mercury Compounds
- Methylene Chloride
- Nickel Compounds
- Polychlorinated Biphenyls (PCBs)
- Polycyclic Organic Matter (POM)
- Quinoline
- 1,1,2,2-Tetrachloroethane
- Tetrachloroethylene
- Trichloroethylene
- Vinyl Chloride
- Diesel Particulate Matter

EPA's List of Persistent Bioaccumulative Toxics (PBTs)

- Mercury
- Dioxin
- Polychlorinated Biphenyls (PBCs)
- Hexachlorobenzene
- Octochlorostyrene
- Organochlorine pesticides
    - Aldrin
    - Dieldrin
    - Chlordane
    - Mirex
    - Endrin
    - Toxaphene
    - DDT
    - Heptachlor
    - Lindane
- Polycyclic Aromatic Hydrocarbons (PAHs)

EPA's List of 33 Urban Air Toxics

- Acetaldehyde
- Acrolein
- Acrylonitrile
- Arsenic Compounds
- Benzene
- Beryllium Compounds
- 1,3-Butadiene
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- Carbon Tetrachloride
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- Coke Oven Emissions
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- 1,3-Dichloropropene
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- Nickel Compounds
- Polychlorinated Biphenyls (PCBs)
- Polycyclic Organic Matter (POM)
- Quinoline
- 1,1,2,2-Tetrachloroethane
- Tetrachloroethylene
- Trichloroethylene
- Vinyl Chloride
- Diesel Particulate Matter

EPA's List of Landfill Gas Compounds of Principle Concerns (COPCs)

- 1,1,1-Trichloroethane
- 1,1-Dichloroethene
- 1,2-Dichloroethane
- Acrylonitrile
- Benzene
- Carbon Tetrachloride
- Chlorobenzene
- Dichlorodifluoromethane
- Chloroform
- Dichlorobenzene
- Dichloromethane
- Ethyl Chloride
- Ethylene Dibromide
- Hydrogen Sulfide
- Mercury (Total)
- Perchloroethylene
- Toluene
- Trichloroethylene
- Vinyl Chloride
- Xylenes (All Isomers)

Global Treaty Banning World's Most Toxic Chemicals
(Dirty Dozen)

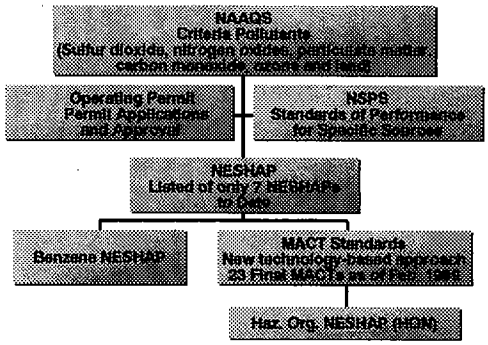
- Polychlorinated Biphenyls (PCBs)
- Dioxins
- DDT
- Furans
- Aldrin
- Hexachlorobenzene
- Chlordane
- Mirex
- Toxaphene
- Dieldrin
- Endrin
- Heptachlor

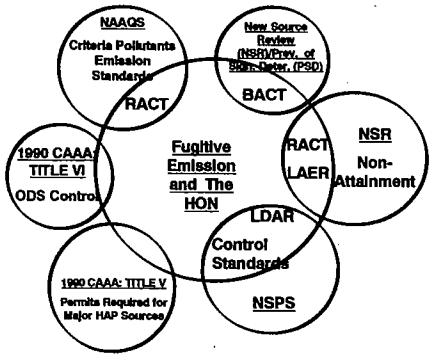
Survey of Regulations Requiring Fugitive Emission Monitoring

Jerry Winberry
EnviroTech Solutions

Lecture Objectives

- Provide an brief overview of the NSPS, NESHAP, and HON equipment leak standards
- Discuss the various standards applicable to the regulated equipment covered in the fugitive VOC regulations





Alphabet Soup

- NSPS = New Source Performance Standard
- NESHAP = National Emission Standard for Hazardous Air Pollutants

Alphabet Soup

- HON = Hazardous Organic NESHAP
- SIP = State Implementation Plan
- SOCMI = Synthetic Organic Chemical Manufacturing Industry

Alphabet Soup

- VOC = Volatile Organic Compound
- HAP = Hazardous Air Pollutants
- VHAP = Volatile Hazardous Air Pollutants
- Organic HAP= Organic Hazardous Air Pollutant

Philosophical Timeline

- 1970 (NSPS)- Emissions were performance base standards
- Sources required to apply best achievable control technology (BACT)

Philosophical Timeline

- 1970-77 (NESHAP)- NESHAP were risk base standards with an ample margin of safety
- 1990 (MACT)- Emissions were technology base standards, requiring control technology application to MACT/SOCMI/HON

NESHAP Standards (as of December, 1997)

Asbestos	March 31, 1971
Mercury	March 31, 1971
Beryllium	March 31, 1971
Vinyl Chloride	Dec. 24, 1975
Benzene	June 8, 1977
Radionuclides	Dec. 27, 1979
Arsenic	June 5, 1980

History of the Passage of the CAAA of 1990

- Failure to meet the ozone, carbon monoxide, particulate standards
- Only seven air toxics regulated in 20 years through NESHAP program
- Automotive emissions increasing
- Acid rain a growing concern

History/Background

- Debate on amendments started in the early 1980s
- Three major issues were either unaddressed or inadequately addressed by the 1977 amendments, including:

History/Background

- Nonattainment Areas
- Air Toxics
- Acid Rain

- Despite SIPs, many nonattainment areas remained

History/Background

- The NESHAP process was very awkward, and EPA regulated few pollutants; states started their own toxic programs
- NESHAP policy established "Zero risk-absolute protection"

History/Background

- The 1977 amendments addressed only the local ambient concentrations of SO_2 and NO_x; long-range transport and acid precipitation was not addressed

Titles of The CAAA of 1990

Title I	Nonattainment
Title II	Mobile Sources/Clean Fuels
Title III	Hazardous Air Pollutants
Title IV	Acid Rain
Title V	Permits
Title VI	Ozone Depletion/ Global Warming
Titles VII-XI	Miscellaneous, Research, Enforcement

Key Features of Title I and III of CAAA of 1990

- Title I: Nonattainment
  - New round of SIPs/FIPs
  - Tighter controls of VOC emissions on existing and new plants

Key Features of Title I and III of CAAA of 1990

- Title III: Air Toxics
  - Now 188 designated substances to be regulated
  - Application of MACT
  - 10^{-6} residual risk/accidental releases

CAAA of 1990, Title I Impact on Industry

- Required Reasonable Available Control Technology (RACT)
- States must revise SIPs following new Control Technology Guidelines (CTGs)

CAAA of 1990, Title I Impact on Industry

- Emission reduction of VOCs of 15% over five years (3%/yr) as determined by enhanced ozone monitoring program
- Tighter requirements for expansion/modernization

Title III HAPs

- Promulgated because NESHAP program not working
- Now list of 188 designated substances
- Awards associated with early achievement of 90 % reduction

Title III HAPs

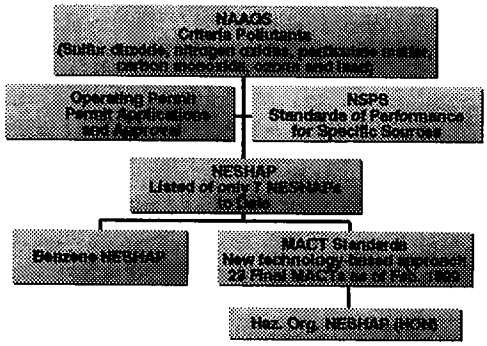
- May require additional controls after MACT to 10^{-6} residual risk
- Must have program for accidental releases

CAAA of 1990, Title III Impact on Industry

- Application of MACT
- Standards are technology-based
- May have to control after MACT to 10^{-6}
- MACT controls will require emission reduction of 75 to 90 % below current levels

CAAA of 1990, Title III Impact on Industry

- MACT required for all major sources (>10 tons/yr or 25 tons/yr) for combination of HAPs



Equipment Leak Regulations NSPS (40 CFR 60)

- Subpart VV: SOCMI (Subpart VV, 60.489 List)
- Subpart GGG: Petroleum Refineries
- Subpart KKK: Onshore Natural Gas Processing
- Subpart DDD: Polymer Manufacturing Industry

Subpart GGG: Petroleum Refineries

- "Rectroactive" to January 4, 1983
- Applies to process units and compressors
- Alternative definition for light liquid (>10% evaporates at 150° C)

Subpart GGG: Petroleum Refineries

- Exemptions:
  - Subpart VV or KKK
  - Process units on Alaska North Shore
  - Compressors in H_2 service (>50% H_2)

Subpart KKK: Onshore Natural Gas Processing

- "Rectroactive" to January 20, 1984
- Applies to process units and compressors
- Alternative definition for light liquid (>10% evaporates at 150° C) and for heavy liquid (<10% evaporate at 150° C)

Subpart KKK: Onshore Natural Gas Processing

- Exemptions:
  - Sampling connections
  - < 10 million scfd design capacity
  - Process units on Alaska North Shore

Subpart DDD: Polymer Manufacturing Plants

- Promulgated in 1984
- Applies to those polymer manufacturing plants that produce polypropylene, polyethylene, polystyrene, and copolymers

Subpart DDD: Polymer Manufacturing Plants

- Exemptions:
  - < 1,000 Mg/yr
  - Pumps in LLS using bleed port

Subpart VV: Synthetic Organic Chemicals Manufacturing Industry

- Broad source category that covers plants that produce many types of organic chemicals (List found in 60.489)
- Promulgated October 18, 1983

Subpart VV: Synthetic Organic Chemicals Manufacturing Industry

- Subpart VV contains the basic requirements of a source leak detection and repair program (LDAR)

Subpart VV Components of a LDAR Program

- 1.Standards for process equipment in "light liquid service."
- 2.Requirements for first attempt to repair equipment when leak is detected (5 days) and maximum days to repair (15 days)

Typical Components of a LDAR Program

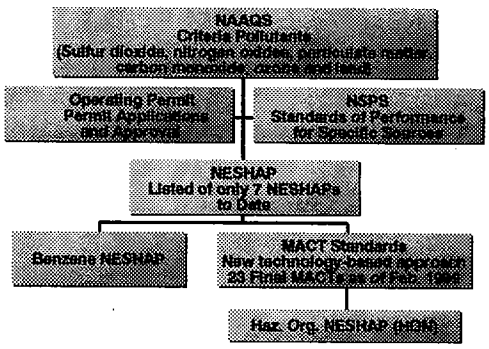
- 3.Exemptions for pumps with barrier fluids
- 4.Stated maximum percent (3%) for "difficult-to-monitor" valves

Components of LDAR

- 5.Alternative standards (skip periods) for well controlled fugitive emissions from valves (<2.0%)
- 6.Guidance on implementing Method 21 test procedures

Components of LDAR

- 7.Stated recordkeeping and reporting requirements associated with the LDAR program
- 8.List of chemicals VOCs regulated under Subpart VV
- 9."No detectable emissions" for pumps



Equipment Leaks Regulations Found Under NESHAP (40CFR 61)

- Subpart F: Vinyl chloride
- Subpart J: Benzene (Incorporates Subpart V)
- Subpart V: Fugitive Emissions Sources (VHAP Equipment Leaks)

Subpart F: Vinyl Chloride (40CFR61)

- Applies to plants which produce ethylene dichloride, vinyl chloride, polymers containing polymerized vinyl chloride

Subpart F: Vinyl Chloride (40CFR61)

- Exemptions:
  - R&D < 50 gallons (< requirements for 50 to 1,075 gallons)
  - Equipment in vacuum service
  - If process has < 2% leaking valves, then recordkeeping and reporting requirements different along with no marking of valves

Subpart J: Benzene (40CFR61)

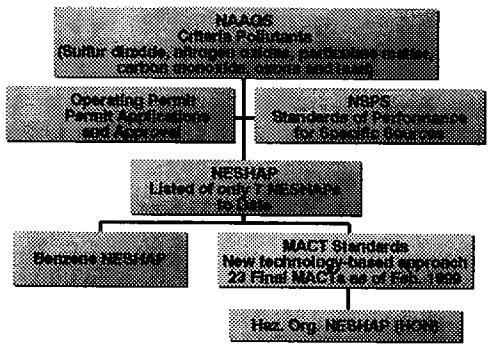
- 10% or more in process fluid (In benzene service)
- Applies to individual pieces of equipment

Subpart J: Benzene (40CFR61)

- Exemptions:
  - Plant design < 1,100 tons/yr
  - No equipment in benzene service
  - Coke by-product plants
  - Equipment in vacuum service

Subpart V: Fugitive Emission Sources

- Covers all equipment that is in contact with the process fluid that is at least 10% by weight a VOC or VHAP
- Standard addresses similar LDAR program requirements found in Subpart VV of 40CFR60, NSPS



MACT Standards (40CFR63)

- 188 HAPs listed in CAAA of 1990
- 174 source categories listed by EPA that emit one or more of listed pollutants
- Source categories divided into bins
- Maximum achievable control technology (MACT) applied to reduce list of 188 emissions

MACT Standards Application

- EPA has regulated at least 65% of Categories/Subcategories by 1998
- EPA has regulated 100% of Categories by 2000 (on schedule)
- MACT Based on Average of Top 1/8 Performers within Category/ Subcategory

MACT Source Bins

2 Year	11/15/92	6 Source Categories
4 Year	11/15/94	39 Source Categories
7 Year	11/15/97	42 Source Categories
10 Year	11/15/00	87 Source Categories

Examples of MACT Bins (40CFR63)

2 Year Bin: Dry Cleaners (Subpart M)
HON (Subpart M)
4 Year Bin: Aerospace (Subpart GG)
Marine Vessels (Subpart Y)
7 Year Bin: Lead Smelting (Subpart X)
Shipbuilding (Subpart XX)
10 Year Bin: Large Appliances,
Leather Tanning,
Semi-Conductor

Section 112(c)(6) Additional Standards

- 7 pollutants (Alkylated lead compounds, POM, Hexachlorobenzene (HCB), Mercury, PCBs (2,3,7,8-TCDD-Dioxin), 2,3,7,8-TCDF-Furans) combined as TEQ (Toxic Equivalents)

Section 112(c)(6) Additional Standards

- Add 2 new categories to MACT list
  - -Open Burning of Scrap Tires
  - -Gasoline Distribution Aviation Fuel

Section 112 Additional Standards

- Add area sources for some categories already addressed by MACT

Additional Standards

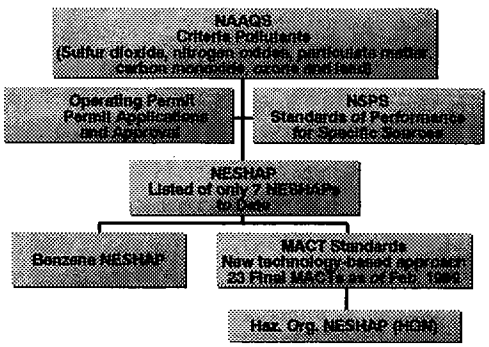
- Section 112(k): 34 New Area Source Categories and Program
- Residual Risk (10^{-6}) MACT Categories Evaluated

MACT Hammer

"If EPA fails to promulgate these standards by the required date, CAA Section 112(j) requires that EPA undertake case-by-case MACT determinations, which would then be incorporated into individual Title V permits..."

MACT Hammer

"A case-by-case MACT is expected to be based on what the federal MACT standard probably would have been, but in reality will likely be overprotective..."



HON Overview (40CFR63)

- Regulates 111 listed SOCMI organic HAPs and 21 polycyclic organic compounds
- Final rule: 4/28/94, 6/6/94
  Most recent revision: 1/17/97

CFR Location and Contents

Found in 40 CFR Part 63

- Subpart F (63.100-106)
- Subpart G (63.110-152)
- Subpart H (63.160-182)
- Subpart I (63.190-193)

Hazardous Organic NESHAP(HON) (40CFR63)

- Subpart F: SOCMI applicability, definitions, reporting, recordkeeping
- Subpart G: SOCMI storage tanks, process vents, transfer operations, wastewater

Hazardous Organic NESHAP(HON) (40CFR63)

- Subpart H: SOCMI equipment leaks
- Subpart I: Non-SOCMI processes

HON Regulations for SOCMI (40CFR63)

- "Retroactive " to January 5, 1981
- Industries that produce one or more chemicals listed in Table 1 of Subpart F
- Used as a reactant or manufacture as a product listed in Table 2 of Subpart F

HON Regulations for SOCMI (40CFR63)

- Process streams that contain 10% or more VOCs
- Applicable to process units

SOCMI Exemptions

- Design capacity < 1,100 tons/yr
- Only heavy liquid chemicals produced from heavy liquid feed or raw material
- Beverage alcohol production
- No equipment in "VOC service"
- Equipment in vacuum service

HON Covers

- 453 organic chemical manufacturing processes
- 385 SOCMI products (Table 1 in regulation)
- 112 organic HAPs emitted from SOCMI processes (Table 2 in the regulations)

Why HON?

- Existing regulations weren't working to control HAPs (only 60-70% reduction)
- New data shows reductions in leak rates can be better achieved (90-95% reduction)
- EPA decides on new regulatory approach... like HON

Difficulty in Rule Setting

- Can a simple set of rules apply for all plants?
- How to provide more flexibility in achieving lower leak rates than provided by LDAR

Difficulty in Rule Setting

- How to apply standards across the industry with data from only a part of the industry
- Need to be consistent with MACT requirements

Rule-making Process

- Committee formed April 25, 1989 to lead EPA in new regulatory approach
- HON part of NESHAP and covers equipment leaks and other emission points

Rule-making Process

- Applicable to equipment in VHAP service (> 300 hours)
- 453 processes that make or use VHAPS
- Same equipment regulated as other fugitive emission rules

Advantages of Reg Neg

- Limited long-run time and resource savings
- Face-to-face involvement of parties
- Build trust and respect
- Develop working relationships

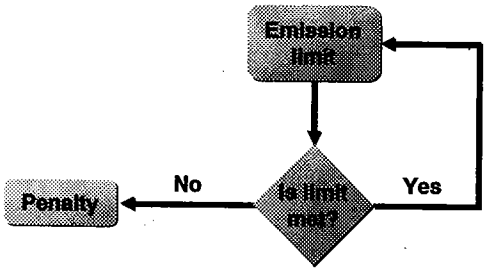
Advantages of Reg Neg

- Reduce litigation
- Broader acceptance of standards
- More pragmatic/cost-effective regulation

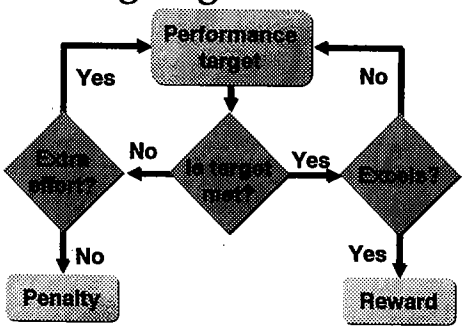
Disadvantages of Reg Neg

- Short-term resource intensive
- More complex regulation, therefore a lot more extra provisions due to so many involved in the process.

Traditional Reg Structure



Reg Neg Structure



Why Negotiate Equipment Leaks?

- Typical SOCMI process unit has over 3,000 components (valves, flanges, connectors)
- This equals roughly 1/3 of total uncontrolled plant emissions
- Impact of equipment leak emissions much greater than equal amount of stack emissions

Why Negotiate Equipment Leaks?

- Need to develop MACT standards quicker
- Need to develop better regulatory framework (negotiate rather than confront)

Why Negotiate Equipment Leaks?

- No more "command and control," rather "performance oriented standard."
- Need to build consensus
- Data not always available for sources being regulated

What's Covered?

- Affected equipment: Contains or contacts a fluid that is at least 5% HAP:
  - Pumps
  - Valves
  - Connectors
  - Compressors
  - Agitators
  - Closed vent systems & control devices

Key Elements of Reg Neg HON Rule

- Lower definition of "in VOC/VHAP service"
  - 10 weight % VOC is now 5 weight % HAPs
- Lower leak definition for regulated components

Key Elements of Reg Neg HON Rule

- Valves: 10,000 ppm to 500 ppm
- Pumps: 10,000 ppm to 1,000-5,000 (Depending upon service)
- Connectors: Was visual to 500 ppm (Must now check with monitor)

Key Elements

- Now LDAR for connectors and agitators
- LDAR and performance provisions for valves, pumps and connectors
- Standards for pumps and valves become more restrictive over time (Phase things into the program: Phase I, Phase II, and Phase III)

Key Elements

- Standard more performance-oriented
- "Rewards" for continued better performance: Less frequent monitoring
- "Penalties" for inferior performance: More frequent monitoring (valves)

Key Elements

- "Quality Improvement Program (QIP)" instead of noncompliance or violation (If "out-of-compliance," do more frequent monitoring)
- This is the "Safety Net!"

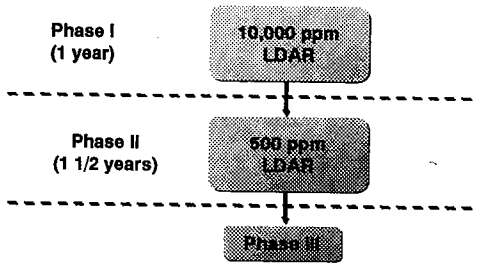
What is a Quality Improvement Program (QIP)?

- New innovative approach
- QIP requires replacement of "poorer-performing" equipment with superior technology
- QIP achieves emission reduction without lengthy enforcement action
- Operators focus on improving poor-performers

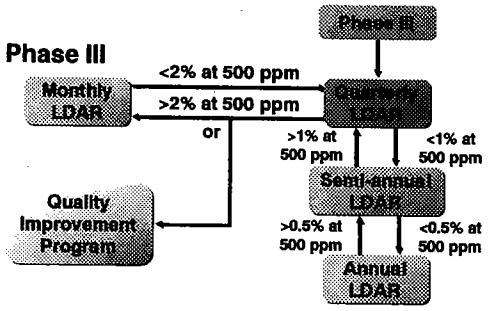
QIP Program

- Gather information
- Determine superior technologies
- Specify that equipment replacement take place until base performance level is reached
- Allows plants exceeding levels to achieve compliance without incurring penalties or being in noncompliance

Valve Standard (Phases I&II)



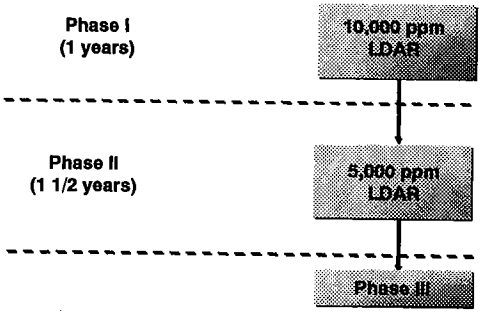
Valve Standard (Phase III)



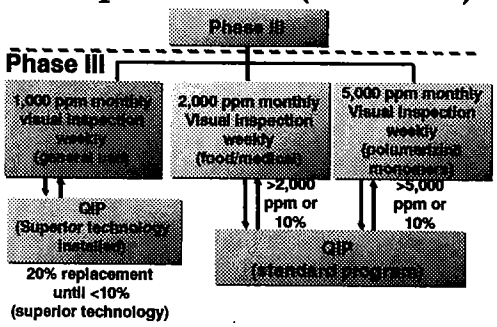
HON Standard for Valves

- Require quarterly monitoring in Phases I and II
- Phase III Performance:
  - 2% or greater Leakers: Monitor monthly or implement QIP and monitor quarterly
  - < 2% Leakers: Quarterly
  - < 1 % Leakers: Every 2 quarters
  - < 0.5 % Leakers: Every 4 quarters

Pump Standard (Phase I&II)



Pump Standard (Phase III)



HON Standards for Pumps (Phase III)

- LDAR program with leak definition:
  - 5,000 ppm pumps in polymerizing monomers service
  - 2,000 ppm pumps food/medical service
  - 1,000 ppm all other processes

HON Standards for Pumps

- Base equipment performance level
- Weekly visual inspection
- Minimum monthly leak detection
- If, on a 6 month rolling average,
  - 10% of the pumps in the process unit leak or
  - 3 pumps in a process unit leak, then must initiate QIP

Pumps Exempt from HON Standard

- Dual mechanical seal systems with barrier fluid system
- Barrier fluid system is in heavy liquid service

Pumps Exempt from HON Standard

- Weekly visual inspection for indications of liquid dripping from pump seal
- Sensors to detect failure of seal system

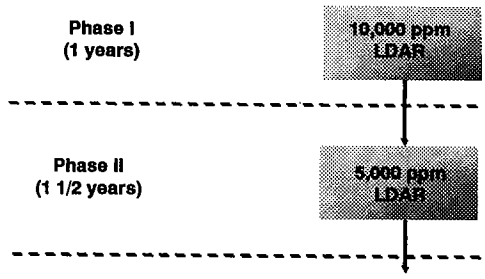
Additional Pump Standards

- "No Detectable Emissions" category if instrument reading of < 500 ppm
- No external actuated shaft penetrating pump housing

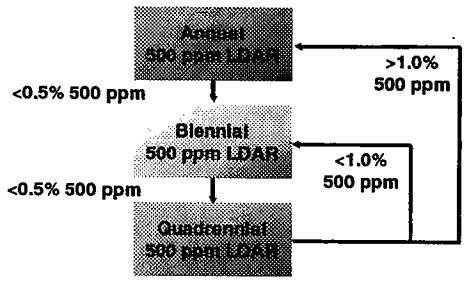
Additional Pump Standards

- Test for compliance
  - Initially
  - Annually
  - As requested by Administrator

Connector Standard (Phase I & II)



Connector Standard (Phase III)



HON Standard for Connectors

- 0.5% or greater Leakers: Once a calendar year
- < 0.5% Leakers in last year: Once every 2 years or at least 40% during year 1 and remaining during year 2

HON Standard for Connectors

- < 0.5% Leakers during the last 2 years: Once every 4 years or at least 20% every year until all are monitored

HON Standard for Connectors

- Yearly monitoring
- Base performance:
  - < 0.5% leaking components
  - 500 ppm leak definition

HON Standard for Other Equipment

- Same as 40CFR61, Subpart V (Equipment Leaks)
- Agitators-LDAR, leak definition at 10,000 ppm

HON Standard for Other Equipment

- Monitor when evidence of a leak for:
  - Pumps, valves, connectors, and agitators in heavy liquid service
  - Pressure relief devices in liquid service

HON Applicability

Must meet the following:

- Major HAP source
- Subject chemical manufacturing process units (CMPUs)
- Subject equipment
- New or existing source
- Emission points

Major HAP Source

- Stationary source or group that emits:
  - 10 tons/year of a HAP or
  - 25 tons/year of any combination of HAPs

Subject CMPUs

- SOCMI unit
- HON chemical used as reactant or manufactured in CMPU
- Plant site = major HAP source

Subject Equipment

- In general, if a listed SOCMI process for producing the listed chemicals (40 CFR 63 Subpart F Table 1)
- A listed organic HAP is produced or used as a reactant (40 CFR 63 Subpart F Table 2)

Subject Equipment

- "In organic HAP service" - equipment that contains or contacts a fluid that is 5% by weight of total organic HAP

Subpart F

- Contains provisions for determining applicability of the HON (SOCMI process defined by a list of products, if HAP used or produced)
- Definitions
- General procedures for testing, compliance, reporting, and recordkeeping
- Lists of SOCMI and organic HAPs

Subpart G

- Specific control (process vents, storage vessels, transfer operations etc.), monitoring, reporting, and recordkeeping requirements
- Referemce Control Technology (RCT)
  - Most widely applicable controls
  - Similar to existing HESHAP and NSPS
- Provisions for emissions averaging

Subpart H

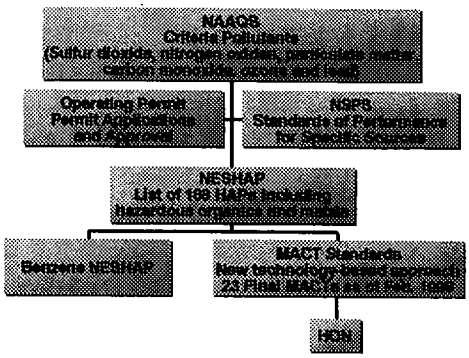
- Work practice standard
  - based on pre-existing equipment leakd standard
    - LDAR program
    - Improved maintenance

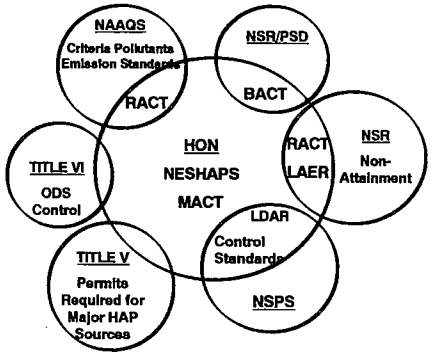
Subpart H

- Specific control, monitoring, reporting, and recordkeeping requirements for equipment leaks from SOCMI processes
- Staggered implementation

Subpart I

- Provides applicability criteria for non-SOCMI processes subject to regulation for equipment leaks
  - Styrene-butadiene ruber production
  - Polybutadiene rubber production
  - Certain pesticide production
  - Certain pharmaceutical production
  - Certain polymers and resins production





Department of Justice

Complaints Against
Petroleum Refineries

Petroleum Refiners

- **Motiva Enterprises LLC/4 Refineries/830,000 barrels per day**
  - **DE, LA, TX**
- **Equilon Enterprises LLC/4 Refineries/460,000 barrels per day**
  - **CA, WA**
- **Deer Park Refining/1 Refinery/830,000 barrels per day**
  - **TX**

Nature of Action

"All of the Companies' refineries have been and are in violation of EPA's regulations implementing the following Clean Air Act statutory and regulatory requirements:

- Part C of Title I: Prevention of Significant Deterioration (PSD)
- Part D of the Act: New Source Review (NSR)
- 40CFR60, Subpart J: New Source Performance Standards (NSPS)

Nature of Action

"All of the Companies' refineries have been and are in violation of EPA's regulations implementing the following Clean Air Act statutory and regulatory requirements:

- 40CFR60/63: Leak Detection and Repair (LDAR)

- 40CFR61: National Emission Standards for Hazardous Air Pollutants (NESHAP) for Benzene

Department of Justice Claims

- Failure to initially comply with the leak detection and repair (LDAR) requirements, including the use of Federal Reference Method 21
- Lack of:
  - Accurately monitoring
  - Failure to report leaking components
  - Failure to repair in a timely manner

Department of Justice Claims

- Failure to monitor all valves that were subject to the requirements
  - In benzene service: 40CFR61 (NESHAP), SubPart V: Equipment Leaks
  - In VOC service: 40CFR60 (SOCMI), SubPart VV: Equipment Leaks

Consent Decree (3/21/2001)

"Consent decrees filed in federal court in Houston call for the companies to spend an estimated $400 million to install up-to-date pollution-control equipment and significantly reduce emissions from process units, wastewater vents, leaking valves, and flares throughout the refineries."

- *$9.5 million civil penalty*
- *$5.5 million on environmental projects in communities affected by the refineries' pollution*

Consent Decree LDAR Program Enhancements

- Written Refinery-Wide Program for LDAR Compliance
  - Leak-rate goal for refinery-wide program
  - Identification of all valves and pumps
  - Process for identifying all valves and pumps

Consent Decree LDAR Program Enhancements

- Procedures for repairing and tracking leaking components
- Identifying and including new valves/pumps
- Identifying and evaluating new replacement equipment

Consent Decree LDAR Program Enhancements

- Training
  - New employees
  - Existing employees (Annual)
  - Operator and maintenance personnel(Annual review course)

Consent Decree LDAR Program Enhancements

- LDAR Audits
  - Refinery wide audit
  - Audit program (Internal/External)
    - Comparative monitoring ... leak rate
    - Records review
    - Tagging
    - Data management
    - Observation of LDAR technicians involving calibration and monitoring techniques

Consent Decree: LDAR Audits

- External Audits
  - Once every four years
- Internal Audits
  - Once every four years
  - Internal from one refinery to another conducted by personnel familiar with LDAR programs and regulations

Consent Decree LDAR Program Enhancements

- Pump Leak Definition
  - 2,000 ppm
- Valve Leak Definition
  - 500 ppm

Consent Decree LDAR Program Enhancements

- Repairs
  - > 500 ppm, 30-days to repair
  - >2000 ppm, 30-days top repair
  - > 100 ppm valve, 1st attempt to repair
- LDAR Monitoring Frequency
  - More frequent monitoring

Consent Decree LDAR Program Enhancements

- Dataloggers
  - Time/date stamp
  - Time between monitoring events
  - Instrument identification

Consent Decree LDAR Program Enhancements

- LDAR Data QA/QC
  - Daily Review
    - # of components monitored per technician
    - Time between monitoring events
    - Adnormal data patterns

Consent Decree LDAR Program Enhancements

- LDAR Personnel
  - Accountability of person on staff/within facility
- Monitoring After Turnaround or Maintenance
- Calibration Drift Assessment (+/- 10 %)
- Delay of Repair

Consent Decree LDAR Program Enhancements

- Quarterly Progress Report
  - Annual results of audits
  - Certification of implementation of calibration drift FRM 21 requirements
  - Certification of implementation of "Delay-of-Repair"
  - Certification of implementation of "First Attempt Repair"

Consent Decree LDAR Program Enhancements

- Quarterly Progress Report (Cont'd)
  - Description of accountability program
  - Status report of dataloggers
  - Written LDAR program
  - Description of training program

Consent Decree LDAR Program Enhancements

- Quarterly Monitoring Report
  - List of process units monitored during quarter
  - Compliance with quarterly monitoring on "Sustainable Skip Period" program
  - Number of valves and pumps monitored in each unit
  - Number of valves and pumps found leaking

Consent Decree LDAR Program Enhancements

- Quarterly Monitoring Report (Cont'd)
  - Number of "Difficult-to-Monitor" components
  - Projected month for next monitoring event
  - Number of valves and pumps on "Delay-of-Repair"

In Summary, Common Violations

- Failure to identify process units and components that must be monitored (especially new sources from additions or modifications)
- Failure to followed established monitoring procedures

In Summary, Common Violations

- Use of incorrect or expired calibration gases
- Failure to repair components within specified timeframes
- Failure to submit quarterly reports and maintain appropriate calibration and/or monitoring records

Enforcement *Trends*

EPA

- EPA is increasing presence at all levels
- Refineries - Significant Fines and Consent Decrees – Now
- Other process sources under review
  - Cooling tower emissions
- Pulp & Paper - Cluster Rule - Now
  - Kraft - Methanol
  - Sulfite
  - Bleach

More Enforcement *Trends*

EPA

- Oilseed producers - Now

  (n-hexane & VOC)
  - Cornseed, Soybean, Cottonseed
- Paint and Coatings – Upcoming
- Leather processors - Upcoming

In General, Consent Decrees...

- Increase in consent decrees
- More stringent leak definitions
  - Depends on process
  - Reduce from 10,000 ppm to 2,000 ppm or 500 ppm
- Increased scope of training
  - More frequent training
  - Must include contract personnel

...Consent Decrees

- Increased LDAR audits
- Increased datalogging requirements
- Calibration
  - ONLY with methane
  - Calibration drift assessment required at the end of each shift
  - Negative drift of >10% requires remonitoring

Next Generation of Consent Decrees...

- Pulp & Paper Plants

- Oilseed Producers

- Paint and Coating Operations

MACT Emission Standards

- Pesticide Active Ingredient (PAI) Production
- 40 CFR 63, Subpart MMM

PAI Manufacturing Unit

- "...means a process unit that is used to produce a material that is primarily used as a PAI or integral intermediate. A PAI unit consist of:
  - The Process
  - Associated Storage Vessels
  - Equipment (i.e., valves, flanges, pumps etc.)
  - Instrumentation System
  - Wastewater System

Pesticide Active Ingredient 40CFR63, Subpart MMM

- Who's Covered
  - Is a major source of HAP emissions (i.e., > 10 tons/yr) of single HAP or > 25 tons/yr combination of HAPs
  - Manufactures at least one pesticide active ingredient (PAI)
  - Is not exempt

Pesticide Active Ingredient 40CFR63, Subpart MMM

- What PAIs are covered:
  - 4-Chlor-2-Methyl Acid Production
  - 2,4 Salts and Esters Production
  - 4,6-Dinitro-o-Cresol Production
  - Butadiene Furfural Cotrimer
  - Captafol Production
  - Captan Production

Pesticide Active Ingredient 40CFR63, Subpart MMM

- What PAIs are covered (Cont'd):
  - Chloroneb Production
  - Chlorothalonil Production
  - Dacthal Production
  - Sodium Pentachlorophenate Production
  - Tordon Acid Production

Pesticide Active Ingredient 40CFR63, Subpart MMM

- Control of the following HAPs:
  - Toluene
  - Xylene
  - Methylene Dichloride
  - Ethylene Dichloride
  - Methanol
  - Methyl Chloride
  - Acetonitrile
  - Carbon Tetrachloride

Pesticide Active Ingredient 40CFR63, Subpart MMM

- Equipment covered Subpart MMM:
  - Process Vents
  - Storage Vessels
  - Wastewater Systems
  - Equipment leaks from pumps, compressors, agitators, pressure relief valves, valves, sample connection system, open-ended valves, connectors etc.

Pesticide Active Ingredient 40CFR63, Subpart MMM

- What Equipment Is Exempt?
  - Lines and equipment that do not contain process fluids
  - Utilities and other non-process lines that do not combine their materials with process fluids
  - Bench-scaled processes
  - Equipment in vacuum service or operated < 300 hours per year

Equipment Leak Compliance Options

- LDAR Program
- Enclosed Equipment and Transport Leaks Through a Closed-Vent System To Control Device
- Pressure Testing
- Limit Monitoring For Batch Processing

PAI Leak Limits

A Leak Is Detected For	Leak Limit
Agitators	10,000 ppm
Pumps	5,000 ppm
Valves	500 ppm
Connectors	500 ppm
Instruments Systems	500 ppm
Pressure Relief Valves	500 ppm

Subpart MMM PAI Designation of Equipment

- "In Service"
- "Difficult-to-Monitor"
  - > 2 meters above a support surface
  - Equipment not accessible at anytime in a safe manner
  - No more than 3% of population
  - Must monitor once-per-year

Subpart MMM PAI Designation of Equipment

- "Inaccessible"
  - Buried
  - Insulated in a manner that prevents access
  - Obstructed by other equipment
  - No more than 3% of population

Subpart MMM PAI Designation of Equipment

- "Unsafe-to-Monitor"
  - Tester is exposed to immediate danger
  - Written plan as to when monitoring is going to occur during "safe-to-monitor" conditions

Subpart MMM PAI Designation of Equipment

- "No Detectable Emissions"
  - No shaft outside casting
  - < 500 ppm over background
  - Must monitor once per year

Subpart MMM PAI Leak Program

- Complying with the LDAR under Subpart MMM
  - Do not have to physically tag equipment
  - Leaks determined through sight, sound, odor or monitoring
  - If a leaker, then must tag leaking equipment

Subpart MMM PAI Leak Program

- Repair of Leaking Equipment
  - Pumps/Agitators in light/heavy liquid
    - Tightening of packing gland nuts
    - Ensuring that the seal flush is operating at design pressure and temperature

Subpart MMM PAI Leak Program

- Repair of Leaking Equipment
  - Valves in gas/vapor service light or heavy liquid service
    - Tightening of bonnet bolts
    - Replacement of bonnet bolts
    - Tightening of packing gland nuts
    - Injection of lubricant into lubricated packing

Subpart MMM PAI Leak Program

- Time Period for Repairing Leaking Equipment (5/15)
  - Weatherproof tag must immediately be attached if leak detected
  - First attempt to repair the leak must be made within 5 days after the leak is detected
  - Leak must be fully repaired within 15 days after detection.
  - Retest for leak; If O.K., remove tag

Subpart MMM PAI Leak Program

- Delay of repair
  - Repair is technically infeasible without a process unit shutdown
  - Repair personnel exposed to an immediate danger if attempt to repair without shutdown
  - Equipment isolated from process and not in organic HAPs service

Subpart MMM PAI Leak Program

- Delay of repair (cont'd)
  - Emissions produced during repair would be higher than emissions from delay of repair
  - Delay of repair would make it a better system when repaired

Recording Information For Leaks

- Instrument and equipment identification number and operator name, initial or identification number
- Date leak detected
- Date of first attempt to repair the leak

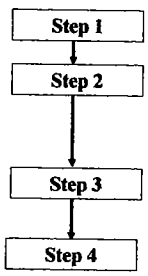
Recording Information For Leaks

- Date of successful leak repair
- Maximum reading measured by FRM 21 after leak is successfully repaired
- If repair delayed > 15 days, then:
  - Reason for delay
  - Date of process shutdown

Repair of Leaks

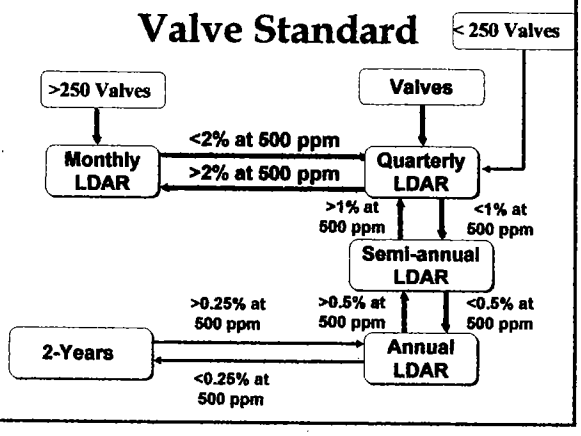
- You must repair leaks as soon as possible after they are detected
- Repair of leaks means:
  - You can no longer see, hear, smell or otherwise detect the potential leak
  - You see no bubbles at potential leak site during leak check with soap solutions
  - The system will hold a test pressure check

Valves in Gas/Vapor/LL Service

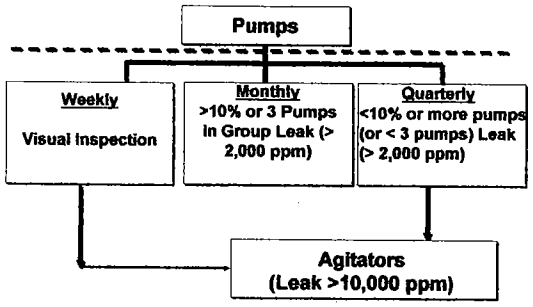


- Identify All Valves In Service
- Identify Valves In Special Service
  - "Unsafe-to-Monitor"
  - "Difficult-to-Monitor"
  - "Inaccessible"
- Monitor All Valves by FRM 21
- Leaker > 500 ppm; Must Repair
- Calculate % "Leakers"
  - > 250 Units...Monthly....
  - < 250 Units...Quarterly....
- % $V_L = [V_L/V_T] \times 100$

Valve Standard



Pump Standard



Exemptions with Pumps

- No externally actuated shaft penetrating the pump housing
- Pump equipped with dual mechanical seal system that includes a barrier fluid system
- Difficult to monitor

Pump Recordkeeping and Reporting Requirements

- Number of pumps with leaks
- Total number of pumps
- % of leaking
- Number of pumps where leaks were not repaired
- Reason for not repairing
- Statement why monthly program was initiated due to leakers

Comparison Monitoring

What Causes Violations As Determined by

National Enforcement Investigations Center

William T. "Jerry" Winberry, Jr.

EnviroTech Solutions

Industry vs. EPA

"...Comparison monitoring conducted by the EPA's National Enforcement Investigations Center (NEIC) shows that the number of leaking valves and components is up to 10 times greater than had been reported by certain refineries."

Comparative Monitoring Results

- A 7,694/170 3,363/354 2.3/10.5 67.8
- B 7,879/223 3,407/216 2.8/6.3 29.5
- C 3,913/22 2,008/108 0.6/5.4 71.8
- M 4,160/40 1,926/22.2 1.0/11.5 166.5

What Causes Violations

- Failure to identify process units and components that must be monitored
- Failure to follow prescribed monitoring procedures
- Use of incorrect or expired calibration gasses
- Failure to repair components within specified time frame

What Causes Violations

- Mis-Interpretation of regulations
- Poor supervision of personnel responsible for LDAR program
- Low performance requirements from corporate for environmental compliance
- Non-legitimate "delay of repairs"
- Lack of applied "good engineering practices"
  - Section 60.11(d)

What Causes Violations

- Improper tagging of equipment
- Failure to submit reports timely
- Maintaining appropriate calibration and monitoring records

First Attempt At Repair

- Tightening of bonnet bolts
- Replacement of bonnet bolts
- Tightening of packing gland nuts
- Injection of lubricant into lubricated packing

Delay of Repairs

- Infeasible without process shutdown (repair at next shutdown)
- Isolated from process and doesn't remain in VOC/VHAP service
- Specific condition of valves and pumps

Delay of Repairs

- Purge material emissions from immediate repair are greater than emissions from delay
- Delay beyond next shutdown (can't get parts, supplies depleted etc.)

Improving Leak Detection Monitoring Reliability

- Energetic LDAR coordinators with responsibility and authority to make things happen
- Continuing education/refresher programs for plant operators
- Diligent and well-motivated monitoring personnel
- Use of lower than required leak definition

Improving Leak Detection Monitoring Reliability

- More frequent monitoring than required
- Established quality assurance/quality control procedures

Mistakes Made by Contractors

- Doesn't apply FRM 21 correctly
- Doesn't know FRM 21
- Too many valves for short period of time
- Recordkeeping lousy (pencil whipping)

Mistakes Made by Contractors

- Not waiting 2X response time at leak
- Failure to take background readings properly
- Not following prescribed route

Potential Sources of Fugitive VOC Emissions

Jerry Winberry
EnviroTech Solutions

Lecture Goal

To Familiarize you with the sources of VOC leaks from process equipment

Lecture Objectives

- Recognize at least three types of process equipment that may potentially leak
- Describe the potential leak areas
- Understand the mechanics of affected equipment which produce VOC leaks

Regulatory Standards

- Equipment leak standards are designed to control fugitive VOCs
  - Specific type of component
  - Design specifications
  - Operational standard
- Work practice also designed to control fugitive VOCs
  - LDAR and Equipment Practices
- Performance standard

Process Equipment Leaks

- Pumps and pumps seals
- Compressors and compressor seals
- Process valves and valve seals
- Pressure relief devices
- Agitators

Fugitive Emissions

- *"...means the loss of VOCs through sealing mechanisms separating process fluids from the atmosphere."*

Sources of Refinery Fugitive VOC Emissions

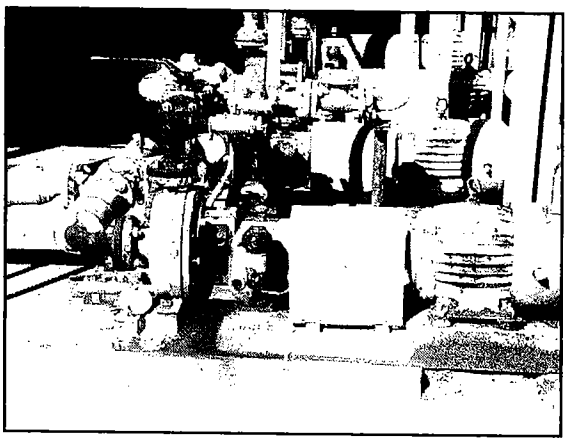
- Air Oxidation Processes (20%)
- Distillation Operations (26%)
- Other Reactor Processes (6%)
- Equipment Leak(35%)
- Storage of Organic Liquids (8%)
- Secondary Sources (5%)

Pumps

- Centrifugal
  - Packed Seal
  - Mechanical Seal
- Positive Displacement
- Reciprocating

Pumps

- Rotary Action
- Canned Motor
- Diaphragm



Pump Operation

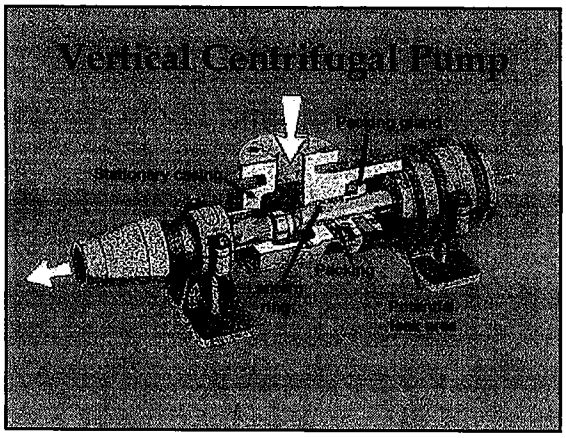
- Most pumps have a moving shaft which is exposed to the atmosphere. The fluid being moved inside a pump must be isolated from the atmosphere. This requires a seal. Leaks occur at the point of contact between the moving shaft and seal/stationary casting.

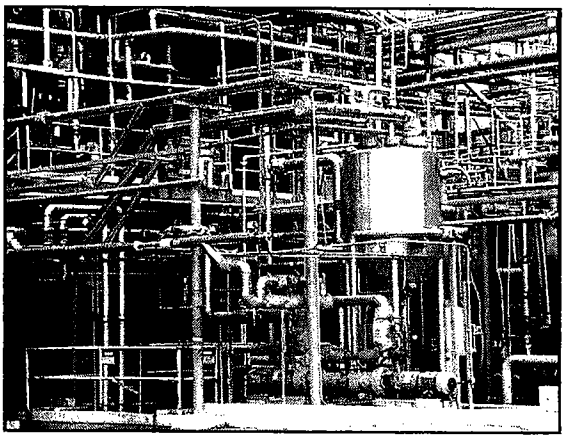
Definition of Centrifugal

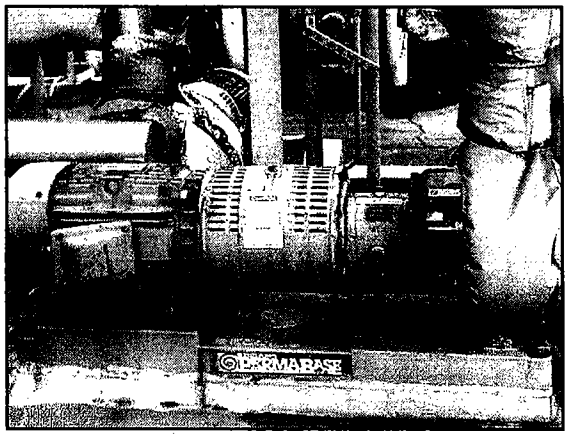
- Moving or directed away from a center or axis

Centrifugal Pumps

- Impeller rotating within a casing
- Impeller at end of shaft that projects outside the casing







Reciprocating Pumps

- Three Basic Types:
  - Piston Pump
  - Plunger Pump
  - Diaphragm Pump
- Liquid flux "back and forth" in a chamber
- Valve attached to regulate flow

Definition of Reciprocating

- To move back and forth, to give back and forth

Rotary Action Pumps

- Mechanical displacement of the liquid is produced by rotation of one or more impellers within a stationary house

Pump Seals

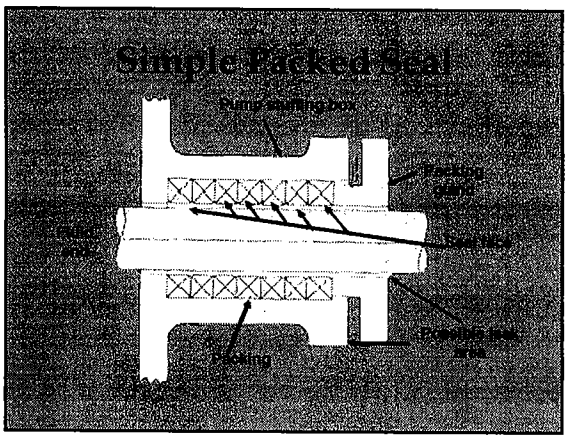
- Packed Seals
  - Reciprocating and Rotating Shaft
- Mechanical Seals
  - Rotating Shaft Only

Packed Seals

- Reciprocating and centrifugal (rotary action) pumps
- Packing material (fibers of woven, twisted or braided strands, then formed into coils etc.) compressed in the cavity (stuffing box) to form a seal around the moving drive shaft

Packed Seals

- Lubrication is required to prevent frictional heat building up between seal and shaft
- Packing gland is used to apply the needed compression
- Leaks from packed seals typically result from the degradation of the packing!



Mechanical Seals (Rings)

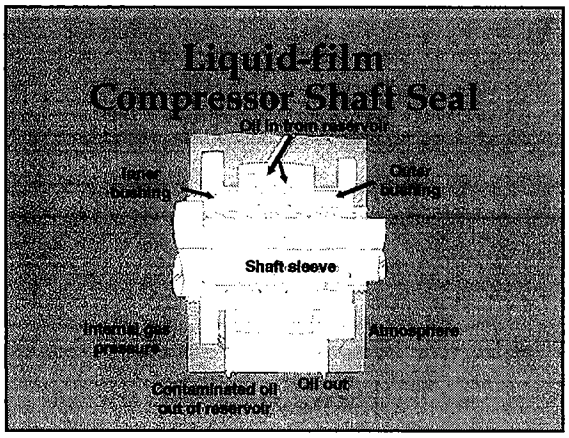
- Mechanical seals prevent leakage by means of two sealing elements: one stationary (mating ring) and one rotating (primary ring)
- Surfaces are polished to a very high degree to maintain contact over the entire material surface

Mechanical Seals

- Mechanical seals limited in use to rotating shaft pumps
- Mechanical seals can also be equipped with "secondary seals" or "O-rings"
- Purpose of packing in mechanical seals is to displace the heat from the shaft (Friction)

Double or Dual Mechanical Seals

- Double mechanical seals are more effective than single seals
- Usually "closed cavity" between the two seals in a back-to-back arrangement
- A seal liquid, such as oil or water, is circulated through this seal-housing cavity



Seal-less Technology

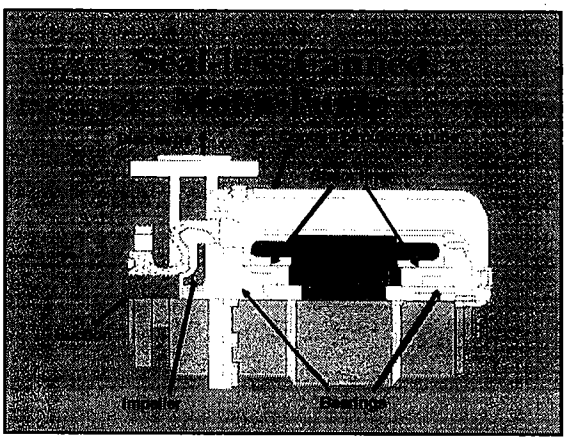
- Canned-motor pumps
- Magnetic drive pumps
- Diaphragm pumps

Seal-less Pump Technology

- Canned-motor pumps: Have an impeller and driven rotor which are mounted on a common shaft supported by a set of sleeve bearings inside a closed magnetically permeable can or containment shell
- The pumpage is used as a source of lubrication and cooling

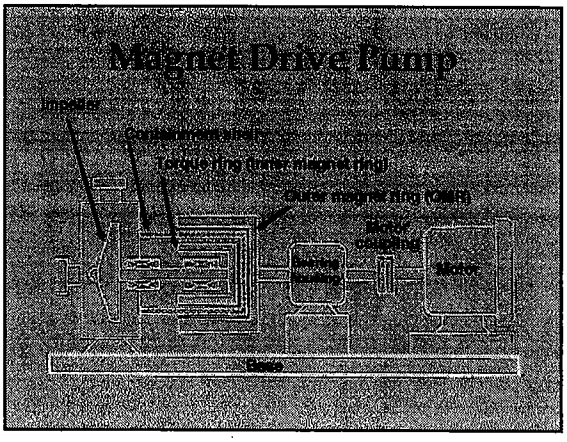
Seal-less Pumps

- The cavity that houses the motor rotor and the pump casting are interconnected and the motor bearings operate in the process liquid
- All shaft seals are eliminated
- No packing on shaft seals are exposed to the process fluid



Seal-less Pumps

- Canned motor pumps: Rotor driven by an AC-induction Motor Stator separated from pumpage by a metallic can
- Magnetic Drive pumps: Driven by a set of permanent magnets that are mounted on a carrier or drive assembly outside containment shell



Seal-less Pumps

- Advantages: Compact, quiet, low installation cost, no alignment required, lowest emissions
- Disadvantages: Not field repairable, motor runs very hot (therefore "flashing" possible, low tolerance for solids

Seal-less Magnetic Drive Pumps

- Advantages: Uses standard electric motor, not necessary to displace motor heat, very low emissions due to containment shell
- Disadvantages: Misalignment of motor shaft, limited to temperature capability of magnets, 3 sets of bearings

Seal-less Diaphragm Pumps

- Diaphragm pumps: The flexible diaphragm is made of metal, rubber, or plastic is eliminates all packing and seals exposed to the process liquid

Major Source of Pump Emissions

- Pump Shaft Seal
  - Seal isolated the pump's interior fluid from the atmosphere
    - Packed Seals: Packing of fibers of woven, twisted, braided strands, formed into coils, spirals, or rings

Major Source of Pump Emissions

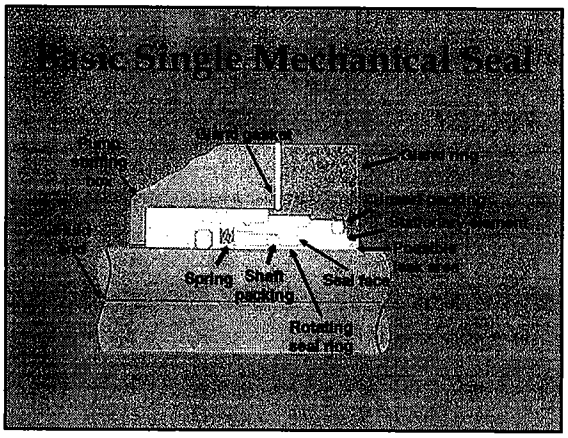
- Used on reciprocating and rotary pumps
- Packing gland applies pressure to form tight seal

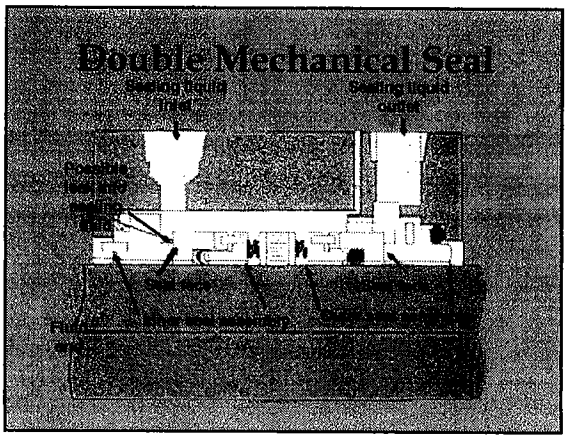
Major Source of Pump Emissions

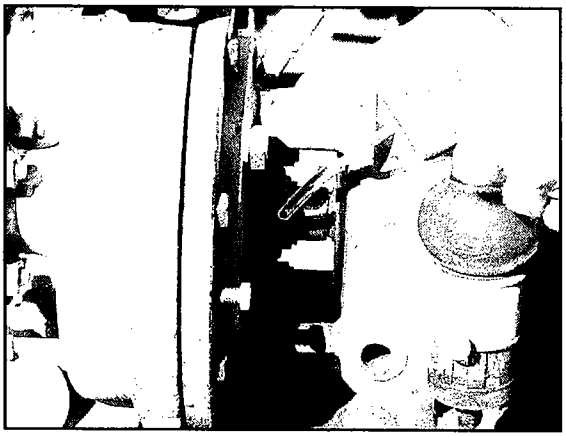
- Pump Shaft Seal
  - Mechanical Seals (single/double)
    - Most popular
    - Two sealing rings, one stationary and one rotating

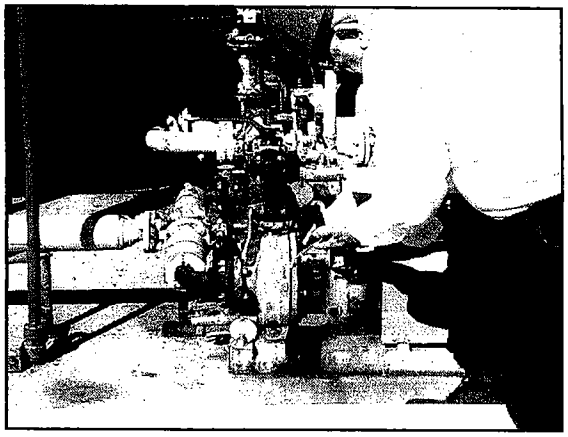
Major Source of Pump Emissions

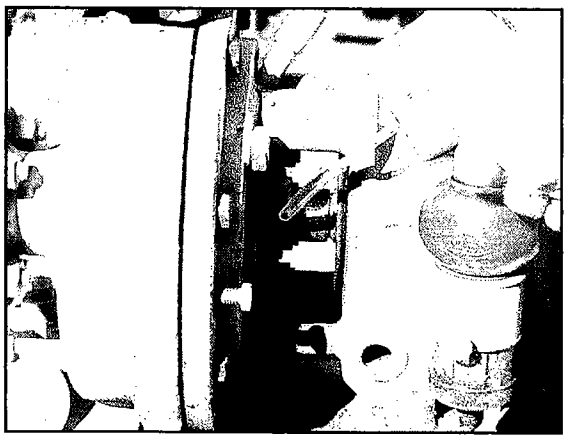
- Dual mechanical seals much better for reducing emissions than single mechanical seal (barrier fluid at greater pressure than process fluid)
- Therefore, leaks into process stream

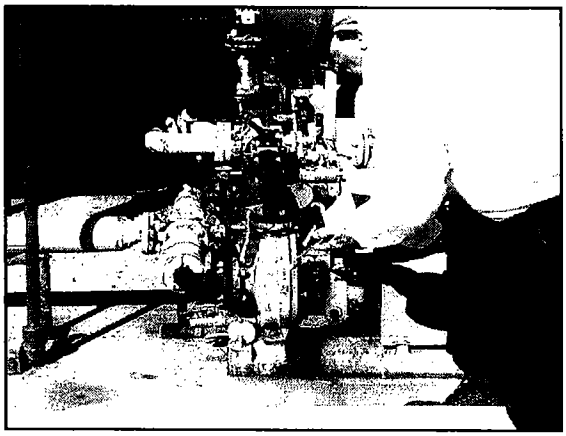












Pumps: No Detectable Emissions

- Instrument reading of < 500 ppm
- No externally actuated shaft penetrating pump housing
- Test for compliance
  - Initially
  - Annually
  - As requested by Administrator

Compressors

- Compressors are used basically in gas service
- Gas compressors in gas service can be driven by rotary or reciprocating shafts and therefore require seals which are the source of leaks

Compressors

- Rotary shafts may use either packed or mechanical seals
- Reciprocating shafts must use packed seals

Types of Compressors

- Centrifugal
- Reciprocating
- Rotary

Centrifugal Compressors

- Rotating element " containing curved blades to increase pressure of a gas"
- Reciprocating/rotary compressors operate by increasing pressure by confining the gas in a cavity and progressively decreasing the volume of the cavity

Mechanical Compressor Seals

- Labyrinth seals
- Restrictive carbon ring seals
- liquid film seals
- Mechanical contact seals

Labyrinth Seals

- Composed of a series of close tolerance, interlocking *teeth* that restrict the flow of gas along the shaft
- Many variations of tooth design and materials of construction are available

Restrictive Carbon Ring Seals

- Consist of multiple stationary carbon rings with close shaft clearances
- May be operated dry or with a sealing fluid

Liquid Film Seals

- Seal is formed by a film of oil between the rotating shaft and stationary gland
- Circulating oil is returned to the oil reservoir which is a source of emissions

Mechanical Contact Seals

- Similar to mechanical seals described for pumps
- Reduced the clearance between the rotating and stationary elements to essentially zero
- Oil or another suitable lubricant is applied to the seal face

Process Valves

- Most Common Types
- Stem Seal Issues
  - Sealing technologies
  - Common stem seal problems
- Other Emission Areas
  - Body/bonnet gasket issues
  - End-of-line service

Monitoring of Valves

- Routine Valves (Monthly/quarterly etc.)
- "Difficult-to-monitor" (Annual)
- "Unsafe-to-monitor" (Annual)
- "No detectable emissions"
  - No shaft outside casing
  - < 500 ppm over background
  - One year monitoring/plan

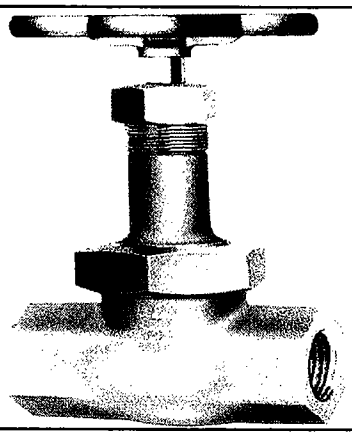
Process Valves

- Process valves make up more than 90 % of the process components that must be checked for leaks
- Usually constitute the largest percentage of fugitive VOC emissions

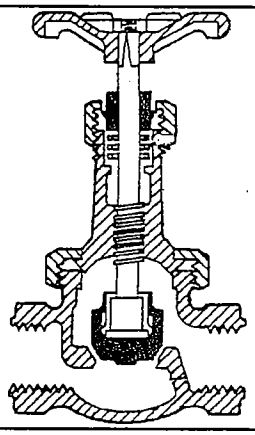
Types of Process Valves

- Gate (On/Off)
- Globe (On/Off, Throttling)
- Diaphragm (On/Off, Throttling)
- Plug (On/Off)
- Ball (On/Off)
- Butterfly (On/Off, Throttling)
- Check Valve (Directional)

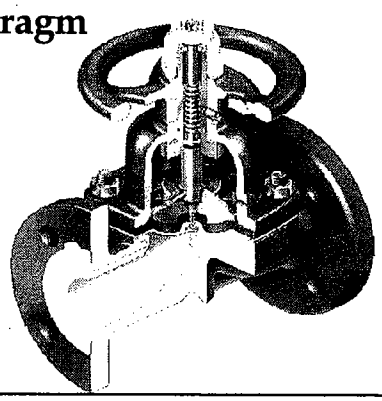
Gate Valve



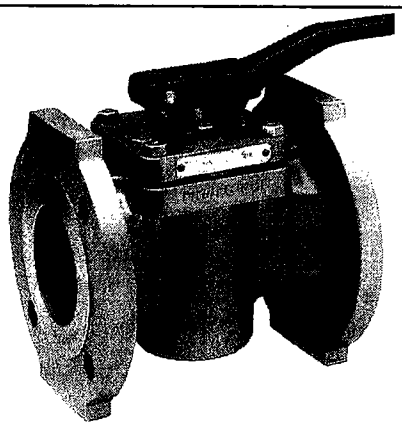
Globe Valve



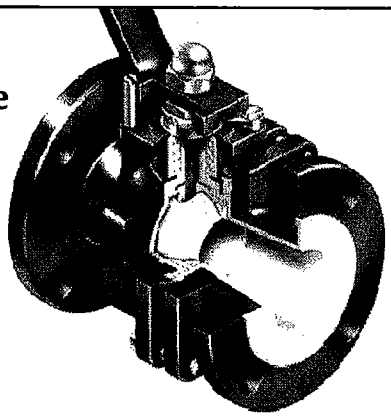
Diaphragm Valve



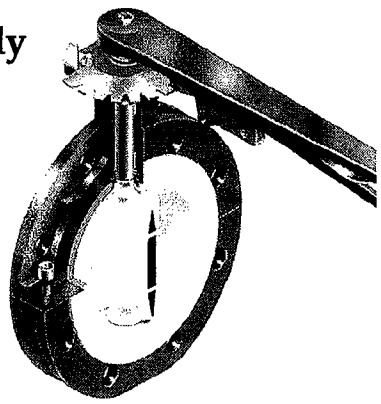
Plug Valve



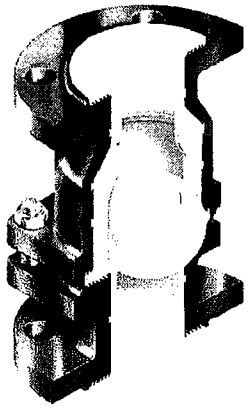
Ball Valve



Butterfly Valve



Check Valve



Process Valves: Three Functional Categories

- Block: Used for on/off, isolation
- Control: Used to automatically flow rate
- Check: Used for directional control (reverse flow)

Process Valves

- Activated by a valve stem
- Operated by handle or actuator
- Stem may be either a rotational or a linear motion
- Process fluid inside the valve must be isolated from the atmosphere ==> stem seals

Stem Seal Emission Reduction

- Selection of Valve Type
- Selection of Seal Technology
- Factors to consider
  - Working media (fluid/gas)
  - Operating parameters
  - Frequency of operation
  - Requirements for fire containment

Valve Sealing Technologies

- Mechanical Packing
- Dual Sealing Methods
- Bellows Sealing
- Purging Methods
- Maintenance Reduction
- Packless Technologies

Mechanical Packing

"...5 to 7 endless or split rings of a packing material are axially compressed by a packing gland to laterally expand and seal on the stem and packing chamber."

Mechanical Packing

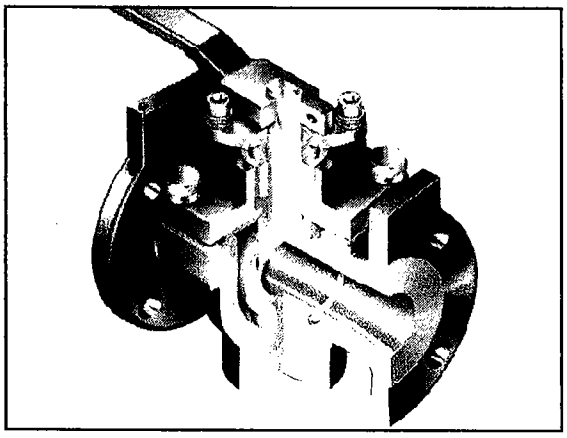
- Flexible Graphite Packing
- PTFE Packing
- Polymer Packing
- Spooled Packing

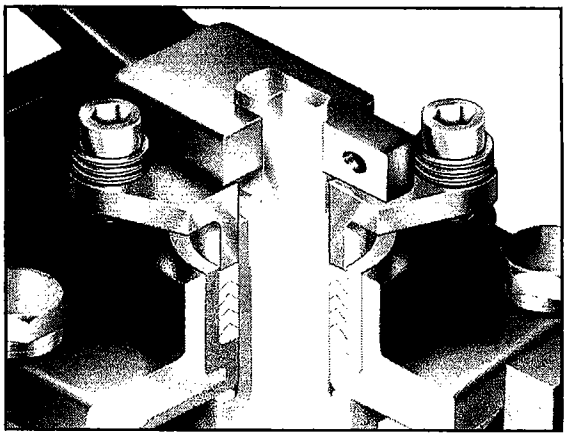
Flexible Graphite Packing

- Most widely used packing
- Packing set is a combination of multiple die-formed pressure rings with braided graphite or carbon split rings on both ends
- Excellent in non-oxidizing service and up to 2000° F

PTFE Packing

- Good alternative to graphite for aggressive chemical and low temperature services
- PTFE packing can be braided rope or solid endless ring
- Weaknesses
  - Cold flow
  - Not firesafe (~ 400°F)





Polymer Packing

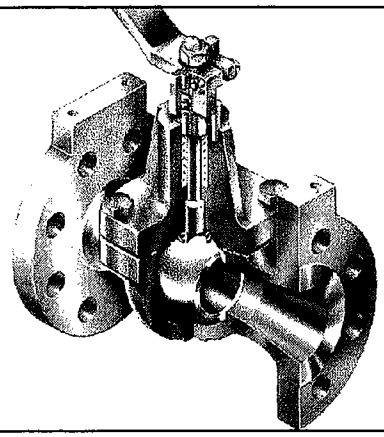
- High temperature polymers (Kalrez[R], Celazole[R], Avalon[R] etc.) have been introduced to replace PTFE at elevated temperatures
- Operating temperatures 500-750°F
- Average cost is higher than PTFE

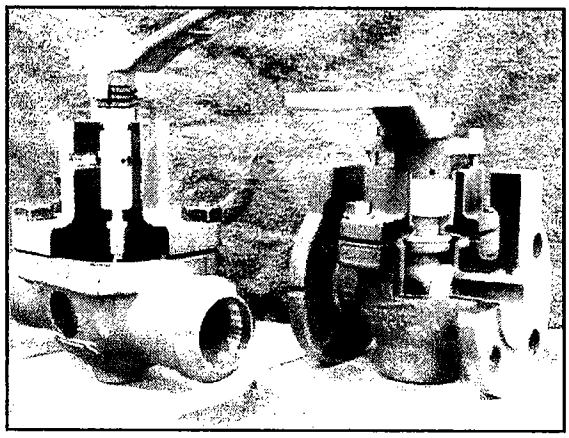
Spooled Packing

- "...the material is most often either a carbon or graphite core with flexible graphite ribbon wrapped exterior or has some degree of carbon braiding either internally or externally."
- Sold in a container and is cut to length by the user

Dual Sealing Methods

- Two sets of seals in a chamber
- Primary and secondary packing
- Lantern ring can be used to separate the dual seals
- Tap to monitor emissions from bottom stem seal set



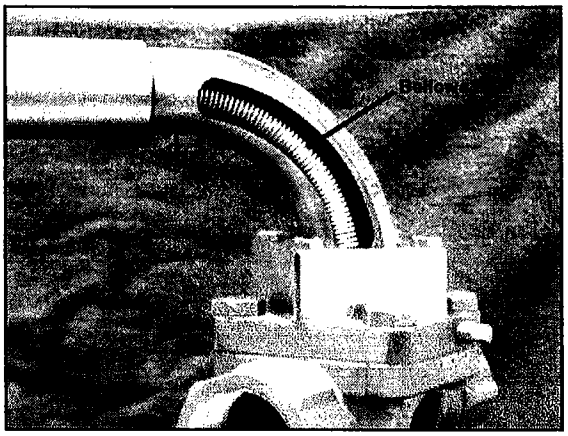


Bellows Sealing

- Formed or welded metal bellows that creates a barrier between the interior and the body bonnet
- Zero emission capability
- Bellows becomes the weak point of the system due to limited cycle life

Bellows Sealing

- Utilized in valves ≤ 6"
- Utilized in services of < 200 psi and < 150° F
- Limited compression, longer bonnets
- Limited cycle life
- If fail, catastrophic failure

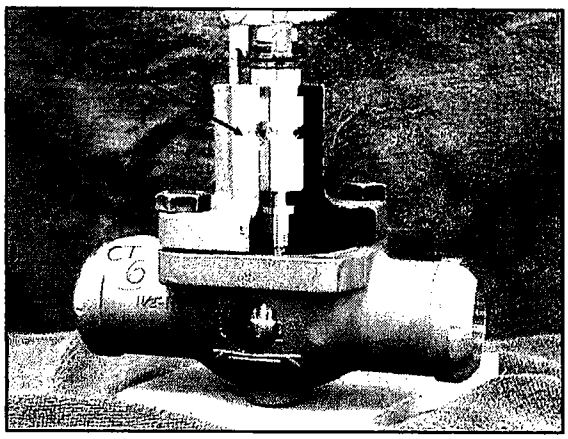


Purging Methods

- Purge Port: The purging media may be a gas or fluid inert to the process which is injected through a port in the stuffing box through a lantern ring
- The gas/fluid pressure is maintained higher than the process pressure

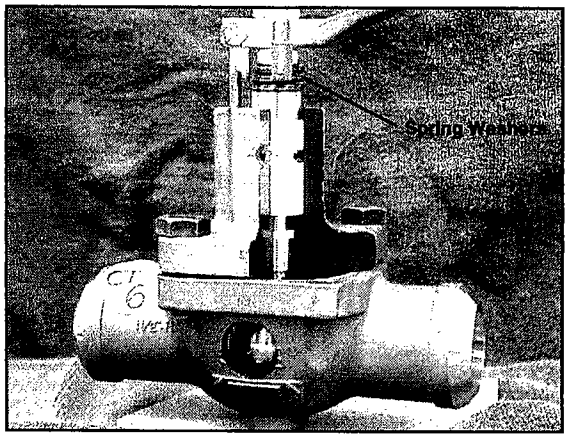
Purging Methods

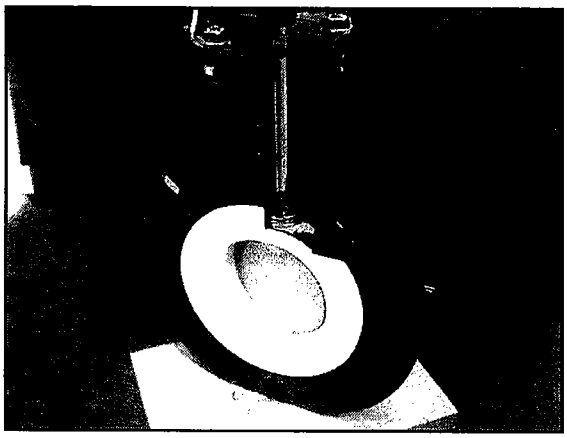
- Vapor Recovery: Opposite of flushing gland
- Sub-atmospheric pressure line is connected to a tap in the packing chamber fitted with a lantern ring
- Low pressure line evacuates emissions to a recovery unit



Maintenance Reduction

- Live Loading: "...to maintain a sustained load on the packing most commonly through the use of stacked belleville or wave spring washers on the packing gland bolts."



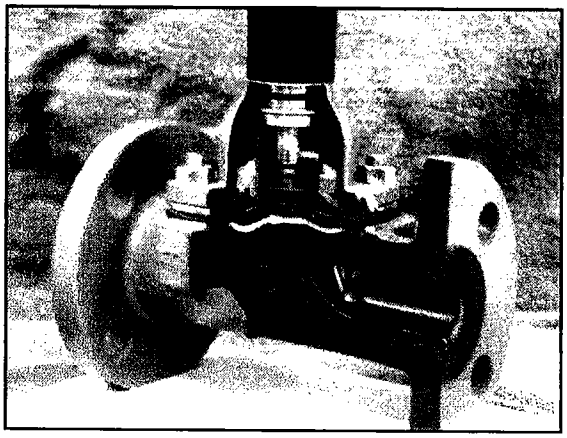


Maintenance Reduction

Sealant Injection: "...packing chamber sealants are typically injected through a port or fitting in the packing chamber. Injection of a sealant creates a hoop compression on the packing, forcing the packing radially inward toward the stem, therefore reducing emissions."

Packless Technology

- **Operating stem not exposed to process media**
- **No use of stem packing**
- **Valve design incorporates the process barrier**
- **Example: Diaphragm Valve**



Advantages/Limitations of Sealing Systems

- Mechanical Packing
  - Advantages: Wide range of application, good performance, relatively high cycle service
  - Limitations: Compression must be maintained, PTFE not fire safe, negative thermal expansion

Advantages/Limitations

- Dual Seals
  - Advantages: Excellent for high cycle service, effective in chemical service, detection of leaks possible with purge port
  - Limitations: Compression must be maintained, more costly than single seal system

Advantages/Limitations

- Bellows Sealing
  - Advantages: Zero emissions technology, effective in chemical service, secondary packing can be added
  - Limitations: Bellows failure can be catastrophic, costly, limited cycle life of metals bellows

Advantages/Limitations

- Purging Methods
  - Advantages: Zero emissions method
  - Disadvantages: Requires interconnecting piping to valve bonnet and inert fluid or gas source, costly, limited capacity (vapor recovery)

Advantages/Limitations

- Maintenance Reduction
  - Advantages: Effective in reducing emissions, good for process variations in P/T
  - Disadvantages: More parts - complicated to replace packing, won't stop leak once started

Advantages/Limitations

- Packless Technology
  - Advantages: No seals to leak, no packing adjustments required
  - Limitations: Limited types of valves, concerns with containment if failure

Common Valve Problems

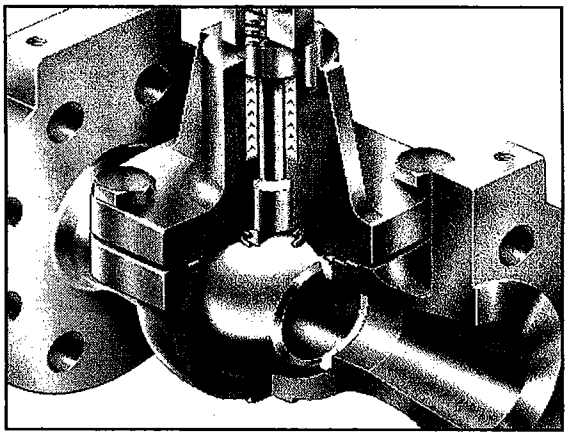
- Excessive clearance preventing packing from being properly compressed
- Poor stem/body finish which abrades packing material
- Damaged stem causing distortion/removal of packing

Common Valve Problems

- Stem "Out-of-Round," thus non uniform compression of packing
- Insufficient sealing due to packing wear
- Improper compression due to environmental conditions surrounding the valve stem

Body/Bonnet Seals

- Machined body and bonnet surfaces with sealing gasket
- Fully contained joints most common
- Static seal maintained by proper torque on bonnet bolts



Gasket Materials

- Graphite
- PTFE
- Filled PTFE
- Spiral Wound

End-of-Line Service

- Downstream line open to the atmosphere
- Open-ended valves used for draining, venting, purging, or when piping removed
- Valve shut-off element may be source of fugitive emissions

Flanges - High Leak Tendencies

- Vibration: Look for flanges on equipment that vibrates (pumps, centrifuges, agitators, mixers, rotating dryers)

Flanges - High Leak Tendencies

- High Temperature: Vapors become 'excited' at high temperatures and therefore will escape more readily
- Also, some gaskets 'creep' or thin more readily with higher temperatures, reducing the bolt load

Flanges - High Leak Tendencies

- Thermal Cycling: Equipment will expand or contract when the temperature increases or decreases, varying the 'load' on the gasket

Flanges - High Leak Tendencies

- Also, some gaskets have more of a tendency to 'creep' or thin with temperature and/or time
- Both reduce the bolt load on the gasketed joint making it more susceptible to leakage

Flanges - High Leak Tendencies

- Old equipment: Older equipment will generally be more susceptible to leaks because of flange surface corrosion and warped flanges

Flanges - High Leak Tendencies

- Fragile equipment: Equipment made with 'fragile' materials, eg.; glass, glass-lined steel, fiberglass, PVC, CPVC, etc., cannot be torqued to high levels, they will be more susceptible to leaks

Flanges - High Leak Tendencies

- Flimsy flanges: Look for flanges with a flange thickness less than 1/4" - these will be susceptible to warping and difficult to seal

Flanges - High Leak Tendencies

- Inadequately designed flanges: As a very general rule of thumb (there are exceptions to every rule), adequately designed flanges flanges have at least one bolt for every inch of I.D.

Flanges - High Leak Tendencies

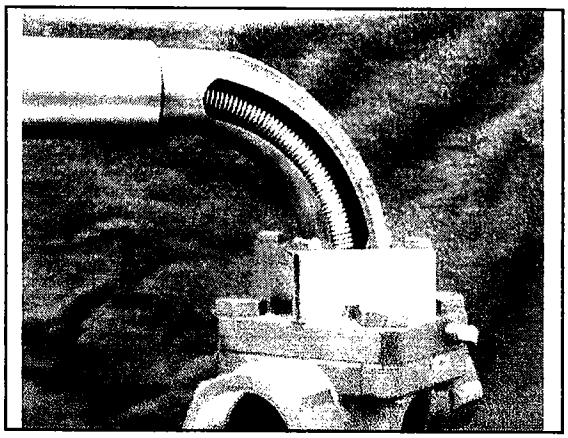
- Example: 24" flange opening (Inside dimension) should have at least 24 bolts
- This is easy to see, there should be a bolt every 3 to 4 inches around the circumference

Dual Sealing Methods

- Bellows Seals
  - Zero emission capability
  - Incorporated a formed metal bellows that makes a barrier between the disc and body bonnet
  - The bellows is a weak point of the system and service life limited
  - Bellow seal usually backed up packing gland (graphite)

Dual Sealing Methods

- Bellow Seals
  - Use in pipes < 3" and < 200 psi and < 150° F
  - Limited compression, longer bonnets
  - Limited cycle life
  - If fail, catastrophic failure



Dual Sealing Methods

- Dual Seals
  - Two or more seals in the packing chamber
  - Lantern ring used to separate the dual seals
  - Tap to monitor emissions from the bottom seal

Isolation Methods

- Flushing Gland: Involves a lantern ring. The flushing media may be either a gas or fluid inert to the refinery which is injected through a port in the stuffing box through the lantern ring
- The gas/fluid pressure energizes the top and bottom seals

Isolation Methods

- Vapor Recovery: Opposite of flushing gland
- Sub-atmospheric pressure line is connected to a tap in the packing chamber fitted with a lantern ring
- Low pressure line evacuates emissions to a recovery unit

Maintenance Reduction

- Live Loading: "...to maintain a sustained load on the packing most commonly through the use of stacked belleville or wave spring washers on the packing gland bolts."

Maintenance Reduction

- Sealant Injection: "...packing chamber sealants are typically injected through a port or fitting in the packing chamber. Injection of a sealant creates a hoop compression on the packing, forcing the packing radially inward toward the stem, therefore reducing emissions."

Advantages/Limitations of Sealing Systems

- Mechanical Packing
  - Advantages: Wide range of application, good performance, high cycles
  - Limitations: Teflon not fire safe, limited experience in use, negative thermal expansion

Advantages/Limitations

- Multiple Seals
  - Advantages: Zero emissions technology, effective in chemical service, packing is a secondary seal
  - Limitations: Bellows failure can be catastrophic, costly, limited to 10" valve size, limited cycle life of metals bellows

Advantages/Limitations

- Isolation Method
  - Advantages: Zero emissions method
  - Disadvantages: Requires interconnecting piping to valve bonnet and inert fluid or gas source, costly, limited capacity (vapor recovery)

Advantages/Limitations

- Maintenance Reduction
  - Advantages: Effective in reducing emissions
  - Disadvantages: Complicated to replace packing, won't stop leak once started, many small parts

Valves Seals

- Diaphragm Seal
  - Diaphragm seals separate environment from the process liquid
  - May also be used to control flow of the process fluid
  - Commonly found on globe valves as the bonnet seal and the weir seal

Valves Seals

- Open-ended Valves or Lines
  - Downstream line open to the atmosphere
  - Open-ended valves may be used for draining, venting, or purging
  - Valve seat may be source of emissions

Pressure Relief Devices

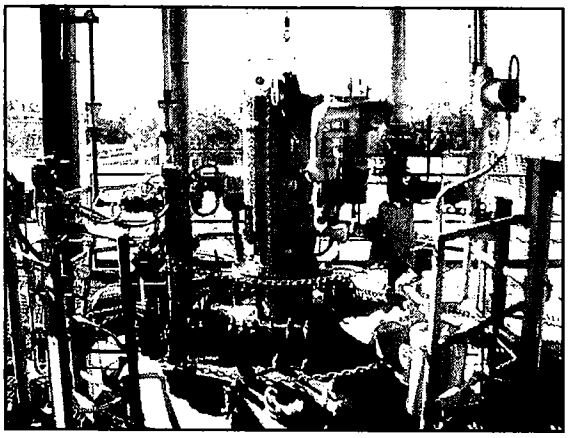
- Used where process pressure may exceed the maximum allowable working pressure
- Typically spring-loaded

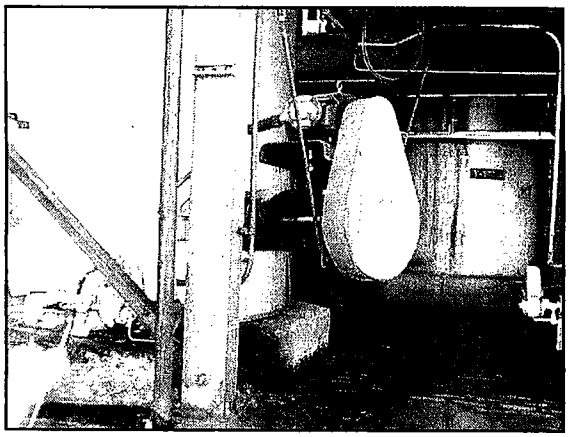
Pressure Relief Devices

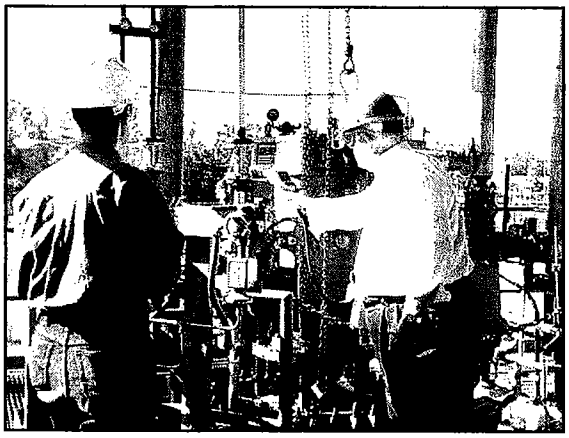
- Two potential causes of leaks
  - Simmering or popping
  - Improper valve seating
- Rupture disks are also commonly used

Agitators

- Used to stir or blend chemicals
- Sources of leak where shaft penetrates the casing
- Four common seals:
  - Packed seals
  - Mechanical seals
  - Hydraulic seals
  - Lip seals







Agitator Seals

- Packed and mechanical seals similar to pump application
- Hydraulic seals, annular cup attached to process vessel containing a liquid that is in contact with an inverted cup attached to the rotating agitator shaft
- Advantage: Non-contact seal

Agitator Seals

- Lip seal is typically a spring-loaded elastomer that fits around the shaft
- Rotating shaft in constant contact with the elastomer (lip seal)

Agitator Seals

- Limitations:
  - Pressure limits of 2 to 3 psi
  - Operating temperature of the elastomer
  - Wears excessively

Flanges and Other Connectors

- Single largest class of fugitive emission sources in a process unit
- Flanges are gasket-sealed junctions used to mate pipes etc

Flanges

- Reasons for emissions:
  - Improperly selected gaskets
  - Poorly assembled flanges
  - Poorly assembled nut-and-ferrule combinations
  - Poorly assembled pipe connections
  - Deformation of sealing surfaces due to thermal stress

Distribution of Fugitive VOC Emissions

- Valves (47%)
- Pumps (16%)
- Compressors (4%)
- Pressure Relief Valves (9%)

Distribution of Fugitive VOC Emissions

- Sampling Connection (3%)
- Open-ended Lines (6%)
- Flanges (15%)

Leak Detection and Repair Program for Valves and Pumps

- Phase I: Detection of Leaks
- Phase II: Repair of Leaks

LDAR Program

- Monitoring Intervals: Monthly/quarterly (< 2%)
- Leak Definition: 500 ppm/Method 21

LDAR Program

- Repair Intervals:
  - Within 5 days of first attempt
  - Completed within 15 days
  - Delays allowed under certain circumstances

LDAR Equipment Covered

- Valves
  - In gas/vapor, in light liquid VOC, in VHAP service
  - Difficult-to-monitor
  - Unsafe-to-monitor

LDAR Equipment Covered

- Pumps
  - In light liquid service
- Other Equipment
  - Flanges, pumps/valves in heavy service

Leak Detection for Valves

- In gas/vapor or light liquid service or in VHAP service: 500 ppm monthly/quarterly
- Difficult-to-monitor: 500 ppm annually (minimum)
- Unsafe-to-monitor: 500 ppm when safe to monitor

Difficult-to-Monitor Definition

- Access to valve is restricted
- Defined as valves that would require elevating the monitoring personnel more than two meters above any permanent available support surface

Unsafe-to-Monitor Definition

- Unsafe-to-monitor valves are defined as those that would, based on the judgement of the owner or operator, expose monitoring personnel to imminent hazards from temperature, pressure, or explosive process conditions (Example: Steam leaks or valves inside pressure units etc.)

Leak Detection for Valves

- Alternative Standards
  - Not more than 2 % leaking valves
  - Allow to skip period LDAR (Two Alternatives)

Alternative #1 For Valve Leak Detection Program

- Not more than 2 % leaking valves
  - Notify administrator 90 days before implementation
  - M21 test initially, annually, and when requested by administrator
  - All valves monitored within one week
  - Leaks repair first attempt 5 days/15 repaired

Alternative #2 For Valve Leak Detection Program

- Option 1: After consecutive quarters with < 2% leakers, skip to semiannual monitoring
- Option 2: After 5 consecutive quarters with < 2 % leakers, skip to annual monitoring

Monitoring Locations

- Valves
  - Seal between the stem and the housing
  - Place the probe where the stem exits the packing gland follower
  - Move around stem circumference.
  - Also placed at the packing gland take-up flange seat and moving along the periphery

Monitoring Locations

- Flanges and Connectors
  - The probe place at the outer edge of the flange/gasket interface
  - Move along the circumference of the flange
  - Area around each of the bolts should also be checked
  - Also screwed fittings, the treaded connector interface

Monitoring Locations

- Pumps and Compressors
  - Along the outer surface of the interface (circumferentially) along the outer surface of the interface between the shaft and the seal where the shaft exits the housing
  - If shaft rotating, then attach "Teflon" piece on the end of the monitor probe and check within 1 cm of the shaft/seal interface

Monitoring Locations

- Pressure Relief Devices
  - Instruments readings taken at the center of the exhaust area.
  - Pressure relief devices should not be monitored during likely upset conditions or at other times when they are likely to activate

Monitoring Locations

- Miscellaneous Sources
  - If regularly shaped opening (e.g., process drains, seal system degassing vents, and accumulator vents) which is < 1.0 " diameter, a single reading in the center of opening
  - Larger openings, traverse across the diameter or grid pattern for very large openings

First Attempt at Repair

- Valves
  - Tightening of bonnet bolts
  - Replacement of bonnet bolts
  - Tightening of packing gland nuts
  - Injection of lubricant into lubricated packing

Delays of Repairs

- Infeasible without process unit shutdown
  - Repair at next shutdown
- Isolated from process and does not remain in VOC or VHAP service
- Valves and pumps specific conditions

Specific Conditions for Delay in Repairs Beyond Next Shutdown (Valves)

- Purged material emissions from immediate repairs higher than emissions from delay
- Valve assembly replacement needed

Specific Conditions for Delay in Repairs Beyond Next Shutdown (Valves)

- Supplies depleted
- Repair at next shutdown

Leak Detection for Pumps

- Leak detection at 10,000 ppm
  - Monitoring frequency is monthly
  - Visual indication is weekly
- Unmanned plant sites to be visually inspected as often as practicable and at least monthly

Specific Conditions for Delay in Repairs Beyond Nest Shutdown (Pumps)

- If repair requires the use of a dual mechanical seal system that includes a barrier fluid system
- Repair within 6 months

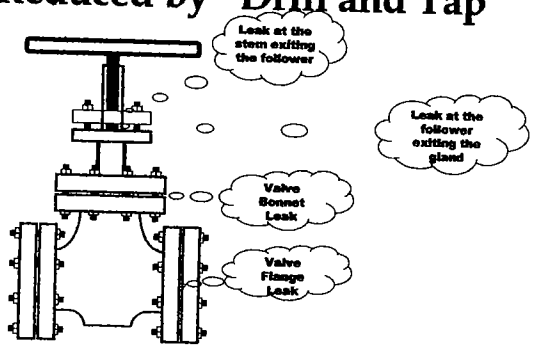
Standards for Pumps in Light Liquid Service (NSPS) or In VHAP Service (NESHAP)

- Equipment and performance standard
- LDAR Program established
- Dual mechanical seal system that includes a barrier fluid system

Standards for Pumps in Light Liquid Service (NSPS) or In VHAP Service (NESHAP)

- "No detectable emissions"
- Close vent system to control device

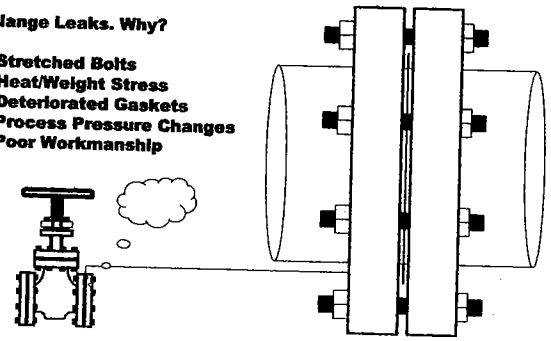
Common Valve Leaks Reduced by "Drill and Tap"



Valve Flange Leaks

Flange Leaks. Why?

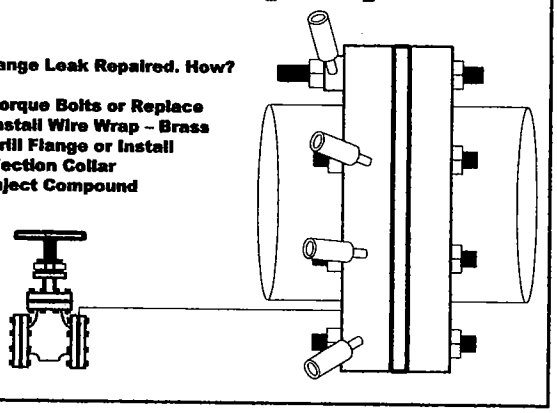
- Stretched Bolts
- Heat/Weight Stress
- Deteriorated Gaskets
- Process Pressure Changes
- Poor Workmanship



Valve Flange Repair

Flange Leak Repaired. How?

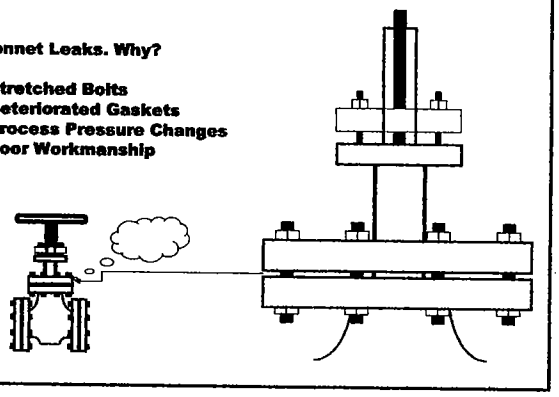
- Torque Bolts or Replace
- Install Wire Wrap – Brass
- Drill Flange or Install Injection Collar
- Inject Compound



Valve Bonnet Leaks

Bonnet Leaks. Why?

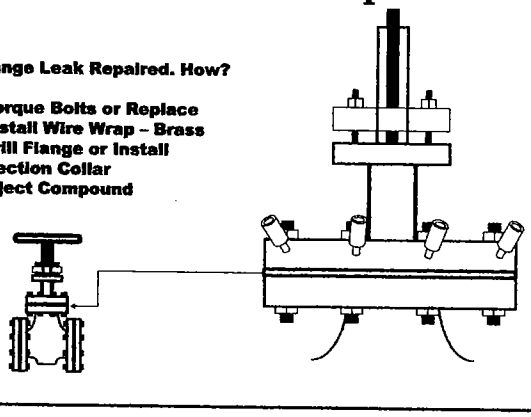
- Stretched Bolts
- Deteriorated Gaskets
- Process Pressure Changes
- Poor Workmanship

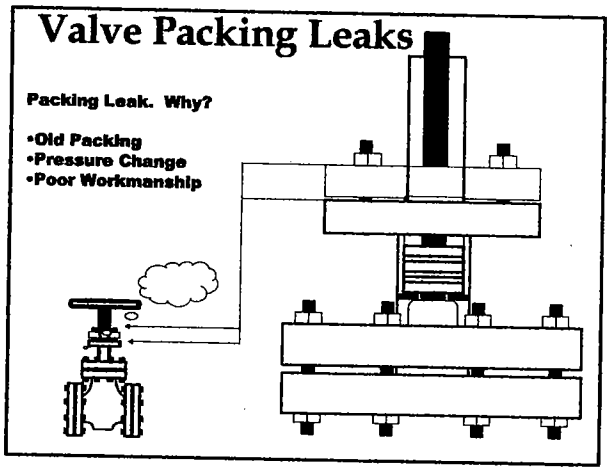


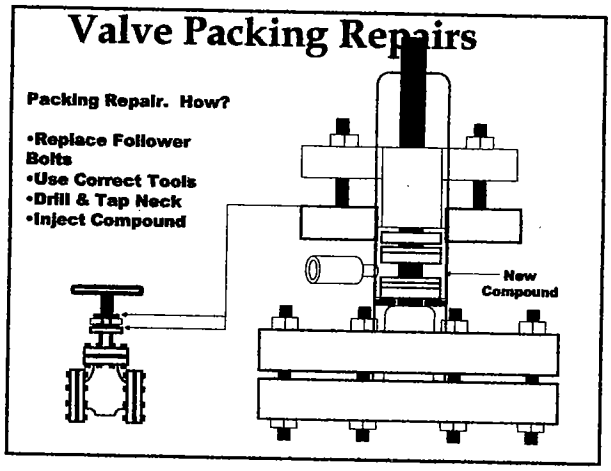
Valve Bonnet Repair

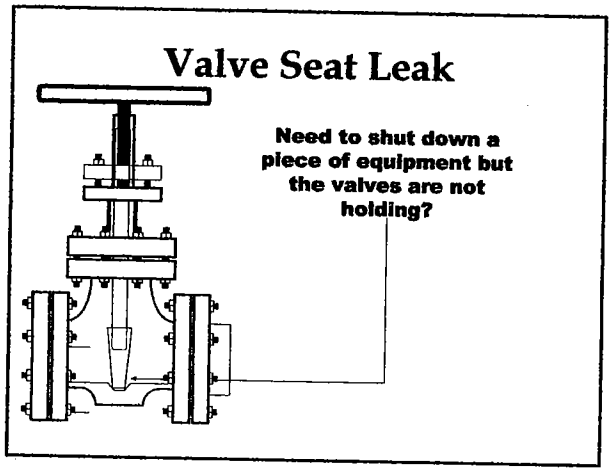
Flange Leak Repaired. How?

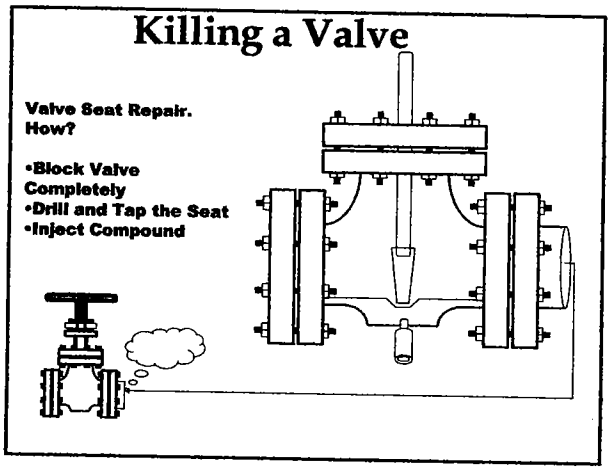
- Torque Bolts or Replace
- Install Wire Wrap – Brass
- Drill Flange or Install Injection Collar
- Inject Compound




Valve Packing Leaks
Packing Leak. Why?
•Old Packing
•Pressure Change
•Poor Workmanship


Valve Packing Repairs
Packing Repair. How?
•Replace Follower Bolts
•Use Correct Tools
•Drill & Tap Neck
•Inject Compound
New Compound


Valve Seat Leak
Need to shut down a piece of equipment but the valves are not holding?


Killing a Valve
Valve Seat Repair.
How?
•Block Valve Completely
•Drill and Tap the Seat
•Inject Compound

Refinery Operations

Jerry Winberry
EnviroTech Solutions

Lecture Objective

- Identify the processes within a refinery
- Learn what equipment is affected by the fugitive VOC regulations
- Analyze typical refinery data

Petroleum Refineries

- *"...Petroleum refineries are a complex system of multiple operations and the operations used at a given refinery depend upon the properties of the crude oil to be refined and the desired product. No two refineries are alike."*

Two Major Phases of Petroleum Products

- Phase I: Desalting and distillation
- Phase II: Downstream processes
  - Purification
  - Conversion
  - Combining
  - Blending

Crude Oil Distillation and Desalting

- *"...One of the most important operations in a refinery is the initial distillation of the crude oil into its various boiling point fractions. Distillation involves:*

Crude Oil Distillation and Desalting

- Heating
- Vaporization
- Fractionation
- Condensation
- Cooling

Phase I: Desalting Crude Oil

- Desalting involves mixing of heated crude oil with water
- Adding demulsifier to break the emulsion
- Applying a high potential electric field across the selling vessel to coalesce the polar salt water droplets

Phase I: Distillation of Crude Oil

- Desalted crude oil is then heated in a heat exchanger and furnace to about 750° F

Phase I: Distillation of Crude Oil

- Fed to vertical, distillation column for vaporized and separated into its various fractions by condensing on fractionation trays (naphtha, gasoline, kerosene, gas oil, light fuel oils, etc)

- Emissions occur from:
  - Combustion of fuels in the furnace (CO, NO_x, SO_2 etc.)
  - Hydrogen sulfide/ammonia (sour gas) from the condensers (flares used as control devices)
  - Fugitive toluene, benzene, xylenes, alkanes, alkenes, semi-volatiles, etc. from process

Gas Plant

- Light gases from the crude distillation are sent to a gas plant where they are further distilled and combined with light gases from other units

Phase I: Distillation of Crude

- Heavier fractions vacuum distilled through the use of steam ejectors and vacuum pumps
- Emissions occur from light gases leaving the top of the condensers on the vacuum distillation columns.

Phase II: Downstream Process

- Certain fractions from the distillation of crude oil are further refined:
  - Naphtha (raw gasoline) has low octane/high sulfur. Sent to gasoline hydrotreater and reformer.
  - Kerosene and diesel hydrotreater
  - Gas-oil better sold as gasoline; therefore sent to fluidized catalytic crackig unit

Phase II: Downstream Process

- Downstream processes change molecular structure of hydrocarbon molecules either by
  - Breaking them into small molecules (Fluidized catalytic cracker)
  - Joining them to form larger molecules
  - Reshaping them into higher quality molecules.

Downstream Processes

- Thermal cracking (heat and pressure) to break large hydrocarbons
- Feed stock heated in a furnace at 1000° F, then fed to a reaction chamber at 140 psig, then mixed with a cooler recycle stream to stop the cracking process

Downstream Processes

- Flasher chamber where volatiles are drawn off, finally to a fractionating tower for additional separation (FCC product distillation).

Catalytic Cracking Emissions

- Catalytic cracking significant sources of air pollutants: Air emissions from catalytic cracking operations include: the process heater flue gas emissions, fugitive emissions, and emissions generated during regeneration of the catalyst

Residue from Distillation Unit

- From the bottom of the crude distillation tower, comes the unboiled portion (residual) which contains heavy tar, asphalt, and gas-oil.
- Use of vacuum distillation which recovers as much of the remaining gas-oil for conversion to gasoline

Downstream Processes

- Coking is a cracking process used primarily to reduce refinery production of low-value residual fuel oils to transportation fuels, such as gasoline and diesel
- Coking also produces petroleum coke, used as anodes in the production of aluminum, fuel for power plant, etc

Downstream Processes

- Alkylation produces a high octane gasoline blending stock from the isobutane formed primarily during catalytic cracking and coking operations
- Alkylation joins an olefin and an isoparaffin compound using either a sulfuric acid or hydrofluoric acid catalyst and produces propane and butane liquids

Downstream Processes

- Isomerization is used to alter the arrangement of a molecule without adding or removing anything from the original molecule
- Paraffins (butane or pentane) are converted to isoparaffins having a much higher octane

Downstream Processes

- Catalytic reforming uses catalytic reactions to process primarily low octane heavy straight run (from the crude distillation unit) gasoline's and naphtha's into high octane aromatics (including benzene)

Downstream Processes (Catalytic Reforming)

- Four major reactions:
  - Dehydrogenation of naphthenes to aromatics
  - Dehydrocyclization of paraffins to aromatics
  - Isomerization
  - Hydrocracking

Downstream Processes

- Solvent extraction uses solvents to dissolve and remove aromatics from lube oil feed stocks, improving viscosity, oxidation resistance, color and gum formation
- Solvent extraction usually occurs in a packed tower or rotating disc contractor

Equipment Types

- Agitators, Compressors, Connectors
- Open-ended lines, pressure relief devices, pumps
- Sampling connections, valves, others

Counting Components

"...an accurate inventory of components is essential for a precise determination of fugitive emissions as well as well as to ensure that all appropriate components are monitored."

Define The Process Unit Boundaries

"A process unit is the smallest set of process equipment that can operate independently and includes all operations necessary to achieve its process objective."

Process Unit Boundaries

- Process flow diagram; However, may not include all the components due to changes
- Systematic follow process stream while counting, categorizing, and labeling
- Divide process stream into grid to search for components

Difficulties in Identification of Sources of Fugitive VOCs

- Insulated valves/flanges
- Difficult-to-monitor components
- Inaccessible components

Difficulties in Identification of Sources of Fugitive VOCs

- Unsafe-to-monitor components associated with high temperature or pressure operations or with process specific safety concerns

Remember in Equipment Inventories

"...note that more components may need to be counted for emission calculations purposes than needed to be monitored as part of a source's LDAR program (i.e., "unsafe-to-monitor, "heavy liquid service," etc.)."

Why Accurate Count

Percent Leaking Valves

$(\%V_l) = [(V_l/(V_t + V_c)] \times 100$

Components not to be Counted

- **Leakless components (such as welded connectors)**
- **Components not in VOC or HAP service**
- **Components under a vacuum**

Anomalies with Equipment Inventory

- Agitators
  - Typically with a single or double mechanical seal with a single penetration
  - Shaft that penetrates both the inboard and outboard sides is counted as two agitator seals

Anomalies

- Compressors
  - Similar to agitators
  - Shaft that penetrates both the inboard and outboard sides is counted as two compressors
  - Other components types attached to the compressor are counted separately

Anomalies

- Connectors
  - Some regulations defines connectors to include all types (i.e., threaded, union, tubing, etc.)
  - Elbow connectors counted as two
  - "Tee" connectors counted as three
  - Heat exchangers having flanged ends are counted

Anomalies

- Open-ended Lines
  - Open-ended lines are counted
  - Potentially open-ended lines controlled with a cap, plug, or blind flange is counted

Anomalies

- Pressure Relief Devices
  - Pressure relief devices are counted
  - Flanges on the upstream side and downstream side should also be counted separately from the pressure relief valve

Anomalies

- Pumps
  - Similar to agitators and compressors, if the shaft penetrates both the inboard and outboard sides, then counted as two components

Anomalies

- Valves
  - Valves are most commonly defined for counting purposes as including the stem seal, the packing gland, and the connection between the parts of a multi-part valve body (like the bonnet flange)
  - Flanges on valves may or should be counted separately from the valve

Analysis of Refinery Screening Data

- Analysis of Refinery Screening Data
- API Pub. No. 310
- November 1997
- Fugitive Emissions From Equipment Leaks II: Calculations Procedures for Petroleum Industrial Facilities
- API Pub. 343
- May 1998

Analysis of Refinery Screening Data

- National Emission Standards for Hazardous Air Pollutants from Petroleum Refineries 40CFR Part 63, Subpart CC
- "Refinery MACT Rule"
- Refinery required to implement leak detection and repair (LDAR) program which involves FR Method 21

Analysis of Refinery Screening Data

- Study involved piping components (valves, flanges, etc.) over a period of 5.5 years at seven Los Angeles California refineries
- Screening measurements to determine the estimated fugitive emissions of volatile organic compounds (VOCs) using FR Method 21

Analysis of Refinery Screening Data

- Screening measurements comprised the detection portion of a leak detection and repair (LDAR) program

Analysis of Refinery Screening Data

- Data were processed to query the following items from refinery LDAR reported database:
  - Repeat leakers, by quarter, for components leaking 2, 3, and 4 times in the preceding four quarters (chronic leakers);

Analysis of Refinery Screening Data

- High leakers, by quarter, for components screening >/= 10,000 ppmv;
- Process-by-process variation;
  - Refinery specific data; and
  - Determine cost-effective approach

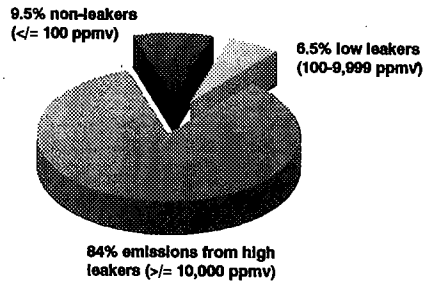
Analysis of Refinery Screening Data

- High leakers (components screening >/= 10,000 ppmv) were found to occur randomly
- Repeat leakers (components screening >/= 1,000 ppmv more than once within a year) were negligible

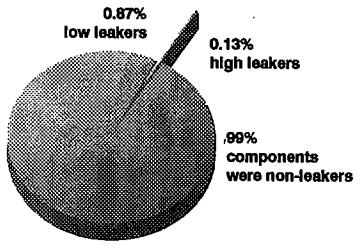
Analysis of Refinery Screening Data

- Only 0.13% of the components were high leakers, but they account for 84% of the reducible VOC emissions

Refinery Hourly Emissions



Refinery Emissions Components



Analysis of Refinery Screening Data

- Relatively few components were found to be repeat leakers
  - Only 5.4% of all emissions were from repeat leakers
- High leakers (>/= 10,000 ppmv) were found to occur randomly.

Analysis of Refinery Screening Data

- Overall percentage of high leakers in any refinery was less than 0.2 percent

Analysis of Refinery Screening Data

- The three processes with the highest emissions were:
  - Catalytic reforming
  - Alkylation
  - Crude distillation

Analysis of Refinery Screening Data

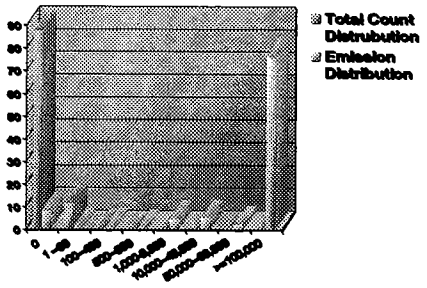
- When normalized, based upon the number of components in the process, isomerization units had the highest emissions per component

Analysis of Refinery Screening Data

- Components in liquefied petroleum gas (LPG) service tend to account for more than half of the high leakers and most of the repeat leakers

Screening Interval	Total Count Distribution	Emission Distribution
0	67.61	6.43
1-99	11.62	1.12
100-499	0.440	1.18
500-999	0.083	0.44
1,000-9,999	0.236	4.31
10,000-49,999	0.073	[illegible]
50,000-99,999	0.012	[illegible]
>=100,000	0.0008	[illegible]
Total	100.00	[illegible]

Distribution of Component Count and Estimate Emissions by Screening Range



Distribution of Emissions by Component Category

Component Category	Service	Total Emissions for Category, lb/hr	Percent of Total Emissions for Category
Valves	G	79.22	33.78
Valves	LL	90.58	33.34
Pumps	LL	9.28	[illegible]
Connectors	G	40.31	[illegible]
Connectors	LL	26.83	[illegible]
	Total	254.87	[illegible]

Contribution to Total Emissions by Process Unit High and Repeat Leakers

Rank	Process unit and letter designation	% of emissions from high & repeat leakers
1	Catalytic reforming unit	13.3
2	Alkylation unit	9.4
3	Crude distillation unit	7.3
4	Product blending unit	6.2
5	Hydrogen plant	[illegible]
6	Interunit pipelines	[illegible]

Contribution to Total Emissions by Process Unit High and Repeat Leakers

Rank	Process unit and letter designation	% of emissions from high & repeat leakers
7	Catalytic cracking unit	5.0
8	Hydrotreating unit	4.9
9	Thermal cracking unit	4.8
10	Full-range distillation unit	3.8
11	Isomerization unit	2.8
12	Hydrocracking unit	2.1

Tagging Techniques for A Source LDAR Program

- Barcode System (Tag-bases Approach)
- Tagless Technology (Drawing-based Approach)
- Radio Frequency System

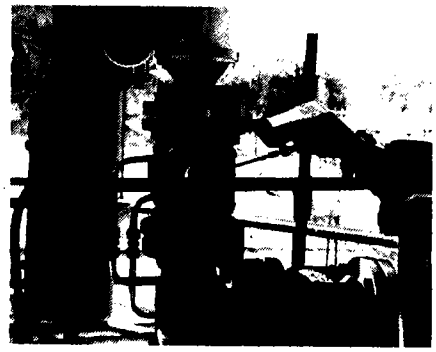
- Communication
- Control
- Documentation
- Organization

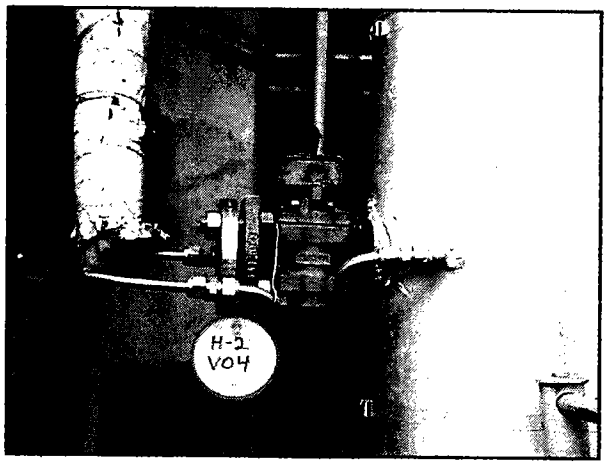
Successful LDAR programs begin and end with clear and concise communication, total program control, detailed documentation, and superior organization.

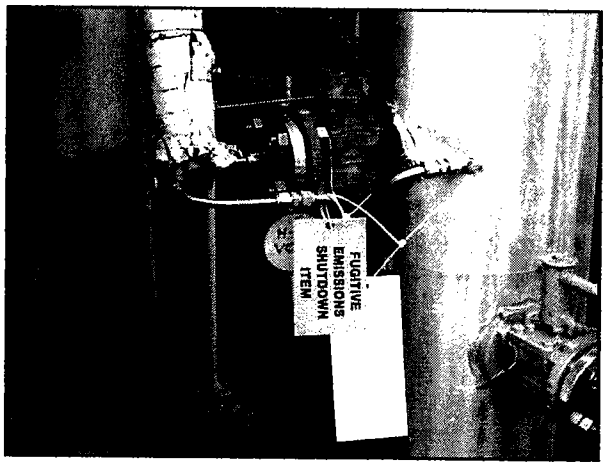
Tagging Techniques

- Embossed Metal or Plastic Tags Directly on the Component
- Bar Codes
- "2D" Tags
- "Hotel Keys"
- "Electronic Chips" or "Buttons"
- Radio Frequency Tagging
- Tagless

Physical Tagging





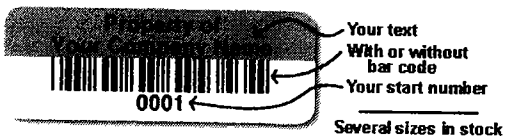


Bar Code Tagging

Bar Code Labels

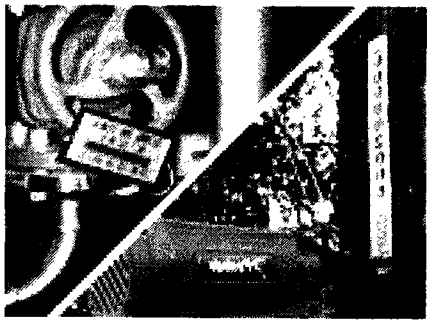
- Metalphoto Aluminum
- Extra High Temperature Aluminum
- Teflon on Aluminum
- Self-Stripping Labels
- Polyester Labels

Bar Code Tagging



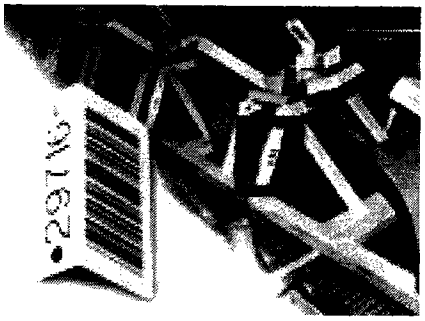
Bar Code Tagging

Bar Code Tagging



Bar Code Tagging

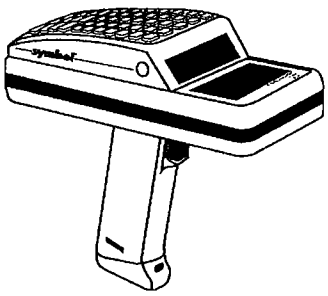
Bar Code Tagging: Work In Progress



Bar Code Readers

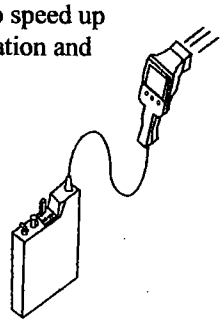
- Metrologic
- Symbol
- POS-X
- PSC
- Intermel
- Opticon
- ID-Tech

Symbol Bar Code Reader



Laser scanners

- Bar code scanning to speed up component identification and datalogging process



Combination of "Sniffer" and Bar Code Reader

Component Tracking

- Component Identification
  - Process Unit Descriptions
  - Equipment ID
  - Type of Equipment (i.e., pumps, valves, etc.)
  - Type of Service (i.e., gas/vapor, light liquid, or heavy liquid)
  - Primary Material Being Transported
  - Unique Location Description

Component Tracking (Cont'd)

- Tagging Information
  - Process Unit
  - Area of the Process Unit
  - Type of Equipment Being Tested
  - Process Fluids in the Process Stream

Remember…

"…most regulations require unique identifying information for each component subject to inspection and repair in the form of a "logbook," but do not necessarily require physical tagging of components."

Tagging

"The exact method for identifying components should be selected by facilities in line with their size, complexity, and compliance documentation requirements."

- Identical tagging for non-regulated components
- Identification from a specific valve or pump following flow (PUB4482-A, -B, -C,…)

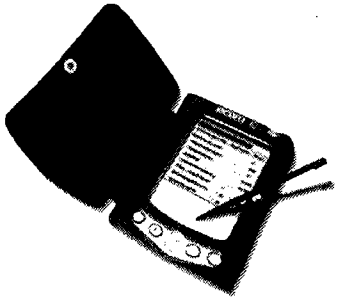
Data Collection

- Hard Copy
- Data Logger
- Combination of Both

Hard Copy/Clip Board

Electronic Data Management

Palm Pilot



Selection Criteria for Data Loggers

- Intrinsically Safe Nature of the Data Logger (With/without Analyzer)
- Number of Components to be Tested and Stored
- Number and Size of Data Fields in the Data Logger

Selection Criteria (Cont'd)

- Weight and Bulk of Data Logger
- Durability Under All Conditions
- Speed and Ease of Data Entry and Interface with Data Management
- Cost and Technical Support From Manufacturer

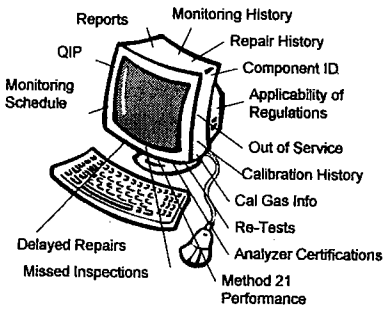
Data Management

- Data Needed for:
  - Repair Requirements
  - Follow-up Monitoring Requirements
  - Regulatory Compliance Determinations

Data Management (Cont'd)

- Emission Calculations
- Statistical Determinations
- Report Generations
- Program Evaluation and Effectiveness

Data Management



Data Management System Selection

- Number of Components Monitored
- Storage and Manipulation Capability of the DMS
- Number of Regulations Applicable to the Facility
- Complexity of the Regulations
- Number of Functions That The DMA Can Performed

DMS Selection (Cont'd)

- Adaptability of the DMS to Revisions to the Regulations
- Speed of the System
- Ease of Implementation
- Ease of Ongoing Use and Training of new Personnel
- Cost and Available Technical Support

PROACTIVE ENVIRONMENTAL SERVICES

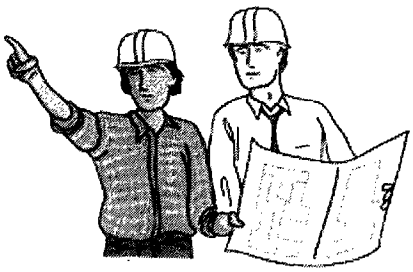
Proudly Presents

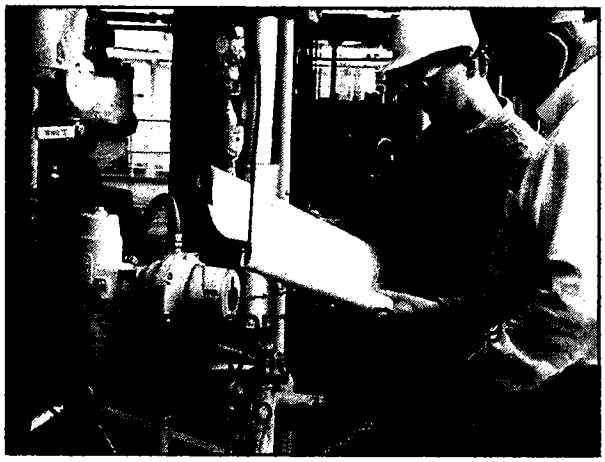
ProVIEW

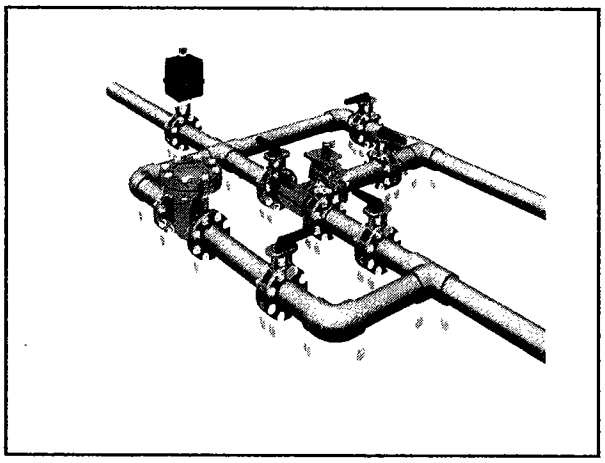
Tagless LDAR

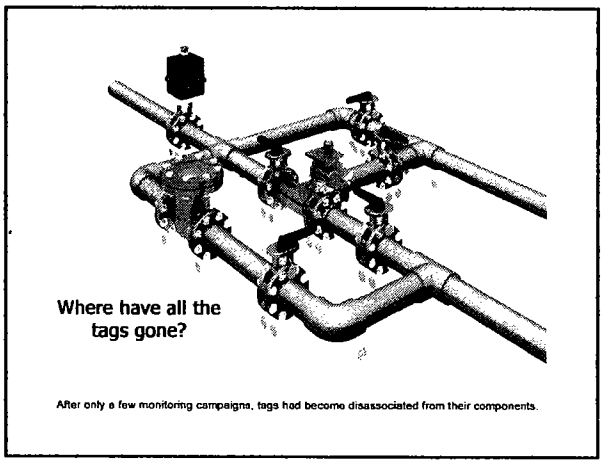
PROACTIVE ENVIRONMENTAL SERVICES

Tagless Technology (Drawing Base)








Where have all the tags gone?
After only a few monitoring campaigns, tags had become disassociated from their components.

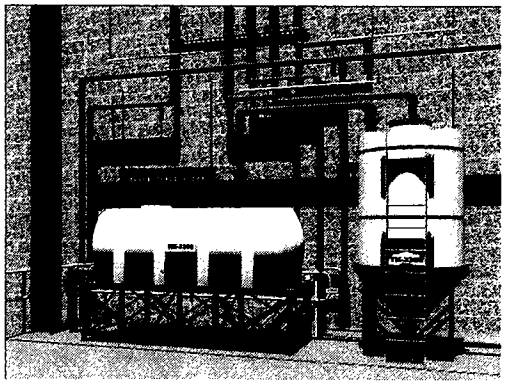
Tags . . . Temporary Identification

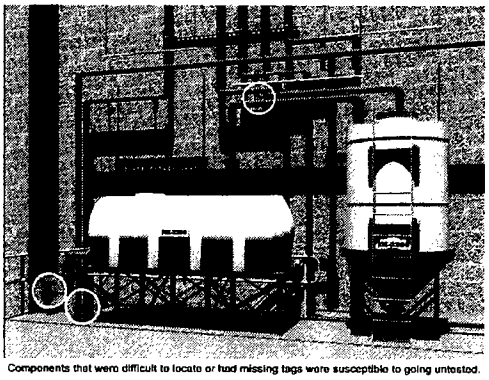
Tag related issues . . .

- Painted over
- Corroded
- Removed by contractors
- Fall off
- Become weathered
- You name it!

. . . results in . . .

- **Wasted Time**
- **Misused Talent**
- **Unnecessary Spending**





Components that were difficult to locate or had missing tags were susceptible to going untested.

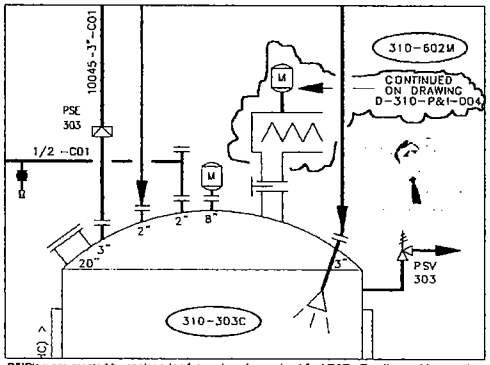
A simple math problem . . .

If 10k tags were tested in quarter one but only 9,800 in quarter two, where are the readings for the remaining 200 components. Knowing exactly which components were in question and locating them was no easy task.

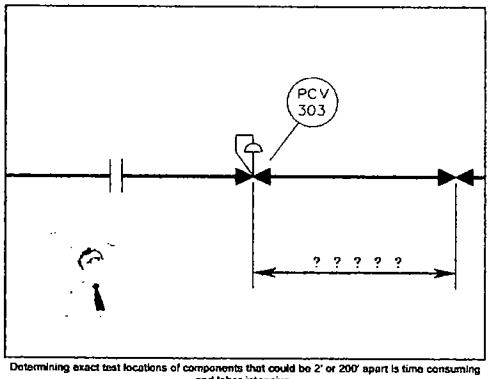
We knew we had to improve LDAR . . .

. . . but how ? ? ?

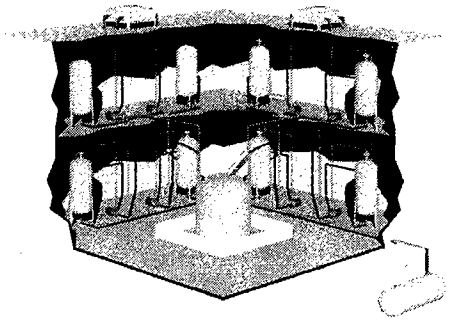
- Eliminate tags
- Drawing based approach to component identification



P&ID's were created by engineering for engineering and not for LDAR Reading and interpreting P&ID's was not easy on the monitoring technicians.



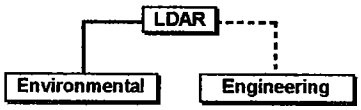
Determining exact test locations of components that could be 2' or 200' apart is time consuming and labor intensive.



Testing with P&ID Flowpaths . . .

P&ID's are single line drawings with no logical route for monitoring.

INDEPENDENCE



Gaining independence from the engineering group was essential for program success.

Rethinking Drawing Based LDAR

- Manageable Drawings
- Less Engineering Clutter
- Smooth Work Flow
- Smallest Fittings Documented
- Varying Degrees of Independence

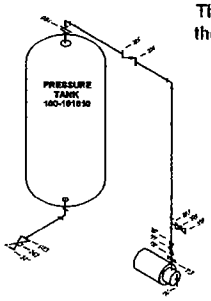
the solution . . .

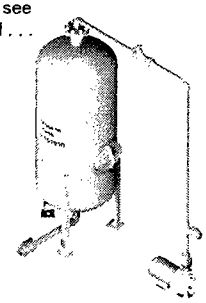
Tagless LDAR

An Evolutionary Step Forward in Emissions Management and Component Identification

The ability to see the real world . . .

Clearly!

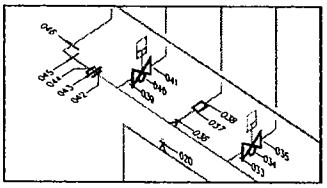


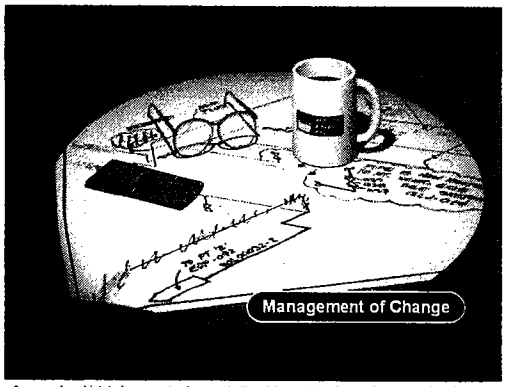


GUARANTEED!

100% Component Identification

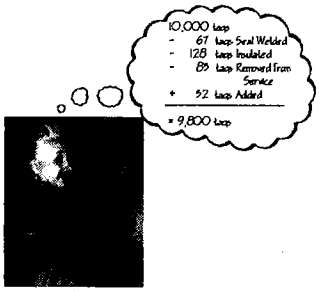
A medium to identify even the *SMALLEST* connectors.





A means by which to incorporate changes to the piping and equipment in both conjunction and simultaneously with the monitoring.

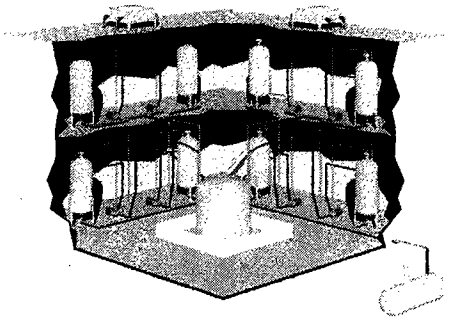
A simple math problem . . .



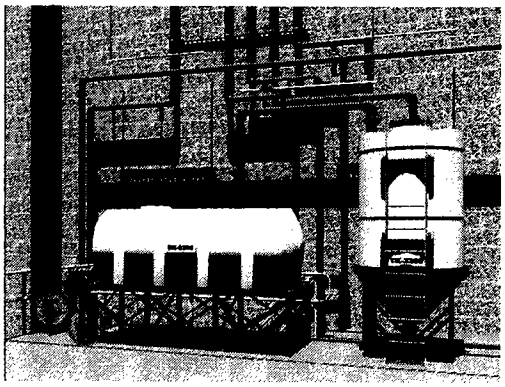
Hard copy proof to validate the inevitable changes that occur within the program

BUILT-IN EFFICIENCIES

With no tags to read or bar codes to scan, monitoring doesn't require getting intimate with the equipment. All testing is done in a comfortable upright position.



Testing with tagless Flowpaths . . .

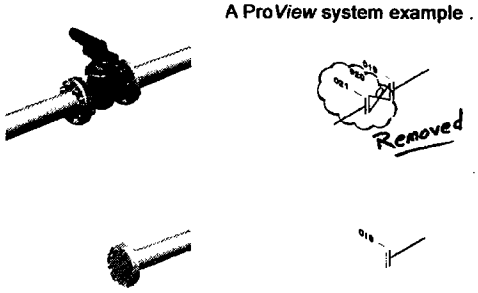


- Components that were once considered to be difficult to locate...

A tagging system example . . .

What was tested in quarter one no longer exists in quarter two. With tags there is no vehicle in place to determine affected components, requiring additional man-hours to track the change.

A Pro*View* system example . . .

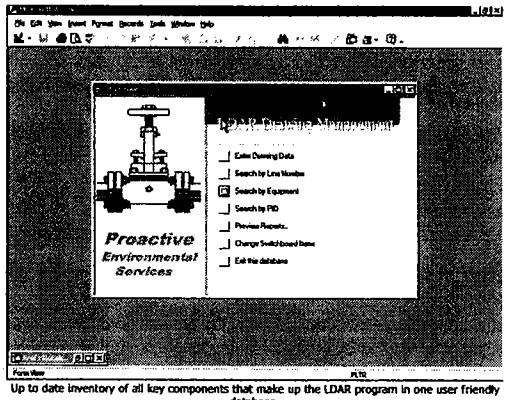


With the tagless system, documenting change is a natural bi product of monitoring. Change is accurately documented with no down time and testing is uninterrupted.

ORGANIZATION

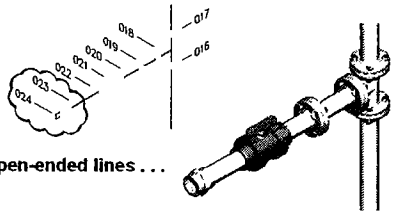
- Line numbers
- Equipment numbers
- P&ID's
- Leakers
- Cross-reference database

The ability to incorporate and track pertinent information directly on the LDAR drawing.



Up to date inventory of all key components that make up the LDAR program in one user friendly database.

CONTROL



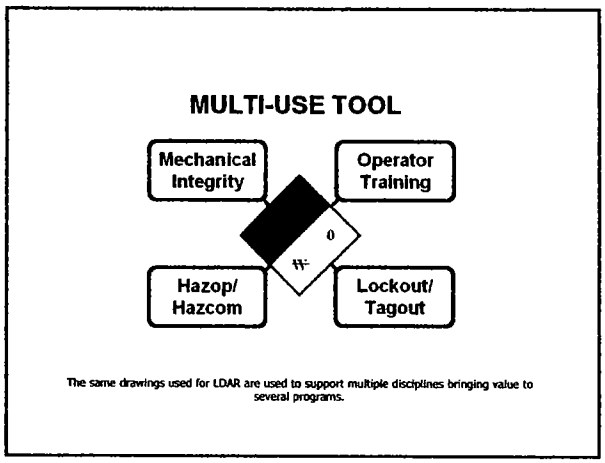
Open-ended lines . . .

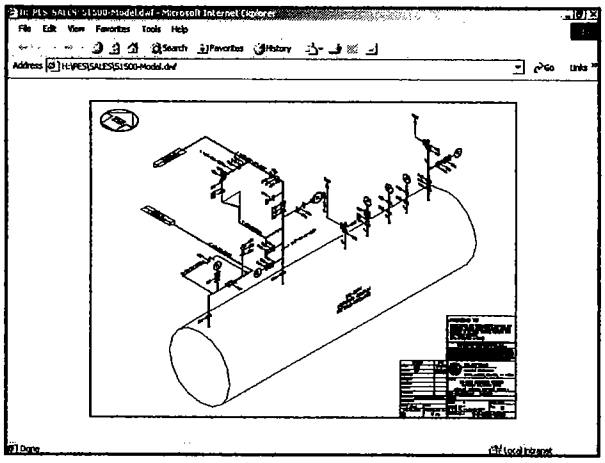
Every trip to the field is an informational gathering linewalk, like the ability to document OEL's so caps or plugs can be installed.

CONTROL

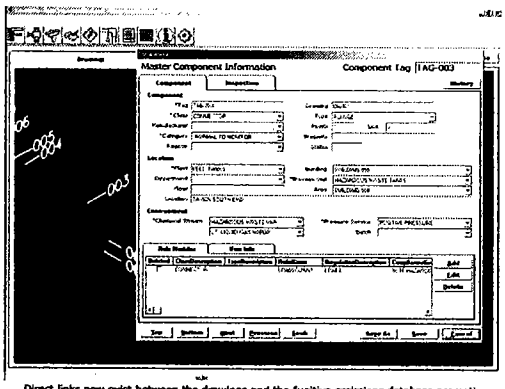
Ladders . . .

Ability to document components requiring ladders for testing so routes can be built specifically for this purpose.


MULTI-USE TOOL
Mechanical Integrity
Operator Training
Hazop/ Hazcom
Lockout/ Tagout
The same drawings used for LDAR are used to support multiple disciplines bringing value to several programs.



LEAK
DATA
ACQUISITION
ORR LeakDAS
3



Direct links now exist between the drawings and the fugitive emissions database promoting greater control and flexibility over the program.

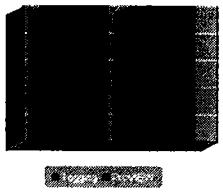
COST $AVING$

- Eliminate cost of tags and tagging
- Reduce administration time
- Eliminate potential audit findings

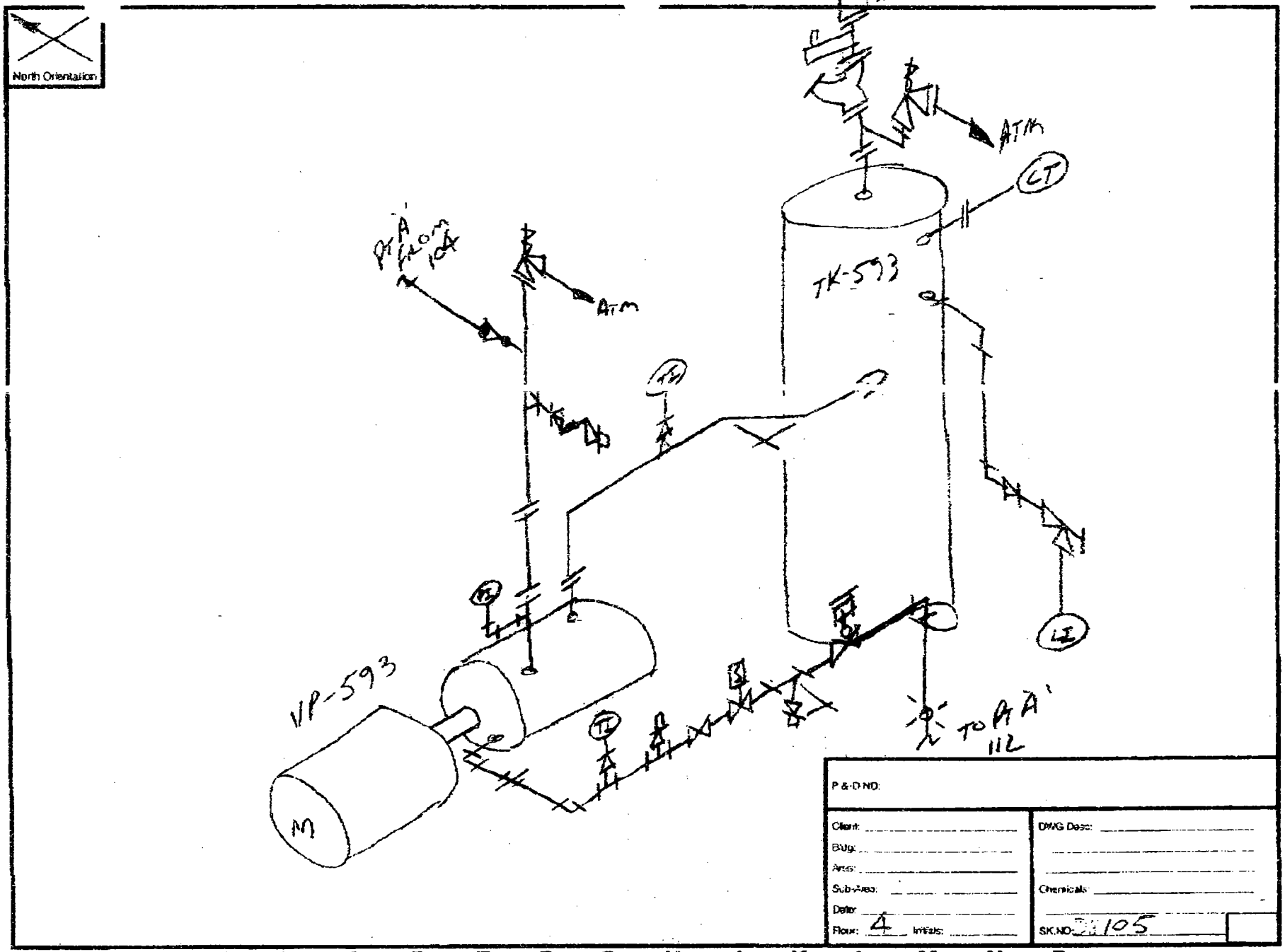
Greater Value

Simple Tagging	Pro*VIEW*
- Hang Tags - Populate Database	- Field Sketches - CAD Drafting - Engineering Information - Populate Database - Print Drawings - Web File Format (DWF) - Cross-reference Database

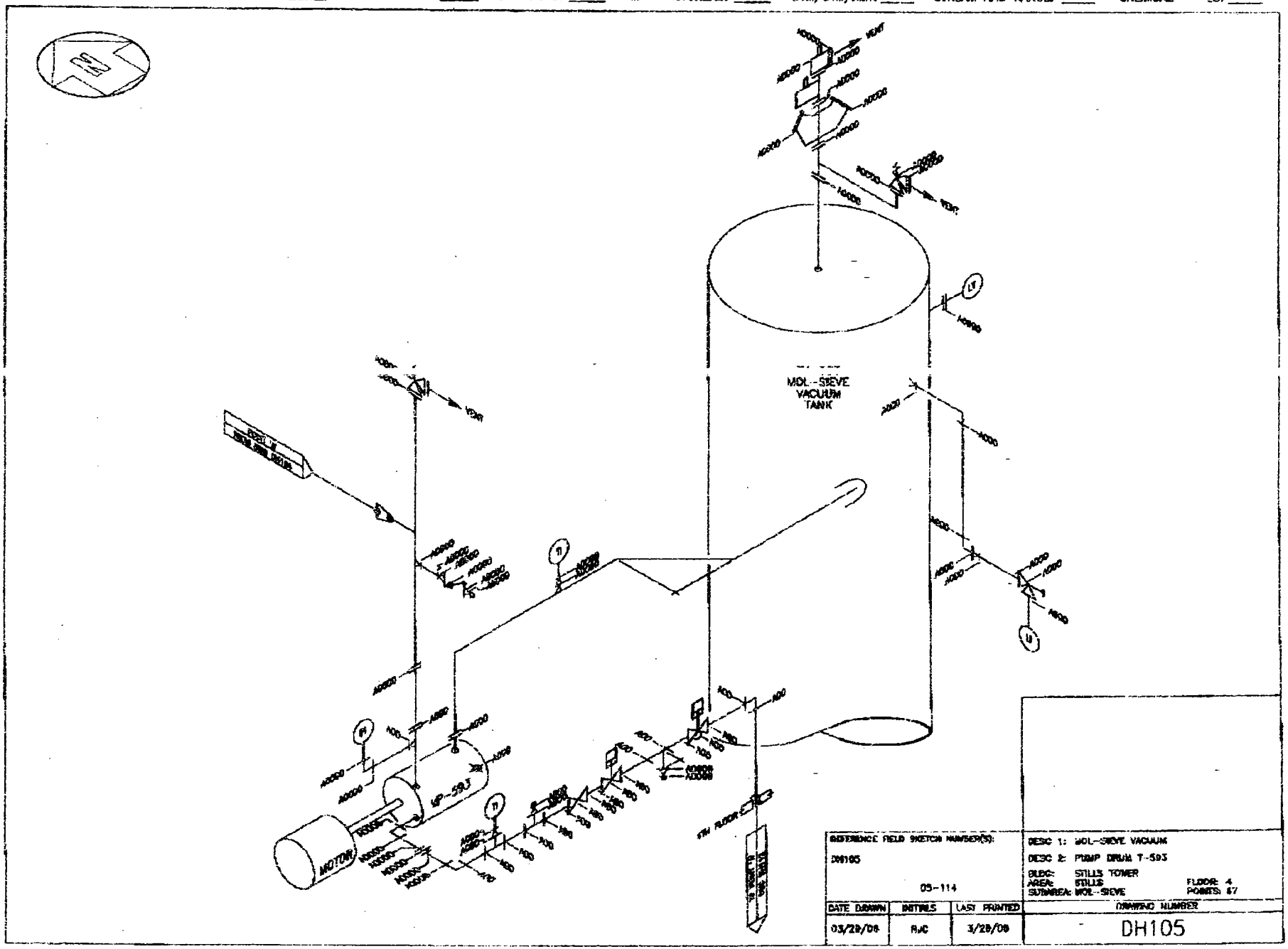
About the same price as a simple tagging based system!



Equip. ID: Line Numbers: Line Sizes: Process Streams: DTM/UTM: P & ID: Comments:



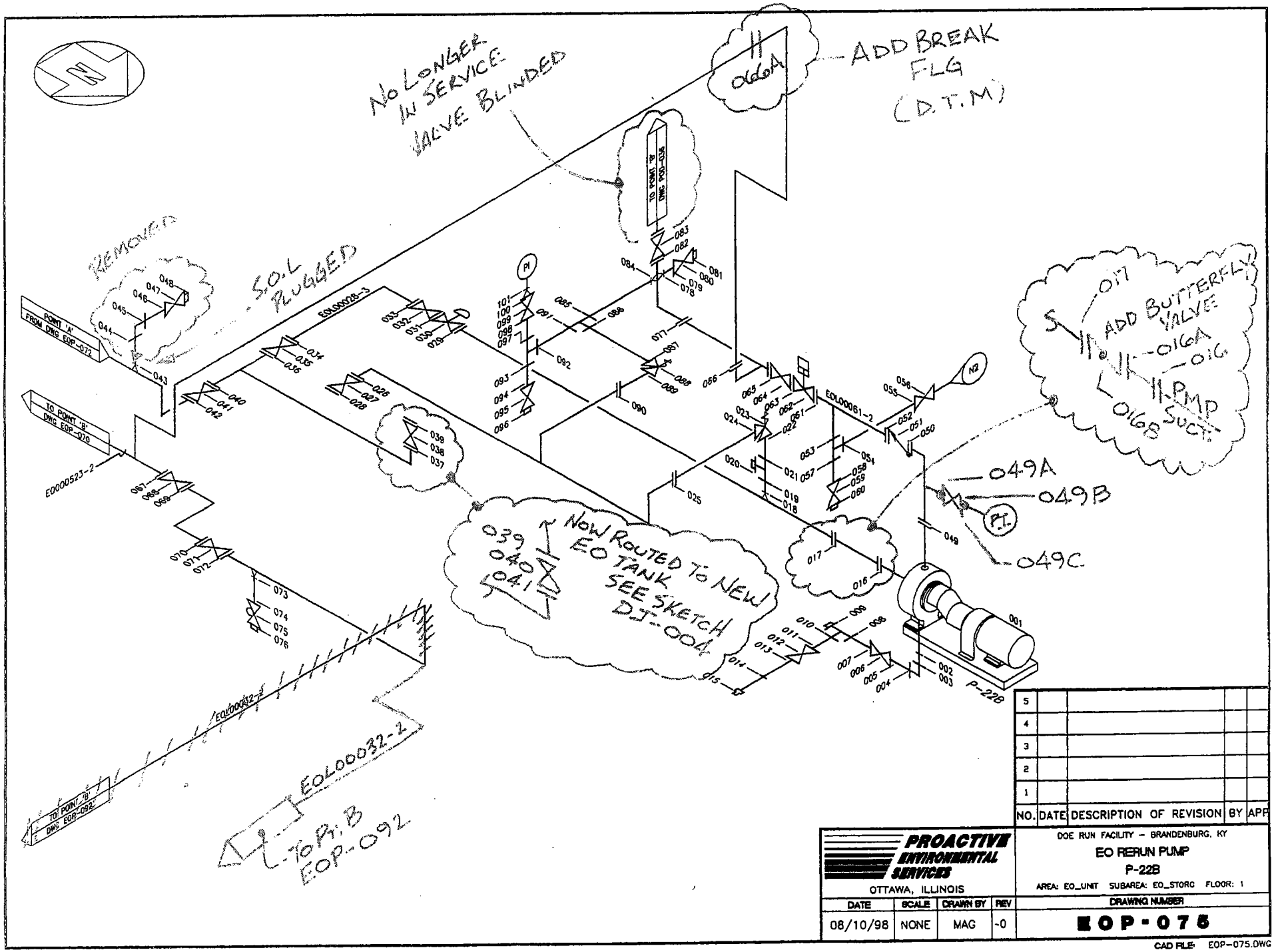
CONTINUATION: ____ TAG SEQUENCE: ____ DWG EXTENTS: ____ LINE SIZES: ____ M ____ CTURERS: ____ DTM/UTM/XMT: ____ STREAM AND RANGE: ____ CHEMICAL ____ ES: ____



REFERENCE FIELD SKETCH NUMBER(S):	DESC 1: MOL-SIEVE VACUUM
DH105	DESC 2: PUMP DRUM T-593
05-114	BLDG: STILLS TOWER AREA: STILLS SUBAREA: MOL-SIEVE FLOOR: 4 POINTS: 67

DATE DRAWN	INITIALS	LAST PRINTED	DRAWING NUMBER
03/29/06	RJC	3/29/06	DH105

Last Plotted: Mar 30, 2006 – 9:38am by RICK



NO.	DATE	DESCRIPTION OF REVISION	BY	APP
5				
4				
3				
2				
1				

PROACTIVE ENVIRONMENTAL SERVICES
OTTAWA, ILLINOIS

DOE RUN FACILITY – BRANDENBURG, KY

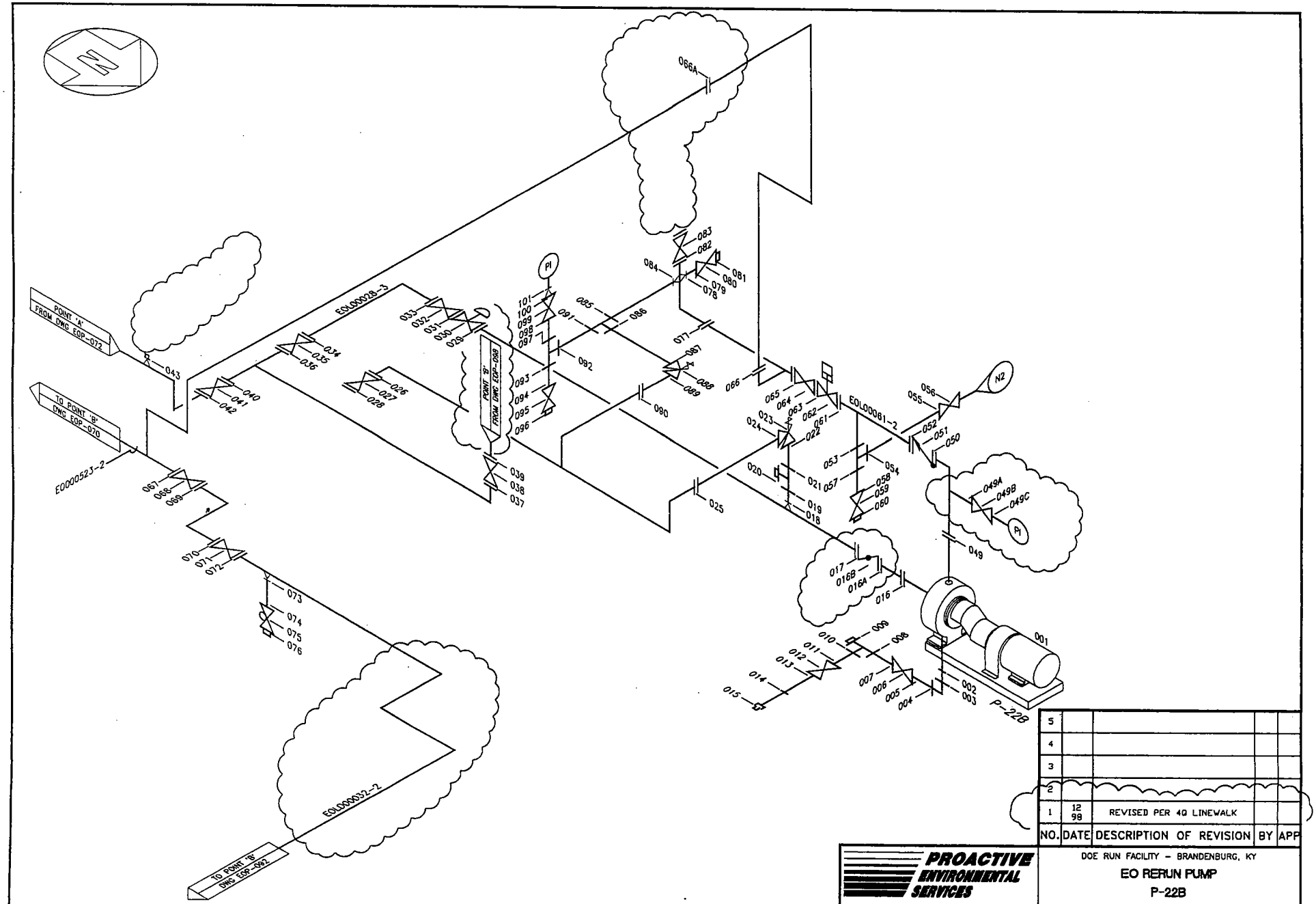
EO RERUN PUMP
P-22B

AREA: EO_UNIT SUBAREA: EO_STORG FLOOR: 1

DATE	SCALE	DRAWN BY	REV
08/10/98	NONE	MAG	-0

DRAWING NUMBER
EOP-075

CAD FILE: EOP-075.DWG



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5				
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1	12 98	REVISED PER 4Q LINEWALK		

PROACTIVE ENVIRONMENTAL SERVICES
OTTAWA, ILLINOIS

DOE RUN FACILITY - BRANDENBURG, KY

EO RERUN PUMP

P-22B

AREA: EO_UNIT SUBAREA: EO_STORG FLOOR: 1

DATE	SCALE	DRAWN BY	REV
08/10/98	NONE	MAG	0

DRAWING NUMBER

EOP-075

CAD FILE: EOP-075.DWG

Federal Reference Method 21

Jerry Winberry
EnviroTech Solutions

Federal Reference Method 21

- What does an inspector needs to know and understand about Federal Reference Method 21 instrumentation and certification?

Lesson Objectives

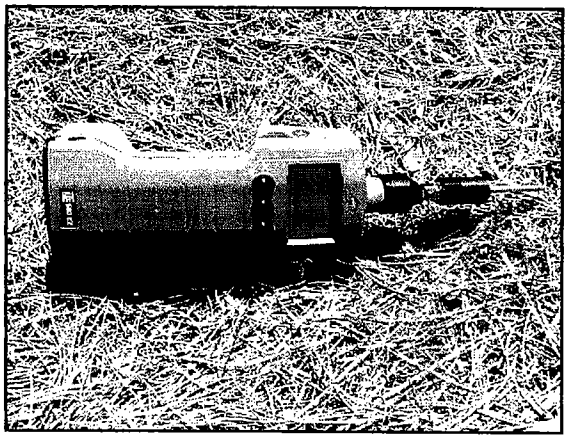
- Review Federal Reference Method 21 requirements
- Identify typical equipment that meets Method 21 specifications
- Explain Method 21 analyzer performance criteria and analyzer performance evaluation

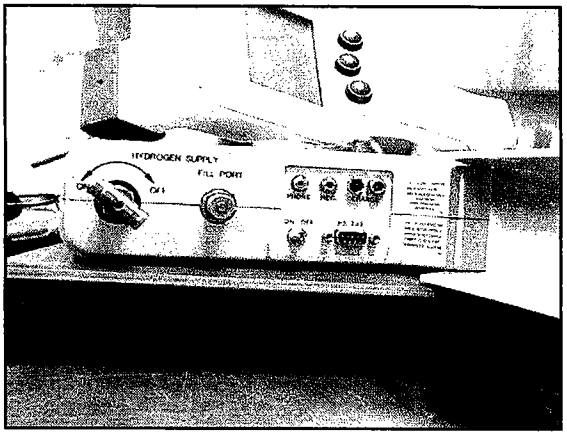
Identification of Leaks/Measurement Technique

- Determination of VOC leaks from process equipment
- Method 21 describes the procedures to be followed in using a hand-held instrument to measure for VOC leaks from process equipment

Portable VOC Analyzers

- Portable VOC analyzers fall within two classes:
  - Single Hand-held Unit
  - Multi-component Hand-held Unit





Parts of a Multi-Component VOC Analyzer

- **Probe/Interface**
  - **Probe/probe extension not to exceed 1/4 " OD**
  - **Optional bar code reader**
  - **Optional meter/readout capability**
  - **Optional particulate filter**

Parts of a Multi-Component VOC Analyzer

- Umbilical Cord
- Analytical Assembly
  - Pump/flow controller
  - Analytical Instr. (detector, cal gas, reg, power)
  - Data acquisition system

Method 21 Requirements

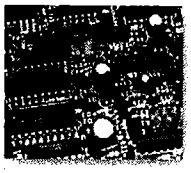
- Instrument Specifications (VOC response, measurement range, scale resolution, sample flow rate, response time, intrinsically safe, 1/4" single ended probe, response factors < 10, and accuracy of +/- 10 %)

Method 21 Requirements

- Performance Criteria (Determination of response factors, perform calibration precision test, and perform response time test)

Method 21 Instrument Specifications

- 1. The instrument must respond to the compound of interest
  - Several detectors are available:
    - Catalytic Oxidation
    - Infrared Adsorption
    - Photoionization
    - Flame Ionization

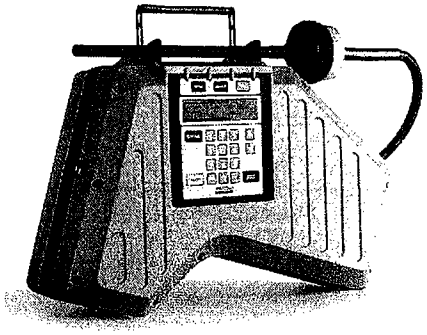


Catalytic Oxidation

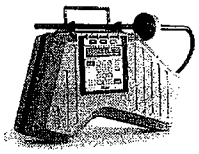
Catalytic Oxidation

- Advantages
  - Provides stable readings in humid environments
  - Unaffected by changes in temperature extremes
- Disadvantages
  - Can only read in low ppm, not high ppm
  - Non-specific and non-linear

Infrared Spectroscopy



Infared Spectroscopy



- Advantages
  - High degree of specificity
  - Low maintenance
- Disadvantages
  - Not portable for ladder climbs, etc.

Photo Ionization Detection

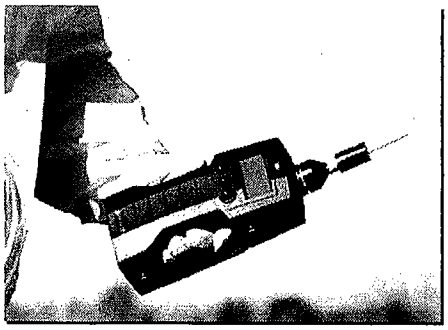
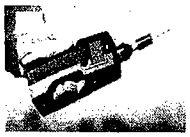


Photo Ionization Detection

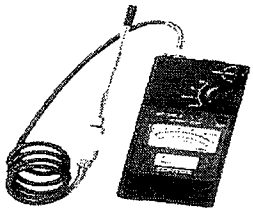
- Advantages
  - Non-destructive detector (allows sample collection)
  - Can measure inorganics
  - Sensitive to aromatics, chlorinated and unsaturated hydrocarbons
  - No support gases required

Photo Ionization Detection



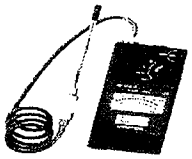
- Disadvantages
  - Affected by water vapor
  - Limited (0-2000 ppm) dynamic range
  - Non specific

Hot Wire Semiconductor



- Advantages
  - Portable
  - No support gases required

Hot Wire Semiconductor

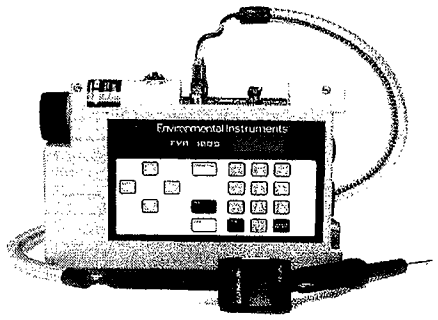


- **Disadvantage**
  - **Slow response time (< 30 seconds)**
  - **Electromagnetic interference (EMI) signals can cause incorrect operation (erroneously high)**
    - **walkie-talkies, etc.**

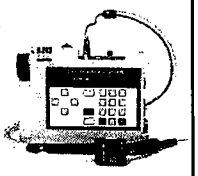
Hot Wire Semiconductor Disadvantages (Cont'd)

- **Response factors > 10 for many compounds resulting in non-compliance with Method 21**
  - **example, styrene is 11.5**
- **Not intrinsically safe when calibrated for certain compounds**

Flame Ionization Detection

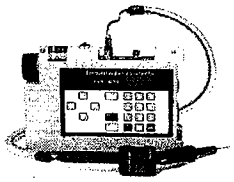


Flame Ionization Detection (FID)



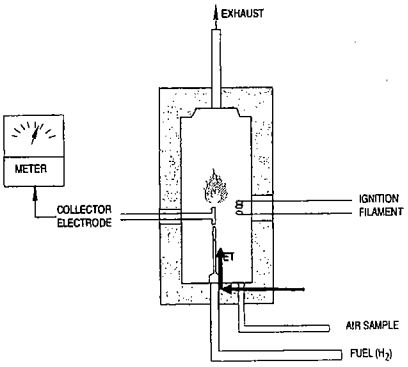
- **Basic Theory:**
  - **Sample is introduced into an ionization chamber and burned**
  - **Process separates free ions**
  - **Free ions are attracted to a collecting electrode**

FID:Basic Theory (Cont'd)

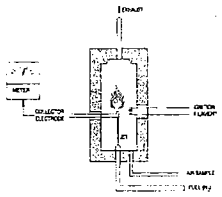


- **Collection of the ions results in an increased current which is proportional to the concentration of the compound**
- **By-products are H_2O and CO_2**

Diagram of FID

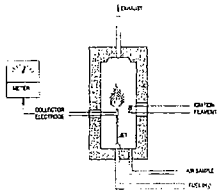


Flame Ionization Detection



- Advantages
  - Wide dynamic and linear range
  - Highly sensitive to hydrocarbon vapors
  - Very stable and repeatable
  - Unaffected by ambient levels of CO, CO_2 and water vapor

Flame Ionization Detection



- Disadvantages
  - Requires oxygen > 16% to operate
  - Total hydrocarbon detector - not specific

Flame Ionization is Most Common

- Speedy response & measurement time
- Provides high ppm measurements
- Stable in humid environment

When in a pinch...

- Bubble leak test
- The old reliable can be used!
- "Alternative Screening Procedure" in Method 21

Method 21

- 2. The linear response range/measurable range must encompass the leak definition
- 3. Scale defined on the instrument to +/- 2.5 % of concentration of leak:
  - 10,000 ppm +/- 250 ppm
  - 500 ppm +/- 12.5 ppm

Method 21

- 4. The instrument must have a pump capable of drawing sample at a rate of 0.10 to 3.0 L/min
- 5. The instrument must be intrinsically safe in at least Class I, Division I area
- 6. The instrument must have a sample probe with an outer diameter (OD) of 1/4 inch

Method 21

- 7. The instrument response factor for the compound of interest shall be less than 10
  - Response Factor (RF) = (Act. Conc.) / (Instru. Observ. Conc.)
  - Typical RF:
    - Benzene: 0.29
    - Chloroform: 9.28

Response Factors

- Ratio of the known concentration of a VOC compound when compared to the reference compound.
- Different types of detectors respond to different compounds with varying sensitivities.
- Examples
  - Methane (the reference) is 1.0
  - Vinyl chloride is 2.842 at 500 ppm
  - Chlorobenzene is 0.791 at 500 ppm

Response Factors

- Response factors can be established by the technician.
- Response factor *must* be less than 10.
- Response factors published by the manufacturer can be used in place of on-site response factor determinations.

Method 21

- The response time should be less than 30 seconds
- The calibration precision must be </= 10 % of the calibration gas

Method 21 Performance Criteria

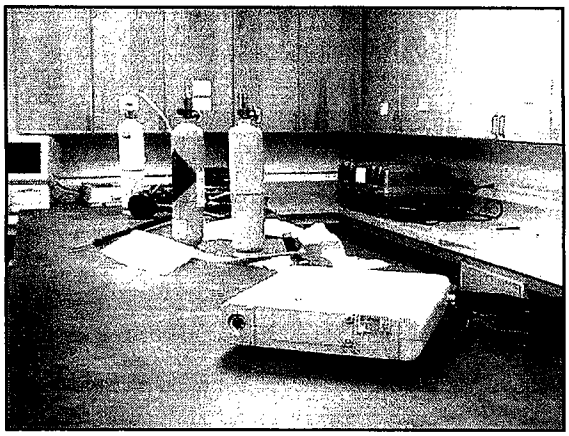
- 1. Determine a response factor or use literature
- 2. Perform calibration precision test
- 3. Perform response time test

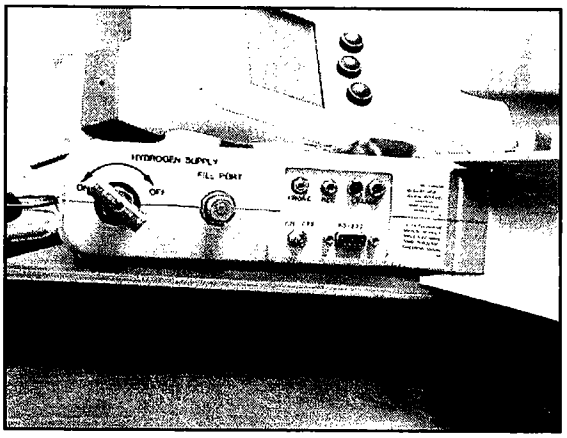
Calibration Precision Test

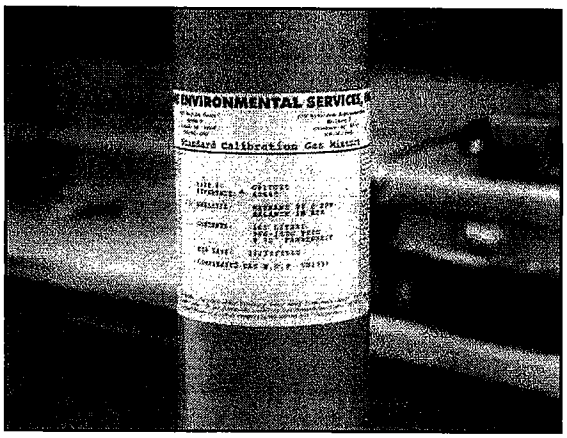
- When:
  - Before testing; at 3-months intervals
- Materials Needed:
  - Zero (< 10 ppm VOCs) and calibration gas (certified)
- How:
  - Calib. Precision = (Obs. Value) - (Cert. Value) / (Cert. Value)

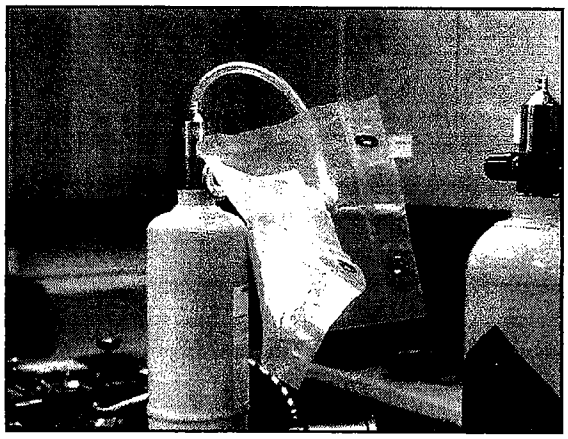
Calibration Precision Test

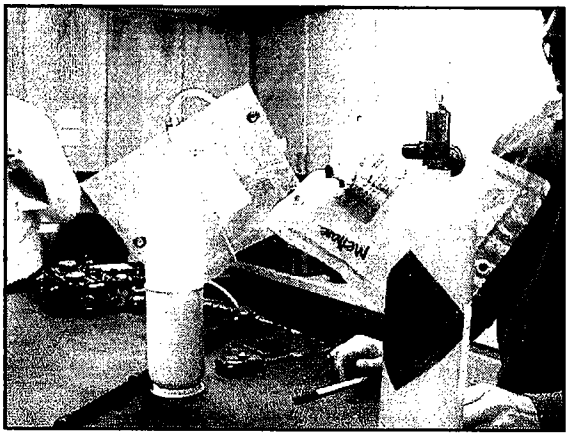
- **Acceptance Criteria:**
  - **Precision +/- 10 %**

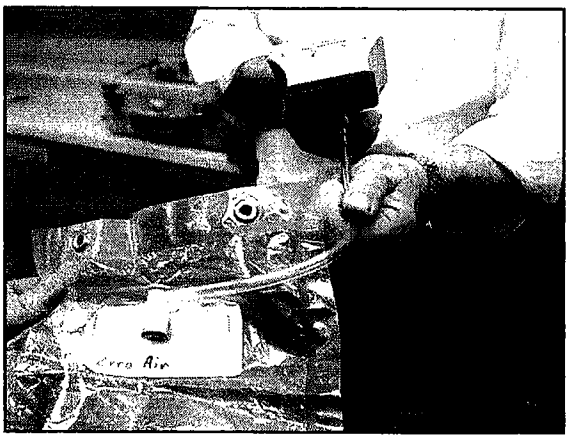


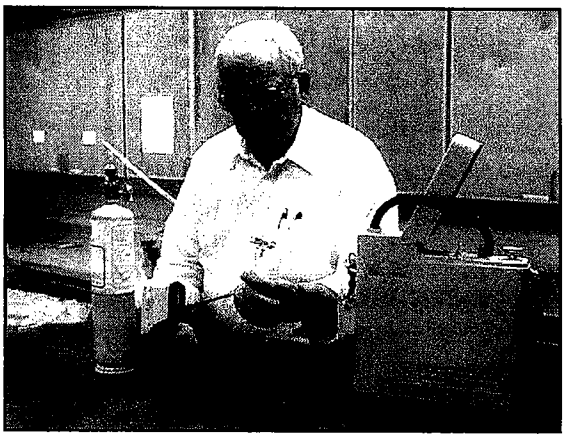

HYDROGEN SUPPLY
FILL PORT
OFF

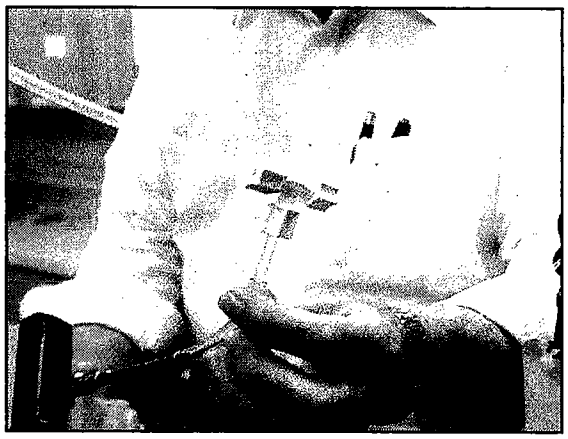

ENVIRONMENTAL SERVICES
Pollard Calibration Gas Mixture

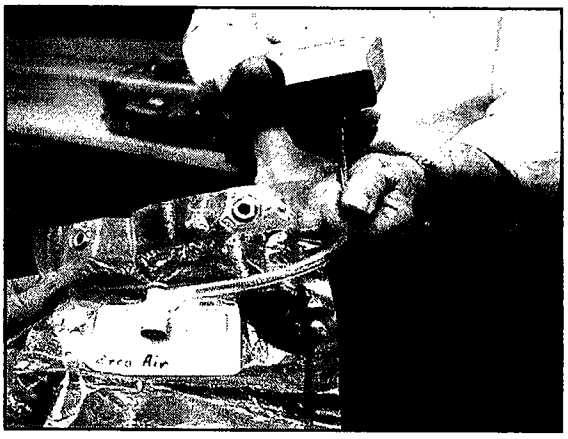


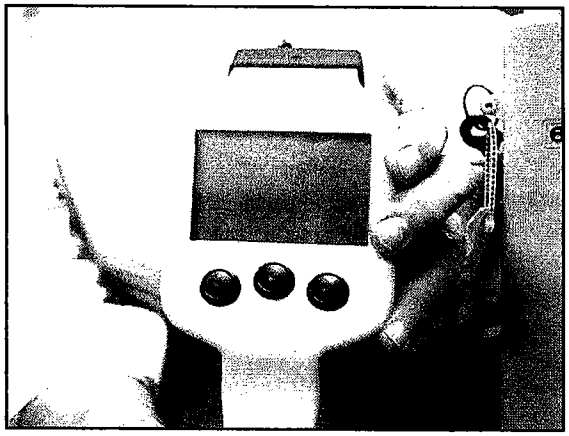


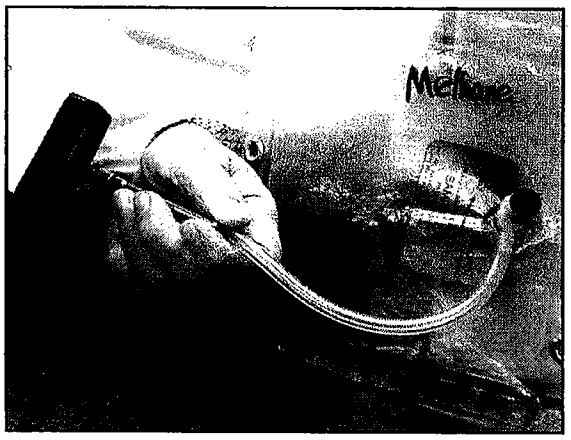


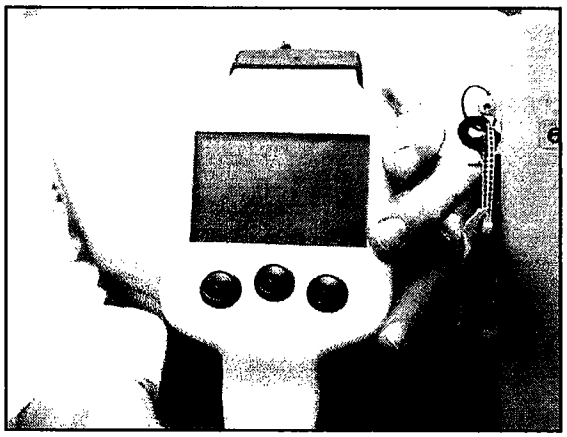









Methane

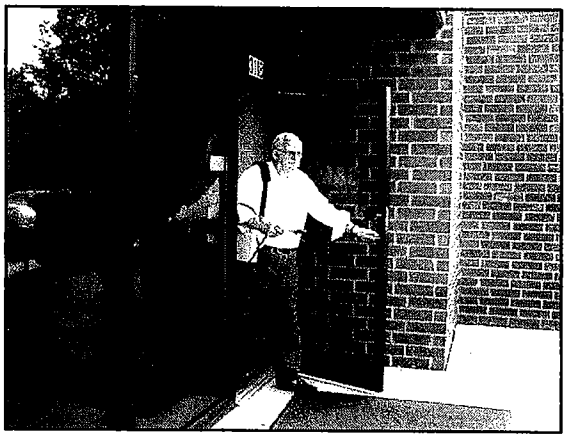


Response Time

- When:
  - Before testing; at instrument modification
- How?
  - Introduce zero gas, then switch to calibration gas, measure time from switching to when 90 % of the final stable reading is obtained; repeat two addition times and average

Response Time

- Acceptance Criteria:
  - Response time less than 30 seconds



Manufacturers of Portable FRM 21 (See Handout)

- Thermo Environmental Instruments/Foxboro (www.thermoei.com)
- Photovac Inc. (www.photovac.com)
- Matheson Gases (www.mathesontrigas.com)

Manufacturers

- Baseline-MOCON, Inc. (www.baselineindustries.com)
- Heath Consultants (www.heathus.com)
- RAE Systems Inc. (www.raesystems.com)
- Bacharach (www.bacharach-inc.com)

Manufacturers

- MSA (www.msanet.com)
- Gasco (www.cascogas.com)
- HNu Systems, Inc. (www.hnu.com)
- Gas Tech, Inc. (www.gastech-inc.com)

Manufacturers

- Sentex Sensing Technology (www.sentex.com)

Thermo TVA 1000B

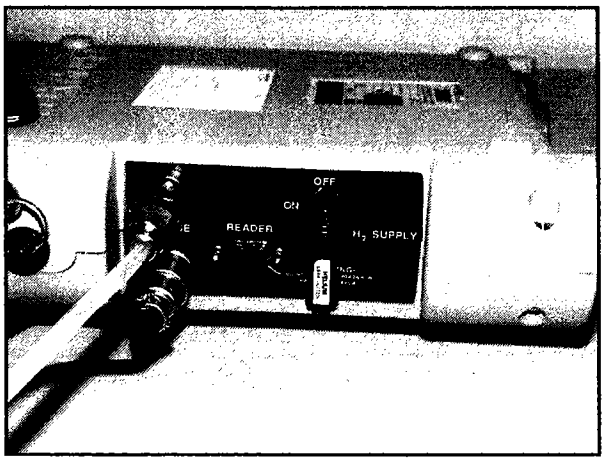
- Data file of RF and curves
- Side-pack connectors to docking station at computer

Dual Ionization Detector FID/PID

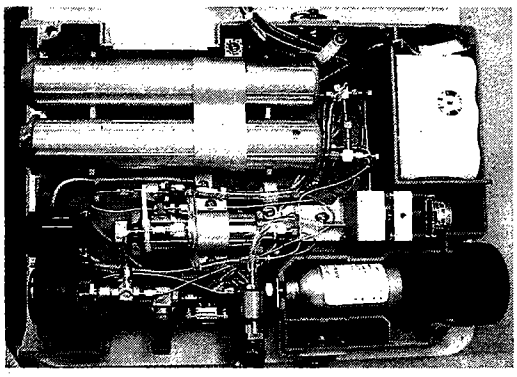
- Provide benefits of both technologies in one package - simultaneously
- Only one operating procedure to follow - ease of use

Dual Ionization Detector FID/PID

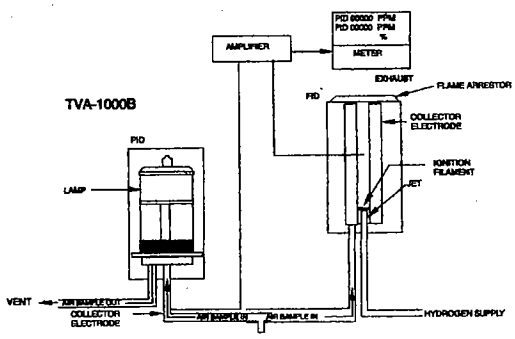
- Enhanced analytical capability if compounds being monitored are known
  - Methane stripping possible
  - Attractive pricing alternative to two individual analyzers
- Good for pulp & paper industry - FID for methanol, PID for sulfites



Internal Packaging



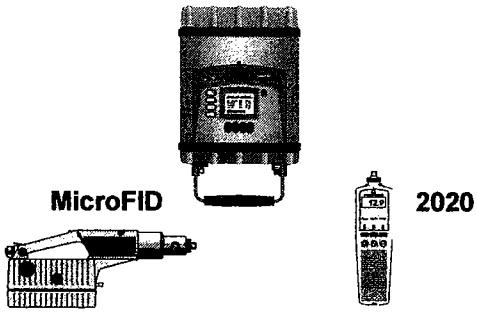
Dual System FID/PID



Photovac Inc. (www.photovac.com) MicroFID

- Hand-held instrument
- Built in data logger capability
- Windows base software
- Auto background subtraction
- Compliance report capability

Voyager Portable Gas Chromatograph



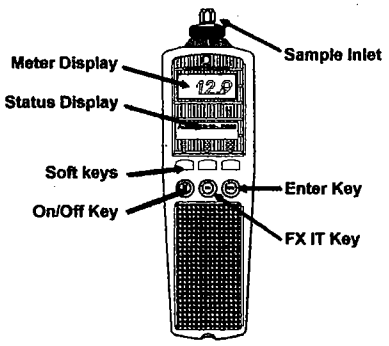
Photovac Instruments

- Detect Volatile Organic Compounds (VOC)
  - Boiling Points < 200o C
  - Vapor Pressures (PV) > 1.0 mm Hg at 20o C
- Detect certain inorganics
  - H_2S, PH_3, AsH_3, NH_3

Photovac Instruments

- Does not detect:
  - Permanent Gases (H_2, O_2, N_2, Water Vapor)
  - CO, CO_2, SO_x, NO_x
  - Metals
  - Semi-volatiles - PAH, higher phenols
  - Non-Volatiles - PCBs, pesticides, herbicides

2020 Total VOC PID



Key Features of the *2020* PID

- Small size and weight, 1.75 lb. (0.79kg)
- Intrinsically Safe: Class I, Division 1, Groups A, B, C, and D, and Ex
- Easy to read dual LCDs

Key Features of the *2020* PID

- Operating concentration range:
  - 0.5 - 2000 PPM
- Built-in datalogger
- Pre-programmed Response Factors

2020 PID Environmental Applications

- Screening hazardous waste sites for air, groundwater, and soil VOC levels
- Leak and source testing for fugitive emissions

2020 PID Environmental Applications

- Emergency response testing for chemical leaks and spills
- Buried chemical waste detection

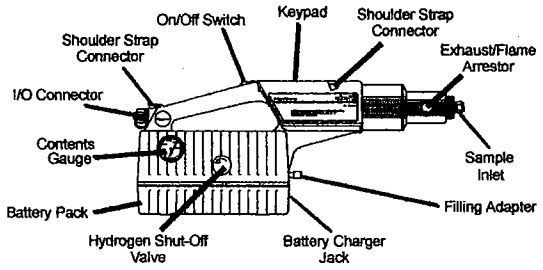
2020 PID Workplace Safety Applications

- Confined space (fuel tank) entry in:
  - Refineries
  - Petrochemical Plants
  - Chemical Manufacturing Facilities

2020 PID Workplace Safety Applications

- Emergency response - fenceline fugitive emissions monitoring
- Arson solvent accelerants
- Fire Dept. HAZMAT investigations

MicroFID Total VOC FID



Key Features of the MicroFID

- Small size and weight: just 8.1 lb. (3.7 Kg)
- Intrinsically Safe: Class I, Division 1, Groups A, B, C, and D
- Operating Concentration Range:
  - 0.1 - 50,000 PPM

Key Features of the MicroFID

- Self-contained; one-hand operation
- Built-in datalogger memory of 30K or 750 entries

MicroFID Applications

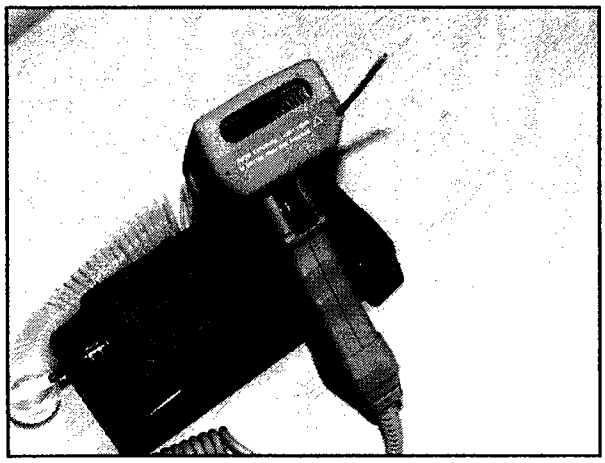
- Fugitive Emissions Monitoring
- Solvent Abatement Systems in Stack Emission Monitoring from Foundry, Solvent and Paint Spray Booths
- Hazardous Waste Site Characterization

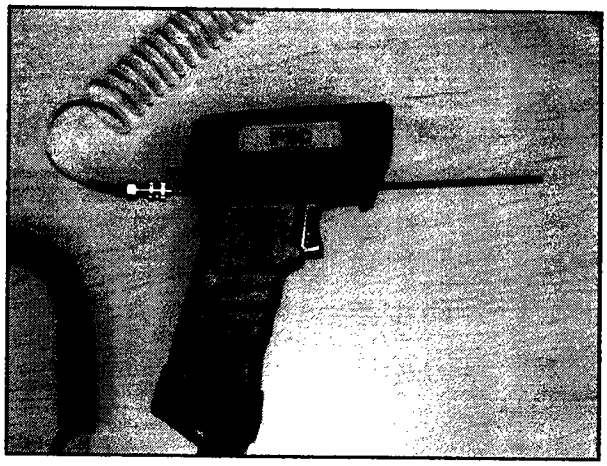
MicroFID Applications

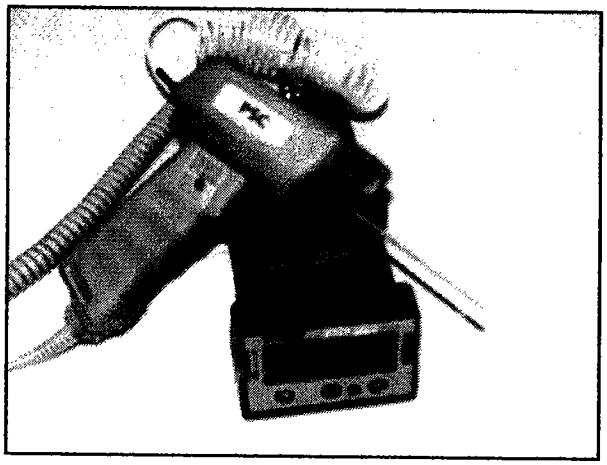
- Detection and measurement of alkanes
- Monitoring >1% (up to 5%)
- EPA Method 21 (LDAR scheduling/reporting)

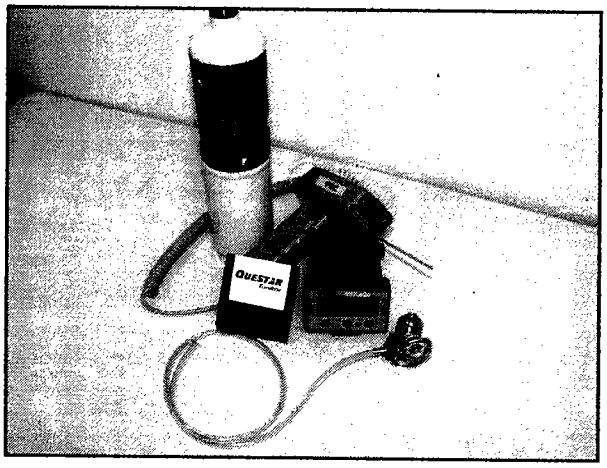
Baseline Industries (www.baselineindustries.com) PID plus (FE)

- Hand held
- Built-in data logger
- Bar code scanner
- Graphics display
- Data file of RF







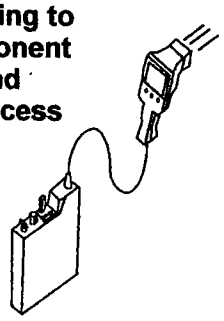

QUESTAR

Instrumentation *Trends*

- Laser scanners
- Palm-type data loggers
- Data management systems
- Use of FID and PID in one system
- Boundary characterization
- Future technologies

Laser scanners

- Bar code scanning to speed up component identification and datalogging process



Palm-type data loggers

Palm Desktop.lnk

- On-site note pad
- Assists in routing procedures
- Can include route maps and component diagrams

technologies

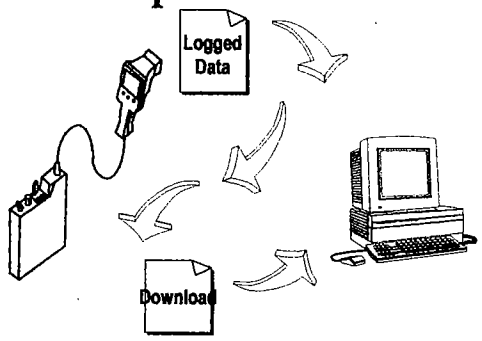
ging Spectrometers

sorption Gas Imaging
stems

detectors

ss Technology

Data Management Capabilities



ns of FRM 21

pounds react
different detectors

onse factors(RFs)
: manufacturers

obe intake rate affects
ncentration

Aftermarket Data Management Software

- Variety of secondary party vendors
- Assists in record keeping requirements of Method 21
- Monitoring data can be downloaded to Internet for further analysis from second party vendor
- Trouble spots are identified and recorded

on of FRM 21

re of compound will
here is a leak

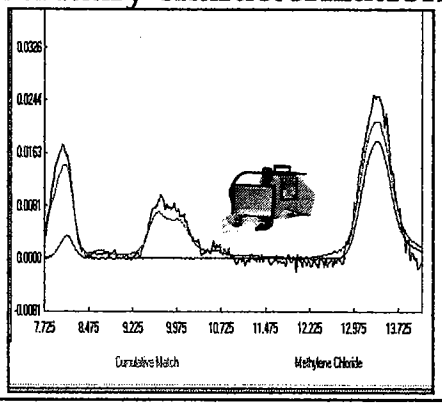
obe orientation affects
l

l conditions:

eak

operties

Boundary characterization



MANUFACTURERS OF PORTABLE VOC INSTRUMENTATION
Federal Reference Method 21

William T. "Jerry" Winberry, Jr.
EnviroTech Solutions
1502 Laughridge Drive
Cary, North Carolina 27511 USA
919-467-2785
919-460-9932 (FAX)
email: jwinberry@mindspring.com

FEDERAL REFERENCE METHOD 21
POSSIBLE MANUFACTURERS OF PORTABLE INSTRUMENTATION

Manufacturer	Phone Number	Model Number	Detector	Maximum Range (ppm)	Flow Rate (L/min.)	Resp. Time (Sec)	Det. Limit (ppm)	Data Log	Bar Code	Dimensions (ins.) Weight (lb)
Thermo Environmental Instruments (www.thermoei.com)	866-282-0430	TVA-1000B	PID FID	2,000 50,000	1.0	2.0	0.1 ppm (Benzene) 0.3 ppm (Hexane)	Yes	No	13x10x3 12 lbs
		Miran SapphlRe	IR	1,000	1.0	5.0	0.1 ppm	Yes	No	15X17X12 14 lbs
		680	FID	50,000	0.5	2.0	0.1 ppm (Benzene)	Yes	Yes	12X11X3 10 Lbs
		580B	PID	2,000 (with dilution probe)	0.4	2.0	0.1 ppm (Benzene)	Yes	No	8x6x10 17 lbs
		580S II	PID	25,000 (with dilution probe)	0.275	4.0	0.1 ppm (Benzene)	Yes	Yes	12X4X4 3 lbs
Photovac, Inc. (www.photovac.com)	781-290-0777	MicroFID	FID	50,000	0.5 L/min	2.0	0.1 ppm (Benzene)	Yes	No	12X11X3 8.1 lbs
		Petro Pro	GC/PID	100's ppm	0.5 L/min	< 10	ppb to ppm	Yes	No	10X10X20 15 lbs
		Voyager	GC/PID GC/ECD	100	1.0	< 5.0	0.001 ppm	Yes	No	8x6x10 15 lbs
		2020PRO Plus	PID	2,000	0.3 L/min	< 3.0	0.5 ppm (Isobuty)	Yes	No	9x3x3 2 lbs
Matheson Gases (www.mathesontrigas.com)	800-828-4313	Cosmos GM-XP-316	Catalytic Combust	5,000 50,000 (Two Scales)	1 L/min	< 30	1 ppm	Yes	No	8X3X2 1.5 lbs

Baseline-MOCON, Inc. (www.baselineindustries.com)	800-321-4665	PID plus FE	PID	10,000	0.350	6.0	0.1 ppm (Isobuty)	Yes	Yes	8x3x4 2.5 lbs
		PID plus IH	PID	10,000	0.350	6.0	0.1 ppm (Isobuty)	Yes	No	8x3x4 2.5 lbs
Heath Consultants (www.heathus.com)	713-844-1300	FI2000	FID	800	0.2	10	0.1 ppm (Benzene)	Yes	No	12x5x11 6 lbs
		Deteco-Pak II	FID	1,000	2.5	5	0.1 ppm (Benzene)	Yes	No	23x11x11 15 lbs
		Deteco-Pak III	FID	10,000 (with dilution probe)	2.0	5	0.1 ppm (Benzene)	Yes	No	23x11x11 15 lbs
RAE Systems Inc (www.raesystems.com)	408-752-0723	MiniRAE 2000	PID	10,000	> 0.4	< 3	1 ppm (Isobuty)	Yes	No	8x3x2 19.5 oz
		UltraRAE	PID	2,000	< 3					
		MultiRAE PLUS	PID	1,000	> 0.4	< 3	0.1 ppm (Isobuty)	Yes	No	7x3x2 18 oz
Bacharach (www.bacharach-inc.com)	724-324-5000	Leakator Jr.	Cat. Combust.	10,000	1.75	< 30	2.0 ppm (Hexane)	No	No	6x6x2 2 lbs
MSA (www.msanet.com)	800-672-2222	Passport PID II	PID	10,000	0.350	6	0.1 ppm	Yes	No	8x3x2 2.5 lbs
Gasco (www.cascogas.com)	800-910-0051	Auto-FIM	FID	10,000	1.0	< 10	0.1 ppm	Yes	Yes	6X3X3 5 lbs
HNu Systems, Inc. (www.hnu.com)	800-724-5600	DL-102	PID	2,000	0.25	< 5	0.1 ppm	No	No	8X3X3 5 lbs
Gas Tech, Inc. (www.gastech-inc.com)	510-794-6200	GT Series -Land Surveyor -Multi-Gas	Electro-chemical	10,000	0.3	30	0.1 ppm	No	No	10x6x5

Method 21 - Determination of Volatile Organic Compound Leaks

1. APPLICABILITY AND PRINCIPLE

1.1 Applicability. This method applies to the determination of volatile organic compound (VOC) leaks from process equipment. These sources include, but are not limited to, valves, flanges and other connections, pumps and compressors, pressure relief devices, process drains, open-ended valves, pump and compressor seal system degassing vents, accumulator vessel vents, agitator seals, and access door seals.

1.2 Principle. A portable instrument is used to detect VOC leaks from individual sources. The instrument detector type is not specified, but it must meet the specifications and performance criteria contained in Section 3. A leak definition concentration based on a reference compound is specified in each applicable regulation. This procedure is intended to locate and classify leaks only, and is not to be used as a direct measure of mass emission rate from individual sources.

2. DEFINITIONS

2.1 Leak Definition Concentration. The local VOC concentration at the surface of a leak source that indicates that a VOC emission (leak) is present. The leak definition is an instrument meter reading based on a reference compound.

2.2 Reference Compound. The VOC species selected as an instrument calibration basis for specification of the leak definition concentration. (For example, if a leak definition concentration is 10,000 ppm as methane, then any source emission that results in a local concentration that yields a meter reading of 10,000 on an instrument meter calibrated with methane would be classified as a leak. In this example, the leak definition is 10,000 ppm, and the reference compound is methane.)

2.3 Calibration Gas. The VOC compound used to adjust the instrument meter reading to a known value. The calibration gas is usually the reference compound at a known concentration approximately equal to the leak definition concentration.

2.4 No Detectable Emission. The total VOC concentration at the surface of a leak source that indicates that a VOC emission (leak) is not present. Since background VOC concentrations may exist, and to account for instrument drift and imperfect reproducibility, a difference between the source surface concentration and the local ambient concentration is determined. A difference based on the meter readings of less than a concentration

corresponding to the minimum readability specification indicates that a VOC emission (leak) is not present. (For example, if the leak definition in a regulation is 10,000 ppm, then the allowable increase is surface concentration versus local ambient concentration would be 500 ppm based on the instrument meter readings.)

2.5 Response Factor. The ratio of the known concentration of a VOC compound to the observed meter reading when measured using an instrument calibrated with the reference compound specified in the applicable regulation.

2.6 Calibration Precision. The degree of agreement between measurements of the same known value, expressed as the relative percentage of the average difference between the meter readings and the known concentration to the known concentration.

2.7 Response Time. The time interval from a step change in VOC concentration at the input of the sampling system to the time at which 90 percent of the corresponding final value is reached as displayed on the instrument readout meter.

3. APPARATUS

3.1 Monitoring Instrument.

3.1.1 Specifications

a. The VOC instrument detector shall respond to the compounds being processed. Detector types which may meet this requirement include, but are not limited to, catalytic oxidation, flame ionization, infrared absorption, and photoionization.

b. The instrument shall be capable of measuring the leak definition concentration specified in the regulation.

c. The scale of the instrument meter shall be readable to + or - 5 percent of the specified leak definition concentration.

d. The instrument shall be equipped with a pump so that a continuous sample is provided to the detector. The nominal sample flow rate shall be 0.1 to 3.0 liters per minute.

e. The instrument shall be intrinsically safe for operation in explosive atmospheres as defined by the applicable U.S.A. standards (e.g., National Electrical Code by the National Fire Prevention Association).

f. The instrument shall be equipped with a probe or probe extension for sampling not to exceed 1/4 in. in outside diameter, with a single end opening for admission of sample.

3.1.2 Performance Criteria.

a. The instrument response factors for the individual compounds to be measured must be less than 10.

b. The instrument response time must be equal to or less than 30 seconds. The response time must be determined for the instrument configuration to be used during testing.

c. The calibration precision must be equal to or less than 10 percent of the calibration gas value.

d. The evaluation procedure for each parameter is given in Section 4.4.

3.1.3 Performance Evaluation Requirements.

a. A response factor must be determined for each compound that is to be measured, either by testing or from reference sources. The response factor tests are required before placing the analyzer into service, but do not have to be repeated at subsequent intervals.

b. The calibration precision test must be completed prior to placing the analyzer into service, and at subsequent 3-month intervals or at the next use whichever is later.

c. The response time test is required before placing the instrument into service. If a modification to the sample pumping system or flow configuration is made that would change the response time, a new test is required before further use.

3.2 Calibration Gases.

The monitoring instrument is calibrated in terms of parts per million by volume (ppm) of the reference compound specified in the applicable regulation. The calibration gases required for monitoring and instrument performance evaluation are a zero gas (air, less than 10 ppm VOC) and a calibration gas in air mixture approximately equal to the leak definition specified in the regulation. If cylinder calibration gas mixtures are used, they must be analyzed and certified by the manufacturer to be within + or - 2 percent accuracy, and a shelf life must be specified. Cylinder standards must be either reanalyzed or replaced at the end of the specified shelf life. Alternatively, calibration gases may be prepared by the user according to any accepted gaseous preparation procedure that will yield a mixture accurate to within + or - 2 percent. Prepared standards must be replaced each day of use unless it can be demonstrated that degradation does not occur during storage.

Calibrations may be performed using a compound other than the reference compound if a conversion factor is determined for that alternative compound so that the resulting

meter readings during source surveys can be converted to reference compound results.

4. PROCEDURES

4.1 Pretest Preparations. Perform the instrument evaluation procedure given in Section 4.4 if the evaluation requirement of Section 3.1.3 have not been met.

4.2 Calibration Procedures. Assemble and start up the VOC analyzer according to the manufacturer's instructions. After the appropriate warmup period and zero internal calibration procedure, introduce the calibration gas into the instrument sample probe. Adjust the instrument meter readout to correspond to the calibration gas value. (Note: If the meter readout cannot be adjusted to the proper value, a malfunction of the analyzer is indicated and corrective actions are necessary before use.)

4.3 Individual Source Surveys.

4.3.1 Type I - Leak Definition Based on Concentration. Place the probe inlet at the surface of the component interface where leakage could occur. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained. Leave the probe inlet at this maximum reading location for approximately two times the instrument response time. If the maximum observed meter reading is greater than the leak definition in the applicable regulation, record and report the results as specified in the regulation reporting requirements. Examples of the application of this general technique to specific equipment types are:

a. Valves - Leaks usually occur at the seal between the stem and the housing. Place the probe at the interface where the stem exits the packing and sample the stem circumference and the flange periphery. Survey valves of multipart assemblies where a leak could occur.

b. Flanges and Other Connections - Place the probe at the outer edge of the flange-gasket interface and sample the circumference of the flange.

c. Pump or Compressor Seals - If applicable, determine the type of shaft seal. Perform a survey of the local area ambient VOC concentration and determine if detectable emissions exist as described above.

d. Pressure Relief Devices - For those devices equipped with an enclosed extension, or horn, place the probe inlet at approximately the center of the exhaust area to the atmosphere.

e. Process Drains - For open drains, place the probe inlet as near as possible to the

center of the area open to the atmosphere. For covered drains, locate probe at the surface of the cover and traverse the periphery.

f. Open-ended Lines or Valves - Place the probe inlet at approximately the center of the opening of the atmosphere.

g. Seal System Degassing Vents, Accumulator Vessel Vents, Pressure Relief Devices - If applicable, observe whether the applicable ducting or piping exists. Also, determine if any sources exist in the ducting or piping where emissions could occur before the control device. If the required ducting or piping exists and there are no sources where the emissions could be vented to the atmosphere before the control device, then it is presumed that no detectable emissions are present. If there are sources in the ducting or piping where emissions could be vented or sources where leaks could occur, the sampling surveys described in this section shall be used to determine if detectable emissions exist.

h. Access door seals - Place the probe inlet at the surface of the door seal interface and traverse the periphery.

4.3.2 Type II - "No Detectable Emission". Determine the ambient concentration around the source by moving the probe randomly upwind and downwind around one to two meters from the source. In case of interferences, this determination may be made closer to the source down to no closer than 25 centimeters. Then move the probe to the surface of the source and measure as in 4.3.1. The difference in these concentrations determines whether there are no detectable emissions. When the regulation also requires that no detectable emissions exist, visual observations and sampling surveys are required. Examples of this technique are: (a) Pump or Compressor Seals - Survey the local area ambient VOC concentration and determine if detectable emissions exist. (b) Seal System Degassing Vents, Accumulator Vessel Vents, Pressure Relief Devices - Determine if any VOC sources exist upstream of the device. If such ducting exists and emissions cannot be vented to the atmosphere upstream of the control device, then it is presumed that no detectable emissions are present. If venting is possible sample to determine if detectable emissions are present.

4.3.3 Alternative Screening Procedure.

4.3.3.1 A screening procedure based on the formation of bubbles in a soap solution that is sprayed on a potential leak source may be used for those sources that do not have continuously moving parts, that do not have surface temperatures greater than the boiling point or less than the freezing point of the soap solution, that do not have open areas to the atmosphere that the soap solution cannot bridge, or that do not exhibit evidence of liquid leakage. Sources that have these conditions present must be surveyed using the instrument technique of Section 4.3.1 or 4.3.2.

4.3.3.2 Spray a soap solution over all potential leak sources. The soap solution may be a commercially available leak detection solution or may be prepared using concentrated detergent and water.

A pressure sprayer or squeeze bottle may be used to dispense the solution. Observe the potential leak sites to determine if any bubbles are formed. If no bubbles are observed, the source is presumed to have no detectable emissions or leaks as applicable. If any bubbles are observed, the instrument techniques of Section 4.3.1 or 4.3.2 shall be used to determine if a leak exists, or if the source has detectable emissions, as applicable.

4.4 Instrument Evaluation Procedures. At the beginning of the instrument performance evaluation test, assemble and start up the instrument according to the manufacturer's instructions for recommended warmup period and preliminary adjustments.

4.4.1 Response Factor.

4.4.1.1 Calibrate the instrument with the reference compound as specified in the applicable regulation. For each organic species that is to be measured during individual source surveys, obtain or prepare a known standard in air at a concentration of approximately 80 percent of the applicable leak definition unless limited by volatility or explosivity. In these cases, prepare a standard at 90 percent of the standard saturation concentration, or 70 percent of the lower explosive limit, respectively. Introduce this mixture to the analyzer and record the observed meter reading. Introduce zero air until a stable reading is obtained. Make a total of three measurements by alternating between the known mixture and zero air. Calculate the response factor for each repetition and the average response factor.

4.4.1.2 Alternatively, if response factors have been published for the compounds of interest for the instrument or detector type, the response factor determination is not required, and existing results may be referenced. Examples of published response factors for flame ionization and catalytic oxidation detectors are included in the Bibliography.

4.4.2 Calibration Precision. Make a total of three measurements by alternately using zero gas and the specified calibration gas. Record the meter readings. Calculate the average algebraic difference between the meter readings and the known value. Divide this average difference by the known calibration value and multiply by 100 to express the resulting calibration precision as a percentage.

4.4.3 Response Time. Introduce zero gas into the instrument sample probe. When the meter reading has stabilized, switch quickly to the specified calibration gas. Measure the time from switching to when 90 percent of the final stable reading is attained. Perform this test sequence three times and record the results. Calculate the average response time.

5. BIBLIOGRAPHY

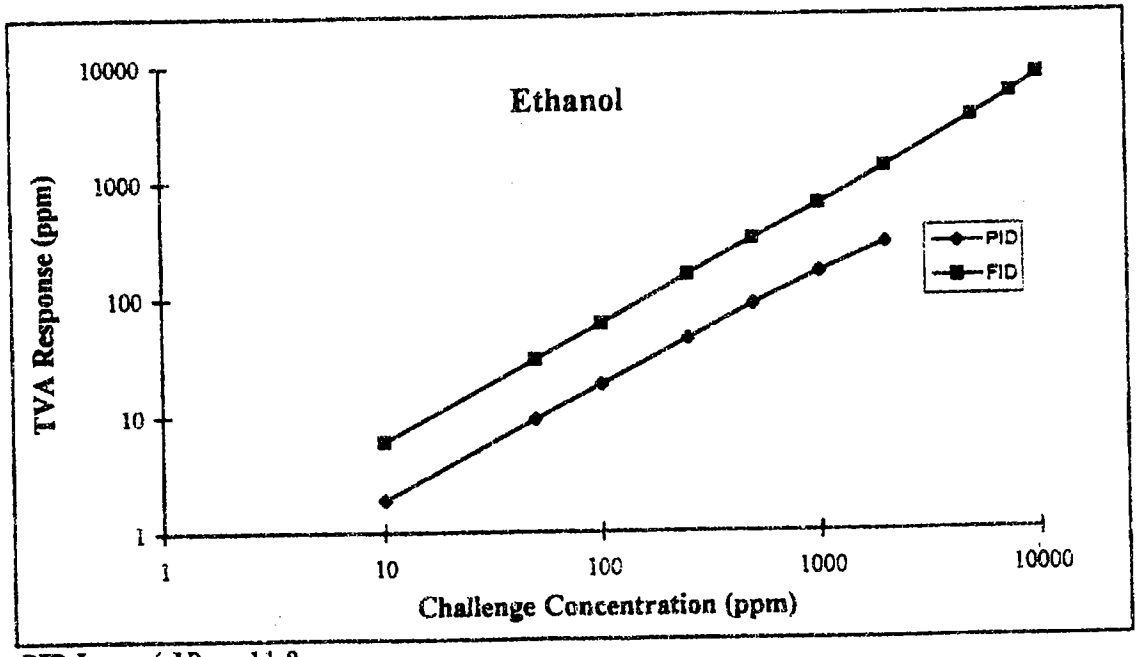
1. Dubose, D.A., and G.E. Harris. Response Factors of VOC Analyzers at a Meter Reading of 10,000 ppmv for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2-81051. September 1981.

2. Brown, G.E., et al. Response Factors of VOC Analyzers Calibrated with Methane for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2-81-022. May 1981.

3. DuBose, D.A. et al. Response of Portable VOC Analyzers to Chemical Mixtures. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2-81-110. September 1981.

FOXBORO TVA-1000 RESPONSE CURVES
Ethanol

Challenge Concentration (ppm)	Foxboro/TVA-1000A (or equivalent) Relative Response Factor		EPA/TVA-1000B (or equivalent) Response Factor Multiplier	
	PID	FID	PID	FID
10	0.234	0.591	5.303	1.644
50	0.232	0.591	5.339	1.643
100	0.230	0.592	5.383	1.641
250	0.225	0.595	5.516	1.635
500	0.195	0.600	5.737	1.625
1000	0.161	0.609	6.180	1.606
2000	0.123	0.627	7.066	1.568
5000		0.638		1.454
7500		0.681		1.359
10000		0.724		1.264



PID Lamp (eV): 11.8

TVA-1000B Response Curve Coefficients:		A	B
	PID	5.29	-8.86
	FID	1.64	0.38

*See the introduction of this manual for the definition of the TVA-1000 Analyzers and their equivalents.

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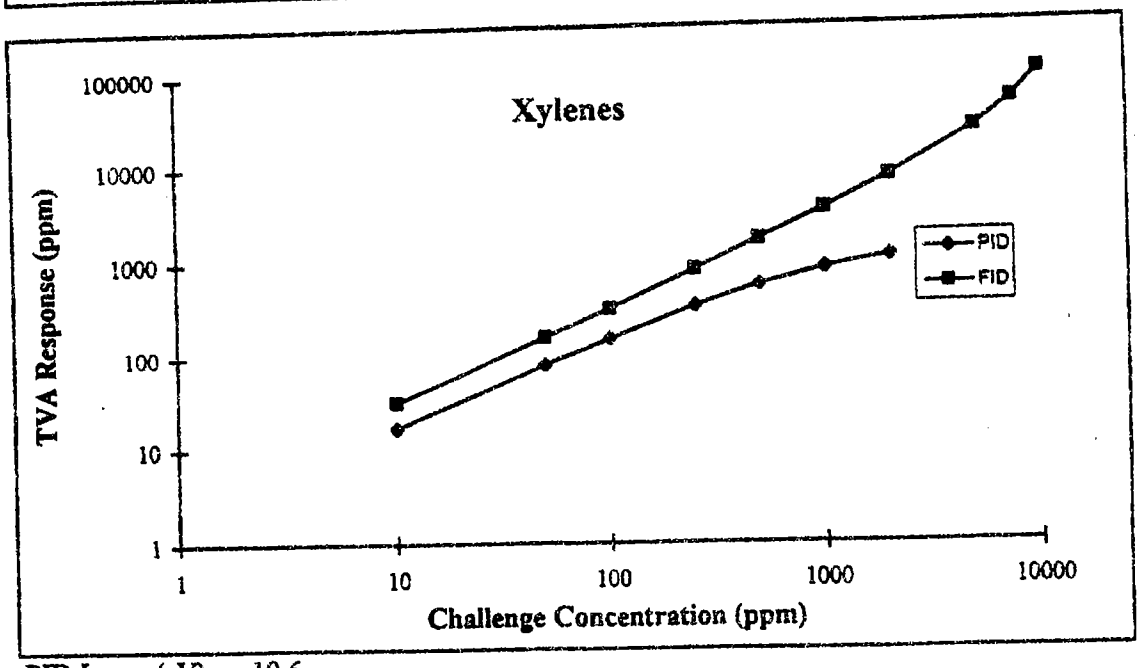
FOXBORO TVA-1000 RESPONSE CURVES
Xylenes

Challenge Concentration (ppm)	Foxboro/TVA-1000A (or equivalent) Relative Response Factor		EPA/TVA-1000B (or equivalent) Response Factor Multiplier	
	PID	FID	PID	FID
10	1.603	2.790	0.605	0.319
50	1.569	2.802	0.630	0.318
100	1.529	2.817	0.662	0.317
250	1.420	2.860	0.758	0.314
500	1.269	2.933	0.917	0.308
1000	1.046	3.079	1.236	0.298
2000	0.774	3.371	1.873	0.276
5000		4.246		0.212
7500		4.975		0.158
10000		5.704		0.104



PID Lamp (eV): 10.6

TVA-1000B Response Curve Coefficients:		A	B
	PID	0.60	-6.38
	FID	0.32	0.21

*See the introduction of this manual for the definition of the TVA-1000 Analyzers and their equivalents.

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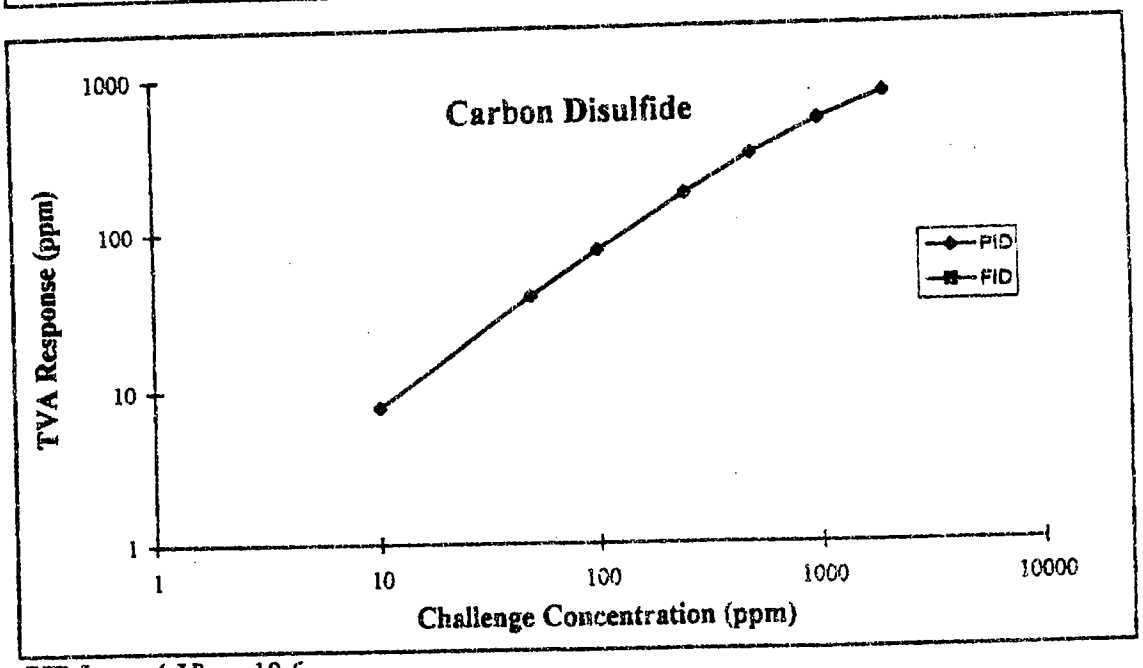
FOXBORO TVA-1000 RESPONSE CURVES
Carbon Disulfide

Challenge Concentration (ppm)	Foxboro/TVA-1000A (or equivalent) Relative Response Factor		EPA/TVA-1000B (or equivalent) Response Factor Multiplier	
	PID	FID	PID	FID
10	0.822		1.285	
50	0.812		1.314	
100	0.792		1.351	
250	0.740		1.462	
500	0.666		1.646	
1000	0.556		2.015	
2000	0.417		2.752	
5000				
7500				
10000				



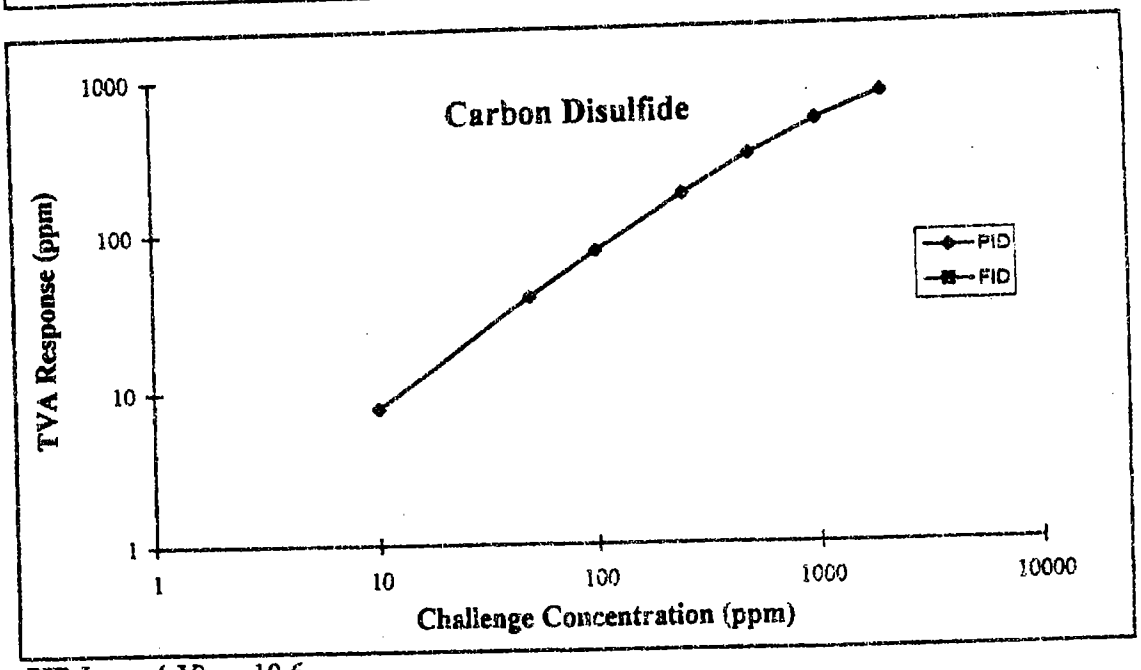
PID Lamp (eV): 10.6

TVA-1000B Response Curve Coefficients:		A	B
	PID	1.28	-7.37
	FID	NF	NF

*See the introduction of this manual for the definition of the TVA-1000 Analyzers and their equivalents.

FOXBORO TVA-1000 RESPONSE CURVES
Carbon Disulfide

Challenge Concentration (ppm)	Foxboro/TVA-1000A (or equivalent) Relative Response Factor		EPA/TVA-1000B (or equivalent) Response Factor Multiplier	
	PID	FID	PID	FID
10	0.822		1.285	
50	0.812		1.314	
100	0.792		1.351	
250	0.740		1.462	
500	0.666		1.646	
1000	0.556		2.015	
2000	0.417		2.752	
5000				
7500				
10000				



PID Lamp (eV): 10.6

TVA-1000B Response Curve Coefficients:		A	B
	PID	1.28	-7.37
	FID	NF	NF

*See the introduction of this manual for the definition of the TVA-1000 Analyzers and their equivalents.

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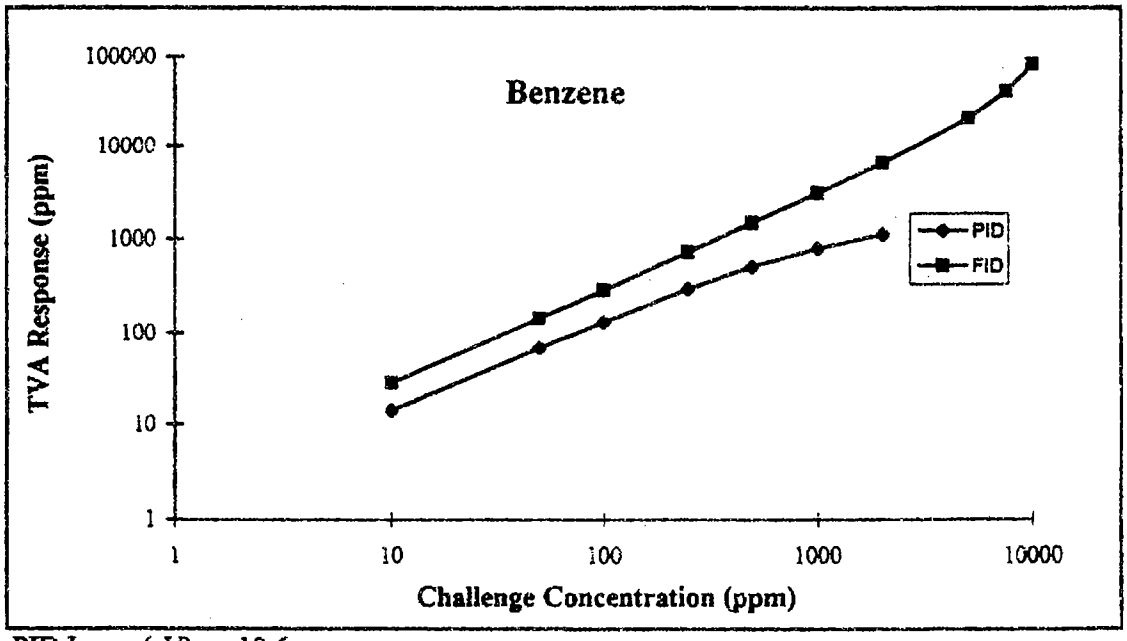
FOXBORO TVA-1000 RESPONSE CURVES
Benzene

Challenge Concentration (ppm)	Foxboro/TVA-1000A (or equivalent) Relative Response Factor		EPA/TVA-1000B (or equivalent) Response Factor Multiplier	
	PID	FID	PID	FID
10	1.795	3.400	0.702	0.346
50	1.744	3.420	0.724	0.345
100	1.684	3.430	0.751	0.344
250	1.527	3.480	0.833	0.340
500	1.322	3.558	0.968	0.335
1000	1.041	3.713	1.239	0.323
2000	0.731	4.023	1.781	0.301
5000		4.953		0.233
7500		5.728		0.177
10000		6.503		0.121



PID Lamp (eV): 10.6

TVA-1000B Response Curve Coefficients:		A	B
	PID	0.70	-5.42
	FID	0.35	0.23

*See the introduction of this manual for the definition of the TVA-1000 Analyzers and their equivalents.

12/96

FEDERAL REFERENCE METHOD 21
CALIBRATION OF FRM 21 VOC ANALYZER

GENERAL INFORMATION

Date_____ Site Name:_____ Operator_____
Analyzer_____ Serial No._____ Calibrated?_____

WEATHER INFORMATION

Wind Speed_____MPH Wind Direction_____Barometric Pressure_____
Air Temperature_____ F General Weather Conditions_____

GETTING STARTED

- ☐ Install filled hydrogen tank (~2200 psig). Do not use tank below ~300 psig.
- ☐ Attach probe/readout assembly.
- ☐ Turn on hydrogen supply valve (red on side of monitor) and wait 4-5 minutes for proper hydrogen flow.
- ☐ Verify battery has proper charge.

STARTING THE UNIT

- ☐ Press ON.
- ☐ Press CONTROL.
- ☐ Press **3** to ignite the FID. You should hear the pump and then a "pop" when the FID is ignited. If "flame out" message appears, clear the message (press EXIT), wait another minute and repeat Press **3** to ignite the FID. For best results, allow the instrument to warm-up for ~ 20 minutes.
- ☐ Press **2 = Setup.**
- ☐ Press **1 = Calibrate.**
- ☐ Press **2 = SpanConc.** _____ **ppm**
- ☐ Select the detector that the span concentration is for, then press the "up or down" arrows to select the correct unit of measure for the span gas. Enter the span calibration value, and press the **Enter** key. Repeat for the second detector. Typically the calibration gases are methane (FID) and isobutylene (PID).
- ☐ Next zero the instrument. Press **3 = Zero** to start this process.
- ☐ Press **1 = Both** for dual detector units, or Enter for single detector units.
- ☐ Introduce zero gas (< 1 ppmz total hydrocarbon) into the analyzer through the probe tip. Use either "T" connection or Tedlar bags containing the zero gas. Verify that the zero gas cylinder is certified and within expiration date.
- ☐ Press **Enter** to start (this assumes manual mode, the factory default).
- ☐ Wait for minimal change in values (about 15 seconds). Typically, the sample is stable when the first 2 digits of the reading do not change for 4-5 seconds.
- ☐ Press **Enter** to accept, then press **1** to save.

☐ Record zero count readings for the FID and PID detectors below:

FID: ☐ Zero counts_____(should be < 5000 counts)
PID: ☐ Zero counts_____(should be < 20000 counts for 10.6 eV lamp)

☐ Next calibrate with the span gas. Press **4 = Span.** Use either the "T" connection or Tedlar bags. Once again verify the pressure of the gas cylinder (> 300 psig) and verify that the calibration gas cylinder is certified and within expiration date.
☐ Select the detector to be calibrated, and press **Enter** to start. Follow the screen prompts. Wait for the reading to stabilize (typically 10-15 seconds). Enter **1** to save and repeat for the second detector.
☐ Record span count readings for the FID and PID detectors below:

FID: ☐ Span counts_____(must = 175-250 counts/ppm methane)
PID: ☐ Span counts_____(must = 3500-6000 counts/ppm isobutylene for 10.6 eV lamp)

Example: (Span Counts – Zero Counts)/(Span Concentration, ppm) =
_____Counts/ppm for FID
_____Counts/ppm for PID

☐ Press **5 = RF** to verify proper response factor.
☐ Confirm that response factor says "RFO: DEFAULT". If not, set to this value.
☐ Press **Exit** twice to return to MAIN MENU.
☐ Press **1 = Run.**

CALIBRATION INFORMATION

☐ To confirm detector counts, perform the following.

Calibration Precision Check

[Procedure: Make a total of three measurements by alternating zero air and the calibration gas (methane ~ 500 ppm) through the probe tip to the analyzer in the **Run** mode. *Record the readings and calculate the average algebraic difference between the instrument reading and the calibration gases as a percentage. The calibration precision must be less than or equal to 10% of the calibration gas value inorder to meet Federal Reference Method 21 acceptance criteria. While performing the calibration precision check, also perform a response time check. The response time must be less than 30 seconds inorder to meet Federal Reference Method 21 acceptance criteria.]*

Instrument ID:_____ Cal Gas Concentration_____
Calibration Gas Certification Date:_____

Trial	Zero Gas Reading		Cal Gas Reading		(Cal Gas Conc. – Cal Gas Reading)	
	FID	PID	FID	PID	FID	PID
1						
2						
3						
AVG.						

Calibration Precision = [Average Difference]/ [Cal Gas Conc.] X 100%

FID = _____ %

PID = _____ %

Calibration precision percentage < 10?

FID = _____ Yes/No?

PID = _____ Yes/No?

Response Time Test

Trial	Response 1 (Seconds)	Response 2 (Seconds)	Response 3 (Seconds)	Average Response (Seconds)
FID				
PID				

Average Response 1, 2 and 3 for each detector to obtain an average response:_____

Is average response time < 30 seconds?_____

SUMMARY OF MONITOR AND PERFORMANCE CRITERIA

- ❑ VOC analyzer responds to VOCs of interest? Yes_____No_____
- ❑ Linear range of analyzer encompasses the leak definition concentration? Yes____No____
- ❑ Scale of instrument meter readable to +/- 2.5 % of the leak definition? Yes___No___
- ❑ Flow through instrument between 0.1 – 3.0 L/min? Yes_____No_____
- ❑ Instrument intrinsically safe for Class 1 and 2, Division 1 conditions? Yes____No____
- ❑ Instrument response factors (RFs) < 10 for each VOC to be measured? Yes___No___Documented_____
- ❑ Instrument response time (RT) equal to or < 30 seconds? Yes___No___
- ❑ Instrument calibration precision < 10% of the calibration gas values? Yes___No____
- ❑ Initial "background" VOC reading:_____
- ❑ Final "background" VOC reading:_____

SHUTTING OFF INSTRUMENT

- ☐ Turn hydrogen supply valve to OFF position.

- ☐ Press OFF button on front of monitor.
- ☐ Recharge battery with side connection leads if necessary.

END OF DAY

- ☐ Wipe off analyzer and probe assembly. Visually inspect sample line fittings for blockage. Clean sample line adapter fitting with a cloth.
- ☐ Check WATERTRAP probe membrane. Replace as necessary and clean debris from sample lines.
- ☐ Check sample line and readout cable for visible damage and contamination.
- ☐ Remove the FID endcap with the special spanner wrench provided with the tool kit. Wipe off the endcap and flame arrester with isopropyl alcohol followed with DI water. Blow out carefully with compressed dry air.
- ☐ Remove FID capsule. If visibly wet, shake-out excess water and let air-dry overnight.
- ☐ Perform visual inspection for signs of damage.
- ☐ For the PID lamp (except the 11.8 eV lamp), remove the PID capsule accord to the instructions in the Maintenance section of the manual. Clean the lamp with a cotton swab and isopropyl alcohol. Reinstall the cartridge and cap.
- ☐ Check and tighten strain-relief screws on readout assembly and screws securing three connectors on sidepack.
- ☐ Store the unit in a dry environment when not in use.

Source Leak Detection and Repair (LDAR) Programs

William T. "Jerry" Winberry, Jr.
EnviroTech Solutions

Things to consider...

...The most successful LDAR programs are those that have a proactive *LDAR Program Administrator* and their programs are consistent...

...Good *data management systems* are essential for proving compliance with LDAR requirements...

Ken Garing
National Enforcement Investigation Center (NEIC)

IBC Symposium on Fugitive Emissions
Houston, Texas
November 1999

Establishing an LDAR Program

If you are going to have an LDAR program at all, it must have **clear written objectives**.

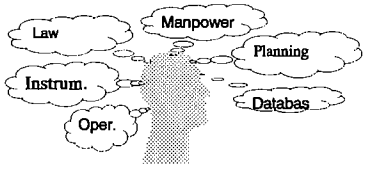
- What is the purpose?
- What is the desired outcome?
- **Who will be the leader?**
- Who will govern the resources needed to achieve the desired outcome?

That leader is the ***LDAR Program Administrator***.

LDAR Program Administrator

LDAR Programs are unique because they bring together different disciplines.

The LDAR Program Administrator has to have some expertise, or at least be conversant, in several areas.



LDAR Program Administrator

Responsibilities

- Monitoring is performed in accordance with each applicable regulation,
- Follow up activities are performed on time and documented,
- Record keeping is done effectively,
- Reports are correct and submitted on time,
- The LDAR program is defensible in an audit.

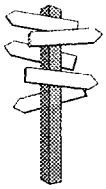
LDAR Program Administrator

Skill Sets Required

- **Regulatory:** Plant's compliance requirements. Requires understanding of environmental regulations.
- **Applicability:** What regulations apply to each component, which have to be monitored, when & how. Requires some process knowledge.
- **Record Keeping:** Monitoring results, report preparation and submittal. Requires computer skills.
- **Equipment Maintenance:** Coordination with whoever does repairs to leaking equipment. Requires understanding of repair techniques.
- **Diplomacy:** Interaction with other departments, contractors and regulators.

Six Aspects of an LDAR Program

- Component Identification
- Location Identification
- Monitoring
- Data Collection
- Repairs
- Data Management Software



Component Identification

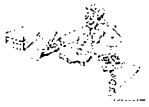
- ✓ Determine Applicability
- ✓ Determine Method of Physical ID
- ✓ Populate Software with Tag ID Information

Location Identification

- ✓ Establish Standard Location Descriptions
- ✓ Determine What a "Reportable Unit" is for Your Facility

Monitoring

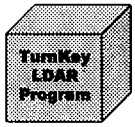
In-House LDAR Program



- ✓ Purchase Analyzers
- ✓ Maintain Analyzers
- ✓ Train Monitoring Technicians
- ✓ Supervision of Technicians
- ✓ Who does first attempt at repair?

Sub-Contract LDAR Program

- ✓ Contract for just monitoring or turn-key?
- ✓ Qualifications
- ✓ Monitoring Equipment
- ✓ Availability
- ✓ Responsibility



Data Collection

Data Loggers

- ✓ How to do it?
- ✓ Pros & Cons
- ✓ Different Types

Pen & Paper

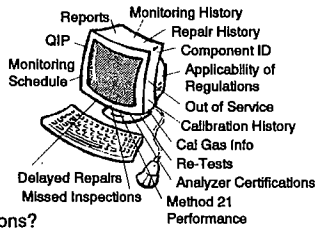
- ✓ How to do it?
- ✓ Pros & Cons

Repairs

- ✓ Who Will Perform the Repairs?
- ✓ Notification that Repairs are Required
- ✓ Re-Testing a Repaired Component

Data Management

- ✓ Build or Buy?
- ✓ Who will use it?
- ✓ Who else needs LDAR information?
- ✓ Scheduling Inspections?



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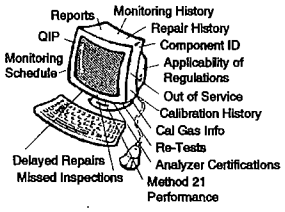
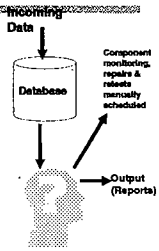


There are two types of LDAR software...

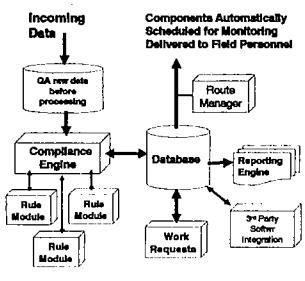
- **Data Storage**
  - Relies on your expertise to manage
- **Knowledge Based**
  - Uses software logic to apply Rules defined by LDAR regulations or user defined criteria

Compare Data Processing Strategies

Data Storage



Knowledge-based/Compliance Driven



Can You Defend Your Program?

- What if the NEIC dropped in tomorrow to ask a few questions?
- What if they took home a copy of your database?

Three Types of Standards

- Performance Standards
  - No detectable emissions
  - (Design and use of equipment, therefore no measurement required)

Type of Standards (Cont'd)

- Equipment Standards
  - Equipment specifications, design specifications, and operational specifications
  - (Design and use of equipment, therefore no measurement required)
- Work Practice Standards
  - Leak detection and repair (LDAR)
  - (Detection and repair, therefore must monitor)

Similarities in Standards

- Cover same equipment in all standards
- Leak definition same except with HON rule
- Method 21 specified in all standards
- Recordkeeping and reporting requirements generally same
- Repair/retest procedures generally same

Establishing a Site-Specific LDAR Program

- Major Steps and Components

Five Major Steps in Developing an LDAR Program

- Step 1: Plan the Program
- Step 2: Contract With Vendor and/or Purchase Instruments
- Step 3: Establish Monitoring Procedures
- Step 4: Establish Repair Procedures
- Step 5: Establsih Data Analysis Procedures

Step 1: Plan the Program

- What are the driving forces for the program?
  - Regulatory requirements
  - Corporate initiative
  - Cost controls
- How will the data be used?
  - For repair only?
  - For emission estimating

Step 1 (cont'd)

- Who will conduct the monitoring?
  - Plant personnel (operators, maintenance staff, or dedicated team)
  - Outside contractor
- What training is required for monitoring personnel?
- Which processes or components will be included?
  - Verify component counts

Step 1 (cont'd)

- What will the leak definition be?
  - What sets the leak level?
  - Same or different for all components?

Step 1 (cont'd)

- Who will be responsible for...
  - Ensuring that program objectives are met?
  - Ensuring that monitoring is performed?
  - Ensuring that repairs are made?
  - Ensuring that reporting is done?
  - Ensuring accuracy of the data and analyses?

Step 2: Contract with Vendor and/or Purchase Instruments

- What equipment will be used?
  - Appropriate for process streams?
  - Ease of use?
  - Calibration requirements?
- Will data laggers be used?
- Will components be tagged?
  - Tpe of tag?
  - Bar code?

Step 2 (cont'd)

- If a contractor is used:
  - Who will own the data?
  - Who will do repairs?
  - Who will supervise?
  - What criteria will be used for choosing the vendor?
  - How will the vendor's performance be monitored?

Step 3: Establish Monitoring Procedures

- Who provides the list of components?
  - Verify inclusion of appropriate components
  - Optimize monitoring path
- Equipment calibration
  - Manufacturer's requirements
  - Additional regulatory requirements

Step 3 (cont'd)

- Data Collection Procedures
  - What data are to be recorded?
  - How are data to be recorded?
  - What happens to data records?

Step 4: Establish Repair Procedures

- When Are Repairs To Be Made?
  - "On-line" repairs (e.g., stud tightening, etc.)
  - Pump seal replacements
  - Valve packing replacements

Step 4 (cont'd)

- Who Makes The Repairs?
  - Monitoring personnel
  - Operations staff
  - Maintenance staff

Step 5: Establish Data Analysis Procedures

- What Data Will Be Tracked?
  - Emission
  - Control performance (e.g., percent leakers, etc.)
  - Maintenance performance
- Who Will Track The Data
  - Monitoring personnel
  - -Environmental Staff

Step 5 (cont'd)

- How Will Data Be Transferred From Monitoring Personnel?
- Will Emissions Be Calculated From Data?
  - Ensure that appropriate procedures are followed
  - Ensure that proper estimating correlations are being used

LDAR Program Development

Component Identification

Initial steps can include the following:

- ❑ Determine what components must be included in the LDAR program per the applicable regulations.
- ❑ Decide how to *physically identify* each affected component so that the person doing the monitoring can easily locate it and monitor it.

Issues to consider when determining how to physically identify each component:

Physical Tags:

a) Attach a physical ID tag to each component.

- ❑ Metal or plastic?
- ❑ Stamped or engraved ID number?
- ❑ Bar code ID?
- ❑ RF (Radio Frequency) ID?
- ❑ Attach with wire?
  Attach at two points so it does not flap around and eventually break free?
- ❑ How many other ID tags are already on the component?

b) ID numbering system.

- ❑ Random numbers?
- ❑ Sequential numbering system?
- ❑ If a sequential number is used, what if new components are added between two sequential tags?
- ❑ Numbers that have some meaning?
- ❑ Is it possible for there to be duplicate tag numbers? If so, what number should be used as the "tie breaker?" Combo of Tag ID and Drawing Number?
- ❑ What if the single piece of equipment being monitored consists of more than one component and each needs to be monitored and recorded separately (i.e., valve stem and two flanges)? Should each component have its own physical tag or should the equipment get one tag to represent all sub components? If one tag is used, how will the records show that the sub-components have been monitored individually?

c) Hanging new tags.

- ❑ Coordinated effort to tag the entire facility all at once?
- ❑ Tag the facility one area at a time?
- ❑ Hire contractor to hang tags?
- ❑ Remove old tags?
- ❑ Always keep a cross reference record of old tag number with new tag number when replacing tags!

d) Tag maintenance.

- ❑ Do the components get painted periodically? What if the tag gets painted?
- ❑ What is the S.O.P. if someone finds a tag laying on the ground? Will people from other departments know what to do with it or that they should report it and to who?
- ❑ What is the S.O.P. for when an LDAR technician discovers a tag is missing?
- ❑ Should a missing tag be replaced by one with the same number? What will that cost in time & material?
- ❑ If a missing tag is replaced with a new number, how is that cross referenced to the old number?
- ❑ What if the component is replaced? Should the tag number from the old component be used, or should a new tag be hung?

Use Drawings instead of Tags:

a) Establish an initial set of drawings the LDAR technician will use.

- ❑ General purpose P&ID or LDAR specific Isometric?
- ❑ Who will create or enhance the drawings that the LDAR technicians will use?
- ❑ How will the components be identified on the drawings? ID numbers? Bar codes?
- ❑ Who decides the initial drawings are a correct base line of information to start with?

b) Keeping the drawings up to date.

- ❑ How will changes noted in the field be conveyed to the technician's drawing?
- ❑ Who/How/When will changes to the drawings be permanently updated?
- ❑ How will the technician know he or she is taking the most up to date drawing set with them when they go out to perform new inspections?
- ❑ Will the "official" records be kept on hard copy drawings or electronic copies?

Populate the software used for LDAR program management with component ID information:

a) Data entry of <u>new</u> component information.

- ❑ Key in data at the PC?
- ❑ Collect data in the field with a data logger during tagging, upload to PC software?

b) Reuse existing component data.

- ❑ Electronically convert data in an existing database or spreadsheet to the new LDAR software?
- ❑ Key in existing data that is currently only in hard copy form?

Location Identification

Initial steps can include the following:

a) Establish standard location descriptions.

- ❑ Carve up the facility into enough areas and sub-areas that the people doing the monitoring can physically locate the components which need to be inspected.
- ❑ Use the location fields available in the LDAR software as a guideline.
- ❑ Set up the LDAR software with the location description pick lists.

b) Establish what constitutes a "reportable Unit" per the regulations.

- ❑ Is it all the components in a specific Building or Area?
- ❑ Is it all the components associated with a specific "process?"
- ❑ If it is components associated with a process, what if some components are used on <u>more than one</u> process? (If they were reported in more than one Unit, then one leak could be counted more than once.)

Monitoring

This aspect has a wide range of issues, but they can be divided into two camps; Subcontract the monitoring task to a qualified contractor who specializes in LDAR, or handle all aspects of monitoring and repair in-house.

ANSWER THESE QUESTIONS NOW:

- ❑ What skill set and/or experience should the LDAR Program Administrator have?
- ❑ Will it be a permanent position for that person, or will it be a temporary assignment?
- ❑ Who (at this moment in time) is the LDAR Program Administrator for my facility?

With those answers in mind, consider what's involved with doing the monitoring in-house or subcontracting it to others:

In-House

a) Purchase analyzers.

- ❑ How many are required?
- ❑ FID or fuel cell type?
- ❑ Data logger built in or separate?

b) Maintain analyzers.

- ❑ Who will calibrate the analyzers? What is the S.O.P.?
- ❑ Who will specify calibration gas standards, purchase the gas & track its inventory?
- ❑ What are regulatory requirements for maintenance or calibration?
- ❑ Who will perform routine maintenance?
- ❑ Who will coordinate with the analyzer supplier if work has to be done?

- ❑ Who will perform quarterly certification of each analyzer?
  - ❑ Certify the analyzers in-house or use a 3rd party?

c) Train technicians.

- ❑ What qualifications do they require?
- ❑ Who will train the technicians?
- ❑ How will they be trained?
- ❑ How much regulatory information do they need to know?
- ❑ What is the S.O.P. for conducting an inspection?
- ❑ What is the S.O.P. for reporting irregularities?
- ❑ How many components should an technician be expected to monitor in a single day?

d) Supervision of technicians.

- ❑ What qualifications does the supervisor require?
- ❑ Who will supervise the technicians?
- ❑ Where will that person get trained?
- ❑ Who should the supervisor report to? Maintenance, Environmental, or Operations?

e) Monitoring only, or Monitor <u>and</u> 1st Repair Attempt

- ❑ Should the technician be required to make the first attempt at repair immediately upon discovering a leak?

Sub-Contract

a) Qualifications.

- ❑ Is LDAR monitoring one of the contractor's core businesses?
- ❑ Does the contractor have experience at similar facilities?

b) Monitoring equipment.

- ❑ Should analyzers and data loggers be supplied by the company or should the contractor use their own equipment?

c) Availability.

- ❑ Can the contractor have a technician on site to do monitoring when it needs to be done?

Other contracting considerations:

- ❑ Sub-contract the whole LDAR program?
- ❑ Combination of in-house and contracted program?
  - a) Contractor does the monitoring and you do the data management.
  - b) Contractor does everything but report preparation.

Data Collection

Fundamental to the LDAR program is effective collection of good data. Managing the program using data that has poor integrity (i.e., does not correlate to what is really in the field) exposes the company to risk of non-compliance and makes managing the program time consuming and frustrating.

In general, data collection can be carried out two ways; using pen & paper or electronic data loggers.

Pen & Paper

a) How it is done:

- Technician goes out into the field with a form that has the list of components to be inspected, along with pertinent component information.
- There is a place on the form for the technician to write in the analyzer reading.
- When all components are inspected, the technician (or other person) keys the readings into the LDAR software. Any other information such as delayed for shutdown, first attempts at repair, etc. is also keyed in.

b) Pros:

- ❑ Lowest cost.
- ❑ It is simple. Nominal training required.
- ❑ No chance of "pushing the wrong button."
- ❑ Little chance of losing a day's worth of inspection data.
- ❑ Which order components are inspected in does not matter.
- ❑ Technician can scan the page and intuitively choose the order of inspection.
- ❑ Missed inspections are obvious, no reading filled in.

c) Cons:

- ❑ Requires the technician to use both hands to write down the reading, could slow him down.
- ❑ Requires data to be keyed in back at the office.
- ❑ Hand writing may be hard to read resulting in wrong information.
- ❑ Damp or wet conditions could damage the paper or make written information illegible.
- ❑ Inspection results could be forged.

Data Collection (con't)

Data Logger

a) How it is done:

- A list of components to be inspected, along with pertinent component information (called a "Route") is downloaded from the PC software to the data logger. Technician takes the data logger into the field to record inspection results.
- Some data loggers have a way for the technician to record other information such as delayed for shutdown, first attempts at repair, new component, etc.
- When all components are inspected, the technician connects the data logger to the PC and uploads all of the information collected directly into the LDAR software.

b) Pros:

- ❑ All inspections are time and date stamped automatically for QA/QC purposes.
- ❑ Data is entered one time. No additional data entry at the PC is required. Less opportunity for error.
- ❑ Typically operated with one hand.
- ❑ With some data loggers, each component comes up on the screen in the order that they are to be inspected.
- ❑ Can be used in bad weather.

c) Cons:

- ❑ Equipment cost can be significant.
- ❑ Potential for lost data due to hardware failure.
- ❑ Can't use it if the battery is not charged.
- ❑ Some training is required.

d) Data Loggers that are stand alone vs. hardwired to the analyzer:

- Data loggers for LDAR fall into 2 families;
  1. Integrated into the analyzer or hard wired so that analyzer readings are automatically recorded in the data logger.
  2. Separate from the analyzer, user has to key in the analyzer reading.
- ❑ Is it more desirable to have the highest reading detected automatically recorded by the data logger, or should the user be able to decide what the highest reading was and key it in? (Note: The regulations do not require the reading to be automatically recorded. Keying in the reading is effectively the same as writing it down using a pen & paper method.)
- ❑ Does cost of the equipment matter when making this decision?

Repairs

The regulations require an "effective" repair be made within 15 days of discovering a leak.

a) Who will perform the repairs.
   - ❑ In house maintenance department who is also responsible for all other repairs at the facility?
   - ❑ Maintenance crew dedicated to LDAR?
   - ❑ Subcontractor?

b) Notification that a repair is required.
   - ❑ How will the LDAR supervisor know a repair is required and what the deadlines are?
   - ❑ How will the maintenance supervisor be notified? What is the S.O.P.?
   - ❑ Does the need for a repair need to be entered into a computerized maintenance management system?

c) Re-testing a repaired component.
   - ❑ How will the LDAR supervisor be notified that a repair is complete and a re-test can be scheduled?
   - ❑ Should technicians be sent out to perform only re-tests, or should they be rolled into other scheduled inspections that need to be performed?

Data Management Software

a) Should you create your own database or purchase an off-the-shelf LDAR software product?

If you have under 1,000 components to manage and you want to handle it in-house, you could do your scheduling and keep records manually with a spreadsheet. A commercially available LDAR software product becomes essential when the component count gets into the thousands and the complexity of the regulations make it impossible to maintain reliable/defendable records. The R.O.I. comes from two places; minimizing the labor of everyone involved with the LDAR program and automatic maintenance of LDAR specific records that can be used to document compliance.

LDAR software is not your "LDAR Program." It's a tool you use to help manage your LDAR Program. If the LDAR Program Administrator function in your company is considered a temporary assignment, then it makes sense to choose LDAR software with features that automate the process of managing fugitive emissions compliance.

b) Access to the LDAR software.
   - ❑ Who will be using the software?
     - ❑ Technicians?
     - ❑ LDAR Administrator/Supervisor?
     - ❑ Environmental Coordinator/Engineer?

- ☐ Maintenance Supervisor?
- ☐ Subcontractor?

☐ Restrict use to one PC, or make the LDAR software available on the network?

☐ Who will use the LDAR software more than anybody else?

☐ How often will others need access and what information will they be looking for?

c) Information that the LDAR software needs to make available to users <u>other than</u> the LDAR administrator/supervisor who handles day to day monitoring requirements (i.e., what do you want to get out of it?).

4 Reports for regulatory submittal:

- ☐ Monthly?
- ☐ Quarterly?
- ☐ Semi-annually?
- ☐ Annually?

☐ Work notification that repairs are needed?

☐ Anything else?

d) Scheduling inspections.

Criteria for when each component should be inspected is specified by each regulation. Part of that criteria takes into consideration the leak history of the component. With some regulations, if components have not leaked for a certain number of monitoring periods, the inspection frequency can be relaxed (i.e., components requiring quarterly inspections could be inspected semi-annually instead).

☐ Should actual inspection schedules be determined by the LDAR administrator / supervisor?

☐ Or should the software have logic built in to automatically determine, based on regulatory criteria, the minimum number of times each component needs to be inspected each year?

☐ Should the software remind the user when deadlines are approaching?

e) Access to historical data.

☐ Is there value in having ready access to information for each component?

- ☐ Previous inspection results, when and by who?
- ☐ Leak history?
- ☐ Repairs that have been done, when and by who?
- ☐ Conditions noted in the field, when and by who?
- ☐ Next scheduled inspection?
- ☐ Which components are out of service and when will they return to service?
- ☐ Old tag numbers correlated to new tag numbers?

☐ Should the software base its logic on the most stringent regulation affecting each component or should it apply the criteria of each regulation separately and record historical information accordingly?

f) Mass Emissions Calculations.

☐ Is mass emissions reporting required?

- ❑ What method(s) should be used?
  - ❑ EPA Correlation Equations?
  - ❑ SOCMI factors?
  - ❑ Unit Specific Factor?
  - ❑ Leak/No Leak?
  - ❑ Stratification?

g) Reporting.

- ❑ Should required reports be produced automatically by the software, or only on demand?
- ❑ What pre-defined LDAR specific report formats come with the software?
- ❑ Should there be a way to customize existing reports or create new ad hoc reports?

h) Security.

- ❑ Will there be people accessing the LDAR software who have varying levels of involvement and accountability?
- ❑ Should there be multi-level security configurable by the LDAR Administrator/Supervisor?

LDAR Fugitives Emissions Data Management Systems

William T. "Jerry" Winberry, Jr.
EnviroTech Solutions

Data Management

- ✓ Build or Buy?
- ✓ Who will use it?
- ✓ Who else needs LDAR information?
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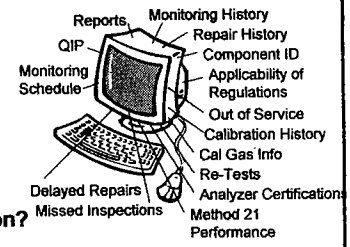

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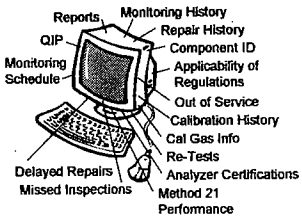

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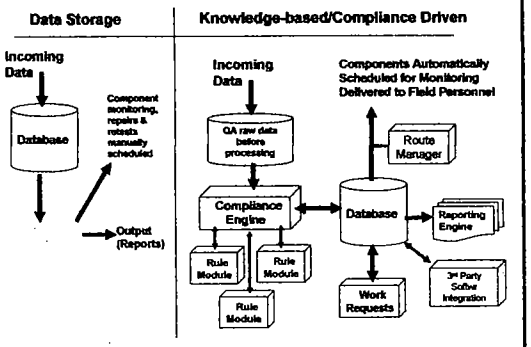


Historical Aspects of Data Management

Notebooks (1990's)

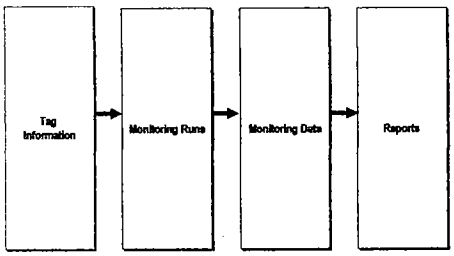
↓

Desk Top PC Based (Late 1990's)

↓

Web Based System (2003)

Getting the Information and Interpreting the Data



Can You Defend Your Program?

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- What if they took home a copy of your database?

LDAR Software Database Manufacturers

- Essential FEMS and FEMS Express by ESS
- LeakDAS by PC Systems
- LEADERD by EMS, Inc.
- P3M Software Solutions
- Palm Top Solutions (Tag-Links and Data Pro System 200)
- ARI Environmental Inc.

ENVIRONMENTAL MANAGEMENT

Essential FEMS

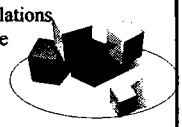
Your Essential Software Solution for Fugitive Emissions Management

- Simplicity and accuracy are essential to maintaining an effective, integrated leak detection and repair (LDAR) program.
- *Essential FEMS* allows you to simplify and automate all information processes for complying with federal and state regulations.
- *Essential FEMS* also makes it easy to schedule component runs with user-defined monitoring groups that can include unmonitored components, leaking components, components tied to a specific regulation, component location, monitoring history and performance.

ENVIRONMENTAL MANAGEMENT

Business Advantages of *Essential FEMS*

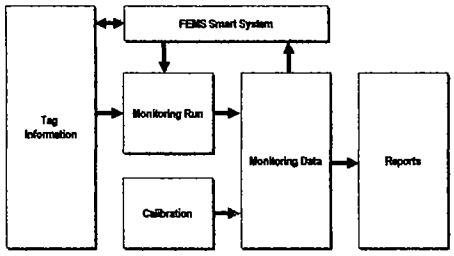
- Simplify and automate all information processes required for complying with LDAR, NESHAPS, RCRA and more.
- Satisfy the database management needs of operations and environmental professionals across multiple sites
- Use site correlation data to ensure the most accurate and up-to-date emissions calculations
- Achieve optimum network performance

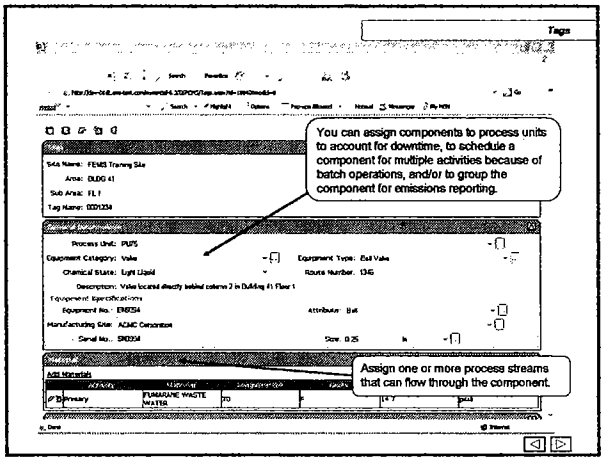


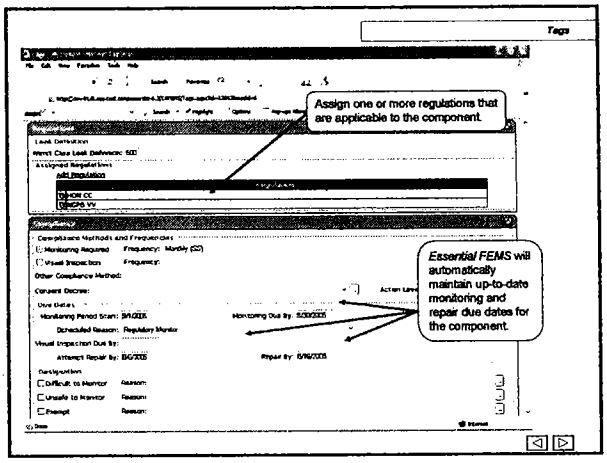
ENVIRONMENTAL MANAGEMENT

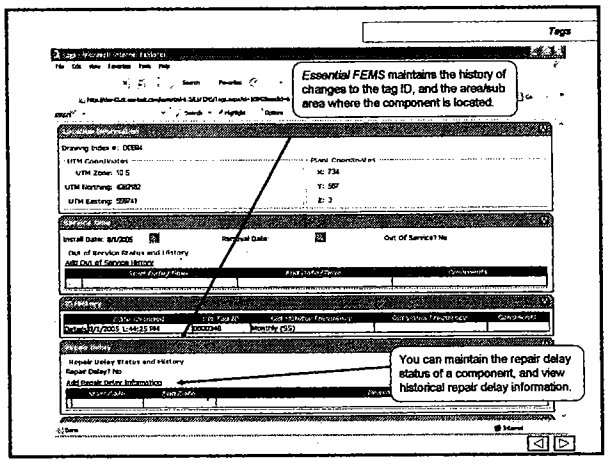
Essential FEMS Overview

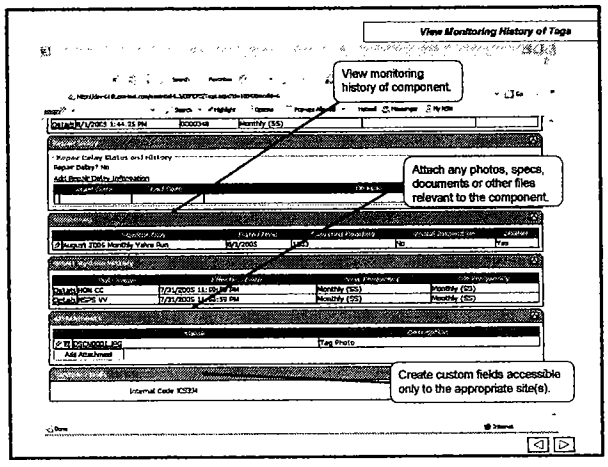
- *Essential FEMS* helps manage your fugitive emission leak detection and repair program (LDAR), and report fugitive emissions.

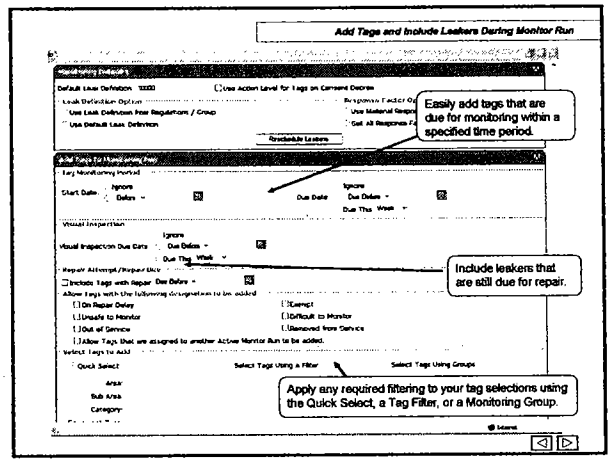


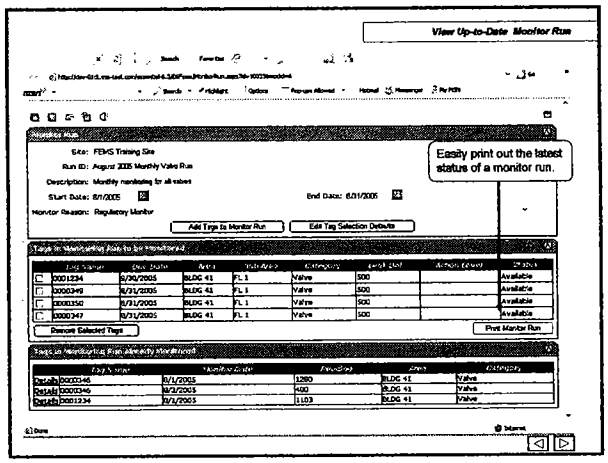


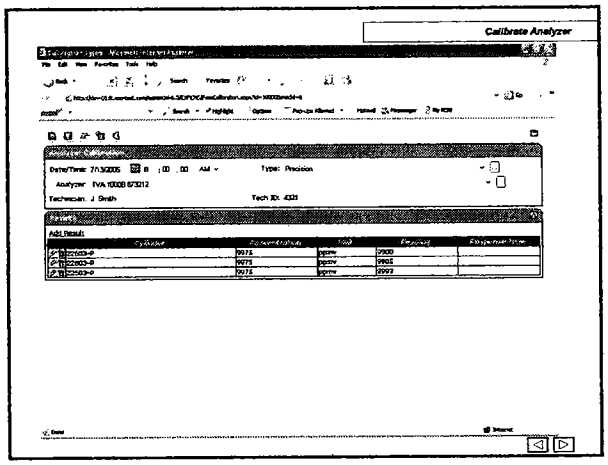

Tags
Assign one or more regulations that are applicable to the component.
Essential FEMS will automatically maintain up-to-date monitoring and repair due dates for the component.

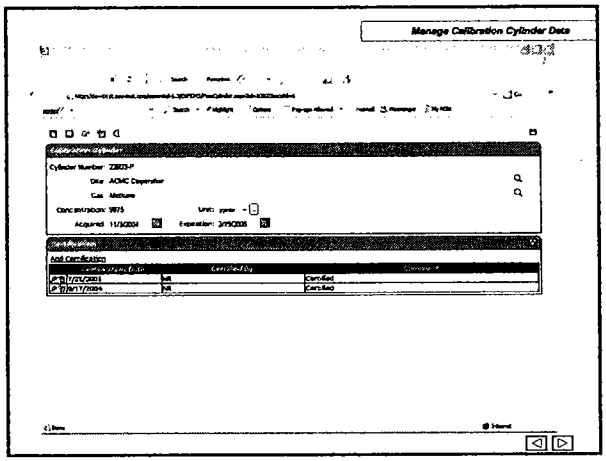

Tags
Essential FEMS maintains the history of changes to the tag ID, and the area/sub area where the component is located.
You can maintain the repair delay status of a component, and view historical repair delay information.

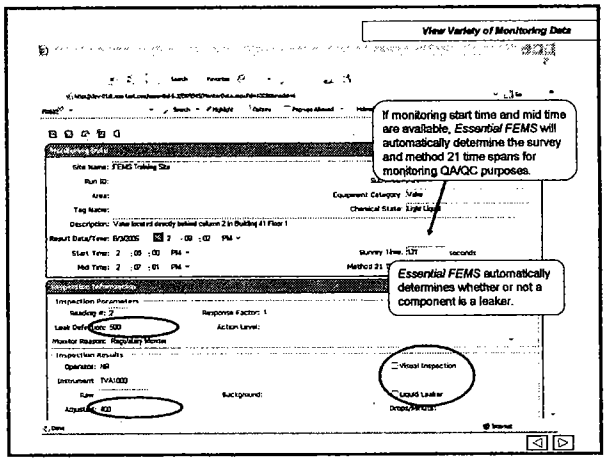

View Monitoring History of Tags
View monitoring history of component.
Attach any photos, specs, documents or other files relevant to the component.
Create custom fields accessible only to the appropriate site(s).

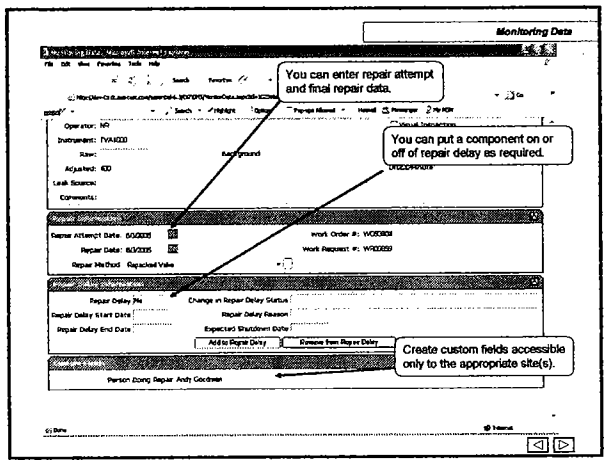

Add Tags and Include Leakers During Monitor Run
Easily add tags that are due for monitoring within a specified time period.
Include leakers that are still due for repair.
Apply any required filtering to your tag selections using the Quick Select, a Tag Filter, or a Monitoring Group.

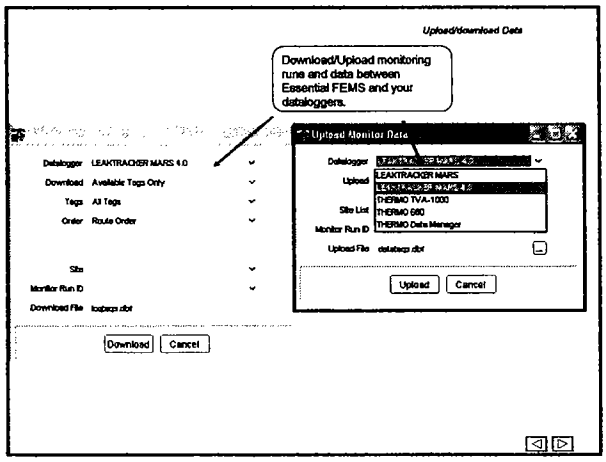

View Up-to-Date Monitor Run
Easily print out the latest status of a monitor run.

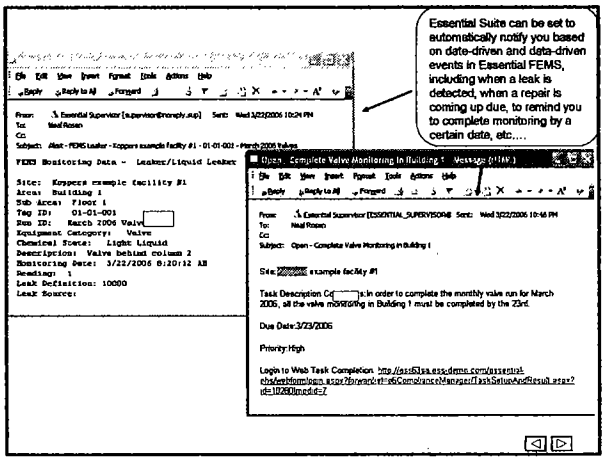

Calibrate Analyzer

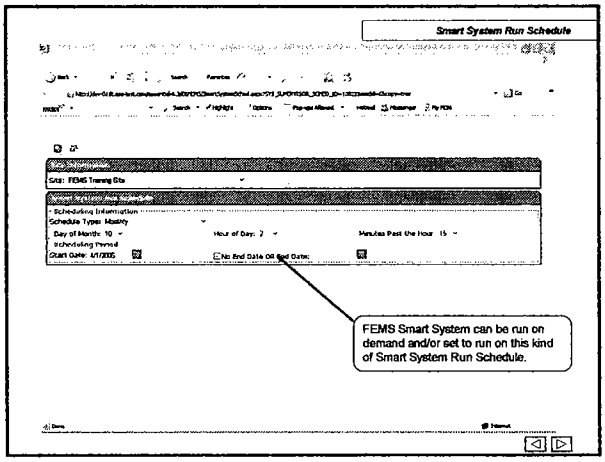

Manage Calibration Cylinder Data

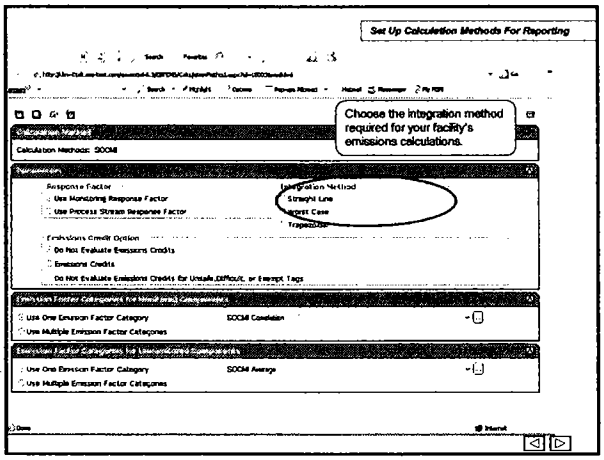

View Variety of Monitoring Data
If monitoring start time and mid time are available, *Essential FEMS* will automatically determine the survey and method 21 time spans for monitoring QA/QC purposes.
Essential FEMS automatically determines whether or not a component is a leaker.

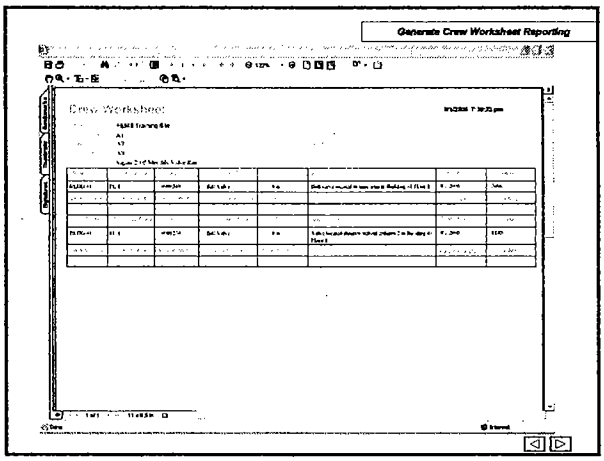

Monitoring Data
You can enter repair attempt and final repair data.
You can put a component on or off of repair delay as required.
Create custom fields accessible only to the appropriate site(s).

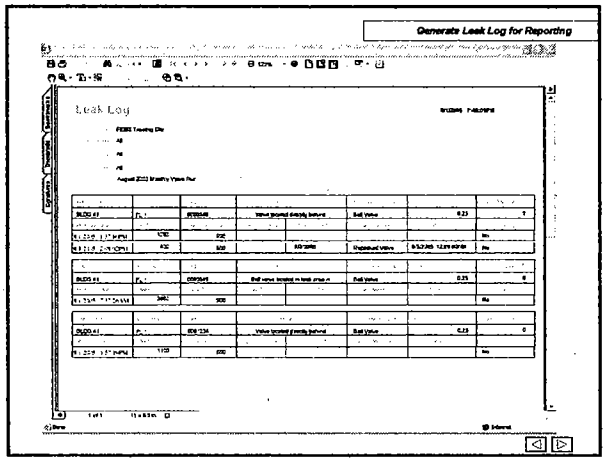

Upload/download Data
Download/Upload monitoring runs and data between Essential FEMS and your dataloggers.
Upload Monitor Data
Datalogger
Upload
Site List
Monitor Run ID
Upload File
LEAKTRACKER MARS
THERMO TVA-1000
THERMO 680
THERMO Data Manager
Upload
Cancel
Download
Cancel


Essential Suite can be set to automatically notify you based on date-driven and data-driven events in Essential FEMS, including when a leak is detected, when a repair is coming up due, to remind you to complete monitoring by a certain date, etc....


Smart System Run Schedule
FEMS Smart System can be run on demand and/or set to run on this kind of Smart System Run Schedule.


Set Up Calculation Methods For Reporting
Choose the integration method required for your facility's emissions calculations.
Calculation Method: SOCMI
Response Factor
Use Monitoring Response Factor
Use Process Stream Response Factor
Integration Method
Straight Line
Worst Case
Trapezoidal
Emissions Credit Option
Do Not Evaluate Emissions Credits
Emissions Credits
Do Not Evaluate Emissions Credits for Unsafe, Difficult, or Exempt Tags
Use One Emission Factor Category
SOCMI Correlation
Use Multiple Emission Factor Categories
Use One Emission Factor Category
SOCMI Average
Use Multiple Emission Factor Categories


Generate Crew Worksheet Reporting
Crew Worksheet


Generate Leak Log for Reporting
Leak Log

Differences Between Essential FEMS and FEMS Express:

- Essential FEMS manages multiple facilities in the same database, while a FEMS Express database accommodates the management of just one facility.
- Multiple users can access and use Essential FEMS at the same time, while FEMS Express accommodates just one user at a time.

Differences Between Essential FEMS and FEMS Express:

- Essential FEMS is web-based (you access the screens through Internet Explorer), while FEMS Express is not a web-based application.
- Essential FEMS has a "Smart System" tool that you can use to regularly analyze your regulations, tags, and tag monitoring history to determine appropriate tag monitoring frequencies. FEMS Express does not offer such a tool.

Differences Between Essential FEMS and FEMS Express:

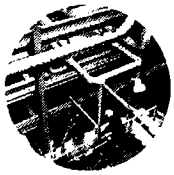
- Essential FEMS offers enhanced capabilities for defining your regulations (being able to define a phase-in period leak definition, being able to define different required numbers of days until first repair attempt and actual repair based on different monitoring ppm levels, etc...).
- Essential FEMS offers enhanced capabilities/options/filters when selecting tags for a monitoring run. Plus, Essential FEMS enables you to remove/add tags to an existing monitoring run (FEMS Express does not enable you to change an existing run.).

Differences Between Essential FEMS and FEMS Express:

- **Essential FEMS is fully integrated with the rest of the Essential Suite EHS & Crisis Management solution. So, for example, you can automatically generate a SARA 313 electronic submittal which includes fugitive emissions calculated directly/automatically from Essential FEMS, and you can receive automatic notifications/emails of FEMS-related events, like when a repair is coming up due, etc....**

ENVIRONMENTAL MANAGEMENT

FEMS Express

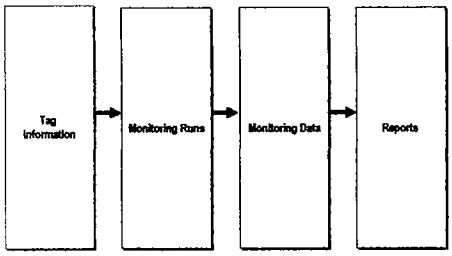


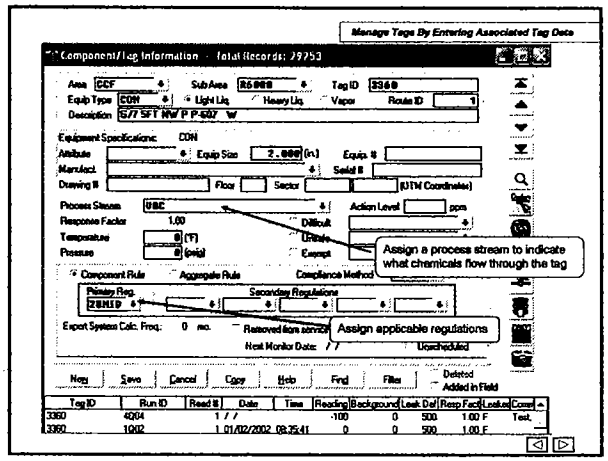
- Simplicity and accuracy are essential to maintaining an effective, integrated leak detection and repair (LDAR) program.
- *FEMS Express* allows you to simplify and automate all information processes for complying with federal and state regulations.
- *FEMS Express* also makes it easy to schedule component runs with user-defined monitoring groups that can include unmonitored components, leaking components, components tied to a specific regulation, component location, monitoring history and performance.

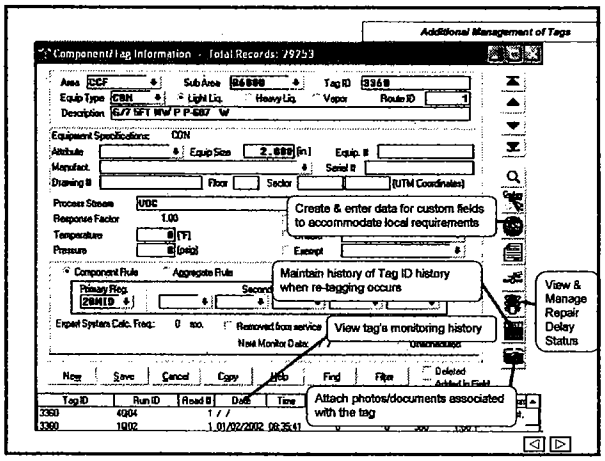
ENVIRONMENTAL MANAGEMENT

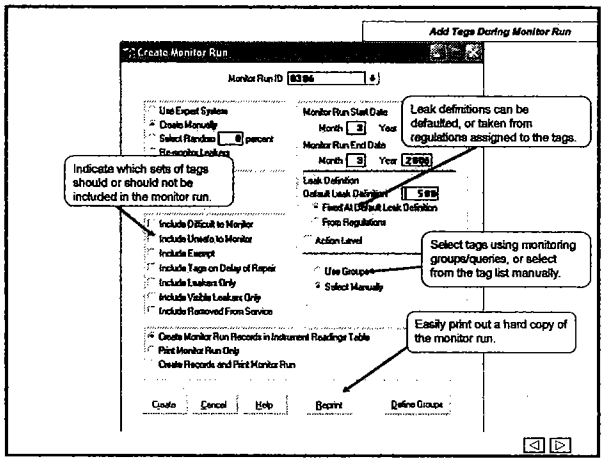
FEMS Express Overview

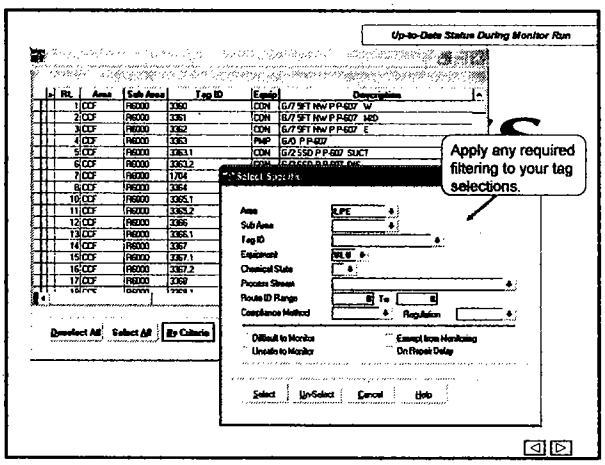
FEMS Express helps manage your fugitive emission leak detection and repair program (LDAR), and report fugitive emissions.

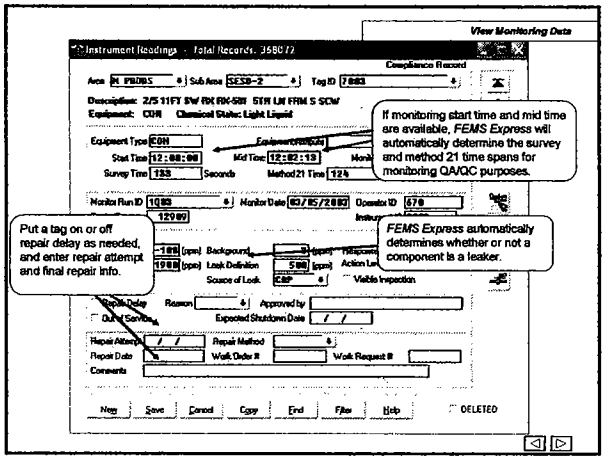


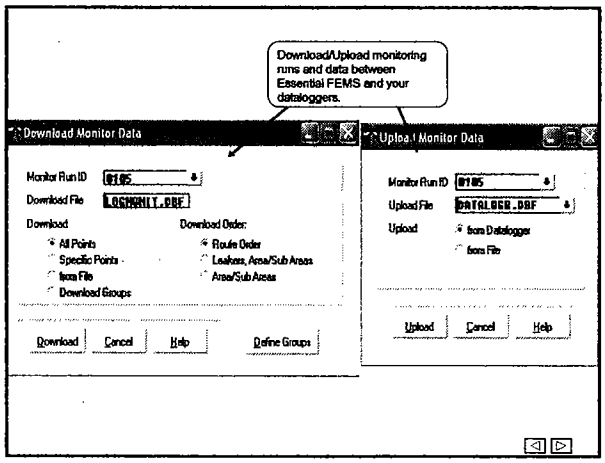

Manage Tags By Entering Associated Tag Data
Assign a process stream to indicate what chemicals flow through the tag
Assign applicable regulations

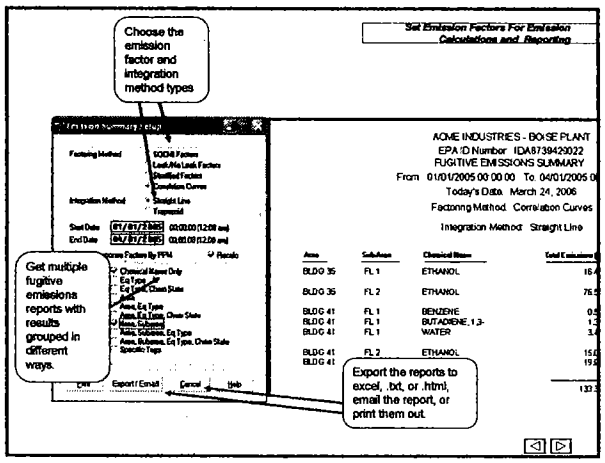

Additional Management of Tags
Create & enter data for custom fields to accommodate local requirements
Maintain history of Tag ID history when re-tagging occurs
View & Manage Repair Delay Status
View tag's monitoring history
Attach photos/documents associated with the tag

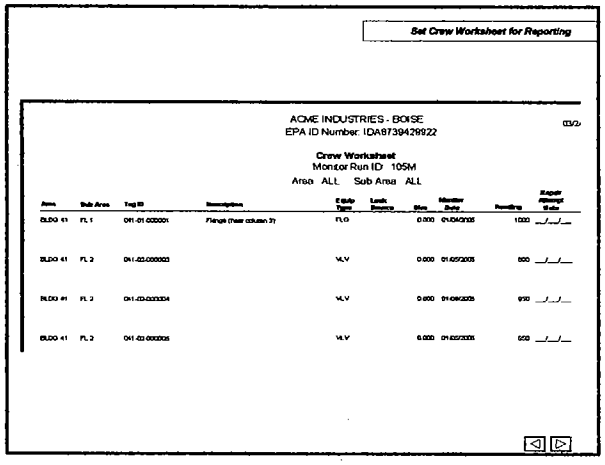

Add Tags During Monitor Run
Leak definitions can be defaulted, or taken from regulations assigned to the tags.
Indicate which sets of tags should or should not be included in the monitor run.
Select tags using monitoring groups/queries, or select from the tag list manually.
Easily print out a hard copy of the monitor run.

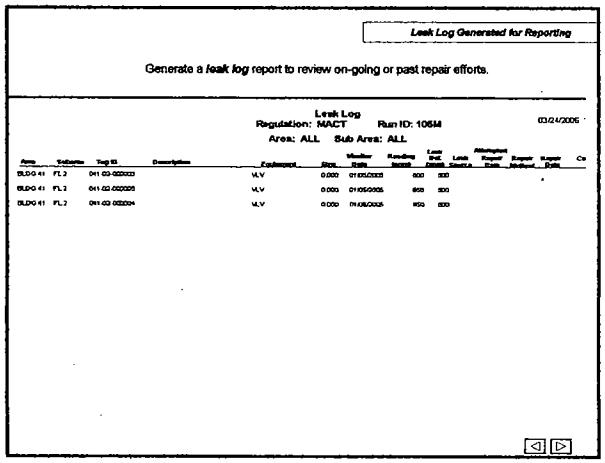

Up-to-Date Status During Monitor Run
Apply any required filtering to your tag selections.


View Monitoring Data
If monitoring start time and mid time are available, FEMS Express will automatically determine the survey and method 21 time spans for monitoring QA/QC purposes.
Put a tag on or off repair delay as needed, and enter repair attempt and final repair info.
FEMS Express automatically determines whether or not a component is a leaker.


Download/Upload monitoring runs and data between Essential FEMS and your dataloggers.
Download Monitor Data
Upload Monitor Data


Set Emission Factors For Emission Calculations and Reporting
Choose the emission factor and integration method types
Get multiple fugitive emissions reports with results grouped in different ways.
Export the reports to excel, .txt, or .html, email the report, or print them out.
ACME INDUSTRIES - BOISE PLANT
EPA ID Number IDA8739429022
FUGITIVE EMISSIONS SUMMARY
Today's Date March 24, 2006
Factoring Method Correlation Curves
Integration Method Straight Line

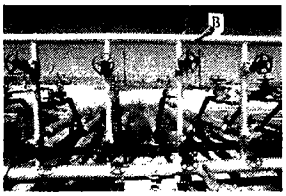

Set Crew Worksheet for Reporting
ACME INDUSTRIES - BOISE
EPA ID Number IDA8739429022
Crew Worksheet
Monitor Run ID 105M
Area ALL Sub Area ALL

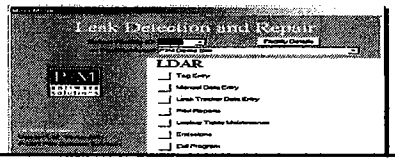

Leak Log Generated for Reporting
Generate a leak log report to review on-going or past repair efforts.
Leak Log
Regulation: MACT Run ID: 105M
Area: ALL Sub Area: ALL

P3M
software
solutions

P3M
Leak Detection and Repair (LDAR)

P3M's LDAR software is a state-of-art database capable of tracking and reporting leaks





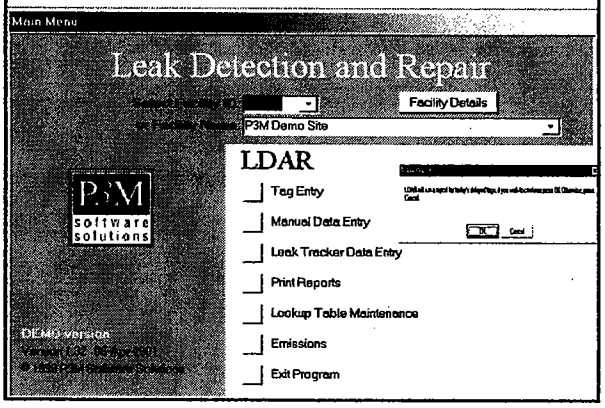
P3M LDAR Features

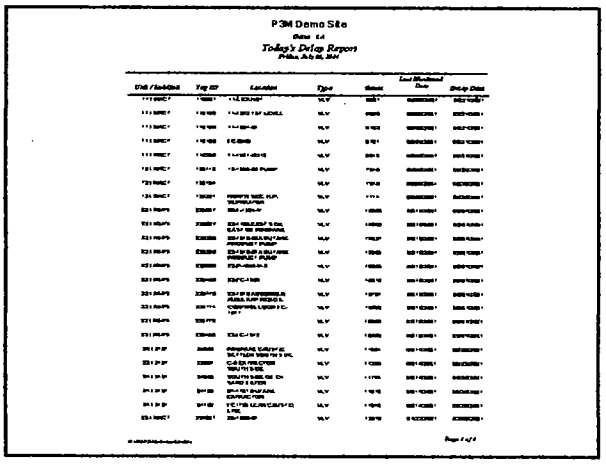
- Set Security Levels
- Define Leak Limits and Frequencies by Regulation and Components
- Apply Regulation to each Unit and Subunit
- Import and Export Tag Information
- Manage Tags, Stream Groups, Route Sequences, etc.
- Interface with Leak Tracker®

P3M LDAR Features

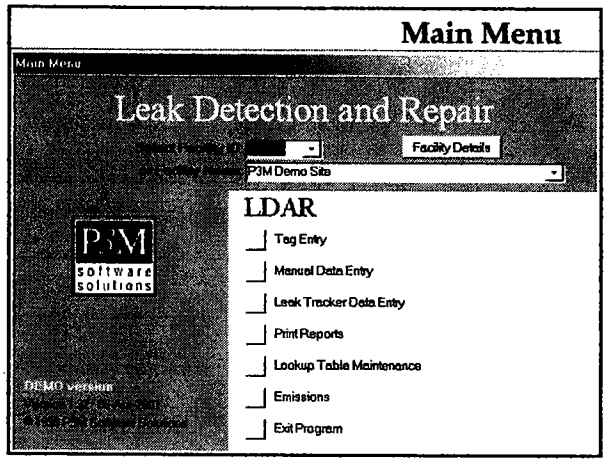
- Manual Monitoring Data Entry
- Import Monitoring Data from a file or from Leak Tracker®
- Tracks Leak Detection and Repair Efforts
- Print Monitoring Schedules
- Print Comprehensive Monitoring and Leak Reports

Startup

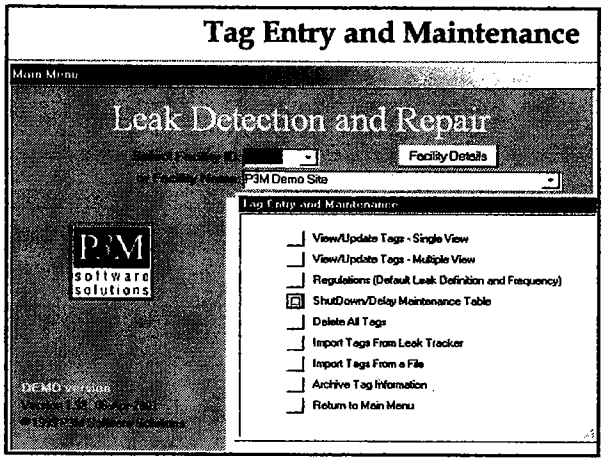




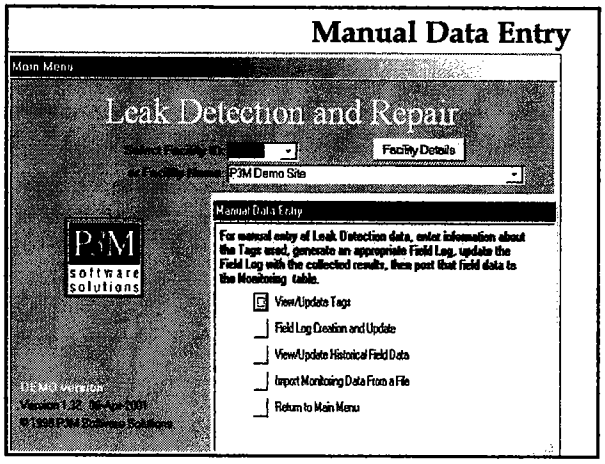
Main Menu



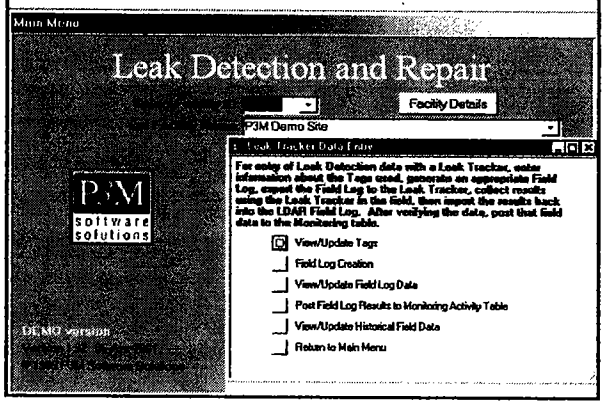
Tag Entry and Maintenance



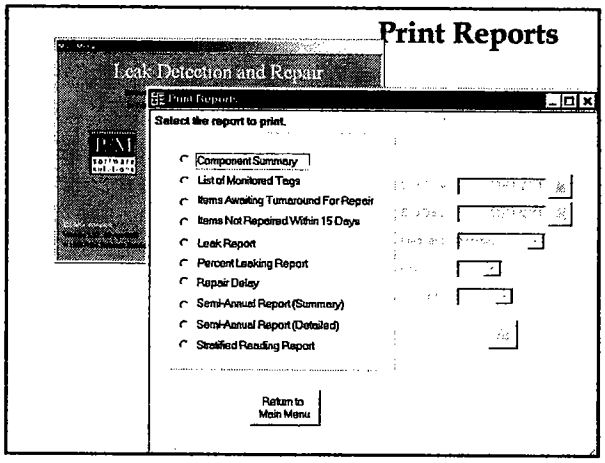
Manual Data Entry



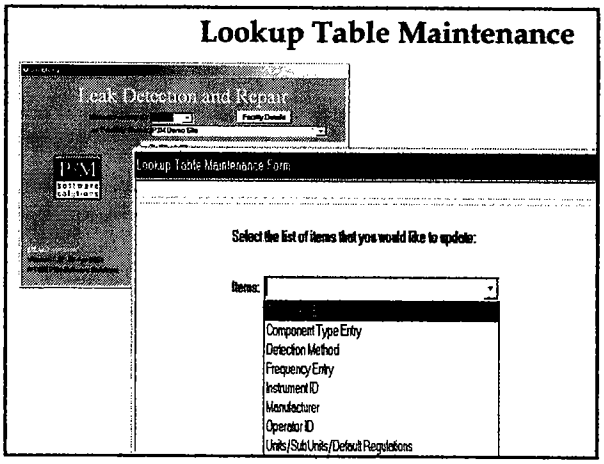
Leak Tracker Data Entry



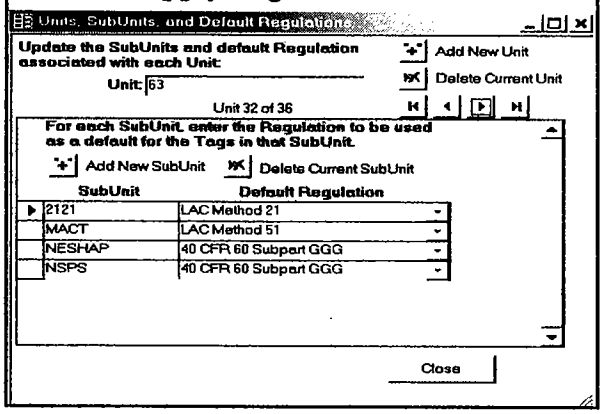
Print Reports



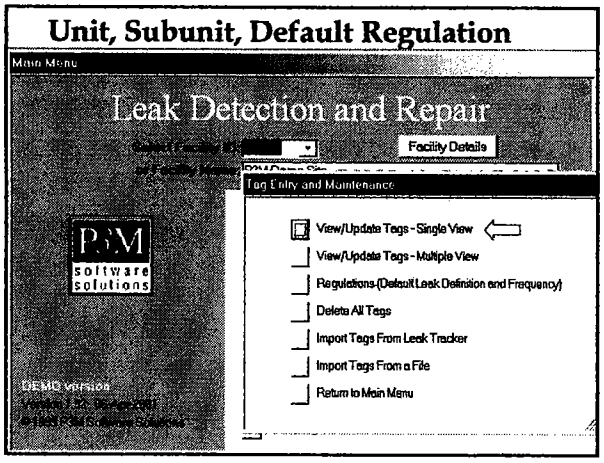
Lookup Table Maintenance



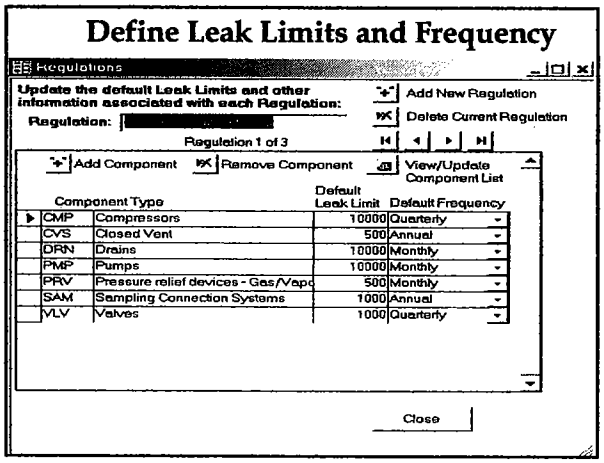
Apply Regulations to Unit and



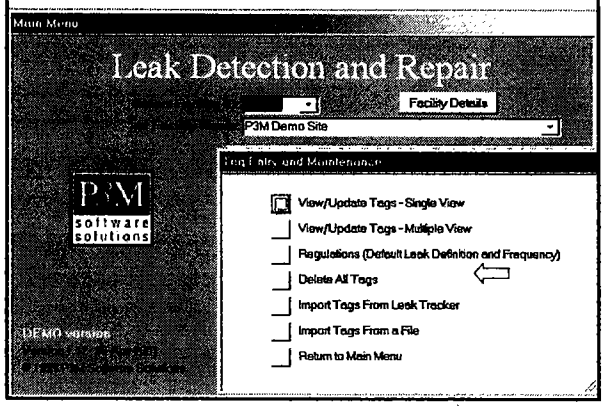
Unit, Subunit, Default Regulation



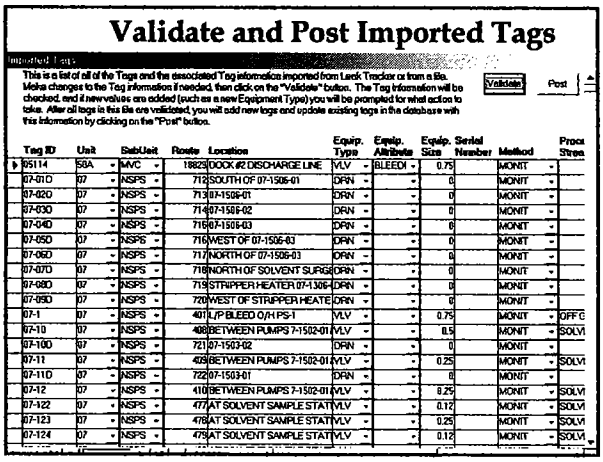
Define Leak Limits and Frequency



Importing Tags

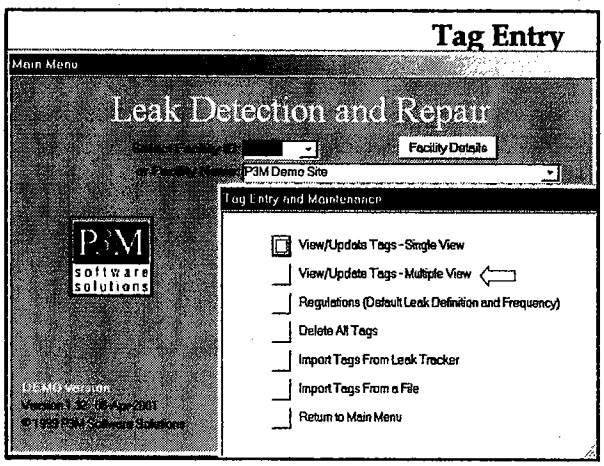


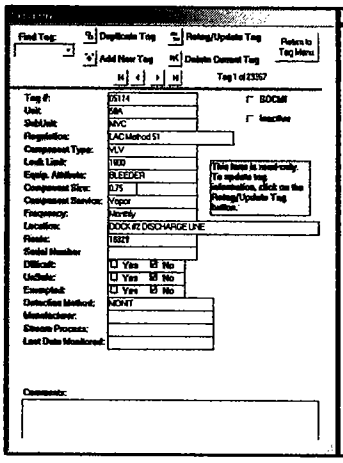
Validate and Post Imported Tags



Tag ID	Unit	SubUnit	Route	Location	Equip. Type	Equip. Attribute	Equip. Size	Serial Number	Method	Proce Stree
05114	50A	MVC	1882	DOCK #2 DISCHARGE LINE	VLV	BLEEDI	0.75		MONIT	
07-01D	07	NSPS	712	SOUTH OF 07-1506-01	DRN		0		MONIT	
07-02D	07	NSPS	713	07-1506-01	DRN		0		MONIT	
07-03D	07	NSPS	714	07-1506-02	DRN		0		MONIT	
07-04D	07	NSPS	715	07-1506-03	DRN		0		MONIT	
07-05D	07	NSPS	716	WEST OF 07-1506-03	DRN		0		MONIT	
07-06D	07	NSPS	717	NORTH OF 07-1506-03	DRN		0		MONIT	
07-07D	07	NSPS	718	NORTH OF SOLVENT SURGE	DRN		0		MONIT	
07-08D	07	NSPS	719	STRIPPER HEATER 07-1306-	DRN		0		MONIT	
07-09D	07	NSPS	720	WEST OF STRIPPER HEATE	DRN		0		MONIT	
07-1	07	NSPS	401	L/P BLEED O/H PS-1	VLV		0.75		MONIT	OFF C
07-10	07	NSPS	408	BETWEEN PUMPS 7-1502-01	VLV		0.5		MONIT	SOLVI
07-100	07	NSPS	721	07-1503-02	DRN		0		MONIT	
07-11	07	NSPS	409	BETWEEN PUMPS 7-1502-01	VLV		0.25		MONIT	SOLVI
07-11D	07	NSPS	722	07-1503-01	DRN		0		MONIT	
07-12	07	NSPS	410	BETWEEN PUMPS 7-1502-01	VLV		0.25		MONIT	SOLVI
07-122	07	NSPS	477	AT SOLVENT SAMPLE STAT	VLV		0.12		MONIT	SOLVI
07-123	07	NSPS	476	AT SOLVENT SAMPLE STAT	VLV		0.25		MONIT	SOLVI
07-124	07	NSPS	475	AT SOLVENT SAMPLE STAT	VLV		0.12		MONIT	SOLVI

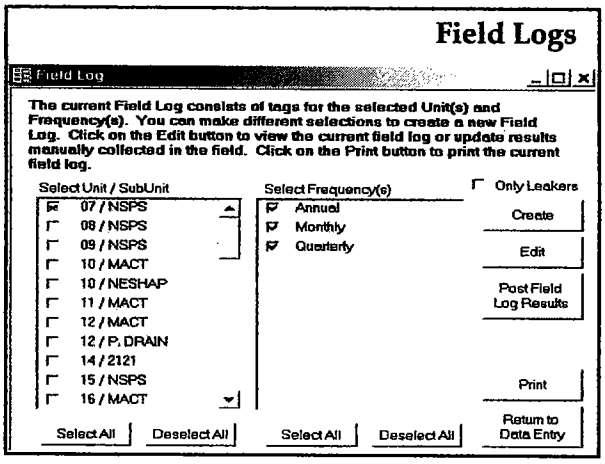
Tag Entry



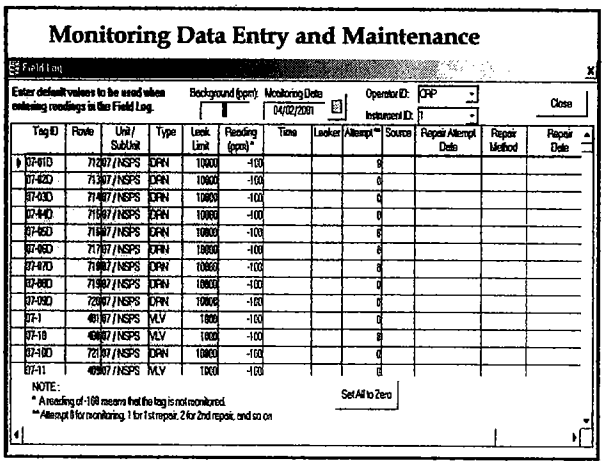


Tag Maintenance

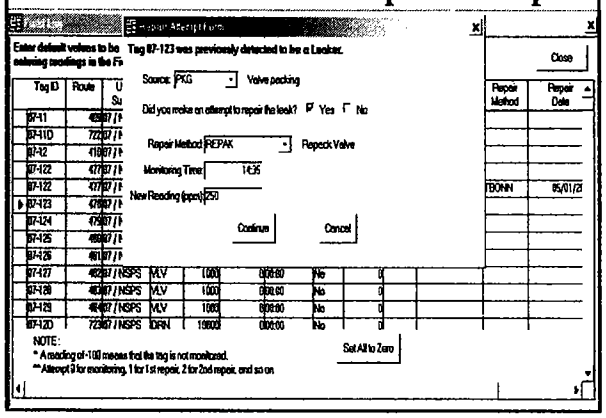
- Add and Delete Tags
- Duplicate Tags
- Retag Existing Tags
- Edit Tag Information



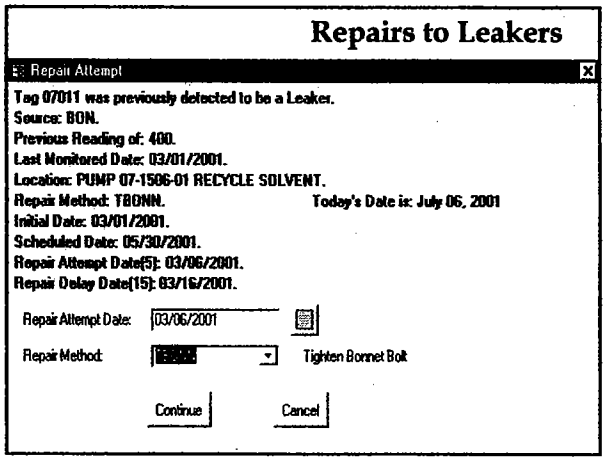
Monitoring Data Entry and Maintenance



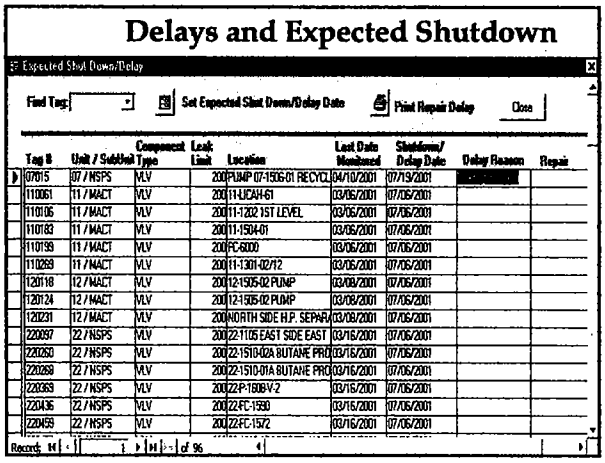
Repair Attempt



Repairs to Leakers



Delays and Expected Shutdown



Monitoring and Leak Reports

- Component Summary
- Master Equipment List
- List of Monitored Tags
- Items Awaiting Turnaround For Repair
- Items Not Repaired Within 15 Days
- Stratified Reading Report

Monitoring and Leak Reports

- Leak Reports
- Percent Leaking Report
- Repair Delay Report
- Semi-Annual Report

Advantages

- Imports and Exports Tag Information
- Manages Regulations, Components, Leak Limits, Monitoring Frequencies, etc.
- Minimizes Data Entry
- Tracks Retagging of Existing Tags

Advantages

- Creates Field Logs For Manual Data Entry
- Imports and Exports Monitoring Data by Interfacing with Leak Tracker®
- Tracks Leakers and Repair Delays
- Manages Historical Monitoring Data
- Prints Comprehensive Monitoring and Leak Reports

P3M software solutions

P3M Software Solutions, LLC
2508 Ticheli Road
Monroe, LA 71202
Phone: 318.410.9178
FAX: 318.323.6593
Email:sales@p3msoftware.com
- www.p3msoftware.com

Inspection Information Management

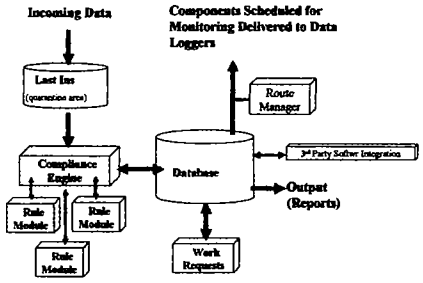
ec systems

Environmental Compliance Systems Corp.

Introducing
ORR LeakDAS v3

What makes ORR LeakDAS unique?

Data Processing Strategy



Where's the compliance burden?

~~Who determines what needs to be monitored and when?~~

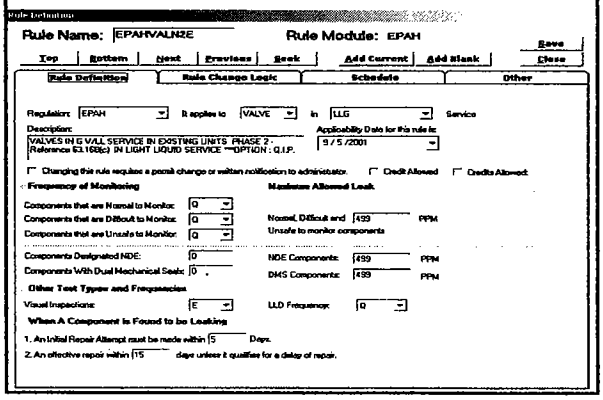
The program administrator manually constructs & manages Monitoring Runs for each month, quarter, etc.

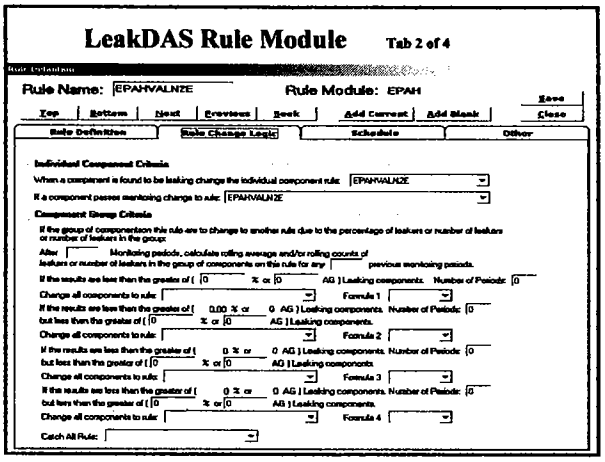
LeakDAS Compliance Engine uses Rule Modules to automatically determine monitoring schedules down to the component level!

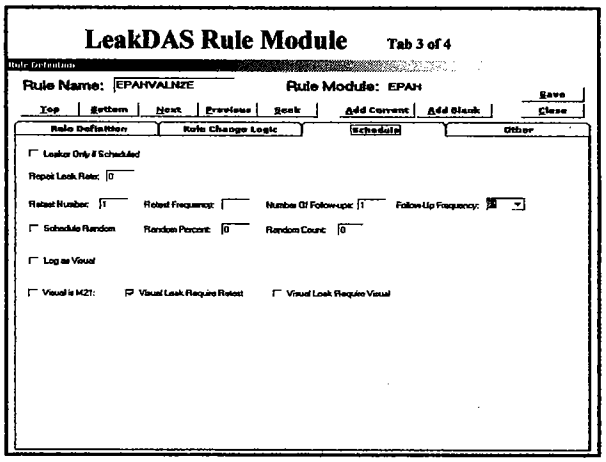
Consistent regardless of who the user is.

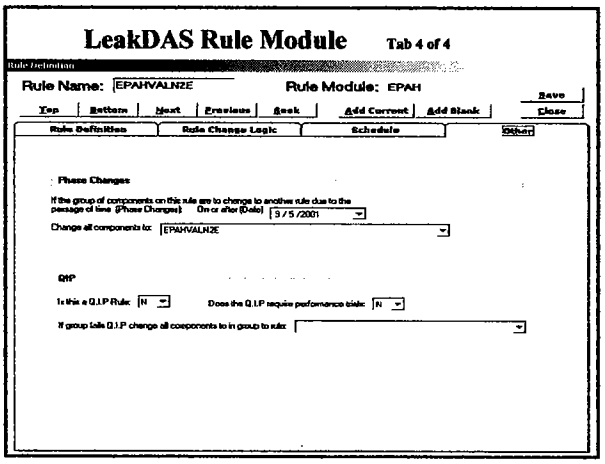
LeakDAS Rule Module

Tab 1 of 4




LeakDAS Rule Module
Tab 2 of 4
Rule Name: EPAHVALN2E
Rule Module: EPAH
Save
Top
Bottom
Next
Previous
Seek
Add Current
Add Blank
Close
Rule Definition
Rule Change Logic
Schedule
Other
Individual Component Criteria
When a component is found to be leaking change the individual component rule: EPAHVALN2E
If a component passes monitoring change to rule: EPAHVALN2E
Component Group Criteria
If the group of components in this rule are to change to another rule due to the percentage of leakers or number of leakers or number of leakers in the group:
Allow Monitoring periods, calculate rolling average and/or rolling counts of leakers or number of leakers in the group of components on this rule for any previous monitoring periods.
If the results are less than the greater of (0 % or 0 AG) Leaking components. Number of Periods: 0
Change all components to rule: Formula 1
If the results are less than the greater of (0.00 % or 0 AG) Leaking components. Number of Periods: 0
but less than the greater of (0 % or 0 AG) Leaking components.
Change all components to rule: Formula 2
If the results are less than the greater of (0 % or 0 AG) Leaking components. Number of Periods: 0
but less than the greater of (0 % or 0 AG) Leaking components.
Change all components to rule: Formula 3
If the results are less than the greater of (0 % or 0 AG) Leaking components. Number of Periods: 0
but less than the greater of (0 % or 0 AG) Leaking components.
Change all components to rule: Formula 4
Catch All Rule:


LeakDAS Rule Module
Tab 3 of 4
Rule Name: EPAHVALN2E
Rule Module: EPAH
Save
Top
Bottom
Next
Previous
Seek
Add Current
Add Blank
Close
Rule Definition
Rule Change Logic
Schedule
Other
Leaker Only If Scheduled
Repair Leak Rate: 0
Retest Number: 1
Retest Frequency:
Number Of Follow-ups: 1
Follow Up Frequency:
Schedule Random
Random Percent: 0
Random Count: 0
Log as Visual
Visual is M21:
Visual Leak Require Retest
Visual Leak Require Visual


LeakDAS Rule Module
Tab 4 of 4
Rule Name: EPAHVALN2E
Rule Module: EPAH
Save
Top
Bottom
Next
Previous
Seek
Add Current
Add Blank
Close
Rule Definition
Rule Change Logic
Schedule
Other
Phase Changes
If the group of components on this rule are to change to another rule due to the passage of time (Phase Changes) On or after (Date) 3/5/2001
Change all components to: EPAHVALN2E
QIP
Is this a Q.I.P Rule: N
Does the Q.I.P require performance tests: N
If group fails Q.I.P change all components to in group to rule:

Compliance Confidence

Compliance worries with Monitoring Runs:

~~Nothing to prevent components from being overlooked.~~

~~Components added mid-month won't get scheduled.~~

Components deleted mid month will get monitored.

LeakDAS automatically schedules components per each regulation, schedule is refreshed every day.

Every component is accounted for.

Minimize Field Labor

~~Manually determine schedules using allowed Skip Periods~~

Time consuming

Custom software

LeakDAS Rule Modules automatically account for Skips

Schedules reflect Skip Periods per each regulation

Proof of Compliance Example

"What do you want to know about that valve?"

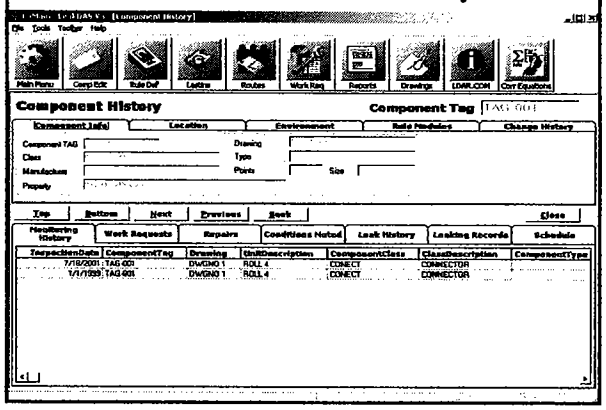
Who monitored the component at which date and time, what the results were, what analyzer was used, when it was calibrated, what the calibration results were, what cal gas was used, what its expiration date is, whether the component was leaking per the criteria of up to 5 different regulations that may be applicable to this component, when a first attempt was made, by who, what repair was made, the condition of the component, when an effective repair was made, by who, when and what they did, when a retest was done, what the results were, and when the component is scheduled for normal monitoring again.

Proof of Compliance Example

"What do you want to know "more" about that valve?"

If this component has ever had an ID tag change, missed as a components, registered in the leak logs or repair records, retested? and what the results were, retested with an analyzer certified and recorded, any out of service information, any return to service information, has an delayed repairs (what, when, why, and approvals) occur, what is the leak percentages, QIP's required, and has that valve been reported correctly in the submittals to EPA.

Audit Defense – LeakDAS History



Operational Efficiencies

~~Monitoring Runs created & downloaded manually~~

~~Time consuming~~

Performed by supervisor

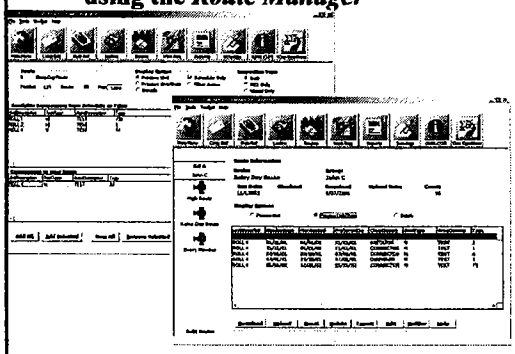
LeakDAS Routes can be staged for pick up

Technician can download their own Routes

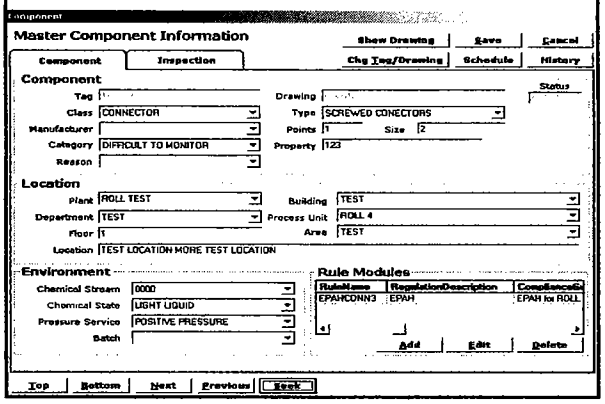
Each Tech can have multiple Routes waiting

Routes can be built once and re-used

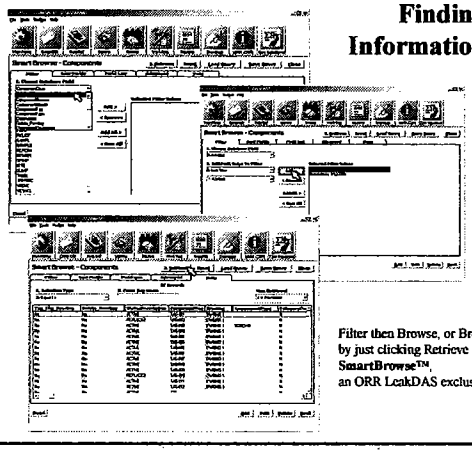
Building or Choosing a Monitoring Route using the *Route Manager*



Component Inventory Information

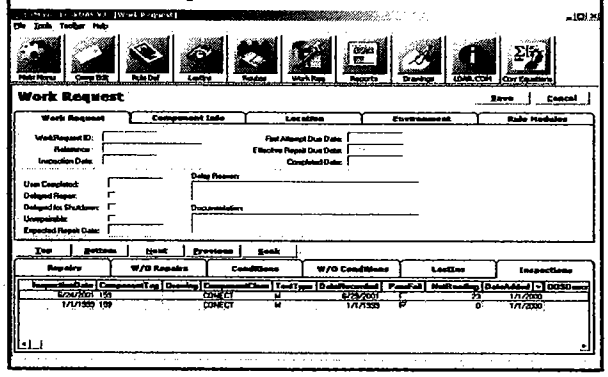


Finding Information

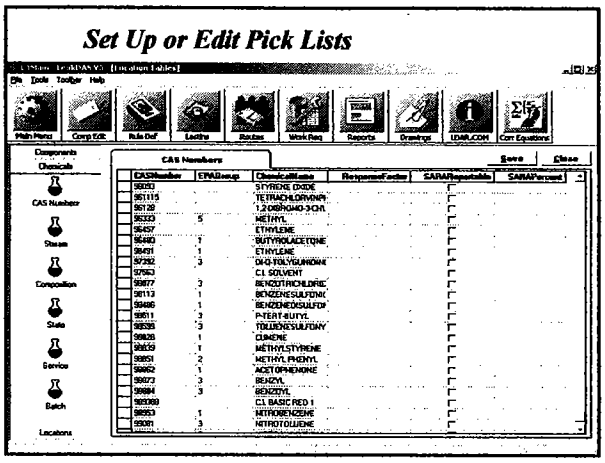


Filter then Browse, or Browse all by just clicking Retrieve with SmartBrowse™, an ORR LeakDAS exclusive!

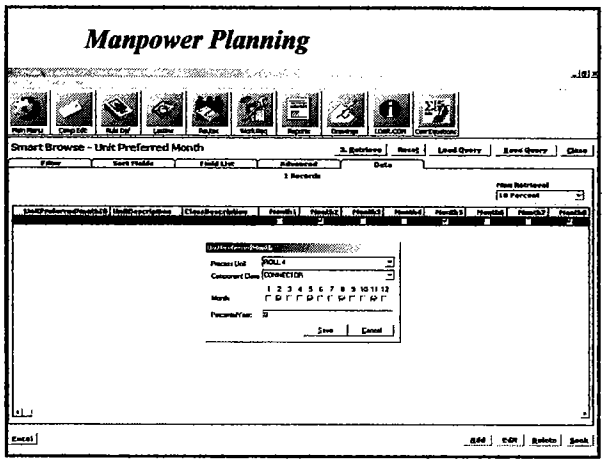
Handling Leakers using the *Work Request Module*



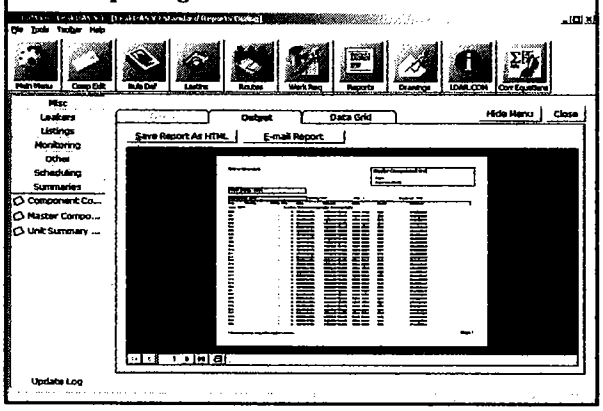
Set Up or Edit Pick Lists



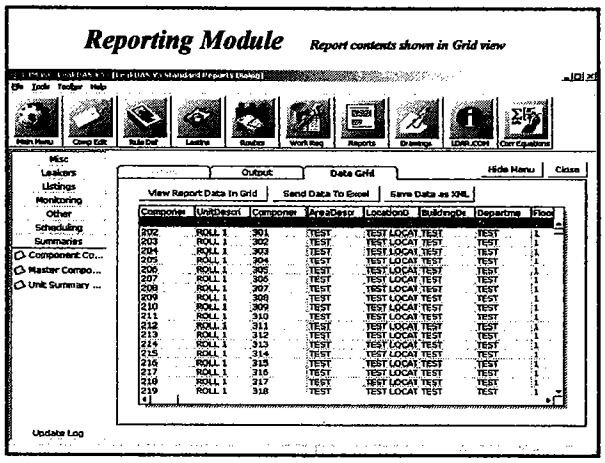
Manpower Planning



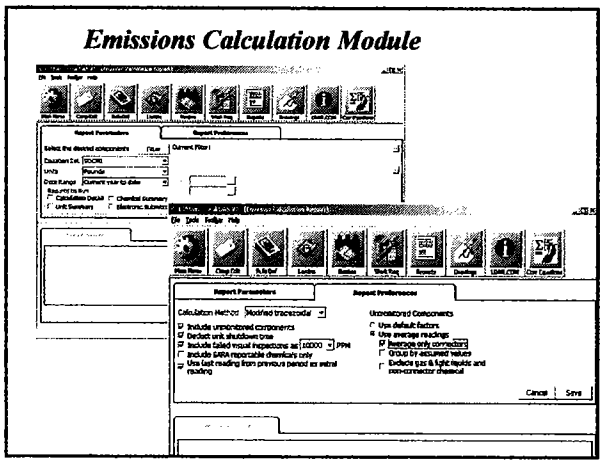
Reporting Module



Reporting Module *Report contents shown in Grid view*

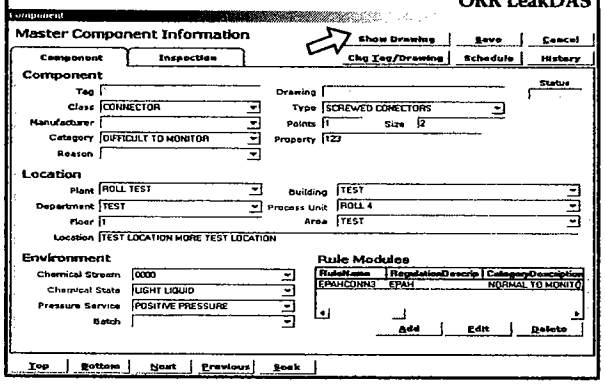


Emissions Calculation Module



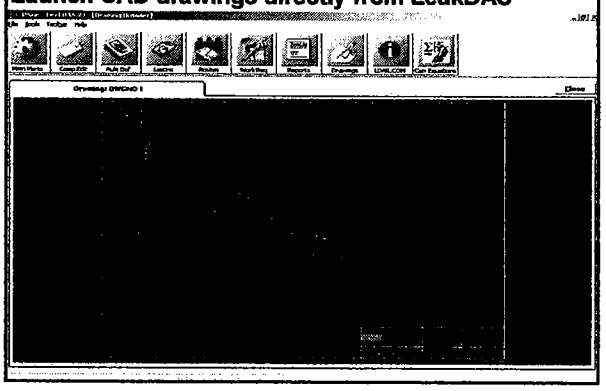
Direct Linkage to Drawings

ORR LeakDAS

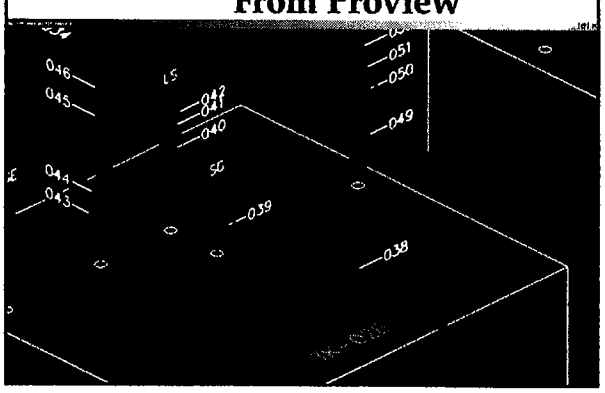


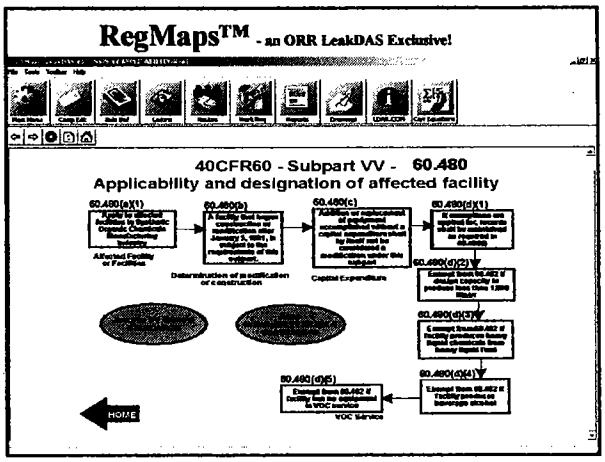
Direct Linkage to Drawings

Launch CAD drawings directly from LeakDAS



Direct Linkage to Drawings From Proview

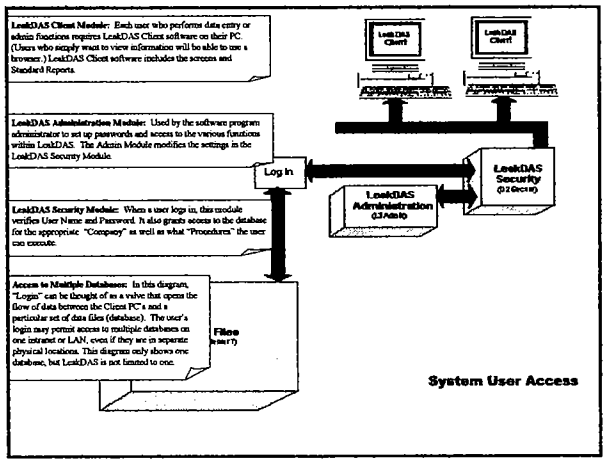


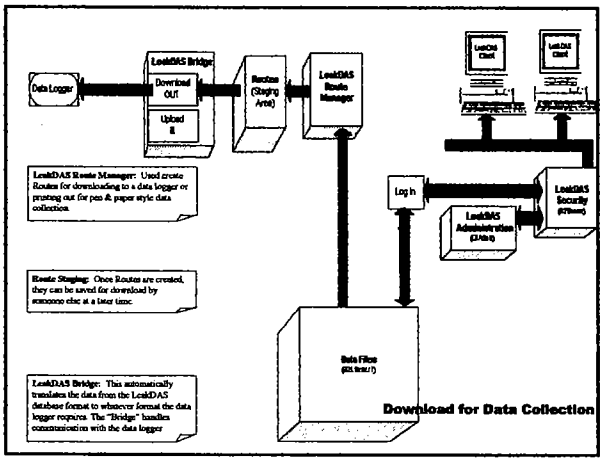


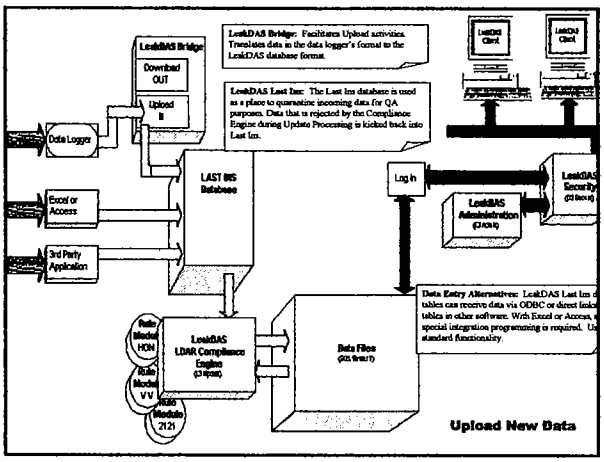
Design Criteria

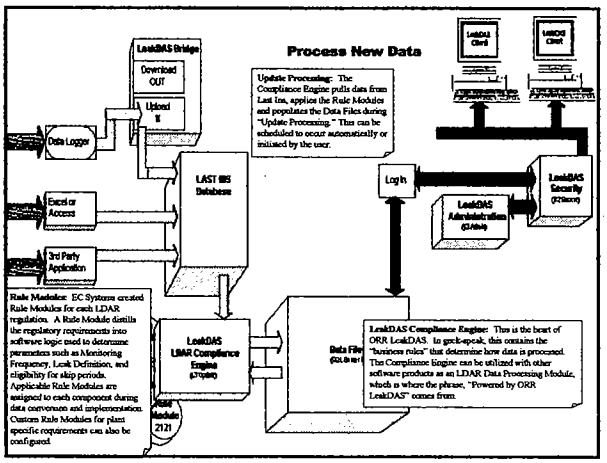
When designing ORR LEAKDAS® v3, EC Systems targeted the following criteria:

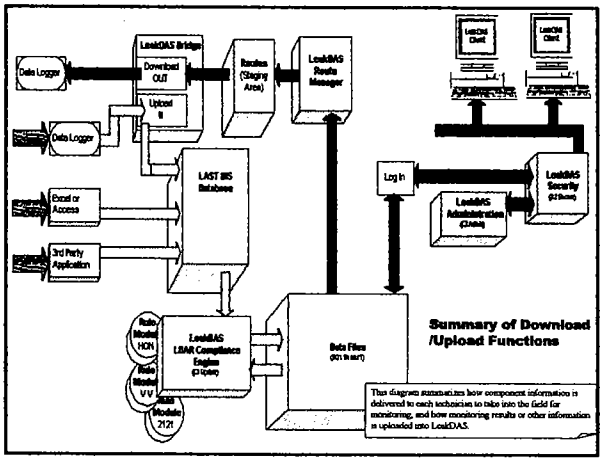
- **Retain LDAR data processing functionality of current version**
- **Easy to use and work flow oriented**
- **Secure**
- **Fast**
- **Network and Intranet friendly**
- **Custom reporting capabilities**
- **Easy data migration to v3**
- **Deployable on stand alone PCs, LANs, and Intranets**
- **Easy to support**
- **Adaptable to 3rd party software such as SAP or EMIS packages**

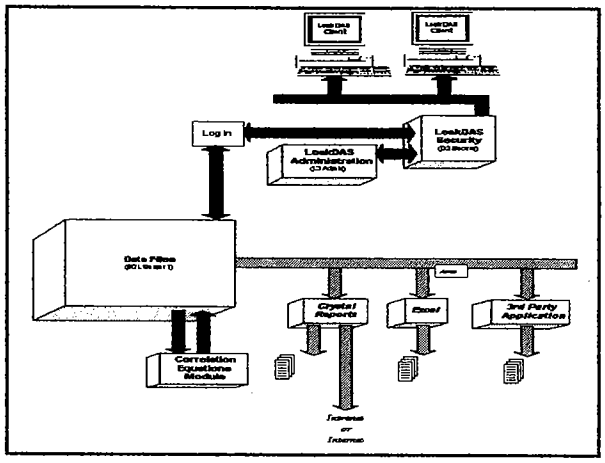


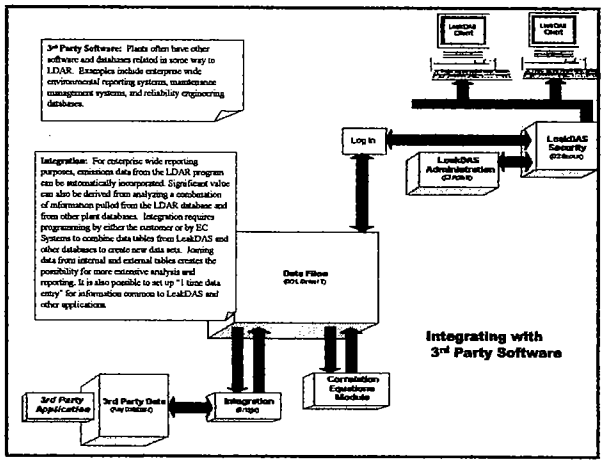

Data Logger
LeakDAS Bridge
Download OUT
Upload IN
Routes (Staging Area)
LeakDAS Route Manager
LeakDAS Route Manager: Used create Routes for downloading to a data logger or printing out for pen & paper style data collection.
Route Staging: Once Routes are created, they can be saved for download by someone else at a later time.
LeakDAS Bridge: This automatically translates the data from the LeakDAS database format to whatever format the data logger requires. The "Bridge" handles communication with the data logger
Log In
LeakDAS Security
LeakDAS Administration
Data Files
Download for Data Collection

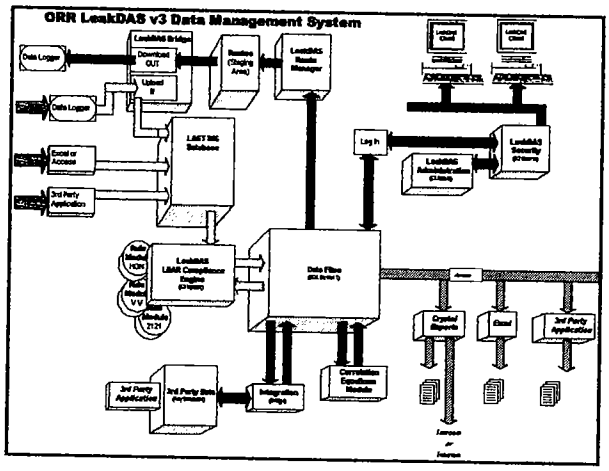

LeakDAS Bridge
Download OUT
Upload IN
LeakDAS Bridge: Facilitates Upload activities. Translates data in the data logger's format to the LeakDAS database format.
LeakDAS Last Ins: The Last Ins database is used as a place to quarantine incoming data for QA purposes. Data that is rejected by the Compliance Engine during Update Processing is kicked back into Last Ins.
Data Logger
Excel or Access
3rd Party Application
LAST INS Database
Log In
LeakDAS Security
LeakDAS Administration
Data Entry Alternatives: LeakDAS Last Ins tables can receive data via ODBC or direct links tables in other software. With Excel or Access, special integration programming is required. Use standard functionality.
Rule Module HON
Rule Module VV
Rule Module 2121
LeakDAS LDAR Compliance Engine
Data Files
Upload New Data


Process New Data
LeakDAS Bridge
Download OUT
Upload IN
Update Processing: The Compliance Engine pulls data from Last Ins, applies the Rule Modules and populates the Data Files during "Update Processing." This can be scheduled to occur automatically or initiated by the user.
Data Logger
Excel or Access
3rd Party Application
LAST INS Database
Log In
LeakDAS Security
LeakDAS Administration
Rule Maintenance: EC Systems created Rule Modules for each LDAR regulation. A Rule Module distills the regulatory requirements into software logic used to determine parameters such as Monitoring Frequency, Leak Definition, and eligibility for skip periods. Applicable Rule Modules are assigned to each component during data conversion and implementation. Custom Rule Modules for plant specific requirements can also be configured.
LeakDAS LDAR Compliance Engine
Rule Module 2121
LeakDAS Compliance Engine: This is the heart of ORR LeakDAS. In geek-speak, this contains the "business rules" that determine how data is processed. The Compliance Engine can be utilized with other software products as an LDAR Data Processing Module, which is where the phrase, "Powered by ORR LeakDAS" comes from.


LeakDAS Bridge
Download OUT
Upload IN
Data Logger
Data Logger
Excel or Access
3rd Party Application
Batches (Staging Area)
LeakDAS Route Manager
LAST IMS Database
LeakDAS LDAR Compliance System
Log In
LeakDAS Security
LeakDAS Administration
Data Files
Summary of Download /Upload Functions
This diagram summarizes how component information is delivered to each technician to take into the field for monitoring, and how monitoring results or other information is uploaded into LeakDAS.


Log In
LeakDAS Security
LeakDAS Administration
Data Files
Crystal Reports
Excel
3rd Party Application
Correlation Equations Module


3rd Party Software: Plants often have other software and databases related in some way to LDAR. Examples include enterprise wide environmental reporting systems, maintenance management systems, and reliability engineering databases.
Integration: For enterprise wide reporting purposes, emissions data from the LDAR program can be automatically incorporated. Significant value can also be derived from analyzing a combination of information pulled from the LDAR database and from other plant databases. Integration requires programming by either the customer or by EC Systems to combine data tables from LeakDAS and other databases to create new data sets. Joining data from internal and external tables creates the possibility for more extensive analysis and reporting. It is also possible to set up "1 time data entry" for information common to LeakDAS and other applications.
Log In
LeakDAS Security
LeakDAS Administration
Data Files
Integrating with 3rd Party Software
3rd Party Application
3rd Party Data
Integration Bridge
Correlation Equations Module



Keys to LDAR Source Compliance

- Software should be:
  - User Friendly
  - Analyze Data
  - Report Generation
- Successful Fieldwork
  - Monitoring
  - Tagging and Maintenance
  - Leaker Management and Documentation

Keys to LDAR Source Compliance

- Verification
  - Requires Monitoring
  - Tag Maintenance
  - Leaking Component Management
  - Management of Change
- Data Validation
  - All Data Entries
  - Technician Performance

Comparison of Data Software Packages

- (See Handout)

William T. "Jerry" Winberry, Jr.
EnviroTech Solutions
1502 Laughridge Drive
Cary, North Carolina 27511

LDAR Data Package Review

INTRODUCTION

Complying with the monitoring requirements associated with EPA's Leak Detection and Repair (LDAR) Program generates large amounts of data. These data must be carefully and consistently recorded and updated. This same data is then used as part of the reporting process. The regulations require each regulated facility to keep the following information for all affected equipment at the facility:

- Equipment ID numbers and process-unit descriptions;
- Type of equipment (e.g., pumps, valves etc.);
- Type of service (gas/vapor or liquid);
- The primary material being transported in the line;
- The method of compliance;
- Emission data;
- Calibration data; and
- Equipment monitoring information.

DATA ACQUISITION SYSTEMS

There are basically two (2) methods for data acquisition, management and storage. The first method is the manual method. The manual method of data management entails developing and updating datasheets, performing calculations, and recording all information by hand. The second method is the automated data management program. Several PC-based information management systems are commercially available for managing information required by the regulations. These systems are effective and offer many advantages over the manual approach. However, they are expensive. The major advantage of these systems is the ability to gather field leak data and then to download to a PC for management, reporting and storage.

I have been able to review six (6) of the major data management products available on the market to address the testing and reporting of fugitive VOC leaks as part of a site-specific LDAR program. The data management companies reviewed included:

- EC Systems Corporation (ORR LeakDOS);
- Environmental Monitoring Services Inc. (LEADERS);
- ESS (FEMS Suite and FEMS Express);
- P3M Software Solutions (LDAR);

- ARI Environmental Inc. (FELDAR 21); and
- ProActive Environmental Services (ProVIEW Tagless LDAR).

I have had an opportunity to acquire demonstration disk from each of the above mentioned vendors. In addition, I was able to talk with each of them to discuss their application to various industrial processes. For each of the reviewed vendors, I have listed below their "pros and cons" associated with their software for a site-specific LDAR program.

SYSTEMS REVIEWED

ORR LeakDAS
EC Systems Corp.
Division of Orr corp.
Louisville, KY USA
281-542-0079
800-347-9677
www.ldar.com

Pros	Cons
• Easy to implement and install • Technical support is outstanding • Process inspection through automation (Inspection Logic) • Optional software for running LDAR reports from any PC (LeakDAS WebReports) • ORR F.I.R.S.T. user configurable data collection/data management system • Most "feature-rich" of all software reviewed (RegMaps; Direct links to drawings; Emission calculations) • Knowledge-based/Compliance Engine/Scheduling	• Designed for companies with 1,000 of components to be monitored • Very, very costly for small companies • Unable to trim system to meet small company demands

LEADERS
Environmental Monitoring Services, Inc.
17043 El Camino Road, suite 100
Houston, TX 77058
800-850-3367
281-488-4411
www.envmonsvc.com

Pros	Cons
• Well designed user interface as part of system software • Company can provide a complete turnkey program • Software compatible with TVA 1000B • Uses wireless "hand-held" DAP PC9800 LS Microflex computer with LEADERS software system for "paperless" documentation (FieldSmart) • Easy report generation • 15 years in field application and use by industries • Software uses EPA 453/R-15-017 emission factors for annual emission calculations	• All readings must be hand entered into data logger • Rules files which controls how regulations drive monitoring is only editable by EMS. • No calculation module is included in the product. Must be customized for the client. • High end cost: Approximately $120,000 initially plus 25% annual maintenance fee. • Requires entry of a calibration record before data can be loaded to a datalogger.

FEMS
ESS
1700 Research Blvd., Suite 200
Rockville, MD 20850
800-999-5009
301-556-1700
www.ess-home.com

Pros	Cons
• Multi-media data storage and report writing • Offers two (2) software packages: Essential FEMS Suite for multiple facilities and FEMS Express for one facility • Web-based application • Software also available for Health and Safety Management and Crisis Management • Multi-language software (Hebrew)	• Company started out strong in 1999, but fizzled for several years, now coming back. • Poor user support in early 2000 • Not many users to date • Initial cost of ownership might be higher than other systems for FEMS Express • Company pushes FEMS Suite rather than FEMS Express

P3M-LDAR
P3M Software Solutions
2508 Ticheli Road
Monroe, LA 71202
318-410-9178
www.p3msoftware.com

Pros	Cons
• LDAR software suite also includes Risk Assessment Software and Groundwater/Discharge Monitoring Software • Software fairly cheap for single-site application (~ $5,000US) • Simple software with various screens for documentation • Small company willing to apply to specific industry	• Essentially has not supported software over the last two (2) years • Software **has not** been updated for several years • Does not have web-based application

FELDAR 21
ARI Environmental Inc.
951 Old Rand Road Unit 106
Wauconda, IL 60084
847-487-1587
www.arienv.com

Pros	Cons
• Regulatory compliance driven wizard • Automatic scheduling per regulations • Manages LDAR program requirements • Multiple database options • Enables user configurable languages • Powerful multi-function monitoring route management • Regulatory compliance driven reporting • Automatic E-mail notification on programmable event • E-mail directly from FELDAR21 • Multiple report output options	• Software is part of a larger program and company has other interest than just software • Expensive software for small company application • Software not designed for system with less than 100,000 components

ProVIEW Tagless LDAR
Proactive Environmental Services
1015 Clinton Street
Ottawa, Illinois 61350
815-434-1018
www.draf-tech.com

Pros	Cons
• Identification of regulated components through isometric CAD drawings • Eliminates tag related labor and associated tagging costs • Better accountability of tag population • Permanent drawing record identifies each emission point • Drawings provide graphic "road map" to easily identify leaking component • No special equipment needs • Works with TVA 1000B and with all other major software packages	• Little more costly for small facilities with < 1,000 components than tagging approach • Limited field application within HON and petroleum industry • Not as well know as different tagging techniques • Must return to Proactive Environmental Services for update to component changes etc.

Agency LDAR Inspection Program

What We Need To know To Determine a Facility's Compliance Status

Jerry Winberry
EnviroTech Solutions

Scope of An Agency Inspection Program

- Determine which Federal equipment leak regulations are applicable
- Understand the overall approach of using both equipment standards and leak detection and repair standards

Scope of An Agency Inspection Program

- Determine if a source is complying with all the requirements of component identification, component marking, equipment design, monitoring, repair, recordkeeping, and reporting as part of a source LDAR program

Scope

- Understand the analyzer performance specifications required by Federal Reference Method 21
- Evaluate source personnel's calibration procedures and records

Scope

- Evaluate field monitoring procedures used by source personnel to detect leaks from regulated components

Overview

- Agency Level Program
  - Pre-inspection Activities Involving Evaluation of Reporting and Recordkeeping Requirements

Overview

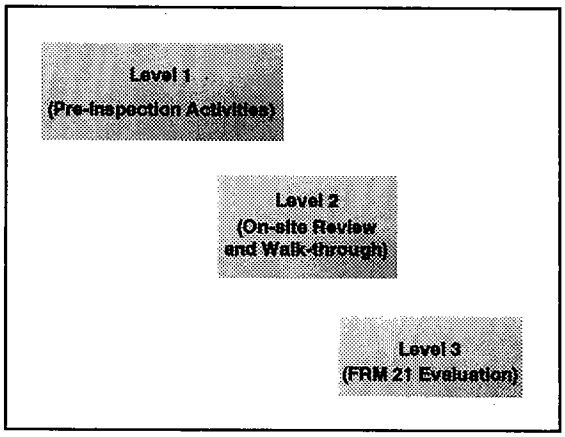
- On-site Inspection
  - Opening Conference
  - Review of Recordkeeping
  - Review of LDAR Program
  - Monitoring for Fugitive VOC Emissions
  - Exit Conference
- Office Records Update

Agency LDAR Level Program

- Level 1: Pre-inspection records review and verification in Agency office
- Level 2: On-site inspection for determination of adequacy of LDAR program and its success

Agency LDAR Level Program

- Level 3: On-site inspection with the addition of monitoring/testing conducted by the inspector



Agency LDAR Level Program: Level 1

- Pre-Inspection Activities At Agency Office
  - Establish inspection scope and objectives
  - Review permit and applicable regulations

Agency LDAR Level Program: Level 1

- Review reports and recordkeeping documents
- Develop inspection plan
- Contact the facility

Level 1: Pre-inspection Activity

- Agency review of records and reports
  - Determination that the records and reports are in compliance with the applicable standards

Level 1: Pre-inspection Activity

- Notification of Construction or Reconstruction Report (Initial)
- Semi-annual Report
- Use of records and reports in the performance of on-site inspections

Level 1

- Review of "Notification of Construction or Reconstruction" Report
  - Notification construction data, initial startup, and notification of physical/operational changes
  - Description of facility's process unit and design capacity

Level 1

- List of regulated equipment (i.e., valves, flanges, pumps etc.) and ID numbers
- List of "no detectable emission" components

Level 1

- Review of "Notification of Construction or Reconstruction" Report
  - % by weight of VHAPs in the process fluid
  - Description of chosen method of compliance

Level 1

- Schedule of subsequent semi-annual reports
- Statement that requirements of the standard are being implemented

Level 1

- Review of Semi-annual Report
  - Process unit identification
  - Documentation of a monthly bases:
    - Total number of detectable leaks
    - Total number not repaired in 15-days
    - Explanation of delay in repairs/why process unit can't shut down
    - Dates when shut down occurred for process

Level 1

- Review of Semi-annual Report
  - Variations from initial report
  - Any performance test completed since last reporting period
    - "No detectable emissions" equipment
    - Valves complying with an alternative standard
    - Valves complying with alternative "skip-period" program
    - Closed-vent systems

Level 1

- Review of reports substantiate noncompliance on the basis of:
  - Failure to submit report
  - Late submittals
  - Missing or incomplete report content
  - Self-reported violations

Level 1

- Other Information Gathering At Agency Office
  - Review any waiver request during the reporting period
  - Cross-check with other air, water (NPDES), hazardous waste (RCRA) and toxic substance (TSCA) permits
  - Check State permit requirements and conditions

Level 1

- Other Information Gathering At Agency Office
  - Review regulatory recordkeeping and reporting requirements for compliance
  - Compare those requirements to semi-annual/annual LDAR reports and findings

Level 1

- Other Information Gathering at Agency Office
  - A thorough review of available source files from other Divisions, EPA Regional offices, and State agency offices to help identify areas with non-compliance problems
  - Highlight questions areas and data to check against plant records

Level 1 Comparison

- Compare data between reports
- Compare records complete per regulations?
- Verify "unsafe" and "difficult-to-monitor" equipment status

Level 1 Comparison

- Compare test/repair data in records to the numbers reported in last several reports
- Compare cumulative totals of leaks and repairs from records and reports

Level 1 Comparison

- Compare "No Detectable Emissions" equipment with previous reports
- Check % leaking in records to reported results

Level 1 Comparison

- Check records to determine if "skip" or exemptions are still applicable
- Check listed repairs and equipment identification along with retest requirements

Level 1: Review of Source LDAR Program

- Review source LDAR program for:
  - Statement of compliance
  - Outline of identification of components and applicable regulations

Level 1: Review of Source LDAR Program

- Written SOP procedures for equipment to be used in source LDAR program
- Identification of responsibility and chain-of-authority

Level 1: Review of Source LDAR Program

- Review of source LDAR program for:
  - Identification of data acquisition methods
  - Establishment of a source quality improvement program (QIP)

Level 1: Review of Source LDAR Program

- Established program for maintaining source records and reports
- Signature of authority signed on the LDAR document

Level 1

- Prepare pre-inspection plan
  - Inspection plan (objectives, activities, methods, safety, administrative requirements)
    - On-site records review only
    - On-site records review and walk-through inspection

Level 1

- On-site records review, walk-through and equipment leak evaluation using Federal Reference Method 21
- Gather inspection materials (source files, notebook, pens, camera etc.)

Level 1

- Prepare pre-inspection plan
  - Acquiring appropriate personnel protection equipment (hard hat, safety shoes, ear plugs etc.)
  - Insuring monitoring equipment is prepared, calibrated and verified operational
  - Obtaining inspection checklists, site map, and process drawings of regulated facility

Level 1

- Establish Monitoring Strategy If A Level 3 is Being Implemented
  - Random Monitoring
    - To cover all and/or some HON/NSPS/NESHAP applicable areas

Level 1

- Targeted Monitoring
  - To cover a specific HON/NSPS/NESHAP applicable area of interest
  - Follow the "start-to-finish" route of the facility

Level 1

- Notify Source of Future Level 2 Inspection
  - By phone
  - By letter
  - Date contacted
  - Record of notification documented

Level 1
(Pre-Inspection Activities)

Level 2
(On-site Review and Walk-through)

Level 3
(FRM 21 Evaluation)

Level 2: On-site Inspection

- Entry
  - Sign logbook, identify the visit as a HON/NSPS/NESHAP inspection
  - Show your credentials identifying yourself/team
  - Obtain entry consent

Level 2

- Opening Interview
  - Scope/objectives of the inspection
  - Inspection agenda
  - Health and safety briefing
  - Procedures to be used during the inspection. Request plant representative to accompany team at all times during the inspection

Level 2

- Review of Records
  - Spot check a different portion of the records during each inspection
  - Compare records kept at the facility with records from Level 1 review
  - Interview facility representative(s) responsible for keeping the records to determine completeness and accuracy

Level 2

- Review of Records
  - List of ID numbers for all subject processes and equipment
    - All subject processes (closed-vent, pressure relief, surge control etc.)
    - Equipment in HAPs service and tagged (pumps, valves, flanges, agitators, connectors etc.)
    - All "unsafe-to-monitor, "difficult-to-monitor," and "no detectable emissions" equipment

Level 2

- Review of Records
  - List of ID numbers for all subject processes and equipment
    - Equipment in vacuum service
    - Open Ended valves and lines
    - Pressure relief devices

Level 2

- Records of fugitive VOC emission monitoring
  - ID of regulated component
  - Type of service
  - Location of component
  - Measured leak rate values
  - Ambient background values

Level 2

- Review of Records
  - Dates of visual inspections of pumps
  - Records of detected leaks
  - Check that all recorded leaks were reported
  - Check for leak detection date
  - Check for date of first attempt at leak repair (is it within 5 days of leak detection?)

Level 2

- Review of Records
  - Check for leak re-monitoring date (that is, the successful repair date)-is it within 15 days of leak detection?
  - If there are leaks exceeding the 15-day repair period, were these reported as delay of repair?

Level 2

- Review of Records
  - For delay of repair, check reason and status (remember that delays are allowed only if repair is technically infeasible without process shutdown and repairs should be completed by the end of next shutdown)

Level 2

- Review of Records
  - Calculate total number of each group (i.e., valves, flanges, pumps, etc.) of regulated components under the regulations

Level 2

- Calculate total number of each group of "leakers"
  - Calculate % leakers for valves
  - Calculate % leakers for pumps
  - Calculate % leakers for connectors
  - Calculate % "unsafe-to-monitor" and "difficult-to-monitor" equipment

Level 2

- Review of Source Fugitive VOC Monitoring Equipment Records
  - The equipment ID number
  - The operator's name, initials or identification number

Level 2

- The equipment logbooks for:
  - Response Factors
  - Calibration Precision
  - Response Time
  - Calibration Gas Certificate

Level 2

- Review of Source LDAR Program
  - Review LDAR for stated objectives, chain-of-command, monitoring and reporting procedures, and recordkeeping requirements
  - Understand the facility identification/tagging system

Level 2

- Review of Source LDAR Program
  - Ask for blueprint of facility with regulated applicable components marked (if not already provided)
  - Check against regulations and applicability determination
  - Is there a Quality Improvement Program (QIP) in place?

Level 2

- On-Site Activities (Walk-through Inspection)
  - Spot check a different area of plant each visit by walk-through in an effort to eventually cover the entire affected facility
  - Spot check a different type of equipment during each inspection

Level 2

- Verify accuracy of facility records and reports (e.g., facility drawings and actual equipment location) during walk-through
- Verify that all HON/NSPS/NESHAP applicable emission points have been identified

Level 2

- On-site Activities (Walk-through Inspection)
  - Check for proper tagging of equipment. Frequently tagging types includes:
    - Plastic tags
    - Stainless steel tags
    - Hole-punched tags
    - Bar-coded tags
  - Visible emissions from flares?

Level 2

- On-site Activities (Walk-through Inspection)
  - Any visible leaks from pumps?
  - Unusual smells in regulated area?
  - Any "hissing" at regulated equipment?

Level 2

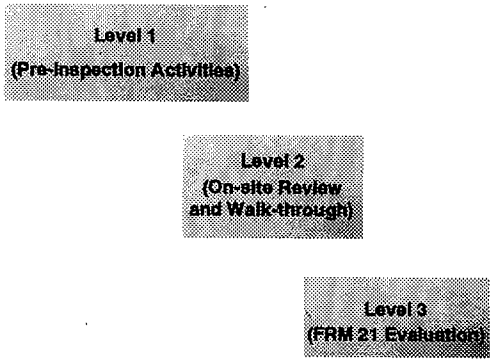
- Observe source perform leak check at:
  - Recently leaking device
  - "No detectable emission" device
  - Exempt device (Verify compliance)

Level 2

- Detection of leak during a Level 2 inspection requires:
  - Identification and tagging of leaking component
  - Tag must be weatherproof and readily visible
  - Tag removed after equipment repair and re-tested

Level 2

- Exit Interview
  - A summary of findings
  - Recommendations
  - Deficiencies or violations
  - Accept the declaration of confidential business information
  - Request additional information necessary to determine compliance



Level 3: On-site Monitoring/Testing

- Level 3 On-site Monitoring/Testing includes:
  - Includes components of Level 1 and 2
  - Monitoring and measurement of selected regulated equipment (flanges, valves, connectors, pumps etc.) with Agency portable VOC analyzer

Level 3: On-site Monitoring/testing

- Establish monitoring strategy if a level 3 is being implemented
  - Random Monitoring
    - To cover all and/or some HON/NSPS/NESHAP applicable areas

Level 3: On-site Monitoring/testing

- Targeted Monitoring
  - To cover a specific HON/NSPS/NESHAP applicable area of interest
  - Follow the "start-to-finish" route of the facility

Level 3: Post-Inspection Report

- Review of Inspection Data
- Summary of Findings/Compliance Status for Regulated Equipment
- Evaluation of Observed Program

Level 3: Post-Inspection Report

- Discussion
- Declaration of Confidential Business Information
- Additional Information Needs

Level 1, 2, or 3 Inspection Questions

- Are in-plant records being properly kept and reports being properly submitted?
- When detected leaks are not repaired in the required time frame, are the delays justifiable?

Level 1, 2, or 3 Inspection Questions

- Can the plant's personnel demonstrate, in general terms, the capability to carry out the work practice standards and source specific LDAR program required by the regulations?

Questions

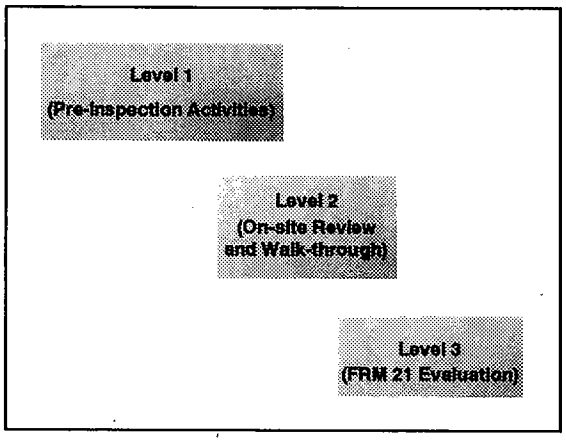
- Is all equipment that should be subject to the standard being treated as such?
- Does the facility meet the applicable regulations through the implementation of the LDAR program?

Agency LDAR Level Program

- Level 1: Pre-inspection records review and verification in Agency office
- Level 2: On-site inspection for determination of adequacy of LDAR program and its success

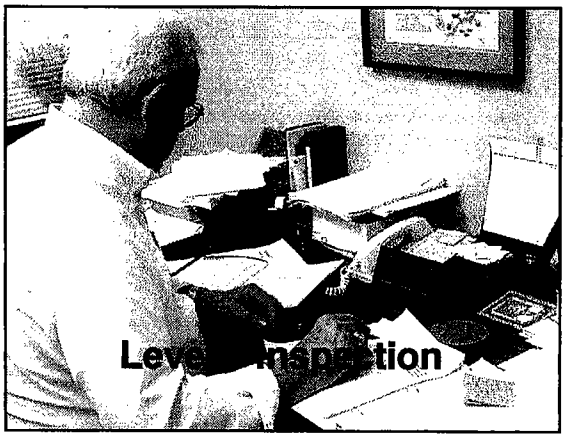
Agency LDAR Level Program

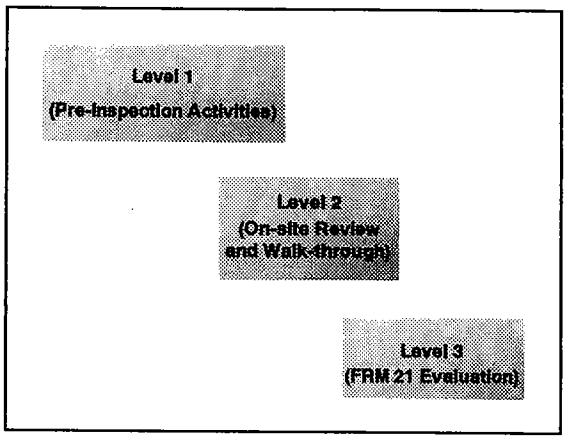
- Level 3: On-site inspection with the addition of monitoring/testing conducted by the inspector



Level 1 Review

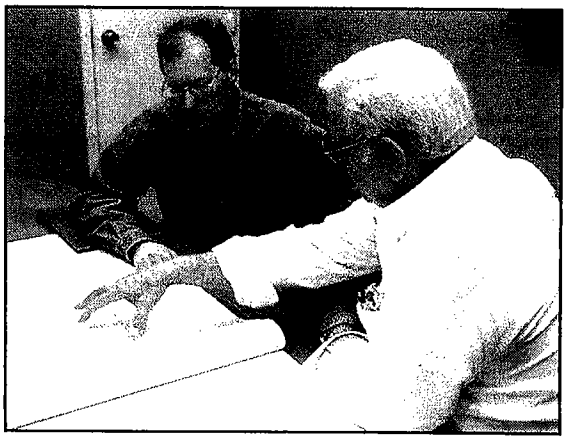
- **LDAR Program Review**
  - Evaluation of number/% of components identified as leakers
  - Summary of leakers not repaired within 15 days
  - Summary of "No detectable emissions," "difficult-to-monitor," and "unsafe-to monitor" components





Level 2: On-site Inspection

- Checking In/H&S Meeting
- Opening Conference
- Records Review and LDAR Program Review
- Walk-through Inspection
- Closing Conference



Level 2 Review

- (Use Slide #64 with the following keys. Key over:
  - Inspection Objectives
  - Inspection Agenda
  - Discussion of Inspection Technique
  - Review of Records
  - Schedule of Personnel
  - Copying Needs)

Level 2 Review

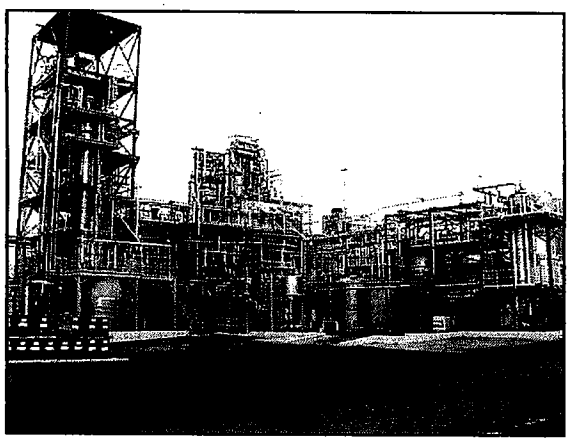
- (Use Slide #65 with following keys. Key over:
  - List of Affected Equipment
  - Records of Fugitive VOC Monitoring
  - Records of Performance Test
  - Records of Visual Inspection of Pumps
  - Calculation of "Leakers"
  - Review of Source LDAR Program)

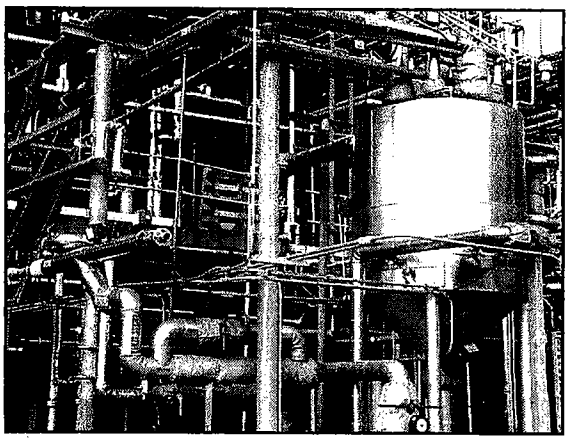
Level 2 Review

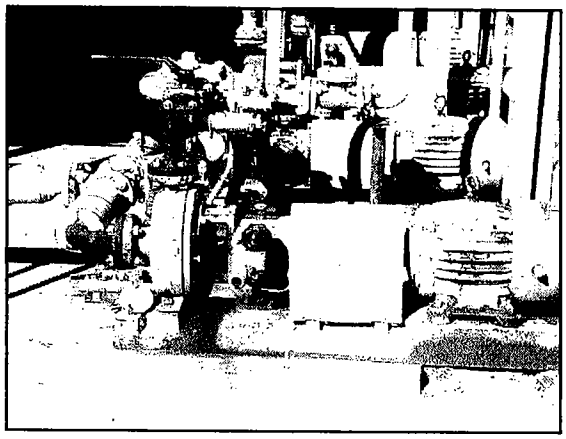
- Accuracy of Records
- Recordkeeping meets regulatory requirements
- Percent leakers in category

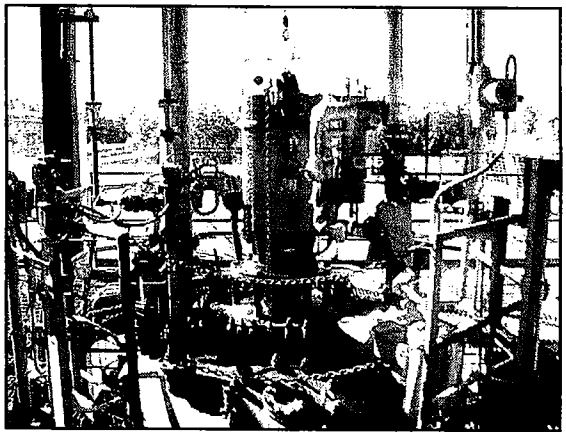
Level 2 Review

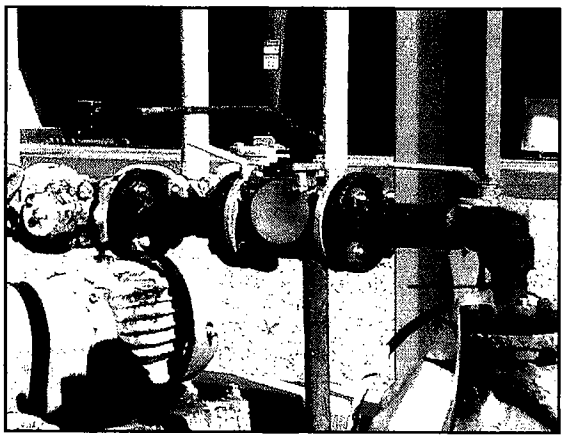
- Failure to record leakers and dates of repair
- Reason for delay in repair
- Failure to report leakers on semi-annual report

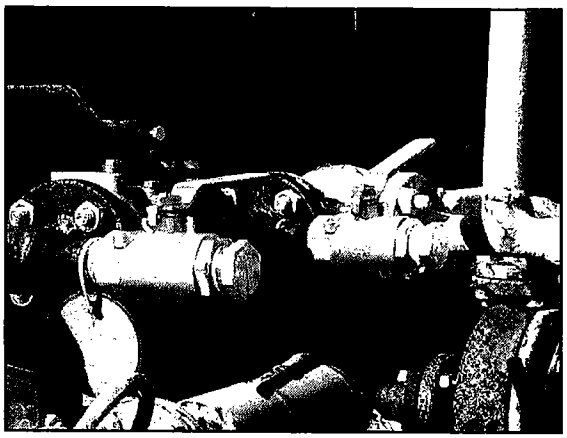


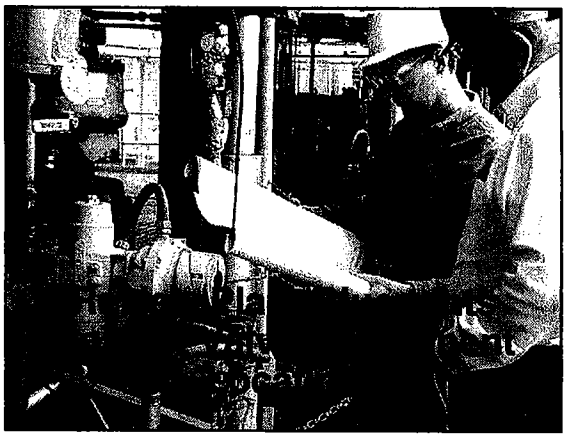


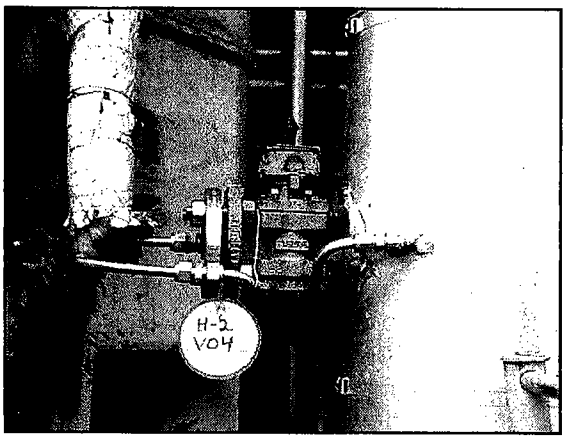








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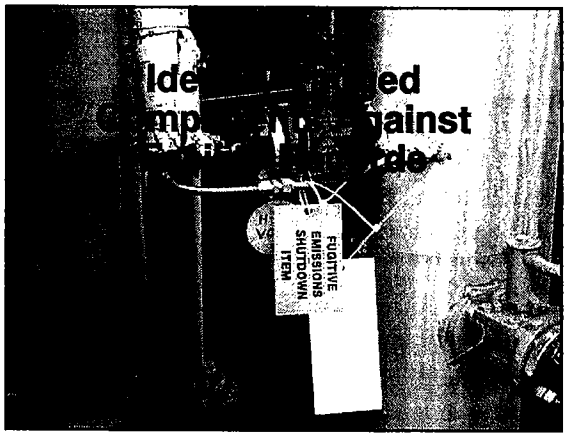
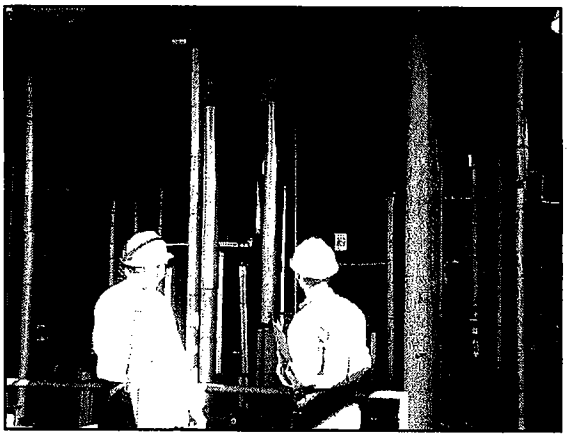
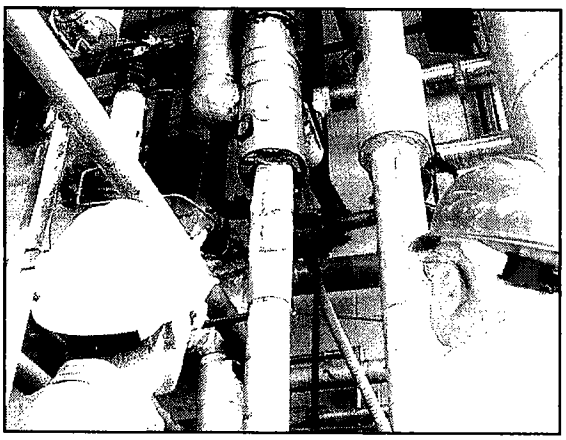
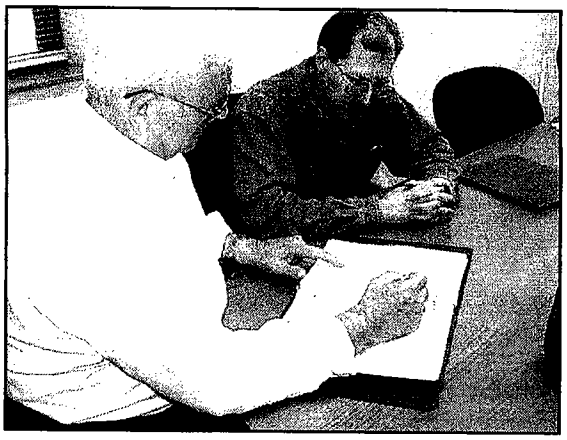

FUGITIVE
EMISSIONS
SHUTDOWN
ITEM

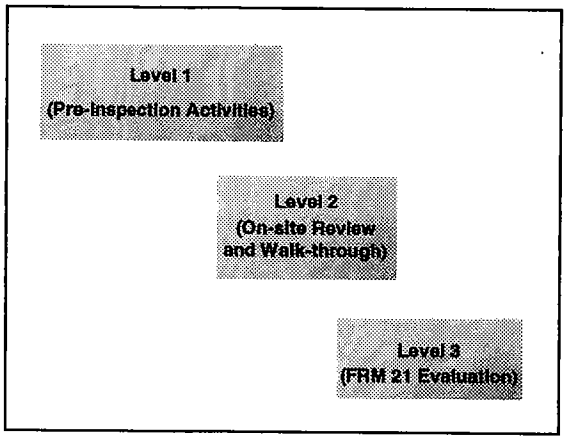




Level 2 Exit Interview

- A summary of findings
- Recommendations
- Deficiencies or violations
- Accept the declaration of confidential business information
- Request additional information necessary to determine compliance



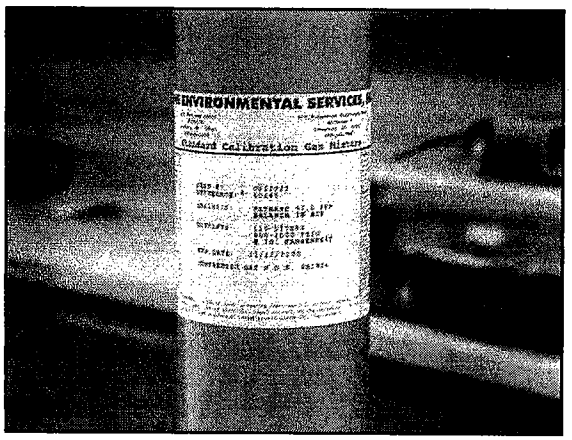


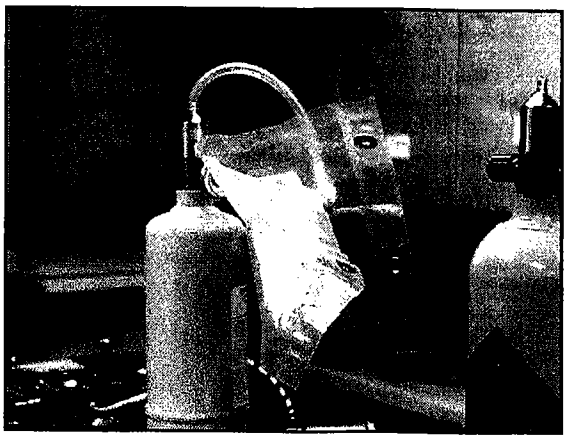
Level 3 Preparation

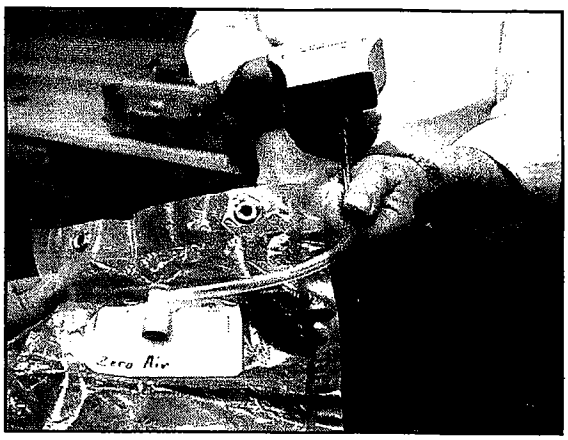
- Several steps need to be accomplished prior to performing monitoring for fugitive VOCs from process equipment:
  - Portable VOC analyzer inspected to confirm good working order
  - Portable VOC analyzer calibrated (single point) when put into operation and every 3-hours during use

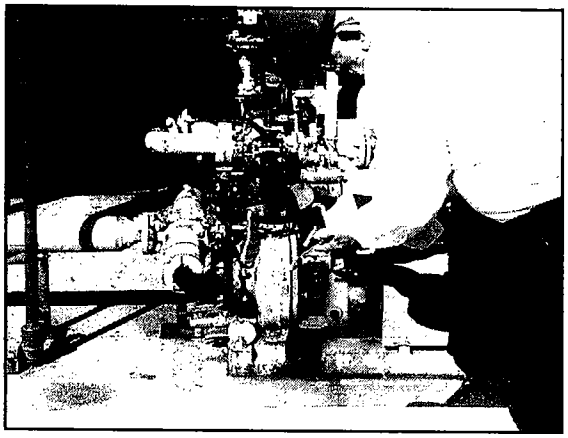
Level 3 Preparation

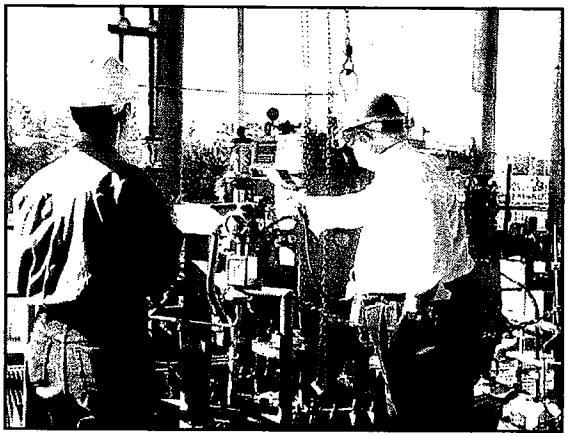
- Auxiliary equipment (probe extension, backpack, calibration gases) determined to be in good working order
- Monitoring route identified and inspection checklist prepared
- Portable VOC analyzer warm-up before entering area

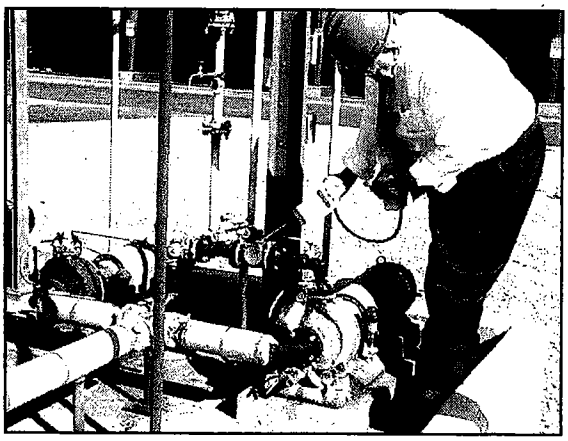





Zero Air





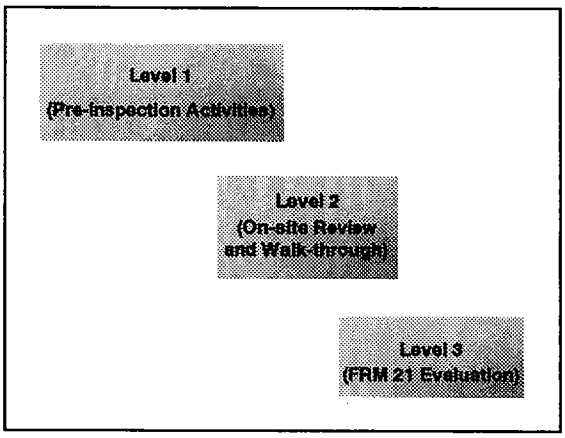


Agency LDAR Level Program

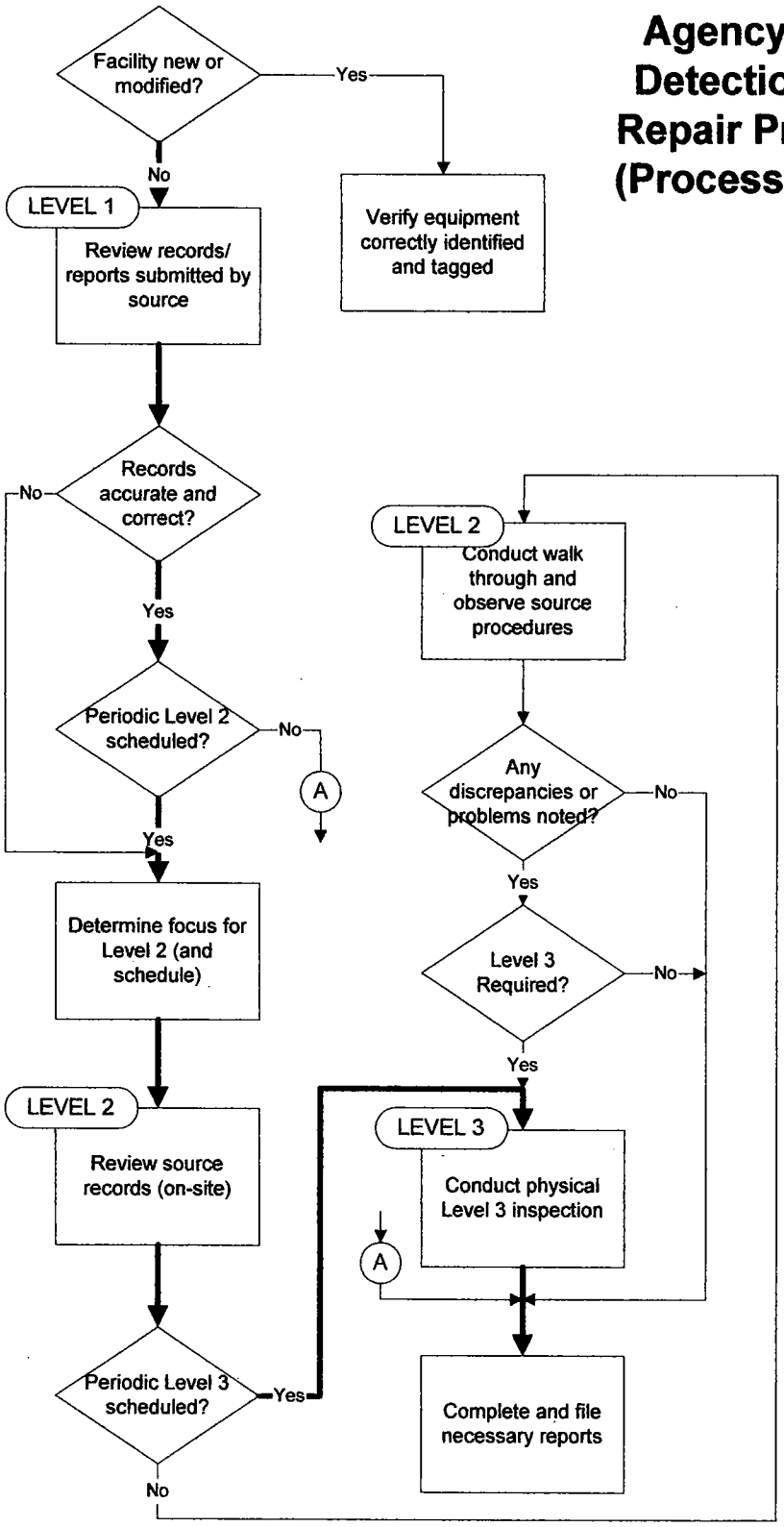
- Level 1: Pre-inspection records review and verification in Agency office
- Level 2: On-site inspection for determination of adequacy of LDAR program and its success

Agency LDAR Level Program

- Level 3: On-site inspection with the addition of monitoring/testing conducted by the inspector


Level 1
(Pre-inspection Activities)
Level 2
(On-site Review
and Walk-through)
Level 3
(FRM 21 Evaluation)

Agency Leak Detection and Repair Program (Process Steps)



Smart LDAR (Leak Detection and Repair)

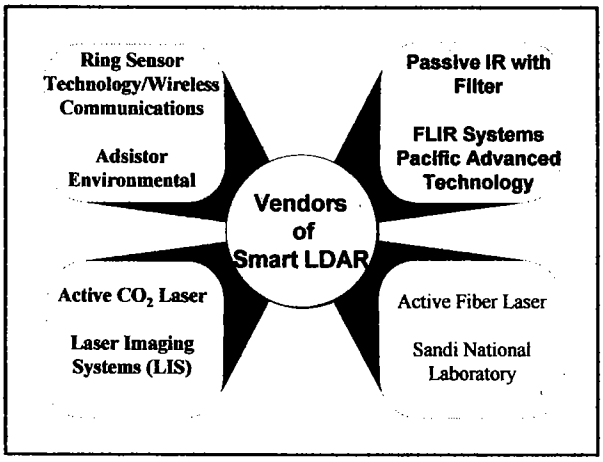
William T. "Jerry" Winberry, Jr.
EnviroTech Solutions

Lecture Objectives

- Explore new ways to monitor fugitive VOCs from valves/flanges remotely
- Understand the various applications of optical sensing and ring sensor technology coupled with wireless communication to fugitive VOC monitoring
- Demonstrate technology and its application to a source's LDAR program

Frequency of Monitoring Valves

- Routine monitored valves- monthly, quarterly, semi-annual or annual
- "Difficult-to-monitor" valves- when applicable/annual minimum
- "Unsafe-to-monitor" valves- annual
- "No detectable emissions" valves- annual (500 ppm background)



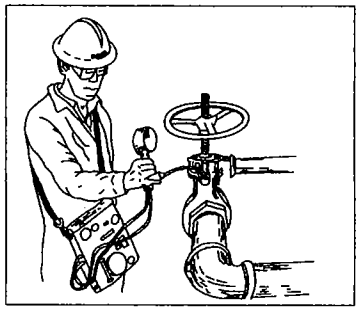
Smart LDAR Objective

- Develop LDAR programs for petroleum refineries that are
  - Cleaner
  - Cheaper
  - Smarter

Background

- Current monitoring practice - Federal Reference Method 21 (FRM 21)
  - Individual measurement of many components using hand-held vapor analyzer
  - Time and manpower intensive
  - Few leaks found for a great many measurements

CURRENT PRACTICE REQUIRES EVERY PIPING COMPONENT TO BE MONITORED INDIVIDUALLY



TYPICAL LARGE US REFINERY

- Large Number of Monitored Components
  - 130,000 valves
  - 325,000 connectors
  - 1,000 pump seals
  - 100 compressor seals
- US Regulatory Requirements
  - Quarterly monitoring (potential to "skip" periods for good performance)
  - Leak level for repairs varies from 100 to 10,000 ppm

Background

- 84% of emissions from only 0.13% of components [high leakers above 10,000 ppm]1
- Several alternative technologies have been examined
  - Ring Sensor
  - Active Laser
  - Passive IR

API Study

- SCAQMD Fugitives Monitoring Database
  - 5+ Years of data
  - 7 Refineries
- Analyses Performed
  - Identify problem components
  - Identify problem processes
  - Quantify emissions from high leakers
  - Quantify emissions from repeat leakers

Conclusions From API Analyses

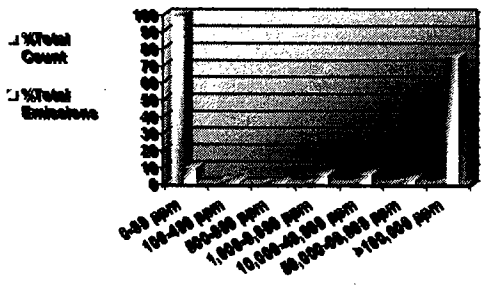
- Leaks Occur Randomly
- Few Significant Repeat Leakers
- 84% of Emissions Come From Only 0.13% of Components (High Leakers Above 10,000 ppmv)
- Need Improved Method to More Cost Effectively Find and Repair High Leakers

Technology Identified for Locating High Leakers

- Tunable Scanning Laser Provides Real Time Optical Plume Image
  - Large leaks quickly and easily located
  - Plume appears as "black smoke" on TV screen
  - Tested at petrochemical plant
    - Over 100 piping components monitored in less than 4 minutes
    - Leak above 10,000 ppmv was found and confirmed with OVA as the only leak

Historical M21 Leak Rate Distribution Data

(7 Refineries, All Components and Services)



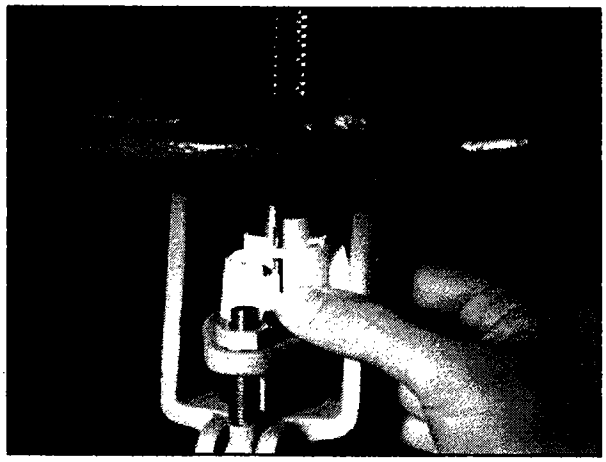
Ring Sensor Wireless Technology

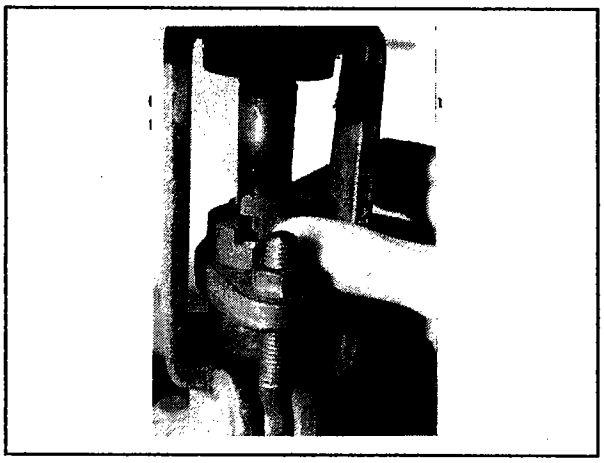
Adsistor Ring Sensor Technology

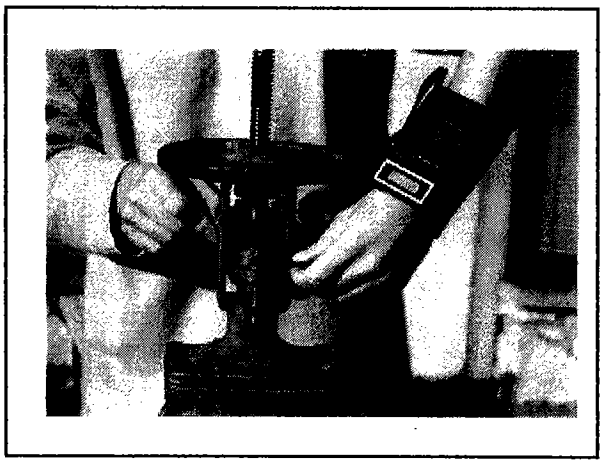
- Proprietary coating on the inside of a ring sensor
- As VOCs pass the sensing element, they absorb to the surface

Adsistor Ring Sensor Technology

- Changes in resistance properties occur
- Directly related to concentration of VOCs passing the surface







Ring Sensor Technology Advantages

- Remote monitoring for difficult/unsafe to monitor valves
- Easy installation
- Instantaneous (real-time) monitoring

Environmental Applications

- Pipeline leak detection system
- Underground storage tanks
- Refinery gas leak monitoring

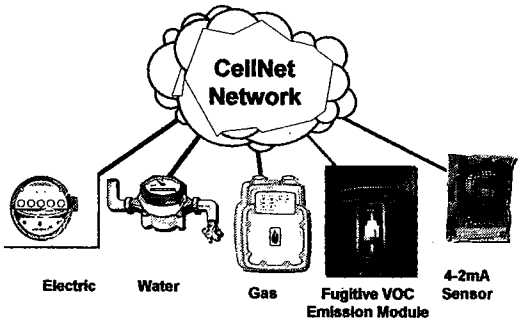
CellNet Data Systems

- Low-cost wireless data communications
- Delivery of real-time information
- Integrated into existing facility data management programs

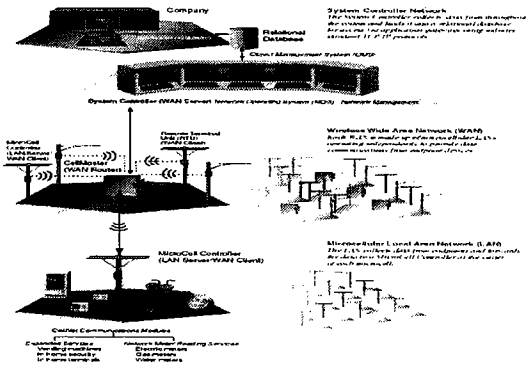
CellNet Data Systems

- Proven technology and superior performance
- Low manpower and maintenance requirements

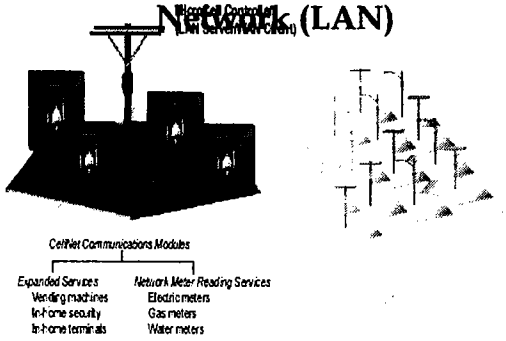
Applications



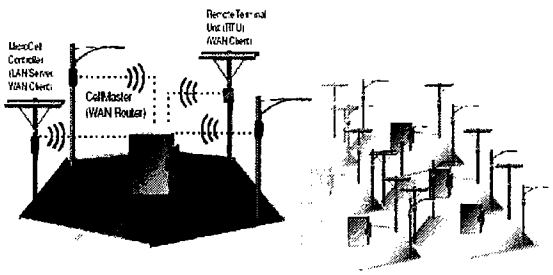
How CellNet Data System Works



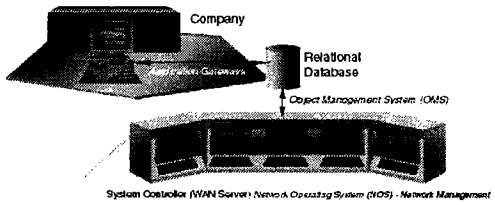
Microcellular Local Area Network (LAN)



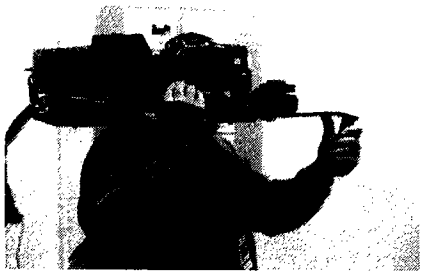
Wireless Area Network (WAN)



System Controller Network



Optical Smart LDAR



Two Basic Types of Optical Imaging

- Laser Illumination (Active Imaging)
- Natural Infrared Imaging (Passive Imaging)

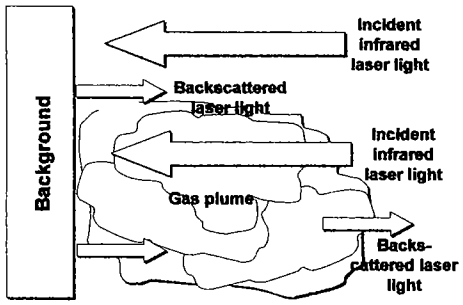
TWO DIFFERENT UNITS TO OPTICALLY IDENTIFY LEAKING COMPONENTS

- Gas Imaging System Developed by Sandia Labs
  - Fiber laser based (3-3.5 micron)
  - Detects C-H bond
  - Applicable for aliphatic hydrocarbons
- Not Available Commercially
- Gas-Vue System Sold by Laser Imaging Systems (LIS)
  - CO_2 laser based (9-11 micron)
  - Detects Olefins (C=C bond)
  - Many chemical plant applications
- Not Intrinsically Safe

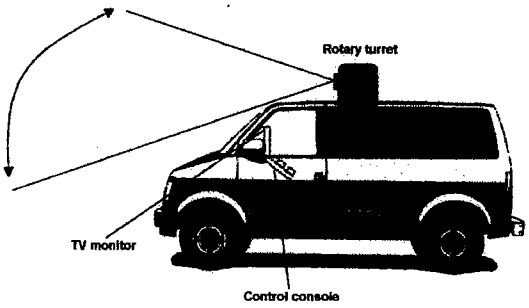
Laser Illumination (Active Imaging)

- Uses Sandia Laboratories developed Periodically Poled Lithium Niobate (PPLN) laser
- Technology available as Laser Imaging Systems GasVue® unit

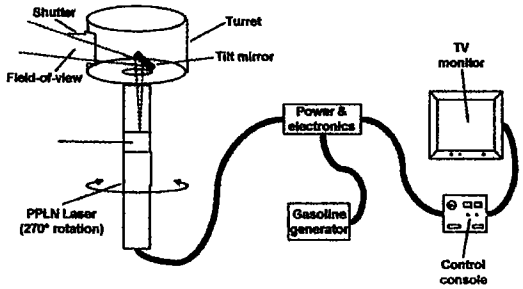
Description of Process

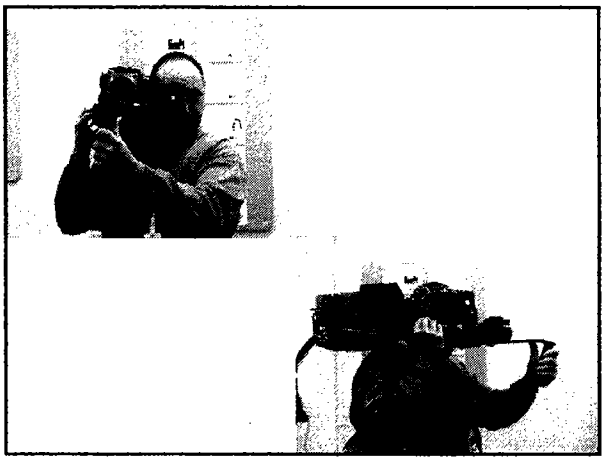


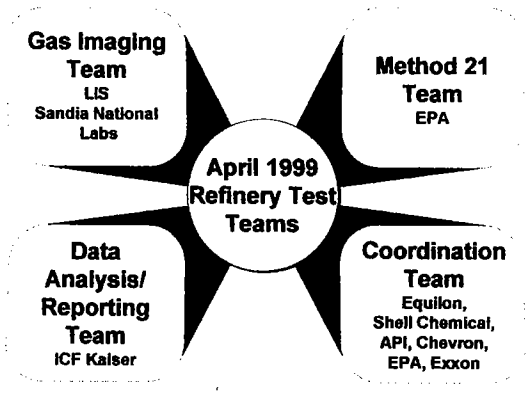
Van-mounted Gas Imaging System



Schematic of Primary Components of Gas Imaging System







April 1999 Refinery Test

- M21 team independently monitored process areas first
  - Measured 1,464 components, primarily valves and pump seals
- Gas Imaging team monitored independently next
  - Observed estimated 6,600 components, all types

April 1999 Refinery Test

- Followed-up leak discoveries with vapor analyzer
- Gas Imaging leak discoveries video-taped
- Both teams tested seven process areas

April 1999 Refinery Test Preliminary Results

- Gas Imaging was able to find high leakers in three process areas
- There are several unanswered questions on performance of Gas Imaging

April 1999 Refinery Test Preliminary Results

- Additional development and field testing needed to make device practicable
- Very few high leakers were found
  - Confirms Smart LDAR concept

Gas Imaging Able to Find High Leakers in Three Process Areas

- High leakers above 100,000 ppm were identified by current prototype
- Lowest leak independently found was 28,000 ppm

Gas Imaging Able to Find High Leakers in Three Process Areas

- Some leaks at about 30,000+ ppm were missed
- Did not find leaks below 10,000 ppm in the refinery setting
- Lower detection limit appears to be between 25,000 and 50,000 ppm

Gas Imaging Able to Find High Leakers in Three Process Areas

- Some variability in detection limits may be due to:
  - Line of sight
  - Distance to leak

Gas Imaging Able to Find High Leakers in Three Process Areas

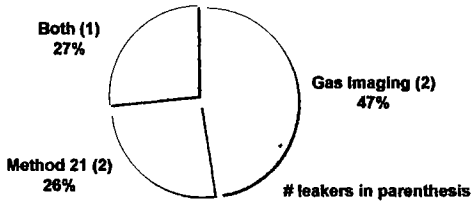
- Wind speed and direction
- Types of hydrocarbons
- Background reflective surface

Gas Imaging Able to Find High Leakers in Three Process Areas

- Steam plumes appear similar to hydrocarbon plumes
  - Visibly able to identify steam plumes
  - Steam plume may obscure hydrocarbon plume

PRELIMINARY

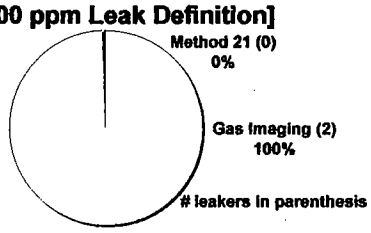
Hydrocracker Unit Percent Emissions From Leaks Found [10,000 ppm Leak Definition]



CREDIT FOR LEAKS ABOVE 10,000 ppm
METHOD 21 = 53% (26% + 27%)
GAS IMAGING = 74% (47% + 27%)

PRELIMINARY

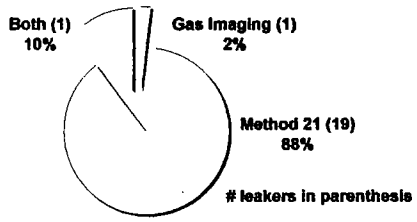
Crude Distillation Unit Percent Emissions From Leaks Found [10,000 ppm Leak Definition]



CREDIT FOR LEAKS ABOVE 10,000 ppm
METHOD 21 = 0%
GAS IMAGING = 100%

PRELIMINARY

Propane Bullets Percent Emissions From Leaks Found [10,000 ppm Leak Definition]



CREDIT FOR LEAKS ABOVE 10,000 ppm
METHOD 21 = 98% (88% + 10%)
GAS IMAGING = 12% (2% + 10%)

PRELIMINARY

Leaks Found by Gas Imaging Compared to Method 21

Emissions (kg/hr) from leakers at or above 10,000 ppm (# of leakers in parenthesis)		
Process Areas	Gas Imaging	Method 21
Crude Distillation Unit	0.18 (2)	0.00 (0)
Hydrocracker Unit	0.39 (3)	0.14 (3)
Propane Bullets	0.17 (2)	1.32 (20)

Performance Comparison

- Method 21
  - ~ 85 components/hour/person
  - No elevated components were included
- Gas Imaging "Detailed" Tests
  - Average - 600 components/hour (Range 250-4000)

Performance Comparison

- Thoroughness of observers for this test reduced efficiency
- With experience, performance would improve
- Best performance was in open area with many closely spaced, unobstructed components

Performance Comparison

- Gas Imaging Rapid "Drive-By"
  - 200 components/minute (estimate)
  - Easily identified a high leaker

Questions On Performance Related To Detection Limits

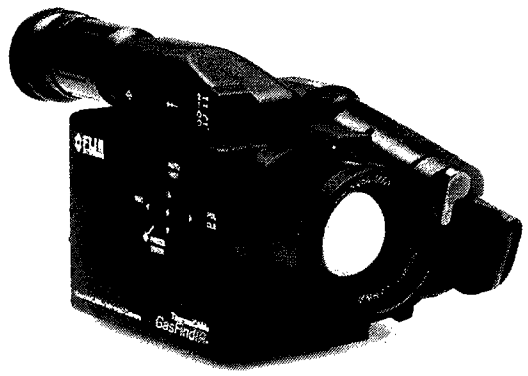
- Effect of distance from leak
- Ability to see high concentration hydrocarbon plume mixed with blocking steam plume
- Wind speed and direction effects

Questions On Performance Related To Detection Limits

- Subjectivity of image interpretation
- Different hydrocarbon types (e.g., aromatics)
- Portability benefits

FLIR Systems ThermaCAM GasFindIR

- Real-time infrared camera
- Scans thousands of components per shift
- Spot small leaks from several feet away and large leaks hundreds of feet away
- Hand-held and shoulder mount



FLIR GasFindIR

- Video

On Guard™ Detection Paint (www.awc-2.com)

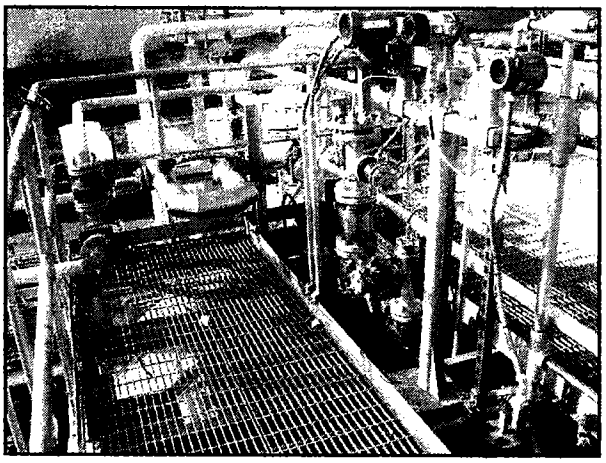
- ON GUARD™ Acid Detecting Paint is a durable, industrial coating with a unique acid-sensitive component, which changes color when exposed to acid or basic vapors.
- ON GUARD™ is applied as a coat of paint over primer

ON GUARD™ Detection Paint

- ON GUARD™ provides an immediate visual indication of a spill or leak, often at quantities that are too small to trigger an exposure with conventional detection devices. This is a lead-free, all-organic, acrylic modified, alkyd enamel.

ON GUARD™ Detection Paint

- On Guard Acid Detection Paint turns yellow to red when exposed to acid gases (pH<3)
- On Guard Basic Detection Paint turns bright white to blue when exposed to basic gases (pH>10)



Smart LDAR
Economic Incentives

- Increase Monitoring Frequency but Repair Only High Leakers
  - Change from quarterly to bi-monthly or monthly monitoring
  - Increase leak definition from 1,000 or 10,000 to 25,000 or 50,000 ppmv

Smart LDAR Economic Incentives

- Significant Reduction in Total Program Costs
  - Mostly from reduced maintenance (no longer need to repair small leakers)
  - Some cost savings from "optical" scanning even with increased monitoring frequency

Smart LDAR Economic Incentives

- Significant Economic Incentive for Smart LDAR as a Replacement for Current Fugitives Control Program
- Technology to Quickly Find High Leakers Available and Proven in Refinery Testing, but Needs Further Development for Routine Refinery Application

Smart LDAR Summary

- Discussions Underway With EPA on Regulatory Revisions Under the Work Practice Provisions of FRM 21 to Allow a Smart LDAR Control Program

Equipment Leaks Records and Reports

Jerry Winberry
EnviroTech Solutions

Recordkeeping and Reporting

- "...HON/NSPS, NESHAP and MACT fugitive leak regulations require the maintenance of extensive, detailed records."

Recordkeeping

- A list of identification (ID) numbers for all equipment subject to the requirements
- A list of equipment ID numbers for equipment designated for "no detectable emissions"
- A list of equipment ID numbers for pressure relief devices in gas/vapor service

Recordkeeping

- A record of the determination of process streams in gas/vapor service and heavy liquid service
- A list of ID numbers for equipment in vacuum service
- A list of ID numbers for "unsafe-to-monitor" valves, explanation, and monitoring plan

Recordkeeping

- A list of ID numbers for "difficult-to-monitor" valves, explanation, and monitoring plan
- A list of ID numbers complying with "skip period," schedule of monitoring and record of percent of valves found leaking during each monitoring period
- A record of monitoring results

Recordkeeping

- Record of visual inspections
- Records of pressure tests
- Records of compressor and pressure relief valve compliance test
- Records for closed-vent systems

Recordkeeping (NESHAP)

- A record of the determination of process streams in gas/vapor service
- A record of the determination of percentage content of benzene in process streams
- A list of ID numbers for pumps in light liquid service that require weekly visual checks

Recordkeeping (Closed-vent Systems and Control Devices)

- Detailed schematics, design specifications, and piping and instrumentation diagrams
- Dates and descriptions of any changes in the design specifications

Recordkeeping (Closed-vent Systems and Control Devices)

- A description of the parameter(s) monitored
- Periods when the closed-vent systems and control devices are not operated as designed
- Dates of startups and shutdowns

Recordkeeping Requirements for Leaks

- Record of each leak for 2 years
- Equipment ID number
- Instrument of monitoring
- Operator ID number

Recordkeeping Requirements for Leaks

- Date of leak
- Maximum instrument reading
- Date of each repair attempt
- Explanation of repair attempt

Recordkeeping Requirements for Leaks

- Date of successful repair
- If repair not within 15 days, why "repair delay"
- Maximum instrument reading measured by FRM 21 after leak is repaired

Reporting Requirements

- Equipment identification number and process unit identification
- Any updates to component identification that are regulated
- List of equipment that includes:
  - "Unsafe-to-monitor"
  - "Difficult-to-monitor"
  - "No detectable emissions"
  - "Skip periods"
- List of visual weekly inspections

Reporting Requirements

- Number of valves, pumps and compressors of which leaks were detected
- Number of valves, pumps and compressors of which leaks were not repaired
- Explanation of delay of repair or why unit shutdown was not performed

Reporting Requirements

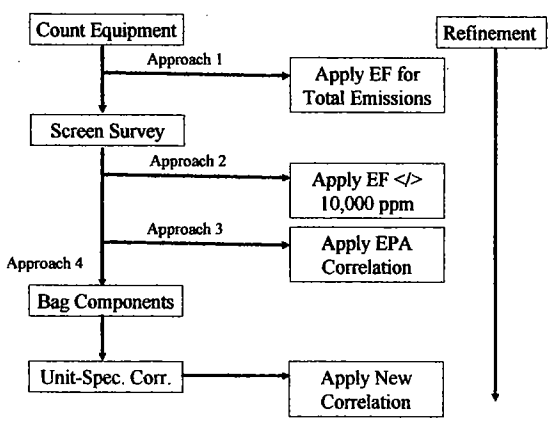
- Dates of process unit shutdowns
- Any revisions of program
- Results of "no detectable emissions"

Equipment Leak Emission Estimates

William T. "Jerry" Winberry, Jr.
EnviroTech Solutions

Emission Estimation Approaches

- Average Emission Factor Approach
- Screening Ranges Approach
- EPA Correlation Approach
- Unit-Specific Correlation Approach



Equipment Leak Emission Estimates

"...the mass emissions rate determined by the four (4) methods can be used to develop a leak rate/screening value relationship (i.e., correlation) for the process..."

Average Emission Factors For Fugitive Emissions

Equipment	Service	EF (kg/hr/source)
Valves	Gas	0.0056
Pump Seals	Light Liq.	0.0494
Compressors	Gas	0.228
PRV	Gas	0.104
Open-ended	All	0.0017
Flanges	All	0.00083
Samp. Conn.	All	0.015

Items Which Affect Correlations

- Definition of State of Emissions
  - Gas/vapor: Material in a gaseous state at operating conditions
  - Light Liquid: Sum of individual constituents with v.p. > 0.3kPa at 20 °C is > 20%
  - Heavy Liquid: Not in gas/vapor service or light liquid service

Items Which Affect Correlations

- Difference between total organic compounds (TOCs) and volatile organic compounds (VOCs)
- Average weight fraction (WF_{TOC}) in the stream
- Full range value of "Sniffer:" > 10,000 ppm or < 10,000 ppm
- "Sniffer" with detection limits > 1ppm

Approach 1: Average Emission Factor Approach

$$E_{TOC} = F_A \times WF_{TOC} \times N$$

Where:

E_{TOC} = Emission Rate of TOC (kg/hr)
F_A = Applicable Emission Factor (kg/hr/source)
WF_{TOC} = Weight Fraction of TOC in Stream
N = Number of pieces of equipment

SOCMI Average Emission Factors

Equipment	Service	EF (kg/hr/source)
Valves	Gas	0.00597
Pump Seals	Light Liq.	0.0199
Compressors	Gas	0.228
PRV	Gas	0.104
Open-ended	All	0.0017
Connectors	All	0.00183
Samp. Conn.	All	0.015

Refinery Average Emission Factors

Equipment	Service	EF (kg/hr/source)
Valves	Gas	0.0268
Pump Seals	Light Liq.	0.114
Compressors	Gas	0.636
PRV	Gas	0.16
Open-ended	All	0.0023
Connectors	All	0.00025
Samp. Conn.	All	0.0150

Oil and Gas Production Operations

Equipment	Service	EF (kg/hr/source)
Valves	Gas	0.0045
Pump Seals	Light Liq.	0.0024
Compressors	Gas	0.228
PRV	Gas	0.104
Open-ended	All	0.002
Connectors	All	0.0002
Samp. Conn.	All	0.015

Approach 2: Screening Ranges Approach (Leak/No-Leak)

- Assumes that components having screening values >10,000 ppm have a different emission rate than < 10,000 ppm
- This approach applied when "screening" data is available

SOCMI Screening Ranges

Equipment	EF (> 10,000 ppm) (kg/hr/source)	EF (< 10,000 ppm) (kg/hr/source)
Valves: G	0.0782	0.00013
Pump Seals: LL	0.243	0.00187
Compressors: G	1.608	0.0894
PRV: G	1.691	0.0447
Open-ended: All	0.01195	0.0015
Connectors: All	0.113	0.000081

Refinery Screening Ranges

Equipment	EF (> 10,000 ppm) (kg/hr/source)	EF (< 10,000 ppm) (kg/hr/source)
Valves:G	0.2626	0.0006
Pump Seals: LL	0.437	0.0120
Compressors:G	1.608	0.0894
PRV:G	1.691	0.0447
Open-ended:All	0.01195	0.0015
Connectors: All	0.0375	0.00006

Oil and Gas Production

Equipment	EF (> 10,000 ppm) (kg/hr/source)	EF (< 10,000 ppm) (kg/hr/source)
Valves: G	0.09	0.000025
Pump Seals: LL	0.074	0.00035
Connectors	0.026	0.000001
Open-ended: All	0.055	0.0000057
Flanges: Gas	0.082	0.000081

Screening Ranges Approach TOC Emission Rate

$$E_{TOC} = (F_G \times N_G) + (F_L \times N_L)$$

Where:

E_{TOC} = Emission Rate of TOC (kg/hr)
F_G = Applicable Emission Factor > 10,000 ppm (kg/hr/source)
F_L = Applicable Emission Factor < 10,000 ppm (kg/hr/source)
N = Number of Pieces of Equipment in Group

Approach 3: EPA Correlation Approach

- This approach offers an additional refinement to estimating emissions from equipment leaks by providing an equation to predict mass emission rate as a function of screening value for a particular equipment type
- Correlation approach is preferred when actual screening values are available

SOCMI Leak Rate/Screening Value Correlation

Equip. Type	Correlation
Valves: G	LR (kg/hr) = 1.87E-06 X $(SV)^{0.873}$
Valves: LL	LR (kg/hr) = 6.41E-06 X $(SV)^{0.797}$
Pumps: LL	LR (kg/hr) = 1.90E-05 X $(SV)^{0.824}$
Connectors	LR (kg/hr) = 3.05E-06 X $(SV)^{0.885}$

Petroleum Leak Rate/Screening Value Correlation

Equip. Type	Correlation
Valves: All	LR (kg/hr) = 2.29E-06 X $(SV)^{0.746}$
Pumps: All	LR (kg/hr) = 5.03E-05 X $(SV)^{0.610}$
Flange: All	LR (kg/hr) = 4.61E-06 X $(SV)^{0.703}$
Connectors	LR (kg/hr) = 1.53E-06 X $(SV)^{0.735}$

Default-Zero Values: SOCMI

Equip. Type	Default-zero Emission Rate (kg/hr/source)
Valves: G	6.6E-07
Valves: LL	4.9E-07
Pumps: LL	7.5E-06
Connectors	6.1E-07

Default-Zero Values: Petroleum Industry

Equip. Type	Default-Zero Emission Rate (kg/hr/source)
Valves: All	7.8E-06
Flange: All	3.1E-07
Pumps: All	2.4E-05
Connectors	7.5E-06

Approach 4: Unit-Specific Correlation Approach

- "Bagging of Equipment" to develop a Unit-Specific Correlation Corresponding to Mass Emission Data

Special Topics Associated with Equipment Leak Emission Factors

- Speciating Emissions
- Using Response Factors
- Monitoring Instrument Type and Calibration Gas
- Estimating Emissions for Equipment Not Screened

Special Topics Associated with Equipment Leak Emission Factors

- Using Screening Data Collected At Several Different Times
- Estimating VOC Emissions Containing Methane and Ethane
- Estimating Equipment Leak Emissions of Inorganic Compounds

Special Topics: Speciating Emissions

$$E_X = E_{TOC} \times (WP_X/WP_{TOC})$$

Where:

E_x = Mass Emissions of Organic Chemical "x" from Equipment (kg/hr)
E_{TOC} = TOC Mass Emissions (kr/hr)
WP_X = Concentration of Organic Chemical "x" in Equipment (Weight %)
WP_{TOC} = TOC Concentration in Equipment (Weight %)

Special Topics: Response Factors

$$RF = AC/SV$$

Where:

RF = Response Factor
AC = Actual Concentration of the Organic Compound (ppm)
SV = Screening Value (ppm)

Special Topics: Response Factors

- If Response Factor is > 3, then:

$$RF_m = 1/\sum (x_i/RF_i)$$

Where:

RF_m = Response Factor of Mixture
N = Number of Components in Mixture
x_i = Mole Fraction of Constituent "I" in Mixture
RF_i = Response Factor of Constituent "I" in Mixture