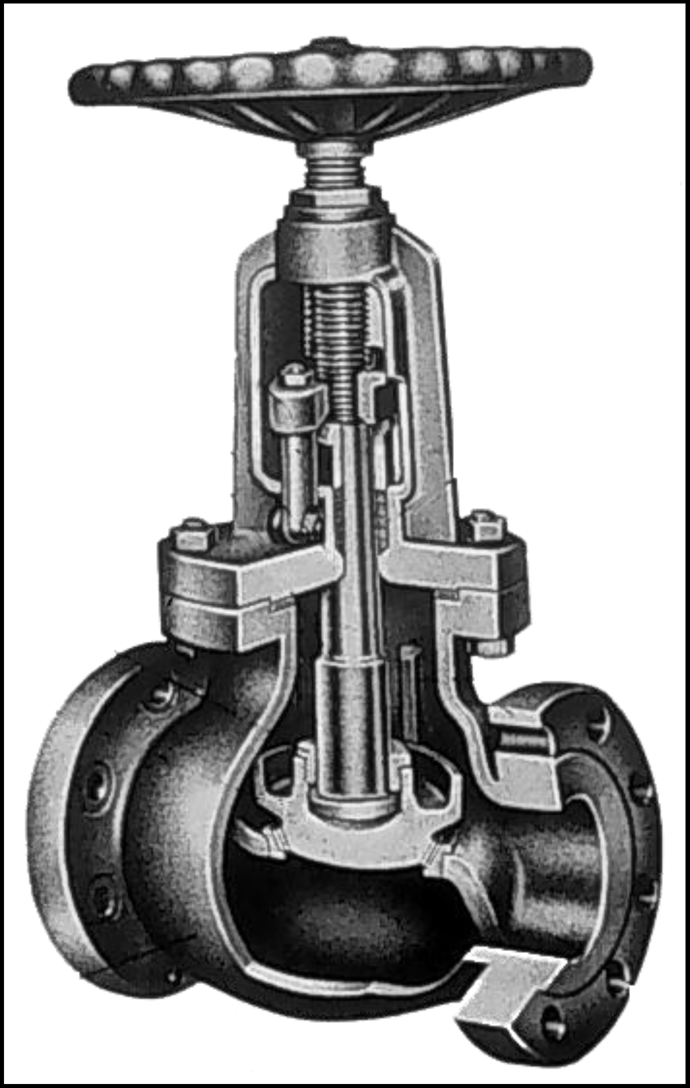
CARB 262

Fugitive VOC Inspections



Course Overview

- Regulated Facilities
- Components
- Estimating Emissions
- Regulations and Standards
- Method 21
- Field Inspections

DEFINITION OF LDAR

LDAR is a work practice designed to identify leaking equipment so that emissions can be reduced through repairs. A component that is subject to LDAR requirements must be monitored at specified, regular intervals to determine whether or not it is leaking. Any leaking component must then be repaired or replaced within a specified time frame.

Elements of an LDAR Program

- LDAR programs. Identifying Components
- Leak Definition
- Monitoring Components
- Repairing Components
- Recordkeeping

Why Check for Leaks?

- Public Health
- Safety
- Reliability
- Economic

The Bad Guys

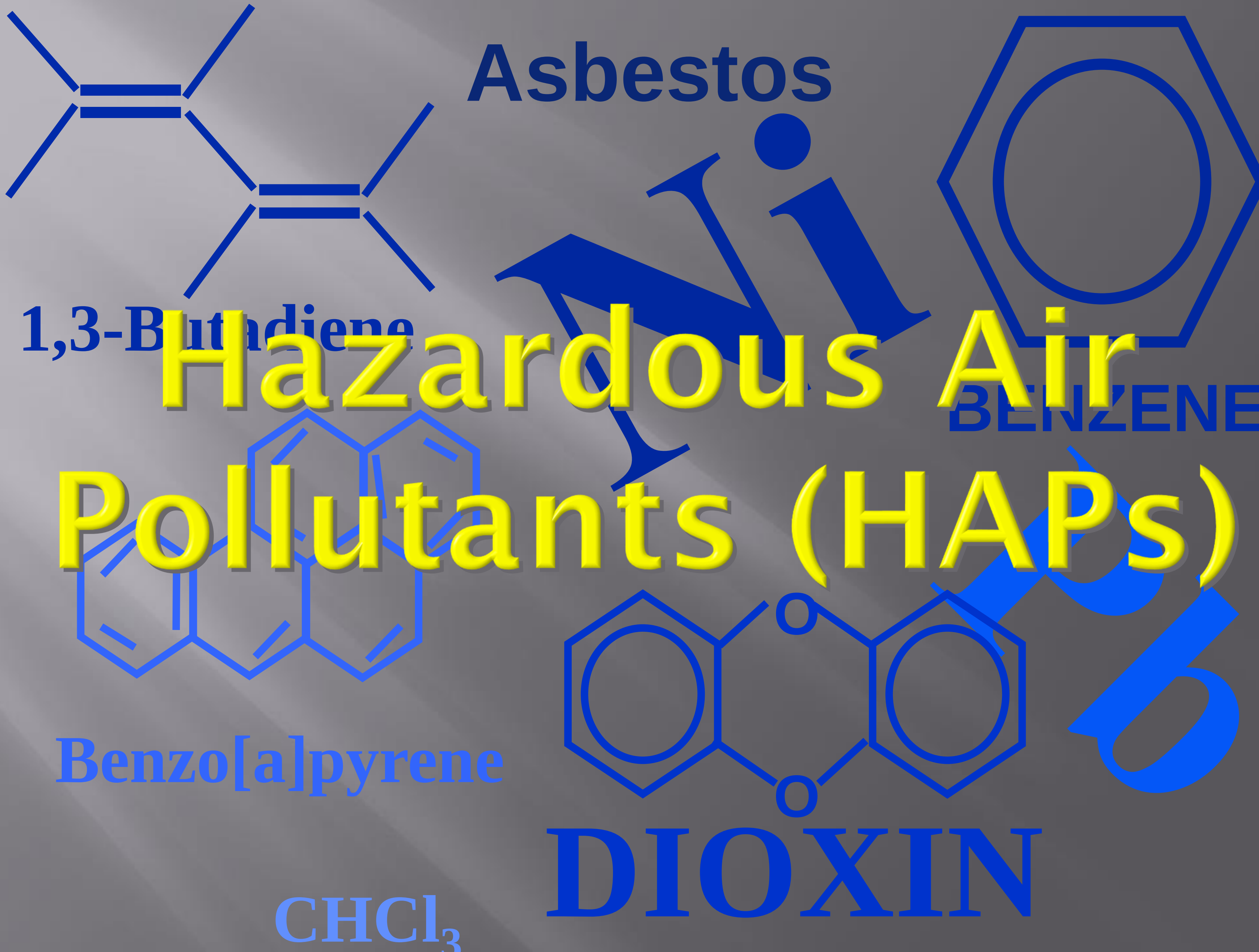
Reactive Organic Compounds (ROCs,ROGs,VOCs)

Non-Reactive Organic Compounds

Total Hydrocarbons

Hazardous Air Pollutants (HAPs)

Hazardous Air Pollutants (HAPs)



INDUSTRIAL SOURCE CATEGORIES


WEST
SACRAMENTO
PLANT


TOLUENE
RI
TOLUENE
RI
NOTICE

EPA Source Categories

- NSPS *(40 CFR 60)*
  - SOCMIs *(Subpart VV)*
  - Petroleum Refineries *(Subpart GGG)*
  - Natural Gas Processing Plants *(Subpart KKK)*
  - Polymer Manufacturing Plants *(Subpart DDD)*
- NESHAP *(40 CFR 61)*
  - Benzene *(Subparts J & V)*
  - Vinyl Chloride *(Subpart F)*
- HON *(40 CFR 63, Subpart H)*
- RCRA *(40 CFR 264, 265, Subparts AA, BB)*
  - Hazardous Waste TSDFs

Appendix A

Federal Regulations That Require a Formal LDAR Program With Method 21

40 CFR

Part	Subpart	Regulation Title
60	VV	SOCMI VOC Equipment Leaks NSPS
60	DDD	Volatile Organic Compound (VOC) Emissions from the Polymer Manufacturing Industry
60	GGG	Petroleum Refinery VOC Equipment Leaks NSPS
60	KKK	Onshore Natural Gas Processing Plant VOC Equipment Leaks NSPS
61	J	National Emission Standard for Equipment Leaks (Fugitive Emission Sources) of Benzene
61	V	Equipment Leaks NESHAP
63	H	Organic HAP Equipment Leak NESHAP (HON)
63	I	Organic HAP Equipment Leak NESHAP for Certain Processes
63	J	Polyvinyl Chloride and Copolymers Production NESHAP
63	R	Gasoline Distribution Facilities (Bulk Gasoline Terminals and Pipeline Breakout Stations)
63	CC	Hazardous Air Pollutants from Petroleum Refi neries
63	DD	Hazardous Air Pollutants from Off-Site Waste and Recovery Operations
63	SS	Closed Vent Systems, Control Devices, Recovery Devices and Routing to a Fuel Gas System or a Process
63	TT	Equipment Leaks – Control Level 1
63	UU	Equipment Leaks – Control Level 2
63	YY	Hazardous Air Pollutants for Source Categories: Generic Maximum Achievable Control Technology Standards
63	GGG	Pharmaceuticals Production
63	III	Hazardous Air Pollutants from Flexible Polyurethane Foam Production
63	MMM	Hazardous Air Pollutants for Pesticide Active Ingredient Production
63	FFFF	Hazardous Air Pollutants: Miscellaneous Organic Chemical Manufacturing
63	GGGGG	Hazardous Air Pollutants: Site Remediation
63	HHHHH	Hazardous Air Pollutants: Miscellaneous Coating Manufacturing
65	F	Consolidated Federal Air Rule – Equipment Leaks
264	BB	Equipment Leaks for Hazardous Waste TSDFs
265	BB	Equipment Leaks for Interim Status Hazardous Waste TSDFs

Note: Many of these regulations have identical requirements, but some have different applicability and control requirements.

Appendix B

Federal Regulations That Require the Use of Method 21 But Do Not Require a Formal LDAR Program

40 CFR

Part	Subpart	Regulation Title
60	XX	Bulk Gasoline Terminals
60	QQQ	VOC Emissions from Petroleum Refinery Wastewater Systems
60	WWW	Municipal Solid Waste Landfills
61	F	Vinyl Chloride
61	L	Benzene from Coke By-Products
61	BB	Benzene Transfer
61	FF	Benzene Waste Operations
63	G	Organic Hazardous Air Pollutants from SOCMI for Process Vents, Storage Vessels, Transfer Operations, and Wastewater
63	M	Perchloroethylene Standards for Dry Cleaning
63	S	Hazardous Air Pollutants from the Pulp and Paper Industry
63	Y	Marine Unloading Operations
63	EE	Magnetic Tape Manufacturing Operations
63	GG	Aerospace Manufacturing and Rework Facilities
63	HH	Hazardous Air Pollutants from Oil and Gas Production Facilities
63	OO	Tanks – Level 1
63	PP	Containers
63	QQ	Surface Impoundments
63	VV	Oil/Water, Organic/Water Separators
63	HHH	Hazardous Air Pollutants from Natural Gas Transmission and Storage
63	JJJ	Hazardous Air Pollutant Emissions: Group IV Polymers and Resins
63	VVV	Hazardous Air Pollutants: Publicly Owned Treatment Works
65	G	CFAR – Closed Vent Systems
264	AA	Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities - Process Vents
264	CC	Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities - Tanks, Surface Impoundments, Containers
265	AA	Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities – Process Vents
265	CC	Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities - Tanks, Surface Impoundments, Containers
270	B	Hazardous Waste Permit Program – Permit Application
270	J	Hazardous Waste Permit Program – RCRA Standardized Permits for Storage Tanks and Treatment Units

SOURCES OF EQUIPMENT LEAKS

Pumps

Valves

Connectors

Sampling connections

Compressors

Pressure relief devices

Open-ended lines

Equipment component counts at a typical refinery or chemical plant(1995)

Component	Range	Average
Pumps	10 – 360	100
Valves	150 – 46,000	7,400
Connectors	600 – 60,000	12,000
Open-ended lines	1 – 1,600	560
Samp connections	20 – 200	80
Pressure relief valv	5 – 360	90

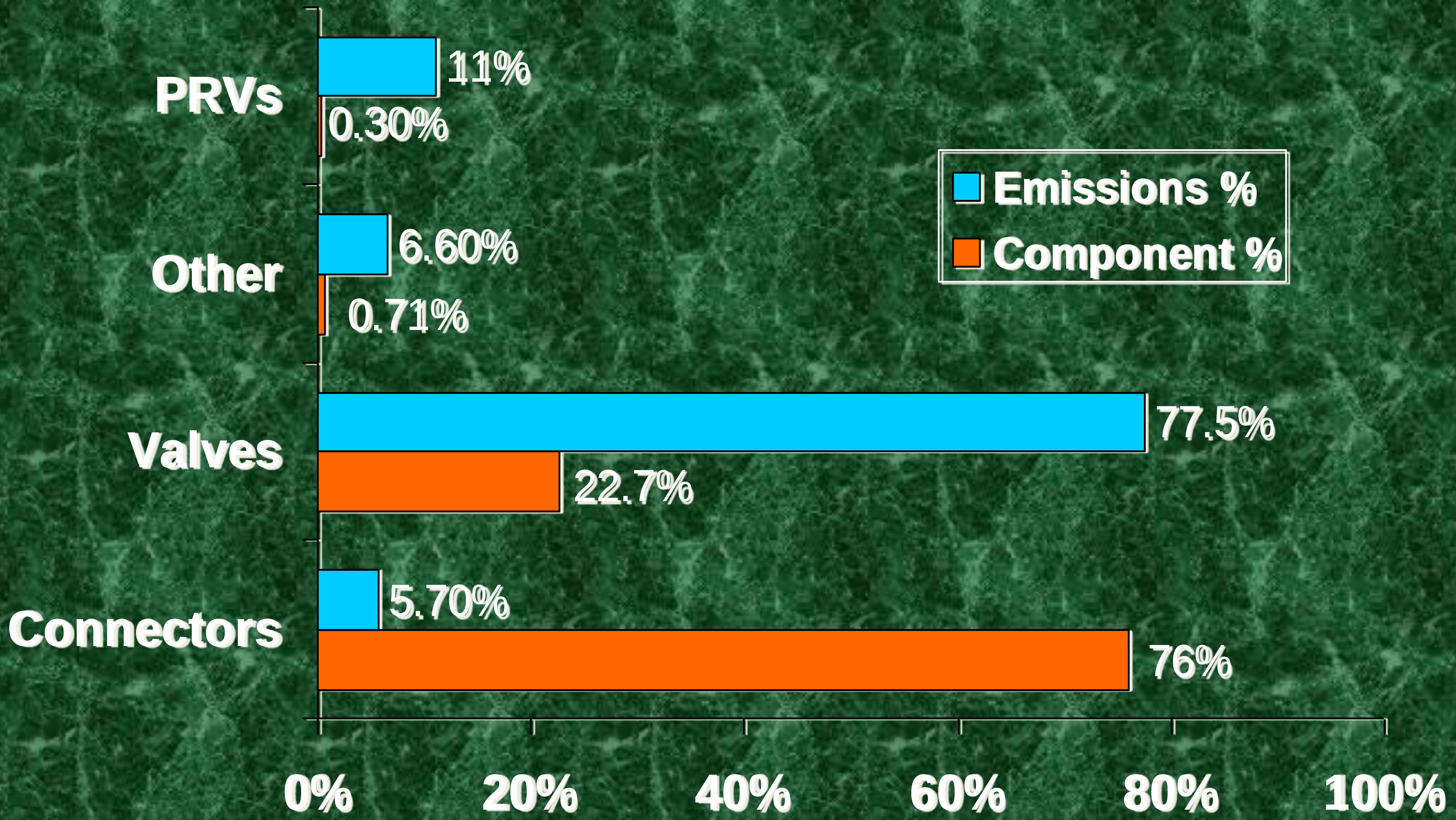
Equipment component counts at a typical refinery or chemical plant (1995)

Component	Range	Average
Pumps	10 – 360	100
Valves	150 – 46,000	7,400
Connectors	600 – 60,000	12,000
Open-ended lines	1 – 1,600	560
Samp connections	20 – 200	80
Pressure relief valv	5 – 360	90

Uncontrolled VOC emissions at a typical facility (1995)

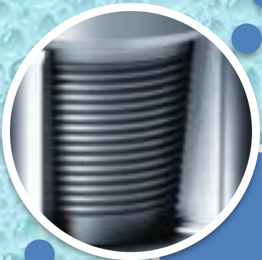
Component	Percent of Total Emissions
Pumps	3
Valves	62
Connectors	31
Open-ended lines	1
Sampling connections	2
Pressure relief valves	1
Total uncontrolled emissions	653T/y

Component Population and Fugitive Emissions Profiles

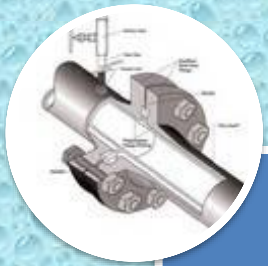


Leaks happen

How

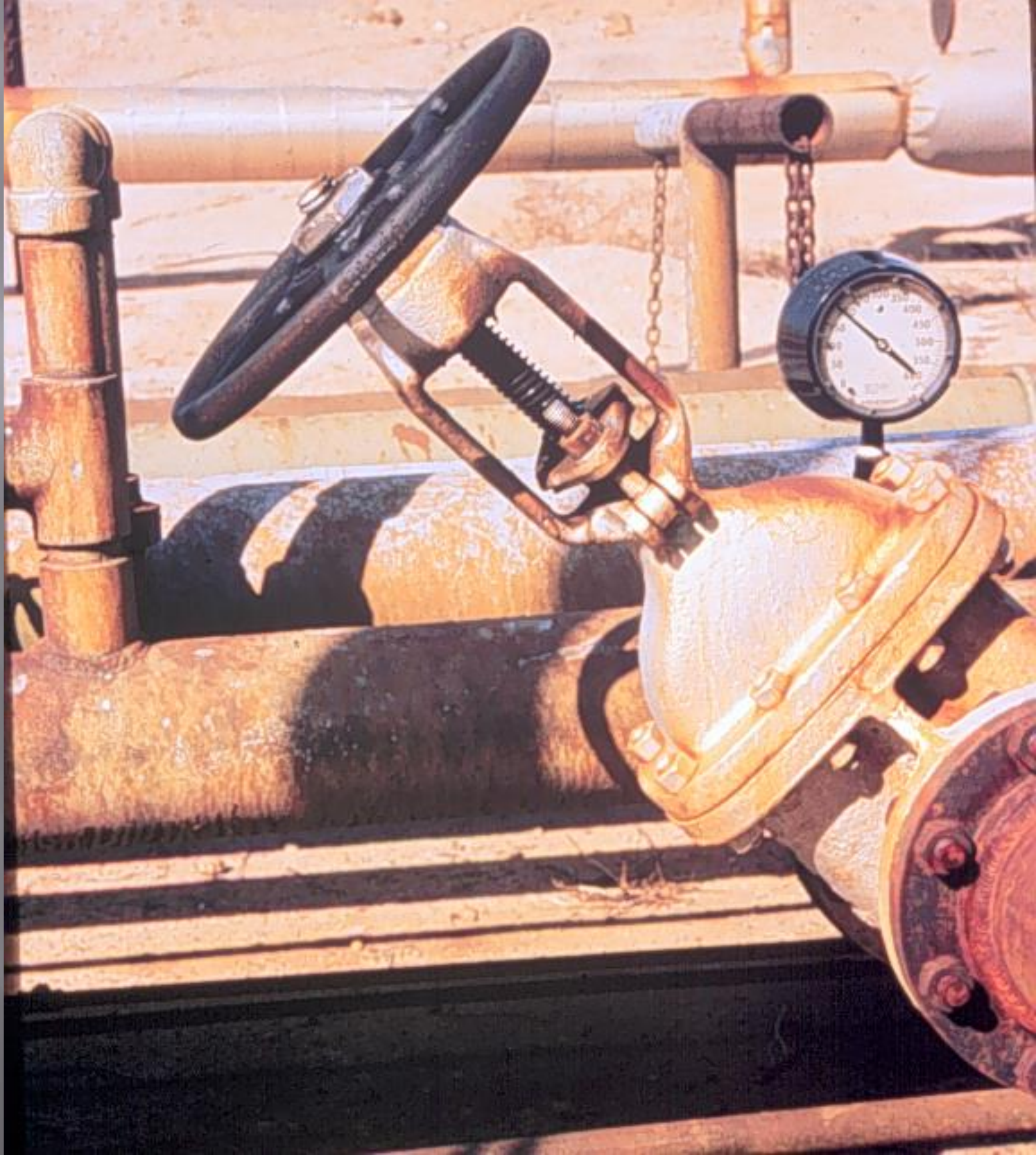


Why

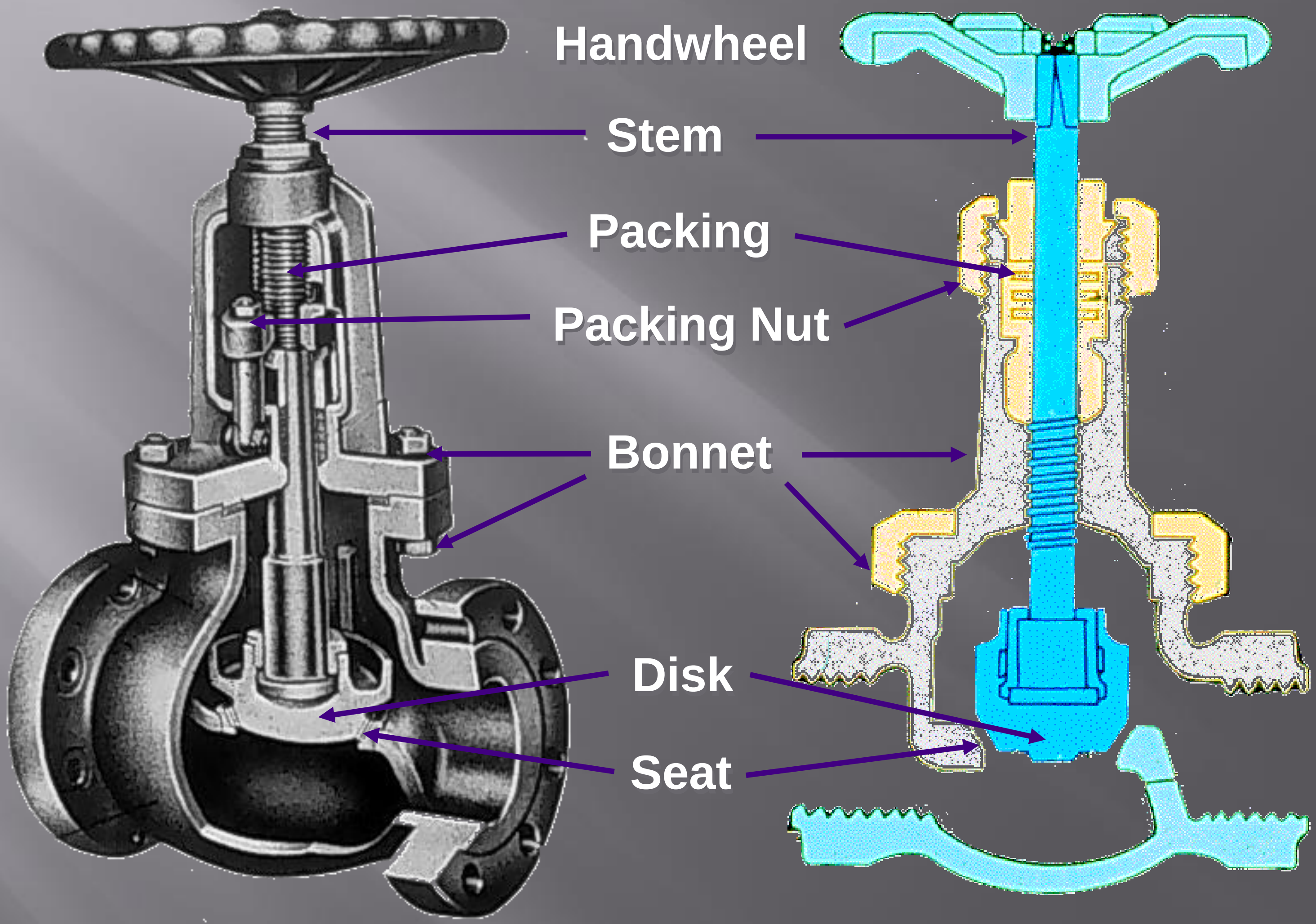


Where

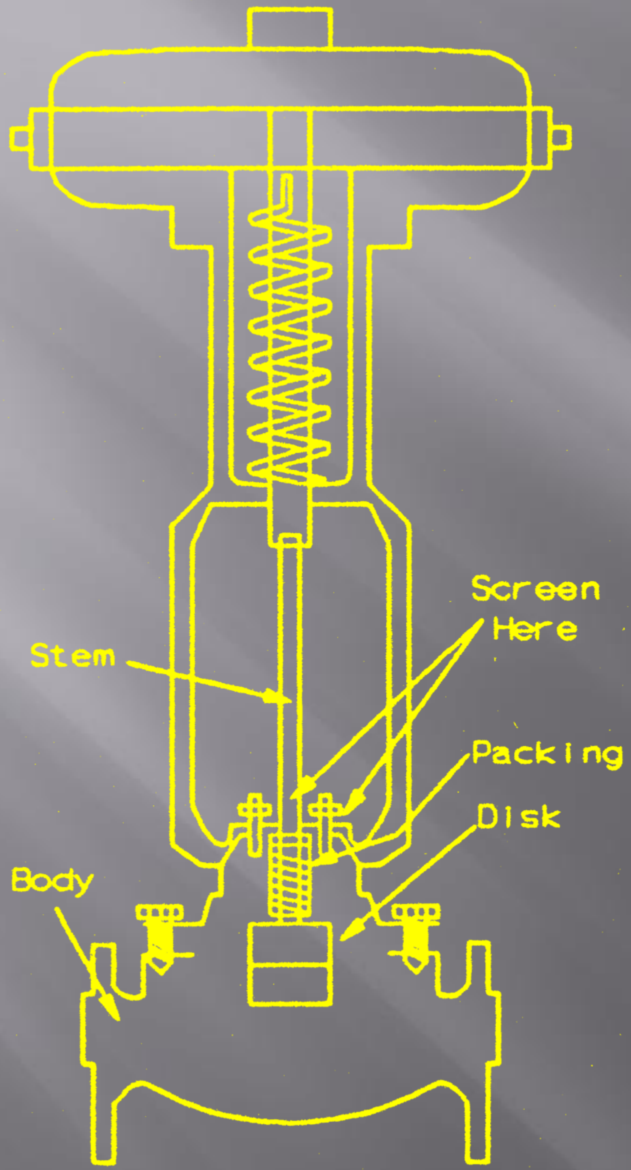
Valve



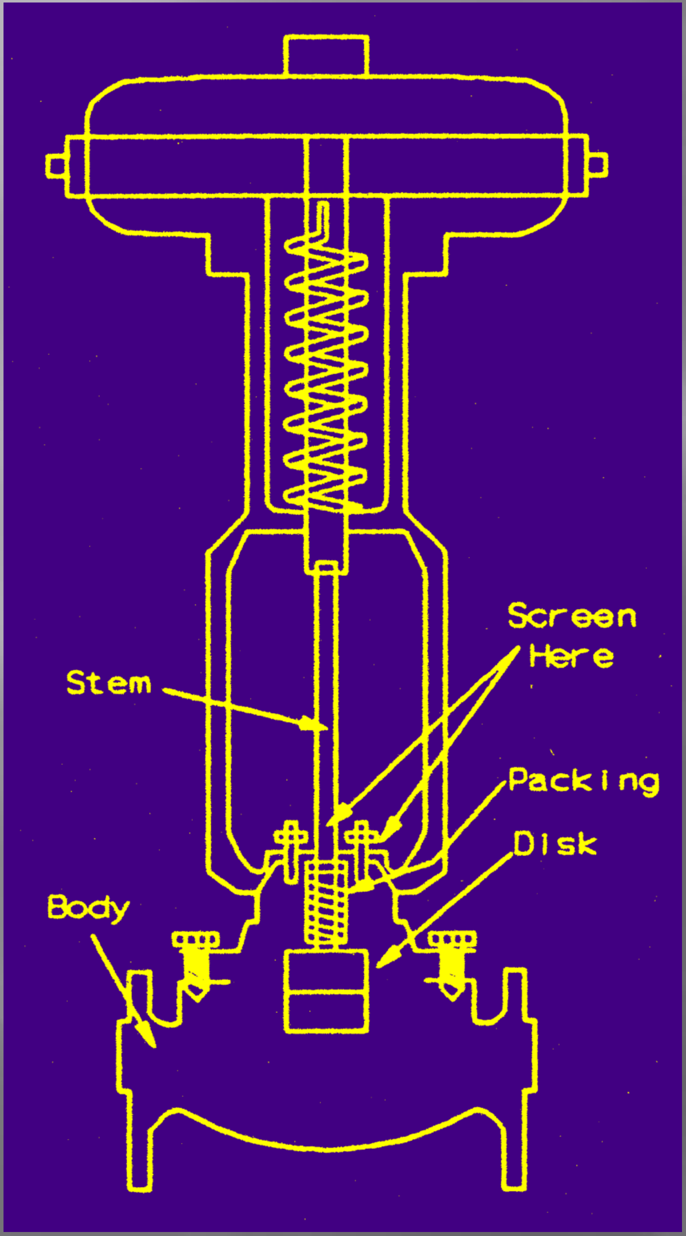
Manual Globe Valve



Control Valve

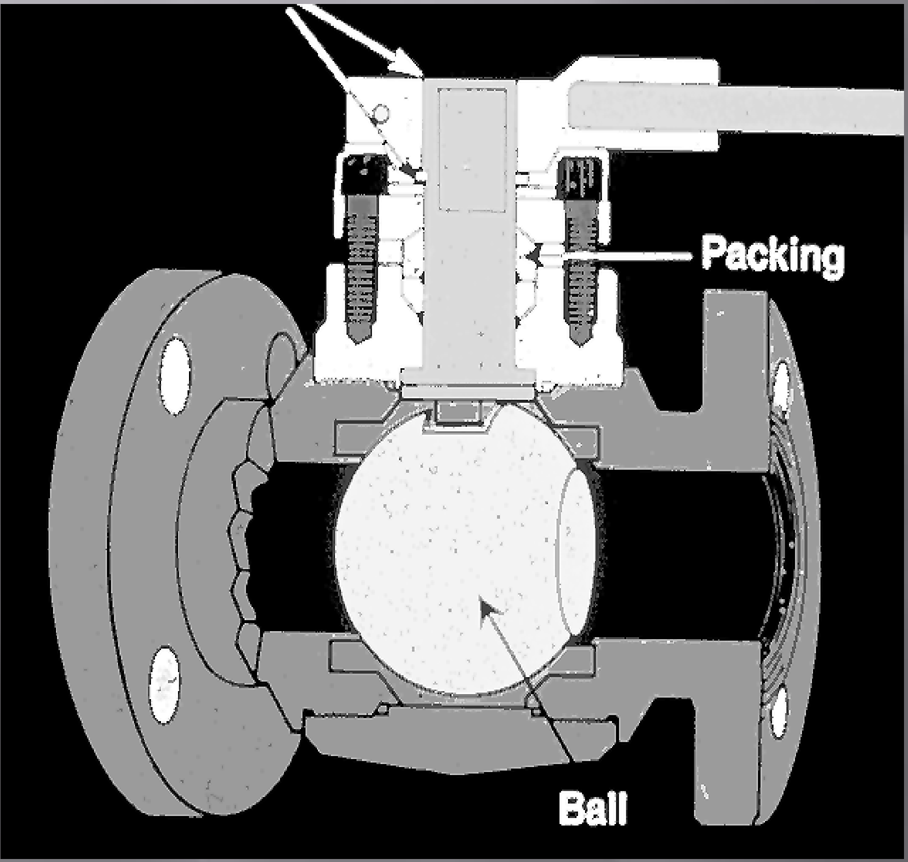


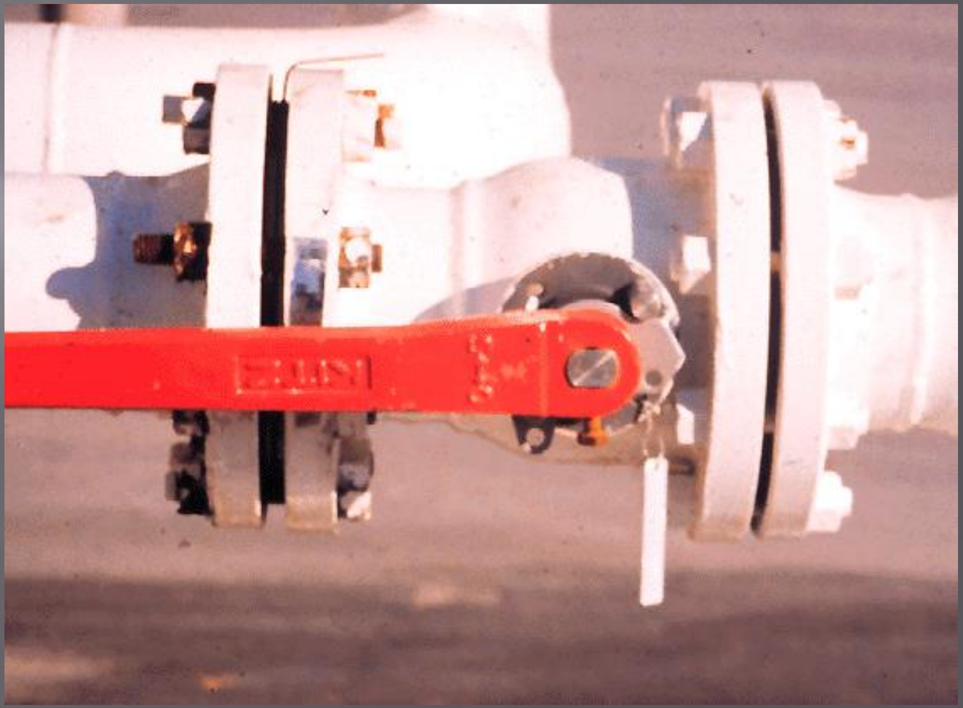
Control Valve



Ball Valve

Potential Leak Areas



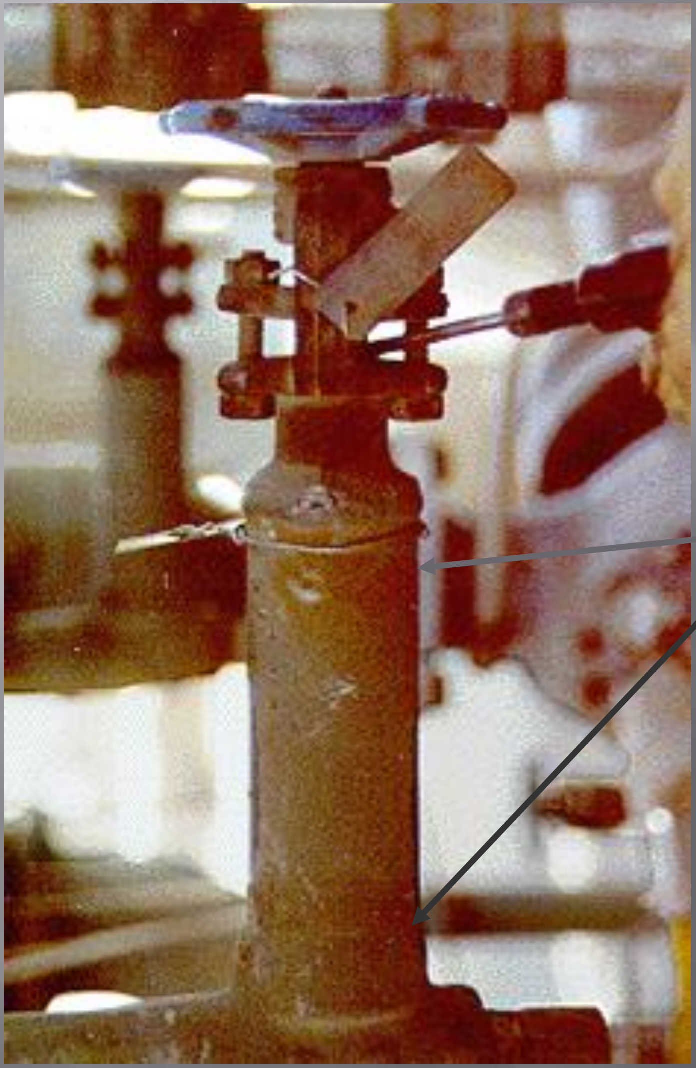


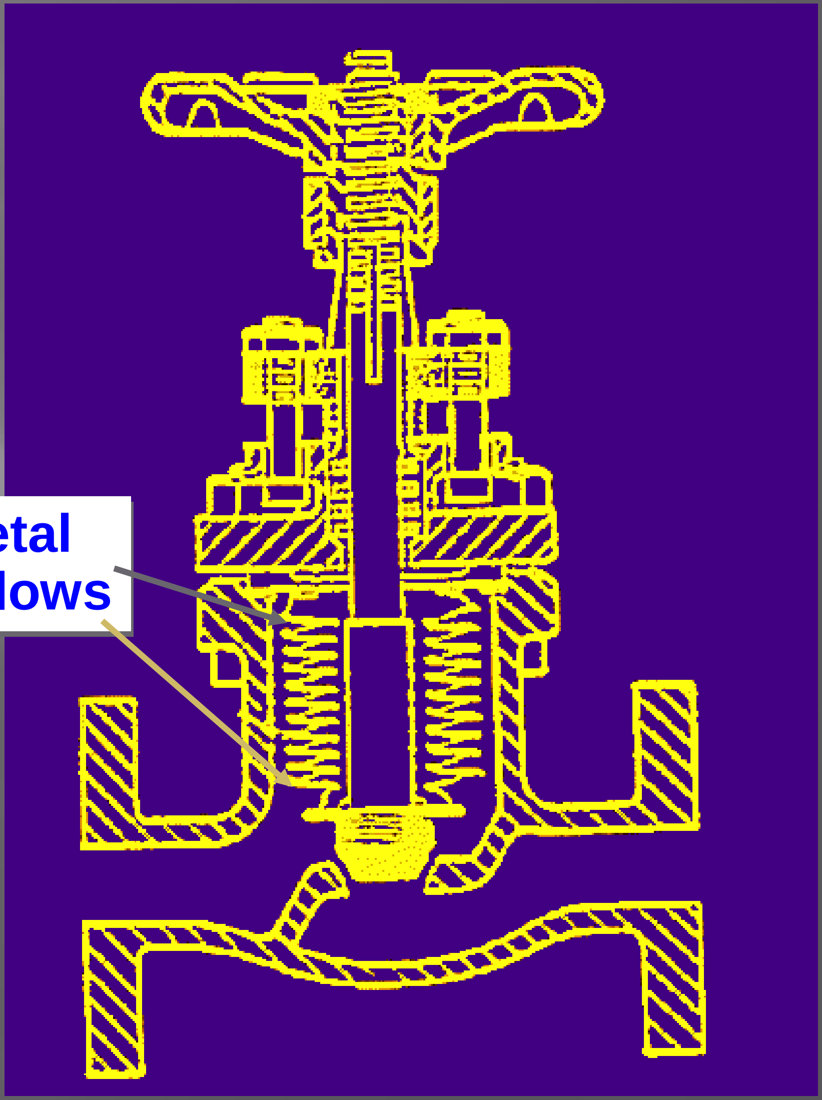
Types of Valve Seals

- Packing Gland
- O-Rings
- Bellows Seal
- Diaphragm

p. 33, 34

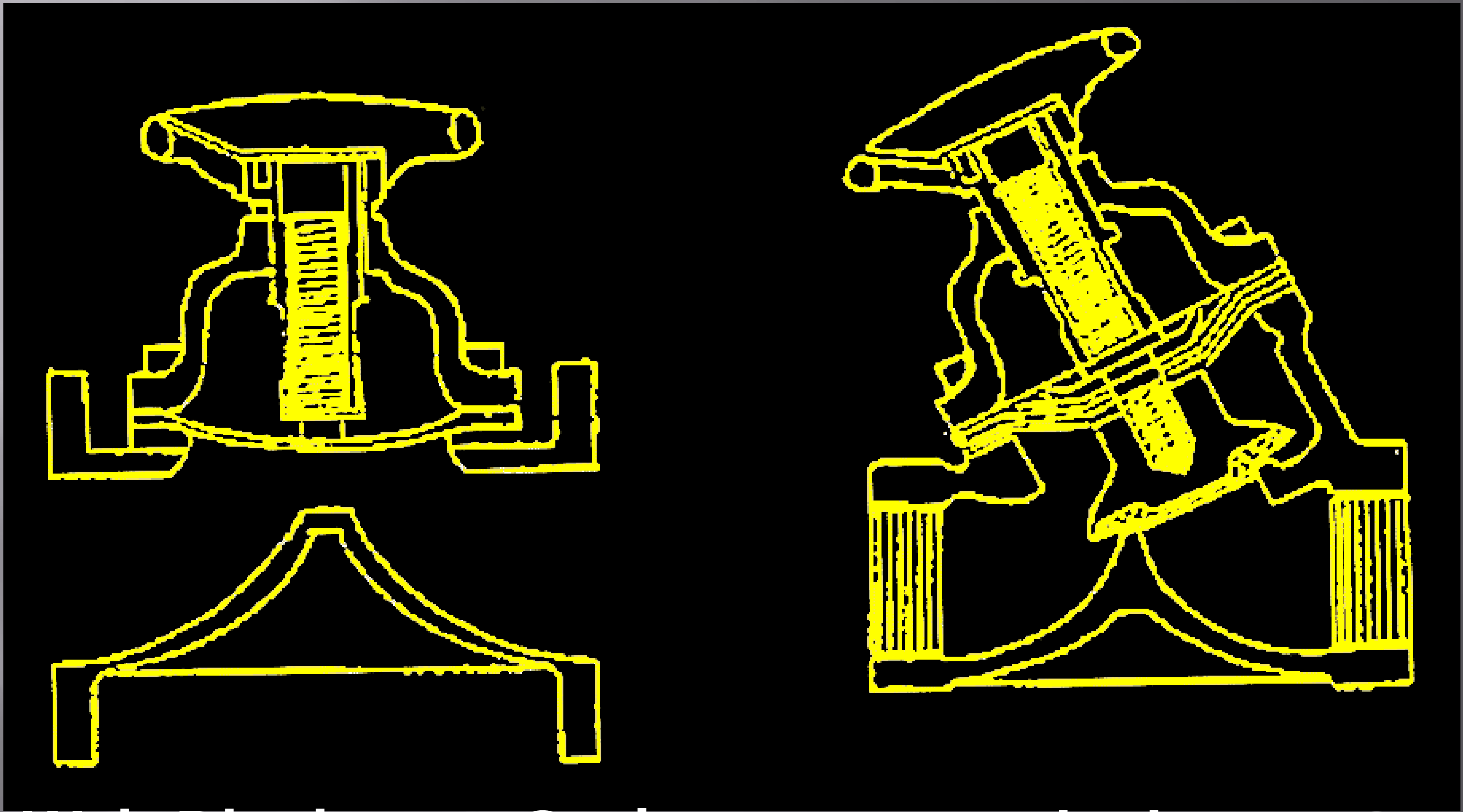
Bellows Valve/Seal





Metal Bellows

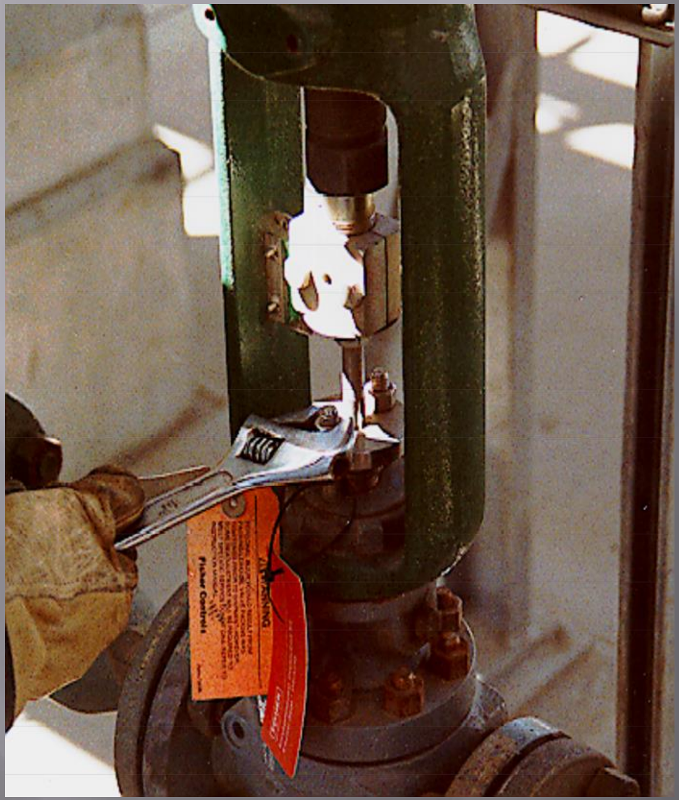
Diaphragm Valves



Weir Diaphragm Seal

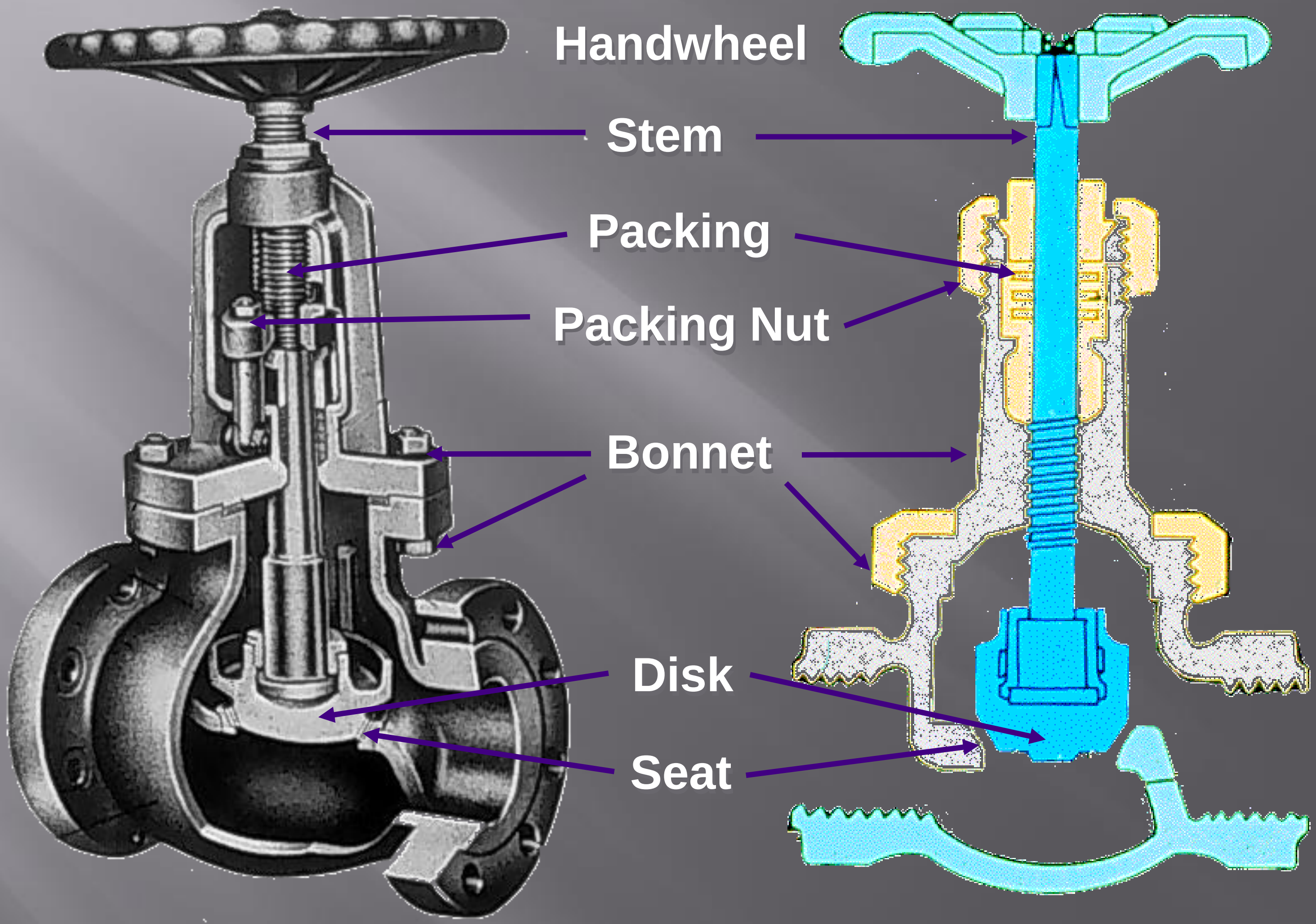
Bonnet Diaphragm Seal

First Attempt at Repair for Valves



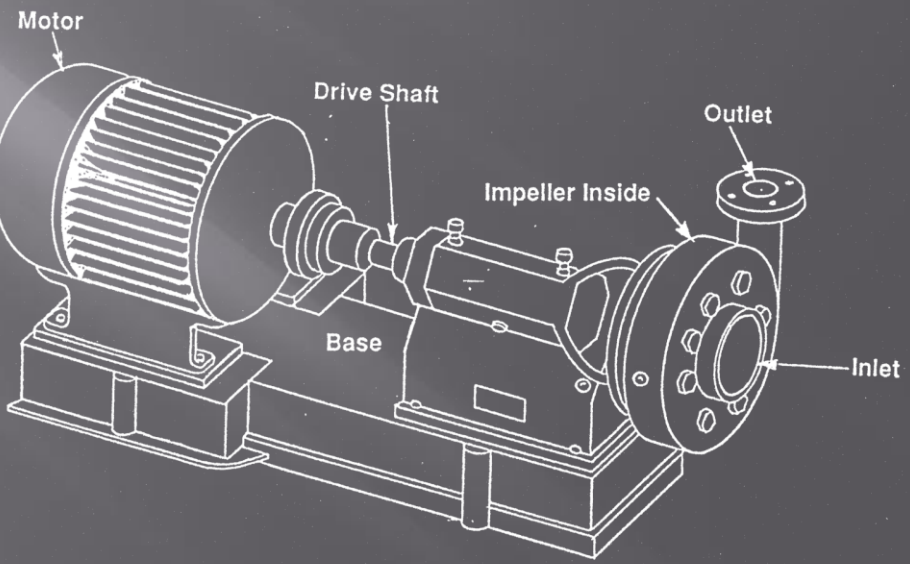
- Tightening bonnet bolts
- Replacing bonnet bolts
- Tightening packing gland nuts
- Injecting lubricant into lubricated packing

Manual Globe Valve



Types of Pumps

- Centifugal
- Rotary
- Reciprocating
- Canned
- Diaphragm
- Magnet Drive



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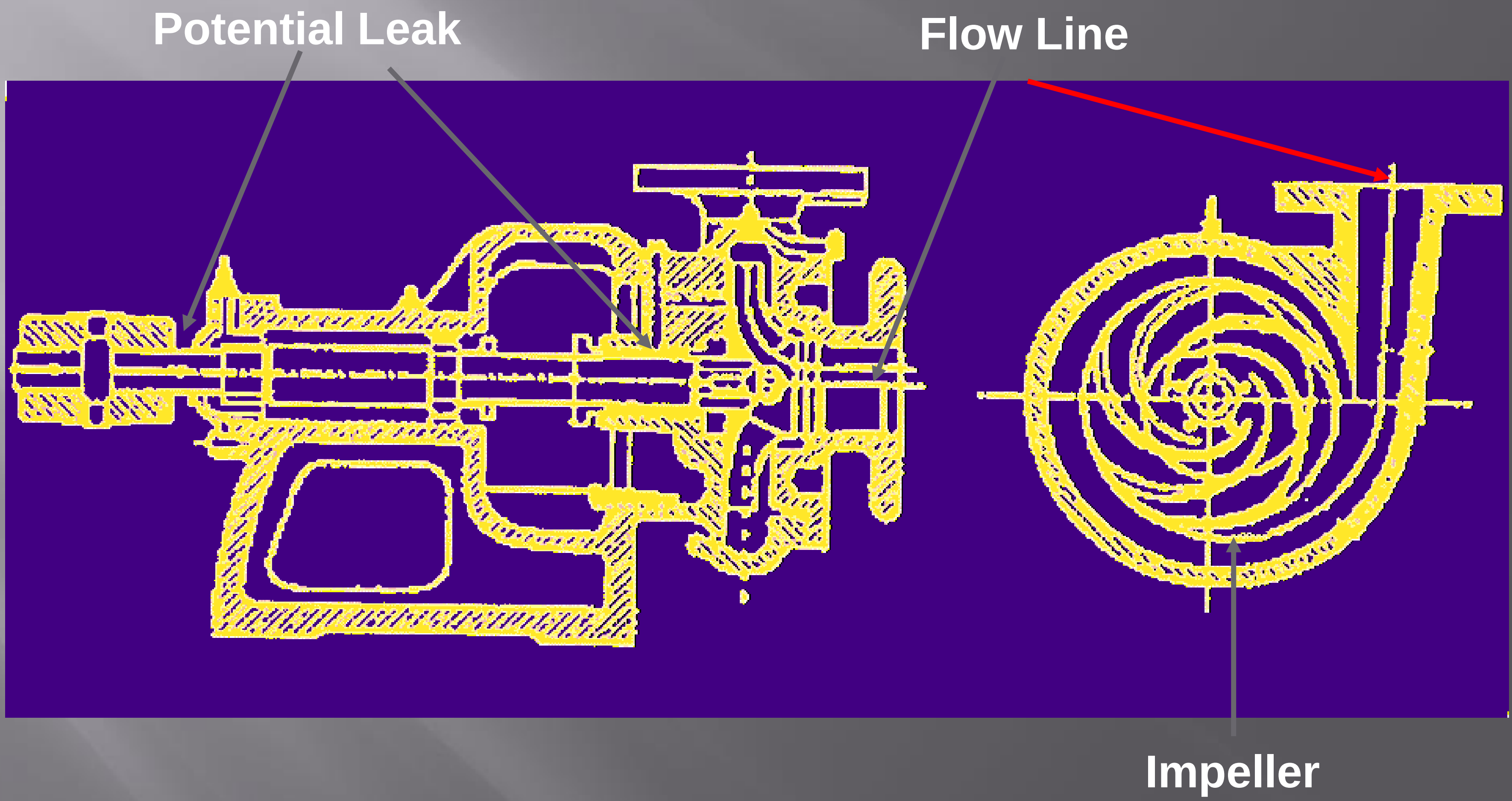
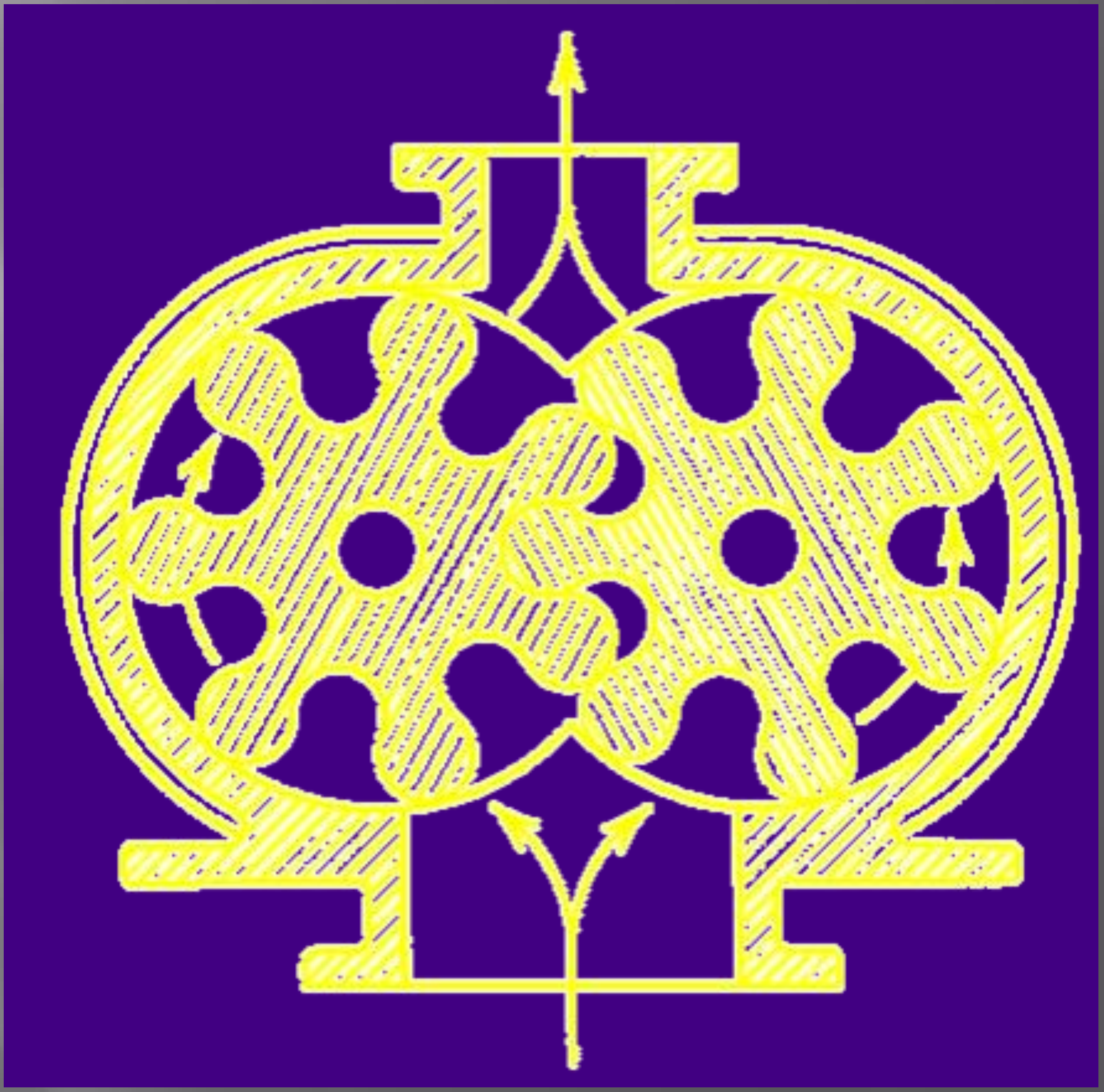
Centrifugal Pump



Centrifugal Pump

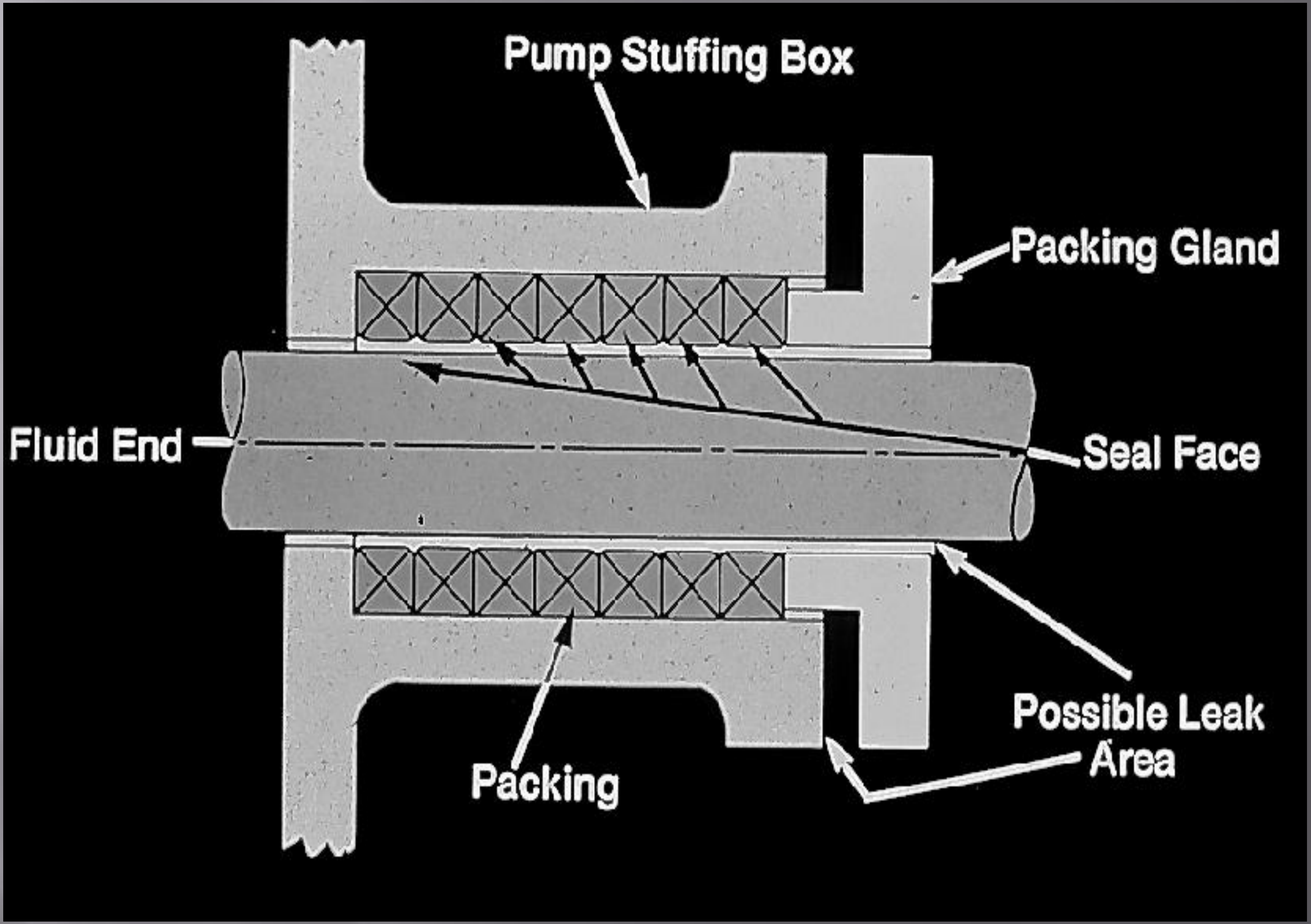
Rotary Pump



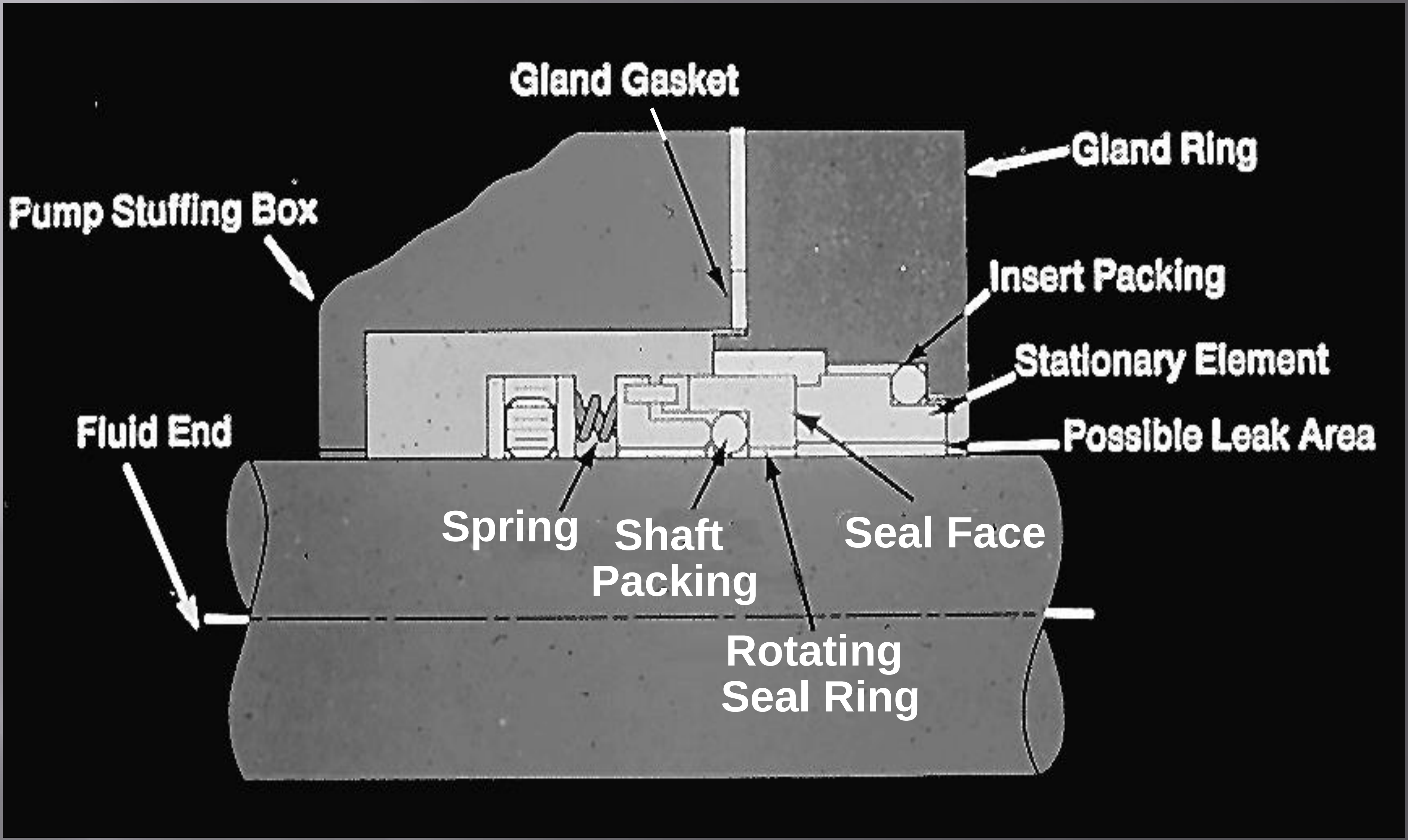
Types of Pump Seals

- Simple Packed Seal
- Basic Single Mechanical Seal
- Dual Mechanical Seal
- Seal-Less
- Diaphragm Pump
- Magnet Drive Pump

pp. 27-29

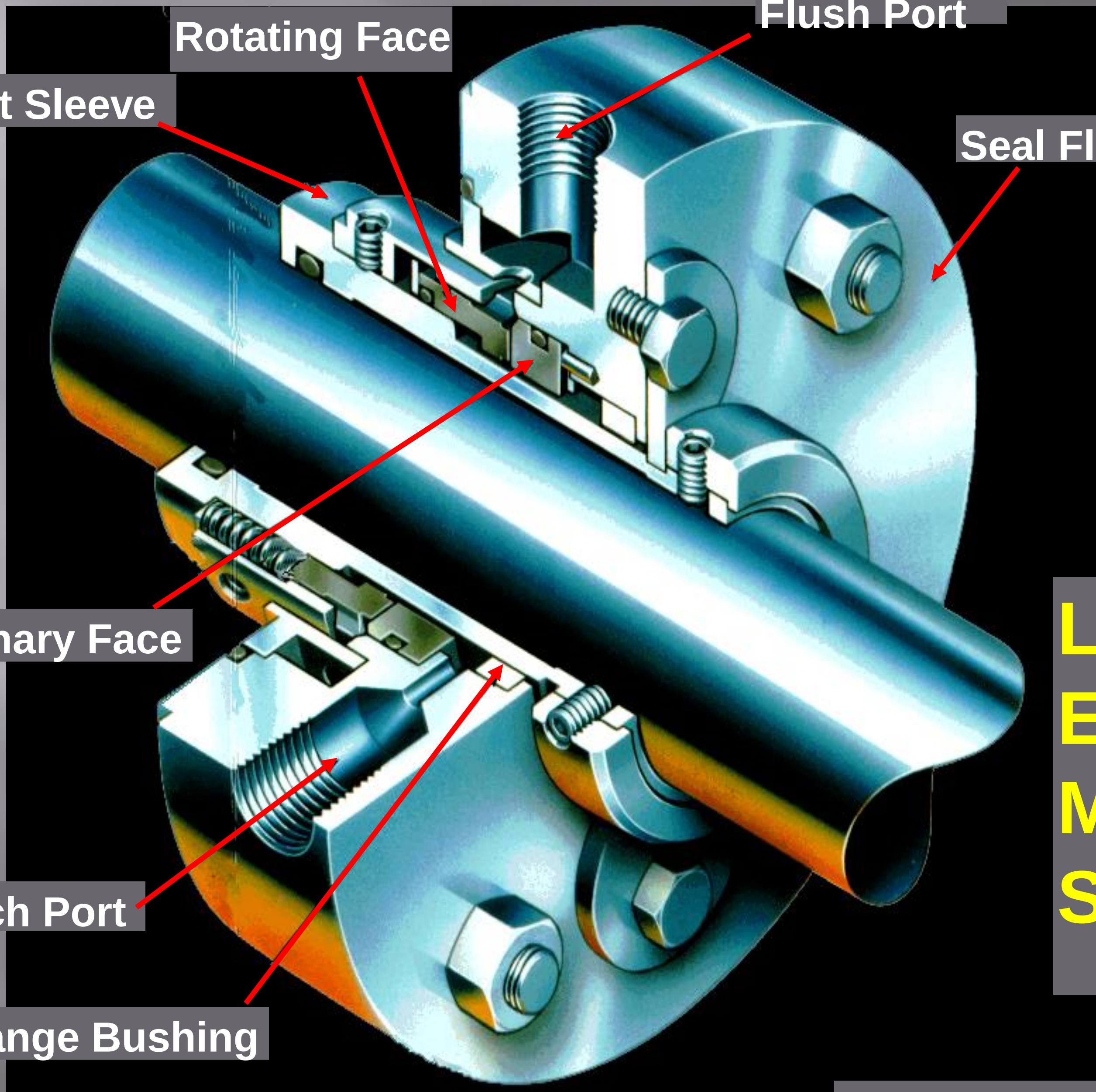


Simple Packed Seal

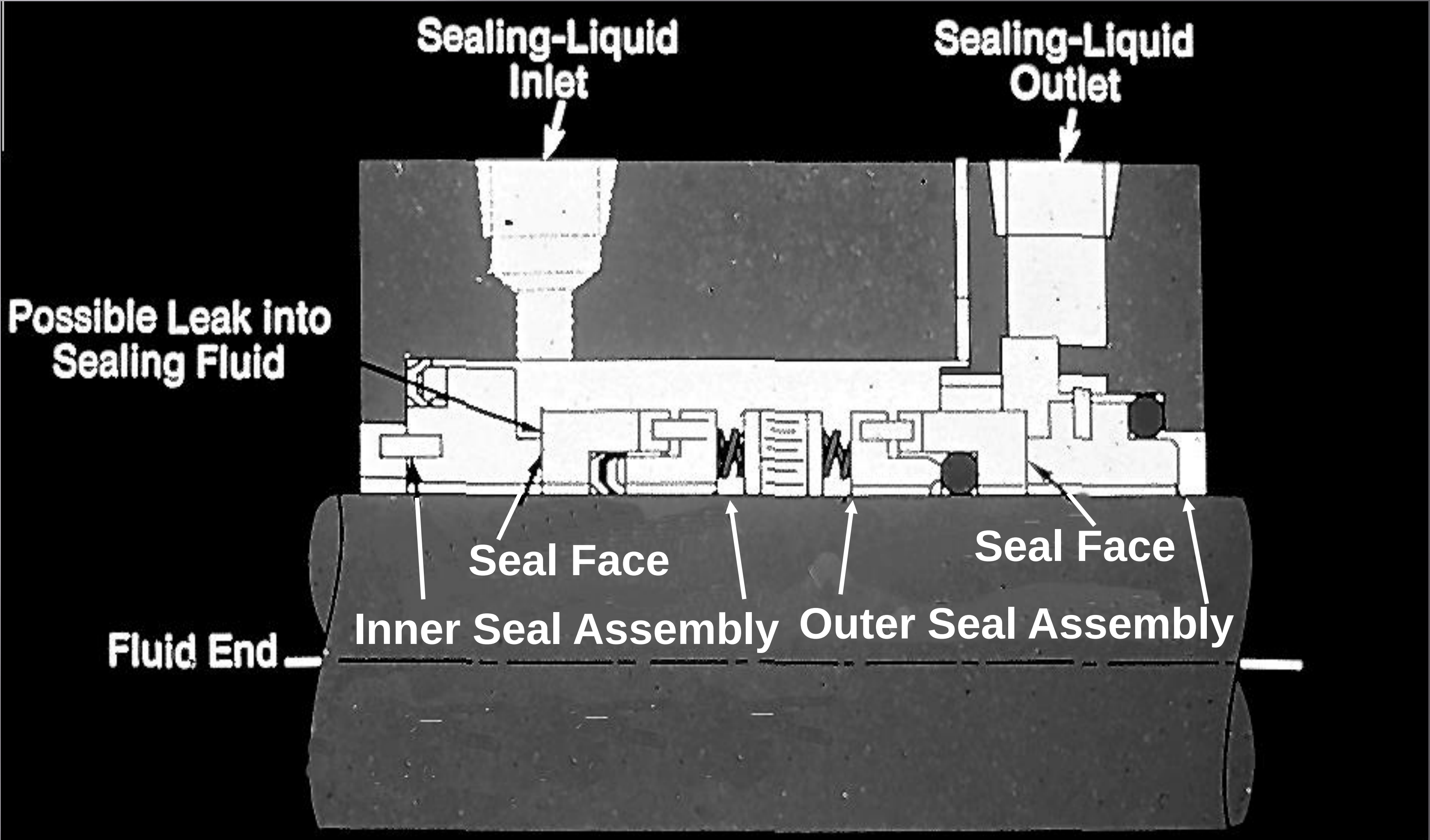


Basic Single Mechanical Seal

Low Emission Mechanical Seal

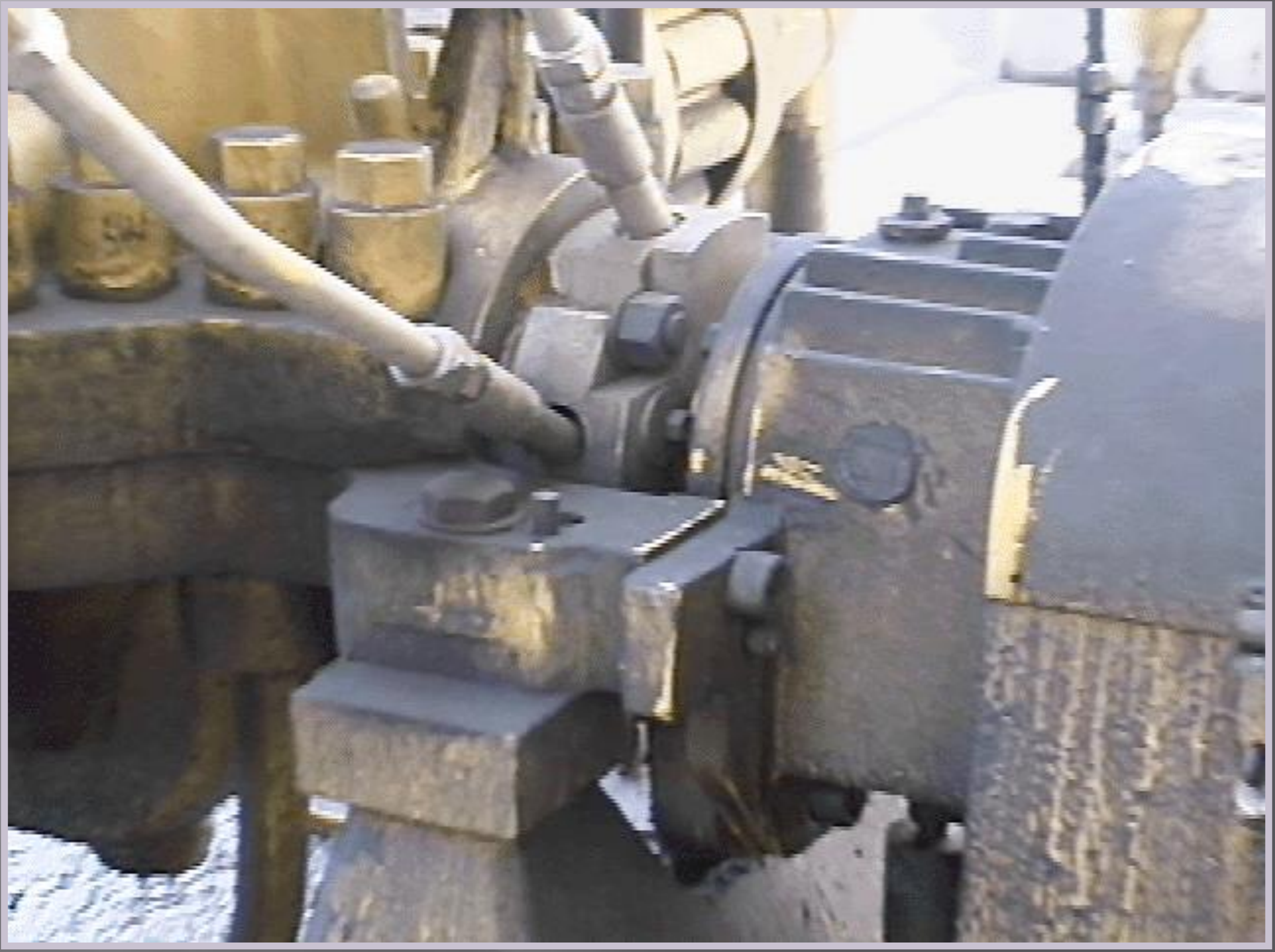


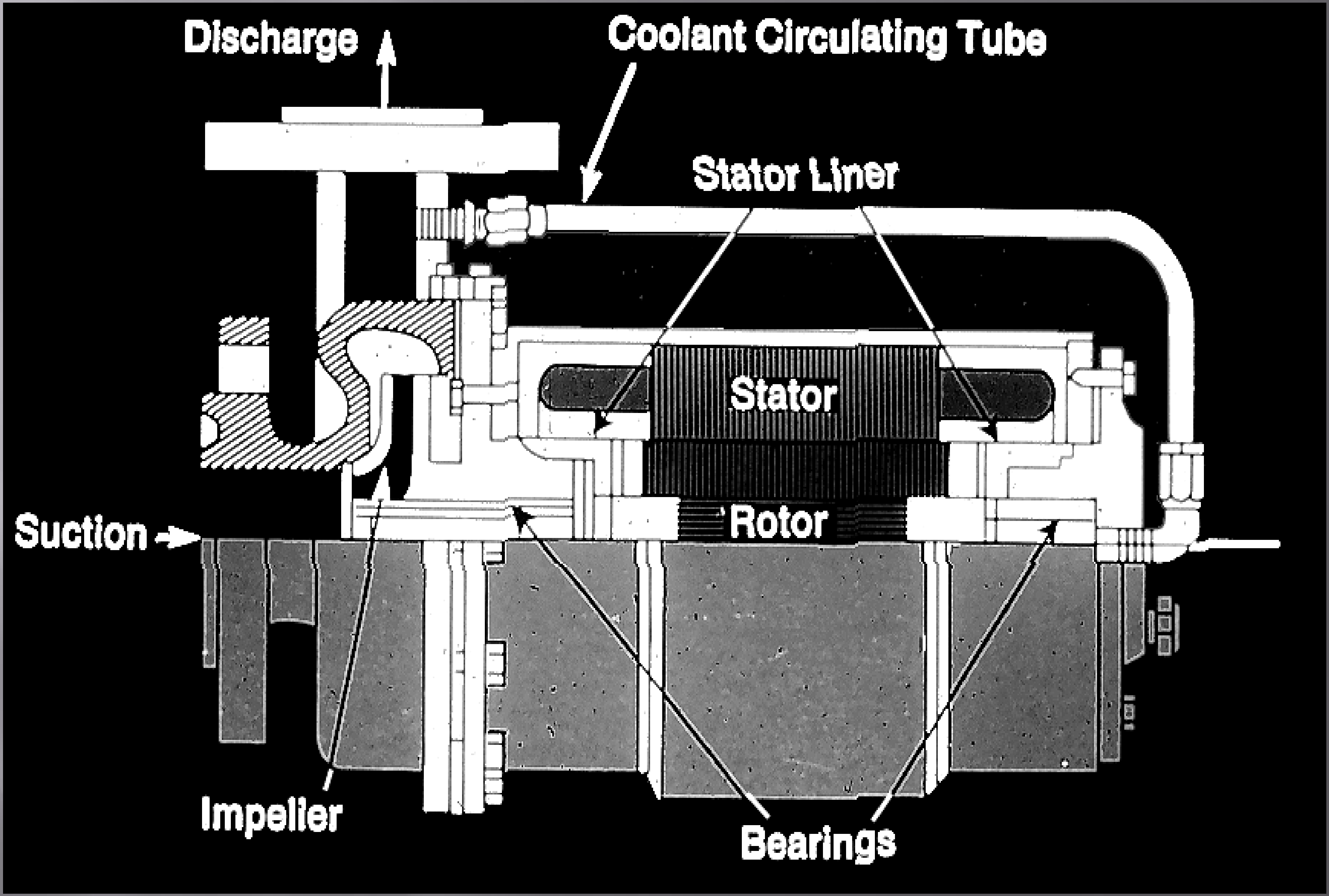
Courtesy BW/IP International, Inc.



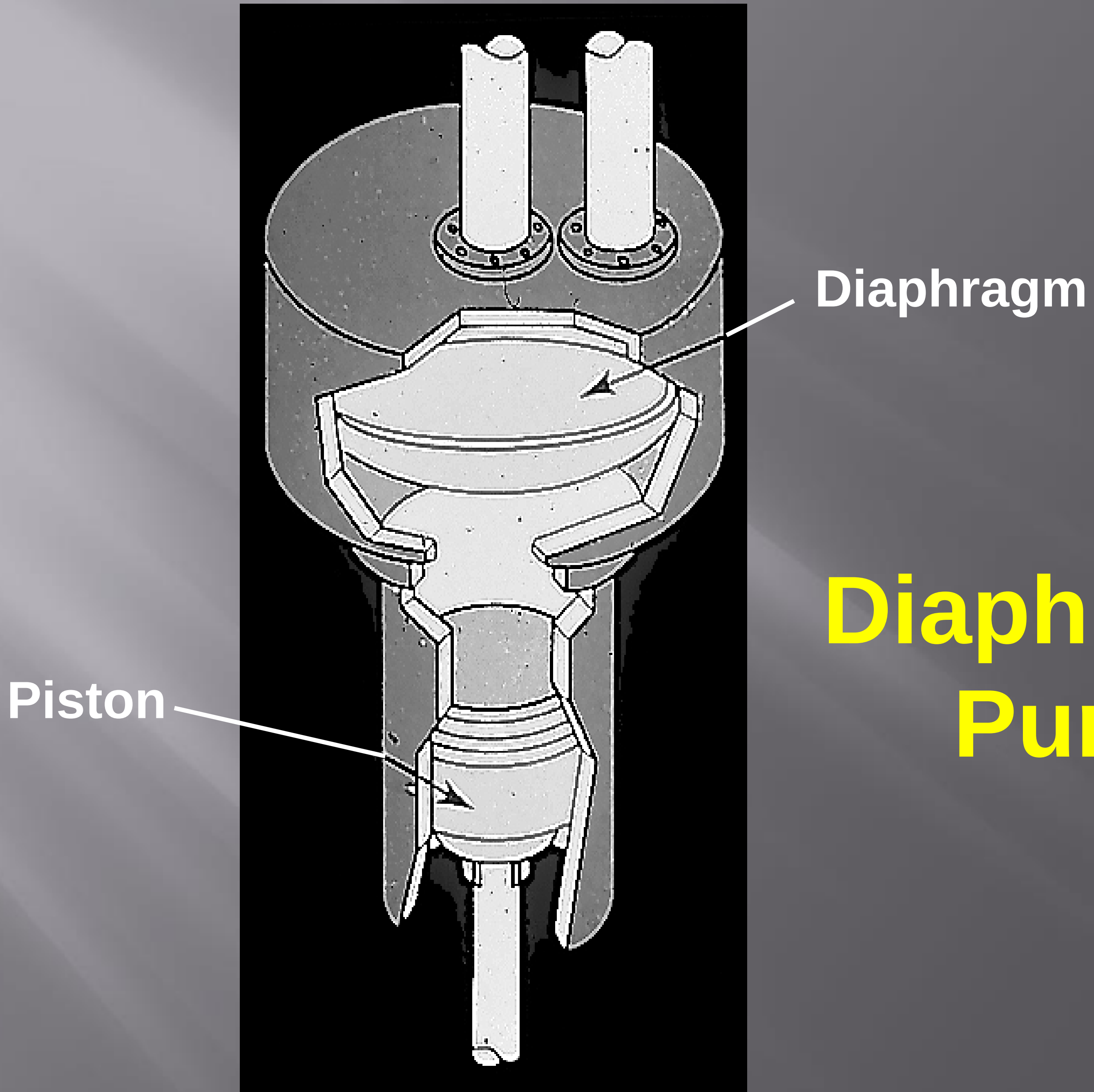
Double Mechanical Seal

Centrifugal Pump with Double Mechanical Seal

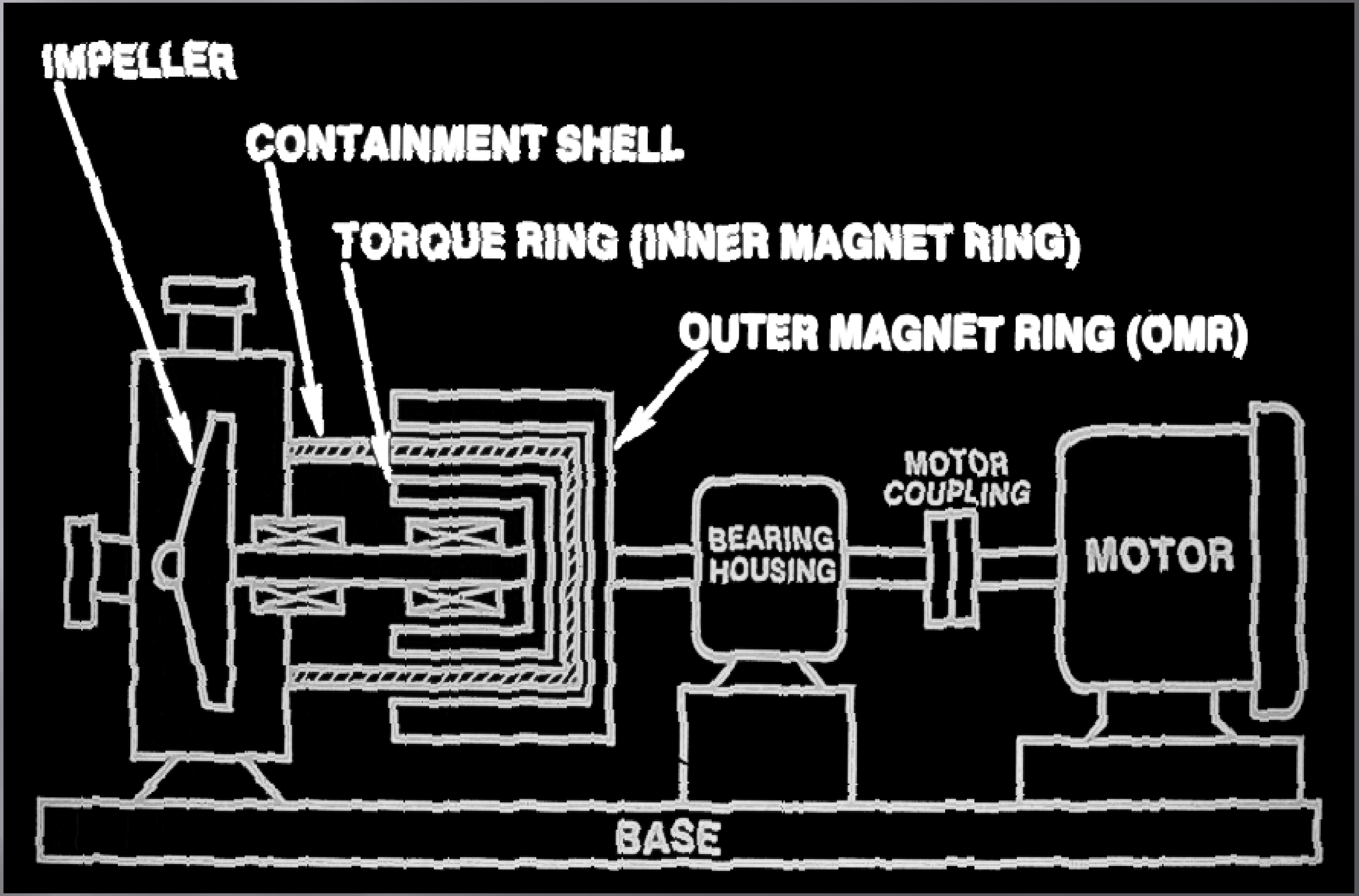




Seal-Less Canned Motor Pump



Diaphragm Pump

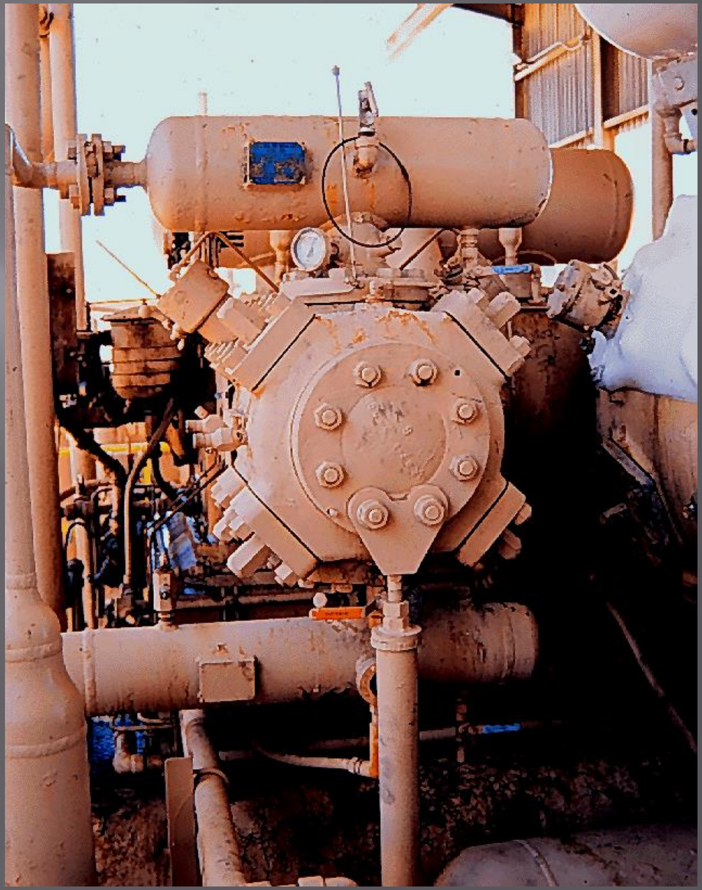


Magnet Drive Pump

Magnet Drive Pump

Types of Compressors

- Centrifugal
- Reciprocating
- Rotary



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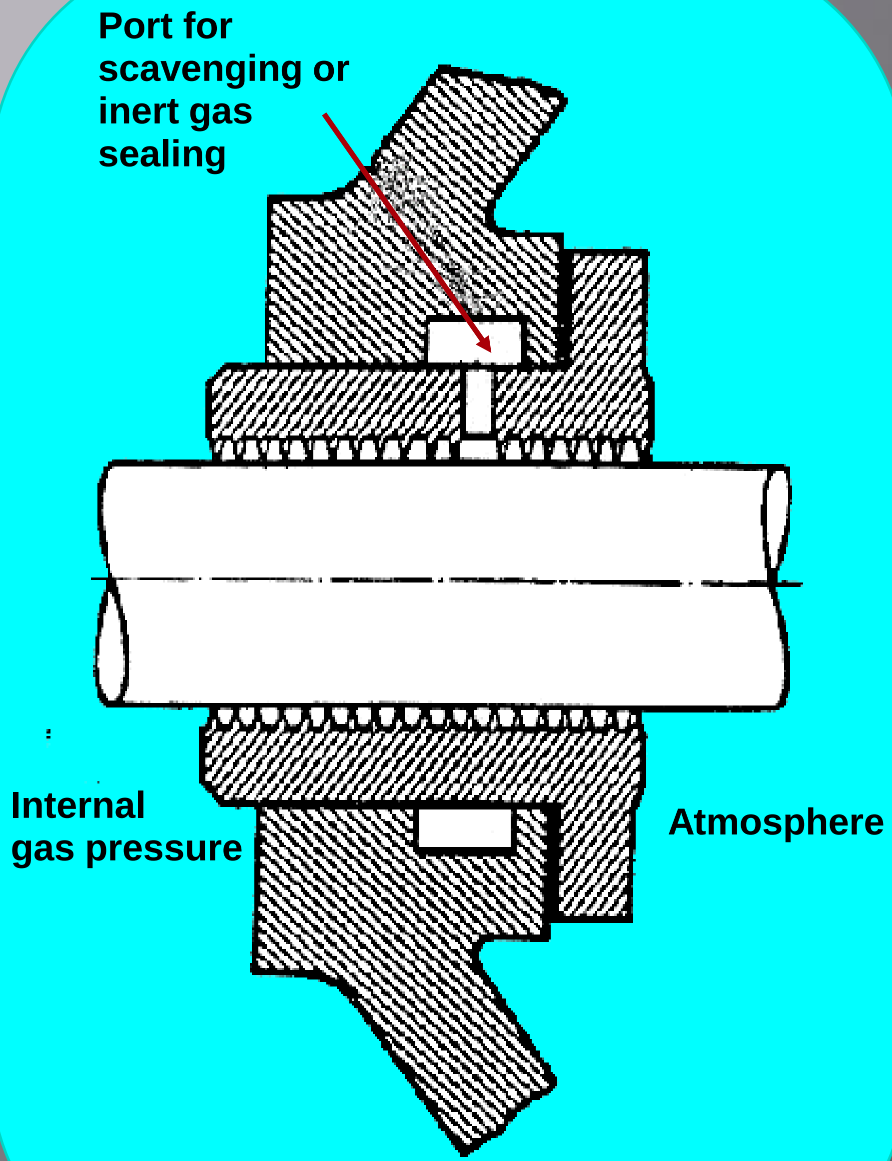
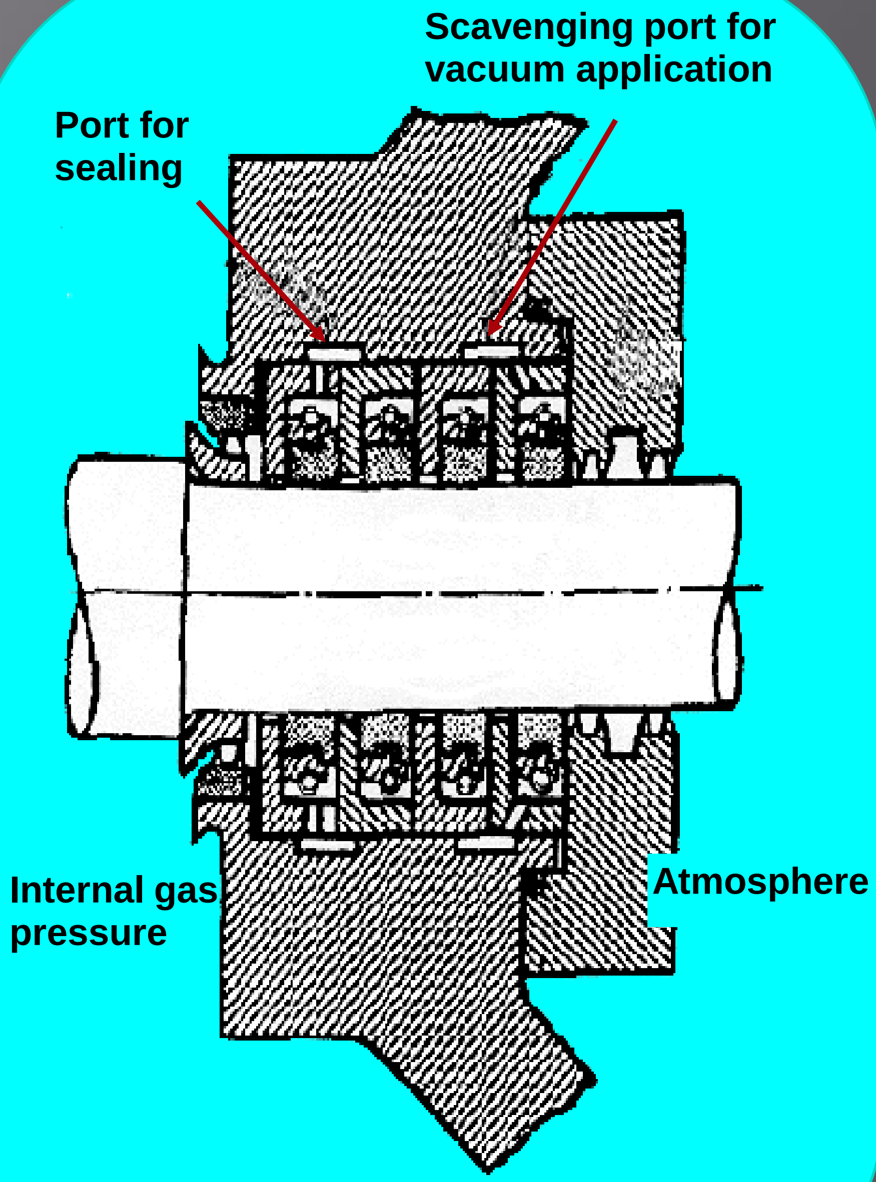
Types of Compressor Seals

- Labyrinth
- Restrictive Ring
- Mechanical
- Packed
- Liquid-Film

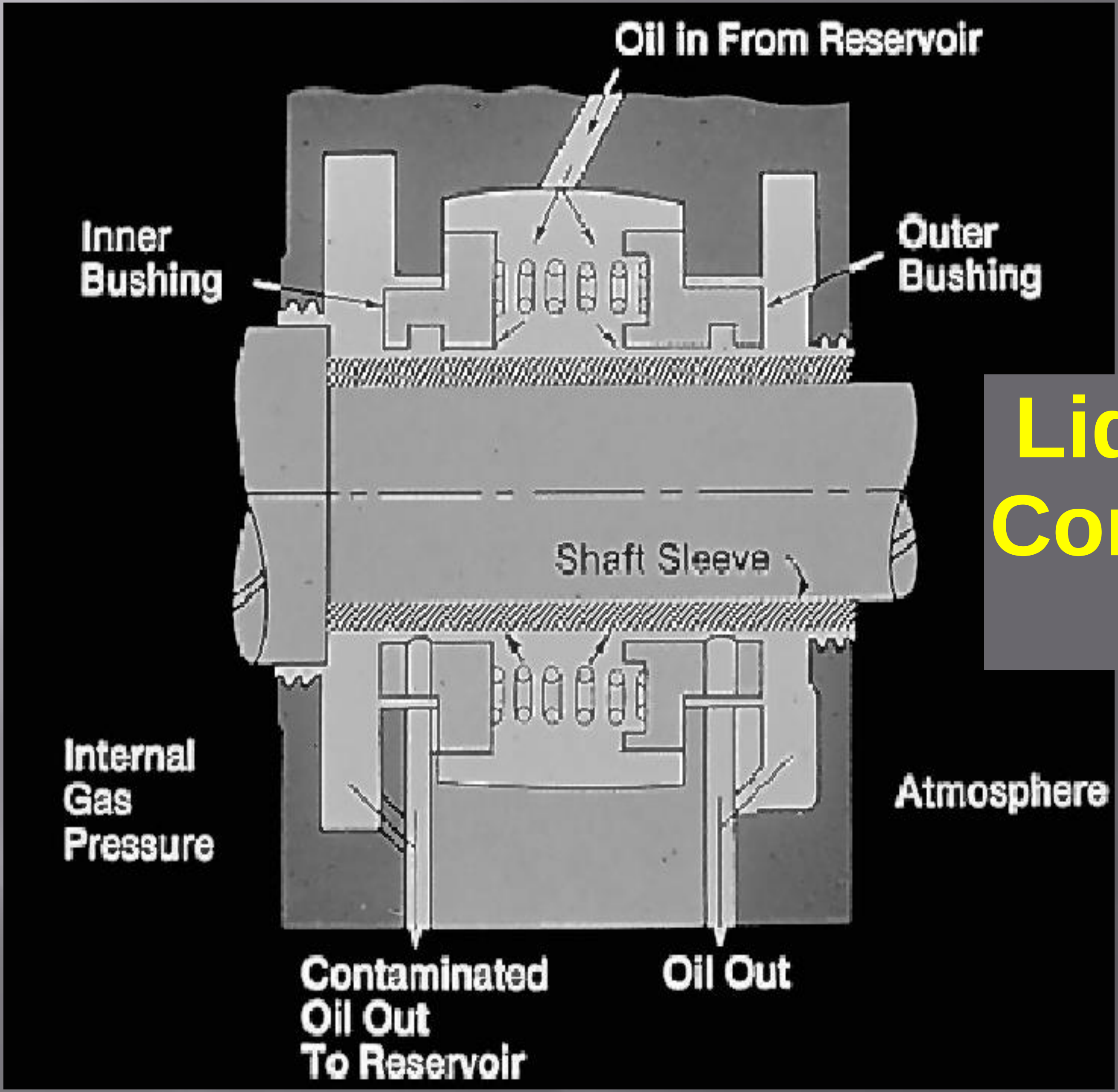
pp. 30-31



Labyrinth Seal



Restrictive Ring Seal



Liquid Film Compressor Seal

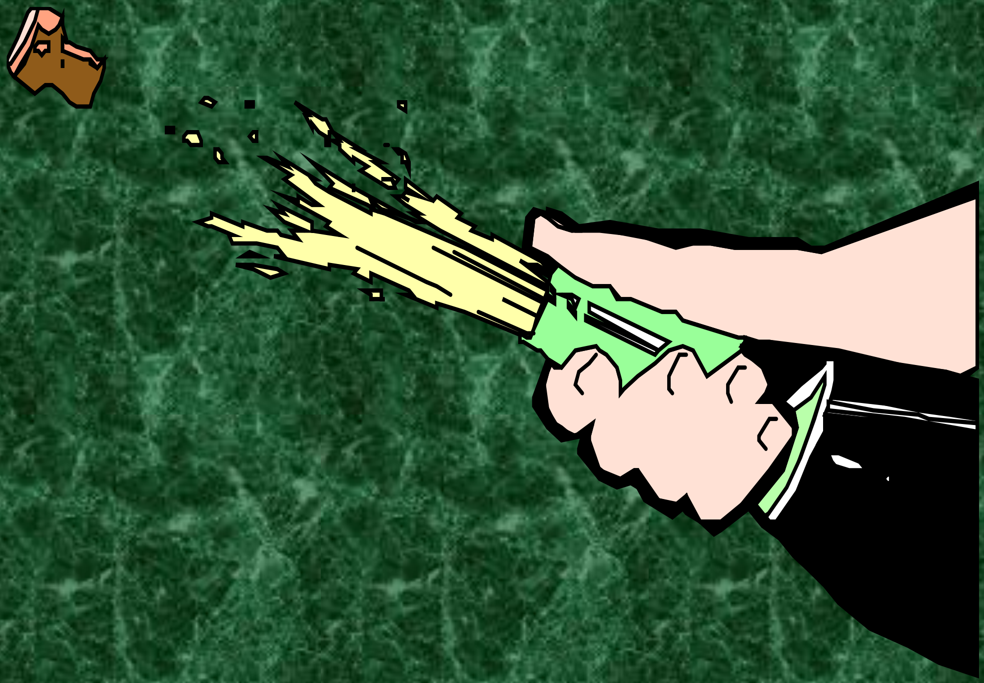
Screening a Compressor

Closed Vent Systems

- Designed and operated for no detectable emissions
- Monitored at startup, annually, and as required by agency
- Facility owner/operator must verify operating parameters

Control Devices

- *Vapor Recovery Systems*
  - 95% efficient
- *Incinerators/Oxidizers*
  - 95% efficient or minimum residence time and temperature
- *Flares*
  - Several conditions



Pressure Relief Devices

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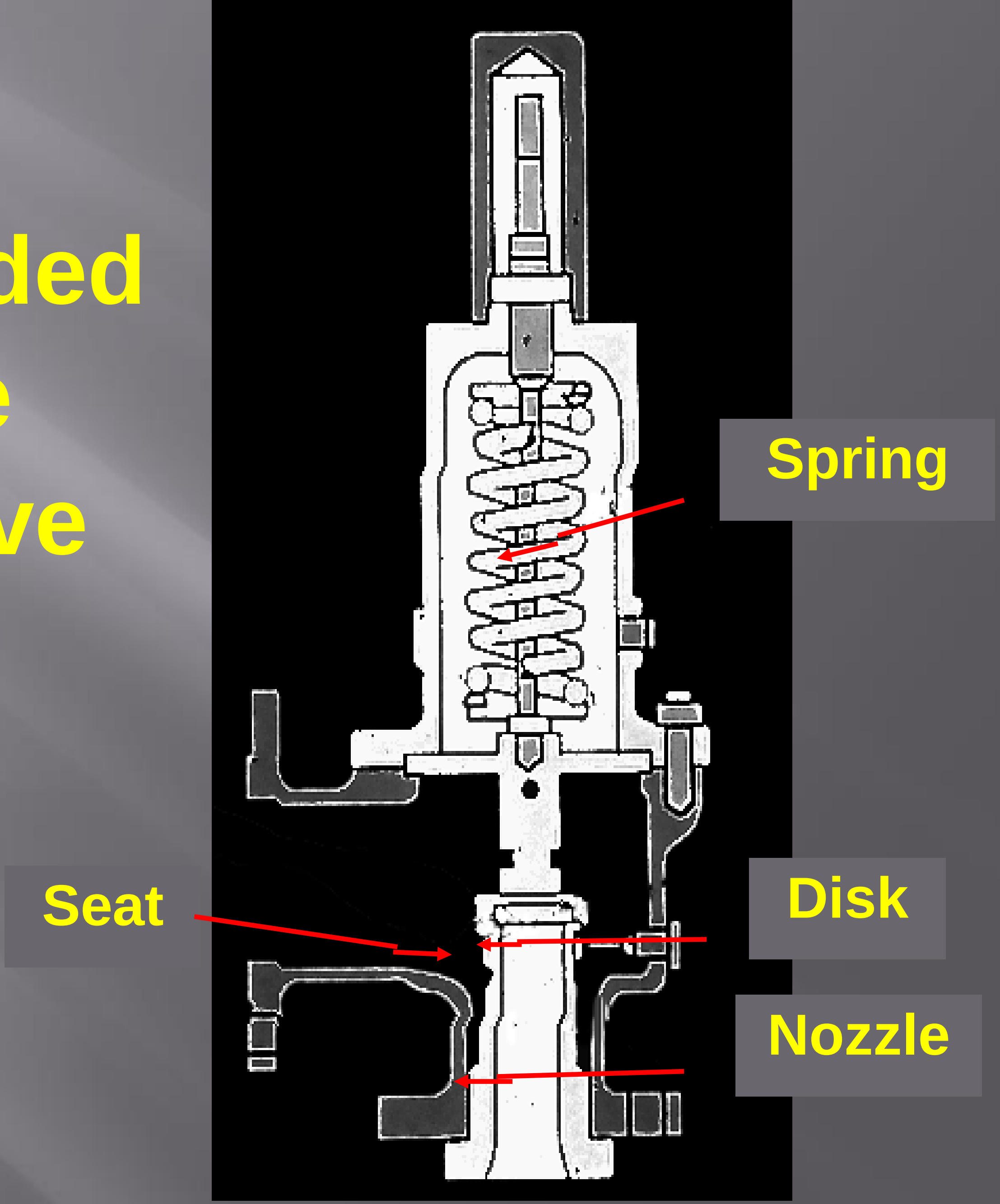
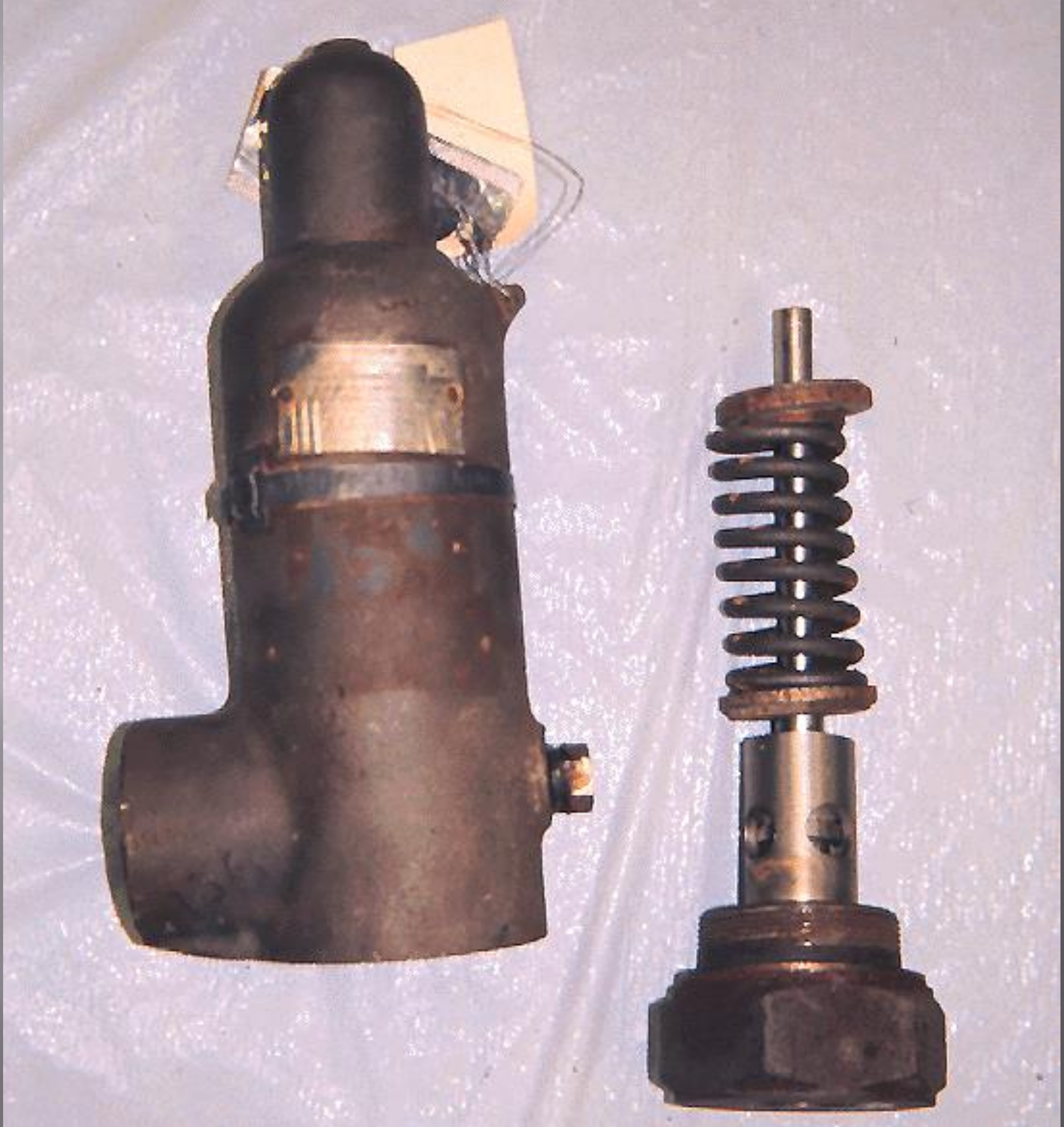
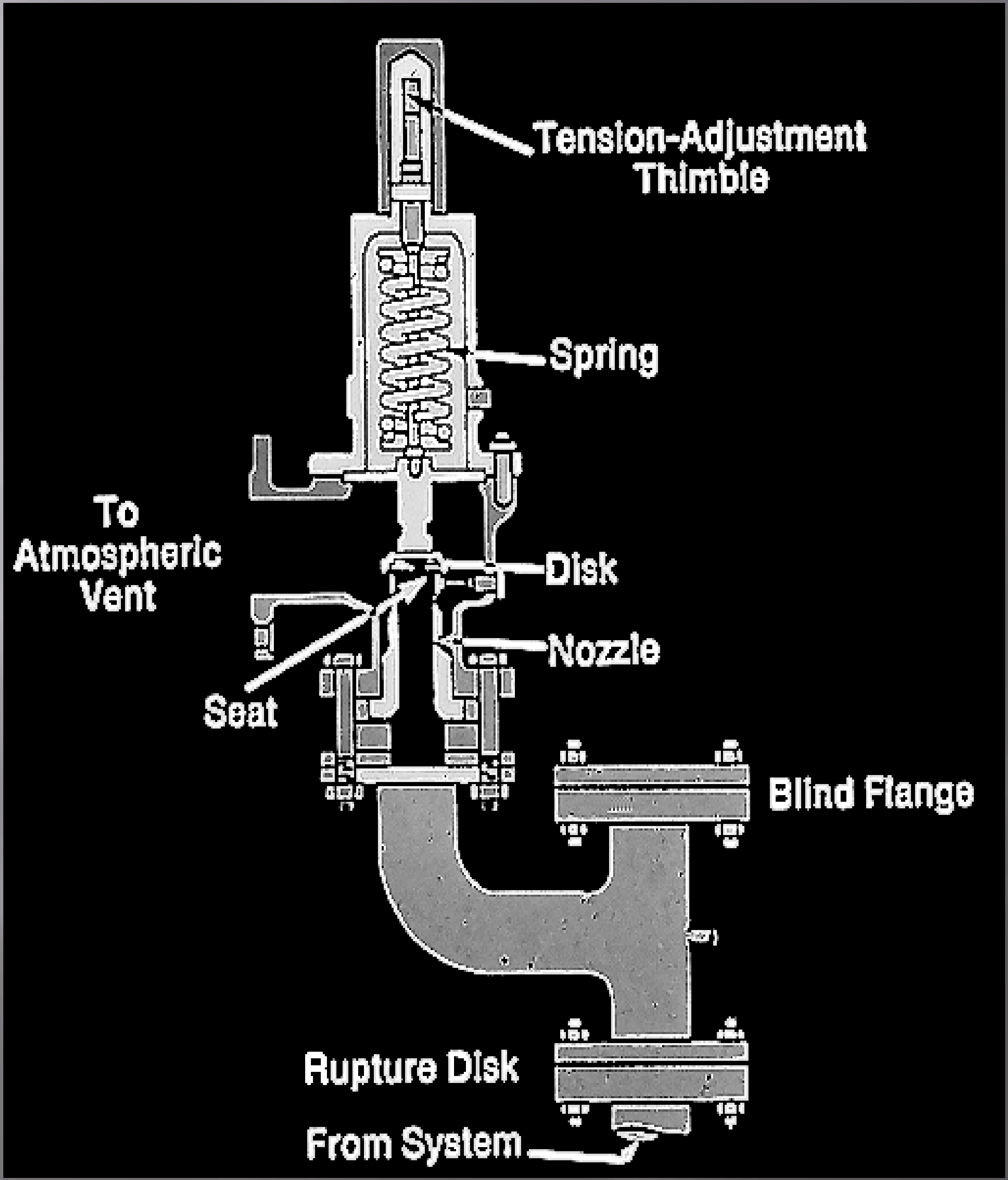
Pressure Relief Valve

Spring-Loaded Pressure Relief Valve





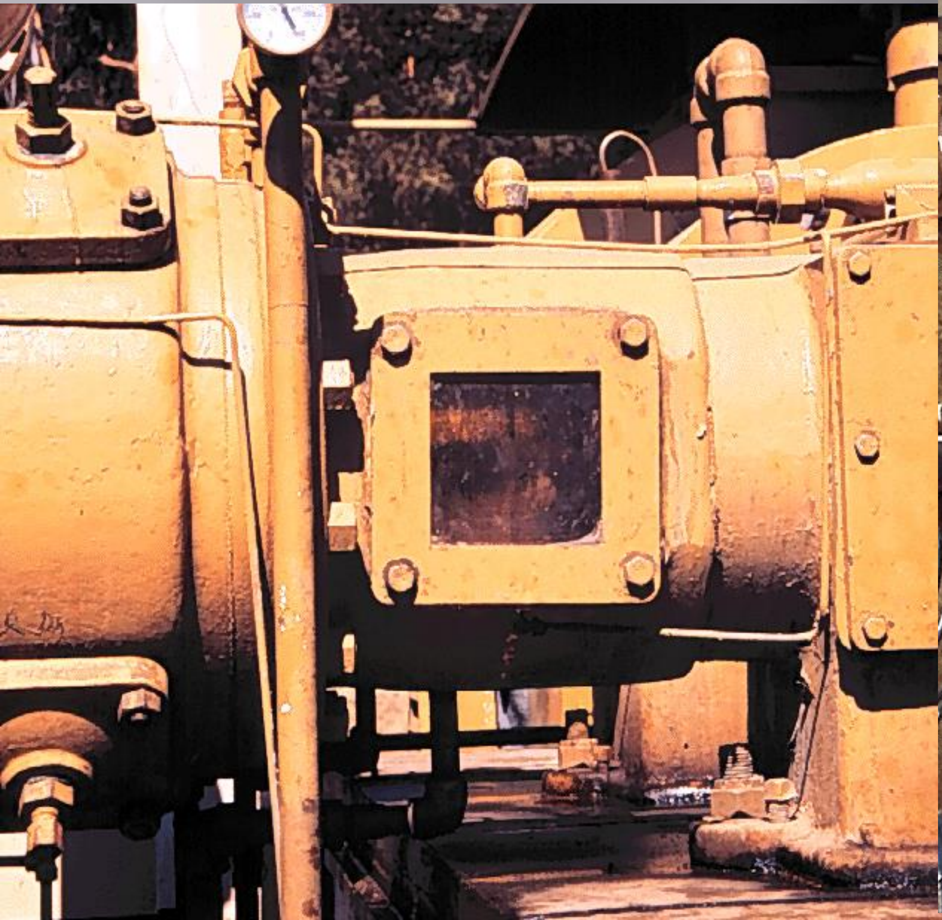


PRV with Rupture Disk

Screening Non-Vented PRVs

Open-Ended Line

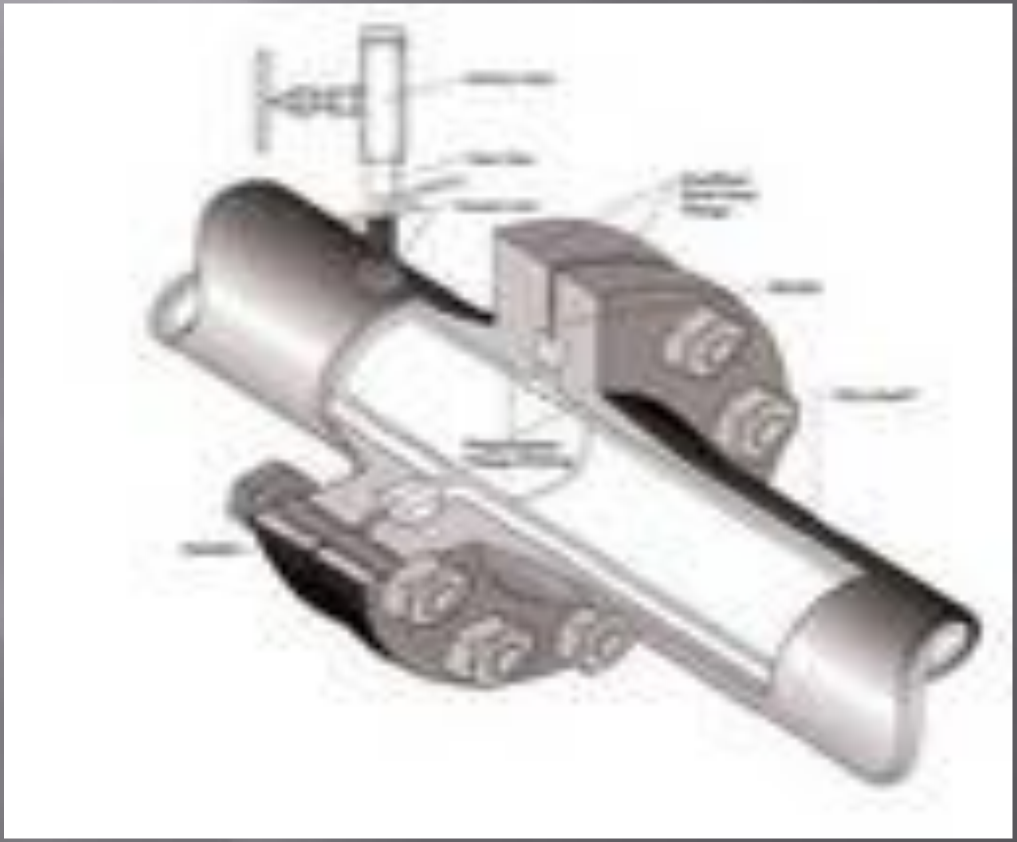
Sight Glass



Connectors

- Flanges
- Threaded
- Welded

Flanges

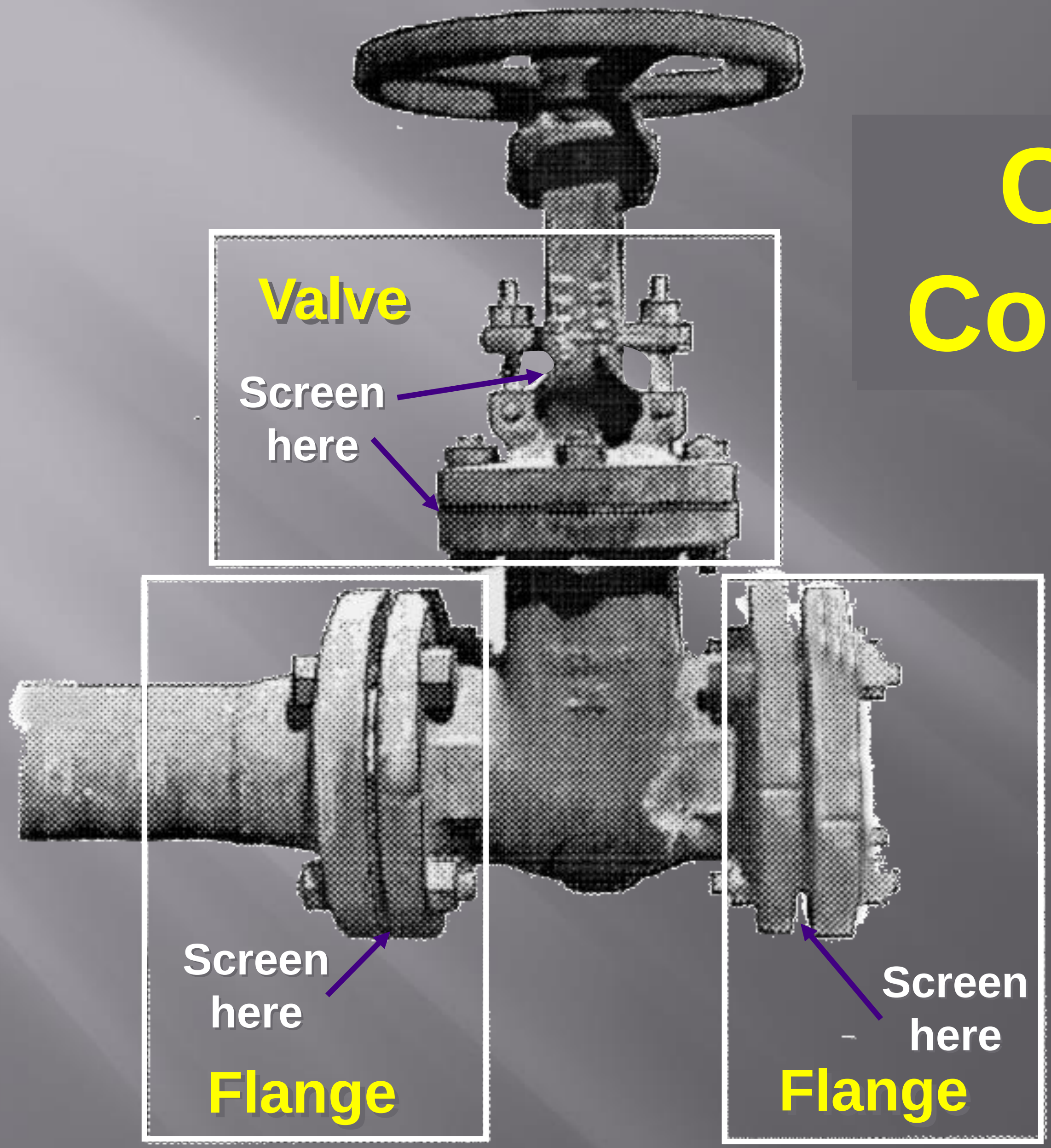


Threaded

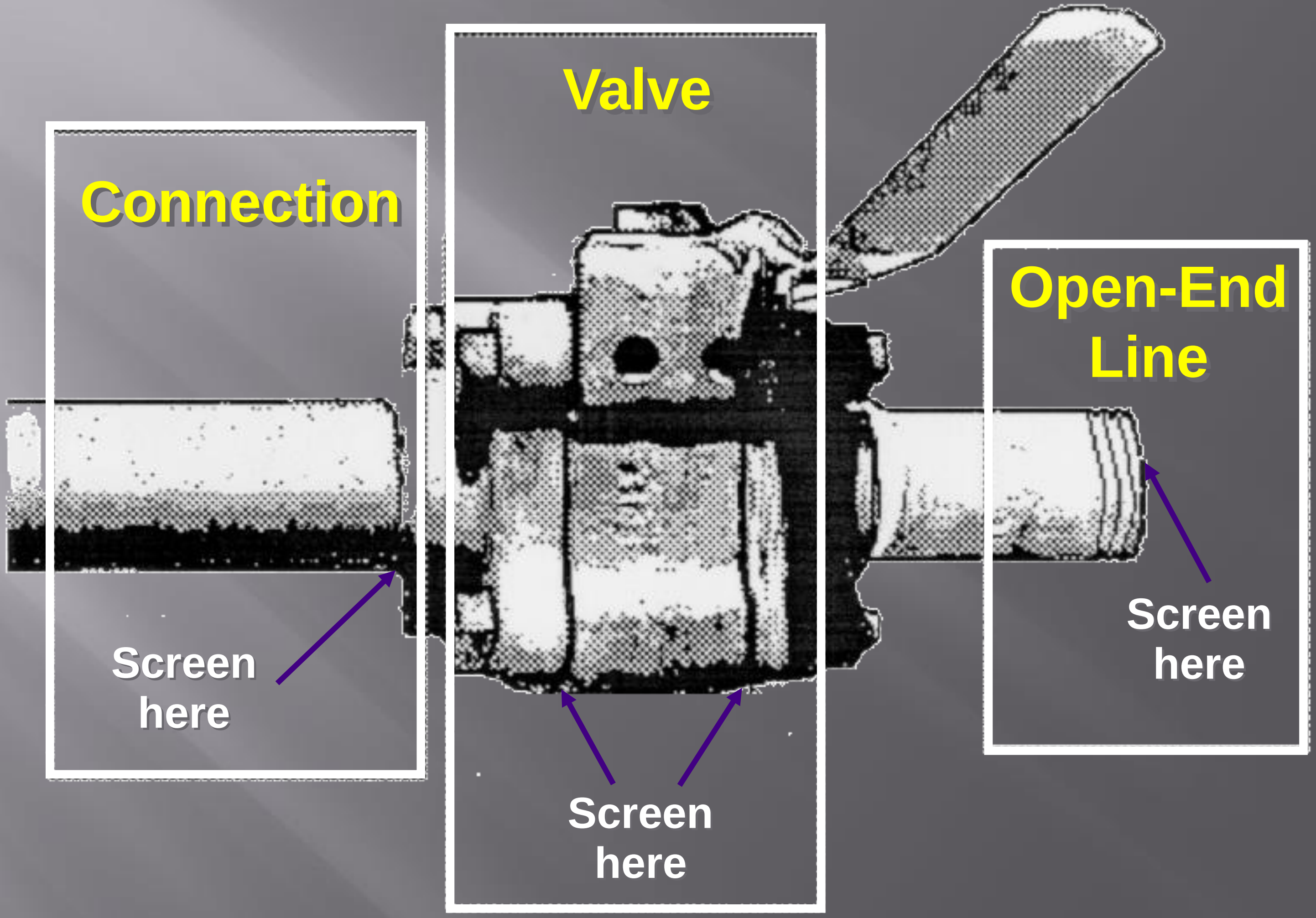
Welded

and now to put it all together

Counting Components



Counting Components



Open-Ended Line?

How many components do you count?

Estimating Component Emissions

- Average Emission Factors
- Screening Value Ranges
- Correlation Equations
- Unit-Specific Correlation Equations

Types of service

- Gas/vapor service
- Liquid service
    - light liquid service
    - heavy liquid service

In VOC or HAP service

VOC -- 10% by weight VOC
NSPS

oHAP– 5% by weight total oHAPs
MACT/NESHAPs

Gas/Vapor service

- The equipment is in gas or vapor phase at the operating conditions
- (temp/pressure)

Liquid service

- The equipment is not is gas or vapor service

Light liquid service

The total concentration of the organic compounds having a vapor pressure > 0.3 kPa at 20 ‘ C and

=>20% by weight of the total process stream and

Is a liquid

Heavy liquid service

- Means a piece of equipment is not in gas/vapor or in light liquid service

1995 EPA Protocol Refinery Average Emission Factors

Component	Service	Emission Factor (kg/hr)
Valves	Gas/Vapor	0.0268
	Light Liquid	0.0109
	Heavy Liquid	0.00023
Pump Seals	Light Liquid	0.114
	Heavy Liquid	0.0210
Compressor Seals	Gas/Vapor	0.636
Pressure Relief Valve	Gas/Vapor	0.160
Connectors	All	0. 00025
Open-Ended Lines	All	0.00230
Sampling Connections	All	0. 0150

1995 EPA Protocol Refinery Screening Value Range Emission Factors

Component	*Service*	*< 10,000 ppm Factor (kg/hr)*	*≥ 10,000 ppm Factor(kg/hr)*
Valves	Gas/Vapor	0.00060	0.2626
	Light Liquid	0.0017	0.0.0852
	Heavy Liquid	0.00023	0.00023
Pump Seals	Light Liquid	0.0120	0.437
	Heavy Liquid	0.0135	0.3885
Compressor Seals	All	0.0894	1.608
Pressure Relief Valves	Gas	0.0447	1.691
Connectors	All	0.000060	0.0375
Open-Ended Lines	All	0.00150	0.01195

Example

TABLE 5-3. CONTROL EFFECTIVENESS FOR AN LDAR PROGRAM AT A REFINERY PROCESS UNIT

Equipment type and service	Control effectiveness (%)		
	Monthly monitoring 10,000 ppmv leak definition	Quarterly monitoring 10,000 ppmv leak definition	HON reg neg[a]
Valves - gas	88	70	96
Valves - light liquid	76	61	95
Pumps - light liquid	68	45	88
Connectors - all	b	b	81

[a] Control effectiveness attributable to the requirements of the proposed hazardous organic NESHAP equipment leak negotiated regulation are estimated based on equipment-specific leak definitions and performance levels.

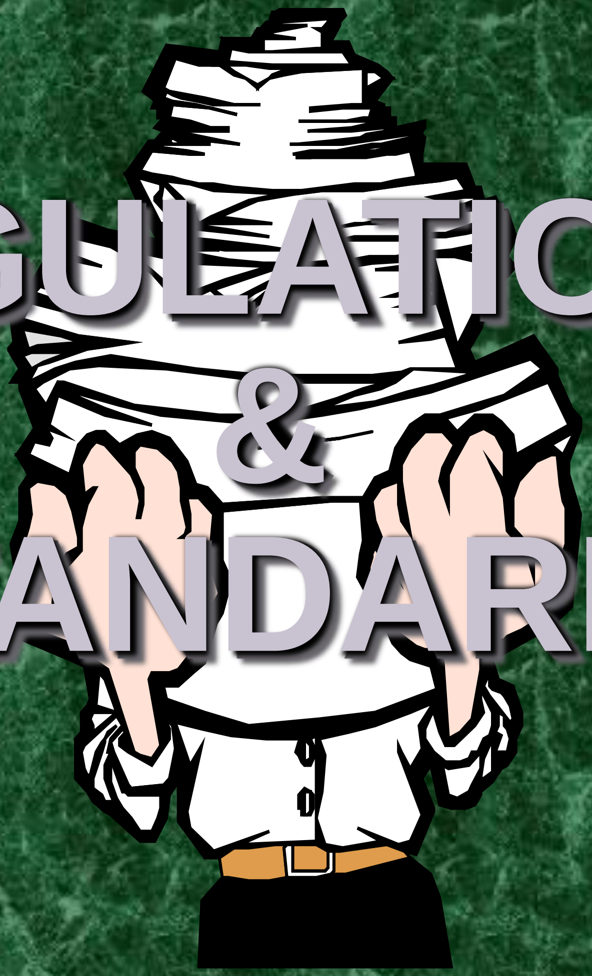
[b] Data are not available to estimate control effectiveness.

Example

TABLE 5-1. SUMMARY OF EQUIPMENT MODIFICATIONS

Equipment type	Modification	Approximate control efficiency (%)
Pumps	Sealless design	100[a]
	Closed-vent system	90[b]
	Dual mechanical seal with barrier fluid maintained at a higher pressure than the pumped fluid	100
Compressors	Closed-vent system	90[b]
	Dual mechanical seal with barrier fluid maintained at a higher pressure than the compressed gas	100
Pressure relief devices	Closed-vent system	c
	Rupture disk assembly	100
Valves	Sealless design	100[a]
Connectors	Weld together	100
Open-ended lines	Blind, cap, plug, or second valve	100
Sampling connections	Closed-loop sampling	100

REGULATIONS & STANDARDS



Generic Fugitive VOC Emissions Regulations

- Applicability
- Exemptions
- Definitions
- Equipment Leak Standards/ LDAR Standards
- Identification Requirements
- Recordkeeping Requirements
- Test Methods
- Compliance Schedule

Applicability

- Source Category
- Process Unit
- Equipment in process unit
- Process gas/fluid

pp. 13-15

Types of Standards

Performance Standards

Equipment Standards

Work Practice Standards (LDAR)

pp. 12-13

Leak Detection and Repair Standards

- Inspection Frequency
- Definition of Leak
- Repair Interval
- Percentage Leaking

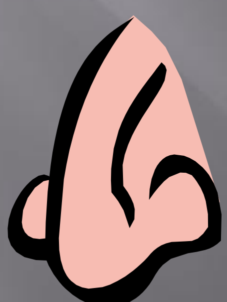
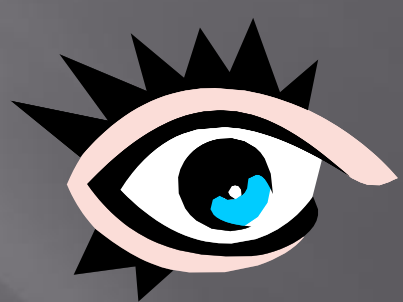
pp. 15-16

Inspection Frequency

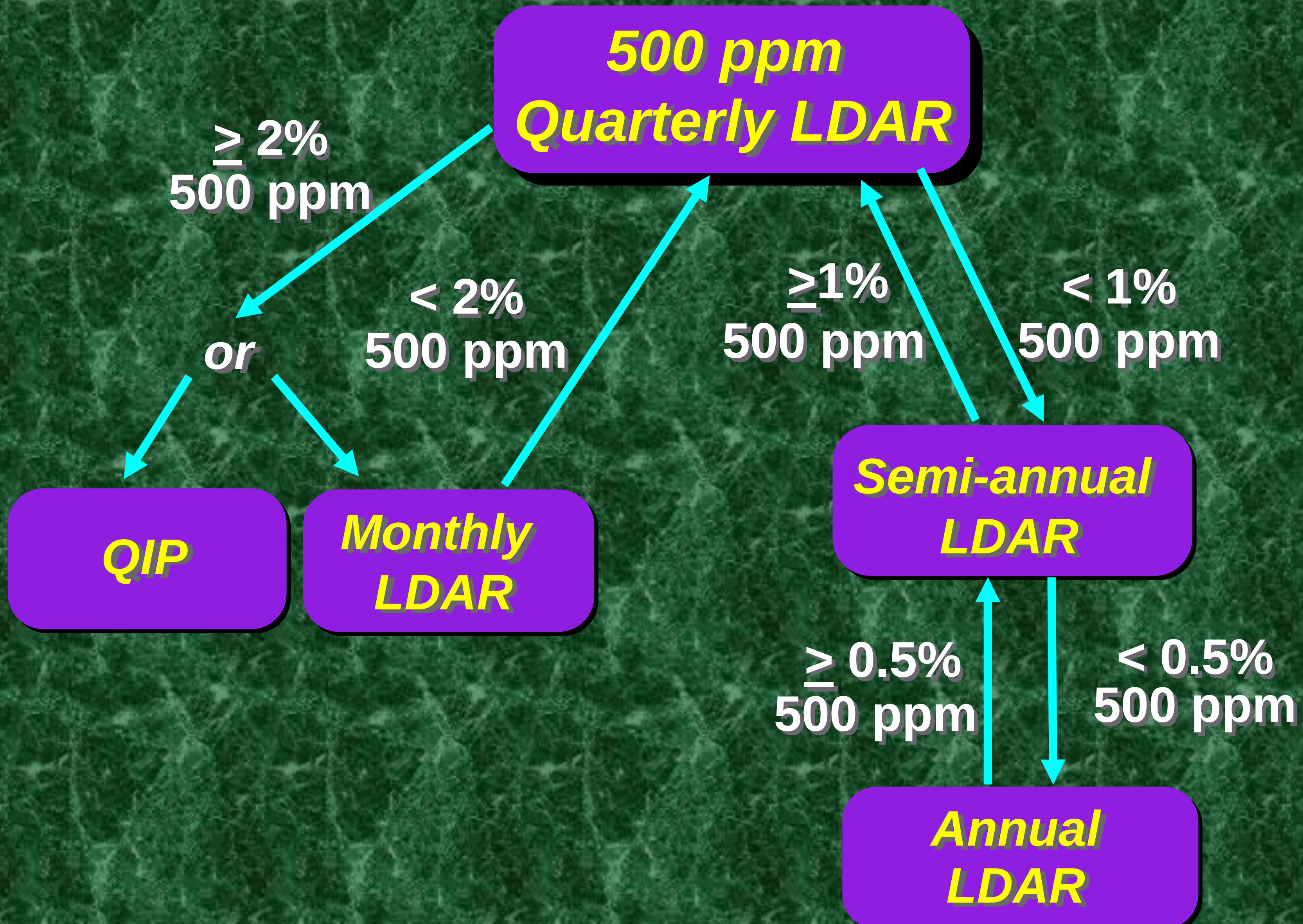
- Regular Compliance Inspection (monthly, quarterly, annually, etc.)
- Daily or Weekly Visual Inspections
- Inspection Interval After Repair
- Inspection Interval After Turnaround

Definition of Leak

- Basic standard: 10,000 ppm
- Range: 50,000 ppm - 100 ppm
- Liquid leaks : 3 (or more) drops per minute
- Other definitions

HON LDAR Standards for Valves



Repair Interval

- Basic standard: 15 days
- First attempt: 5 days
- Range: 1-15 days
- Repeat leakers: Possible replacement
- Delay of Repair: Until next shutdown
  (DOR) 6-month to 5-year limit
- Percentage awaiting repair

Component Identification

- Tags
  - Inaccessible components tagged
  - Leaking components: brightly-colored, waterproof tag with date leak detected, other info.
- P & IDs

Recordkeeping Requirements

1. Component ID code, description, process unit, service, material transported, concentration, compliance method
2. Dates of inspection
3. Emission levels (compliance or leak) and method of detection
4. Dates of repair (or attempt) and reinspection
5. Emission levels after repair or replacement
6. Repair delayed, reason, expected date of repair
7. List and number of components awaiting repair
8. Portable monitoring instrument records

Reporting Requirements *(NSPS, NESHAP)*

- Notification of Construction or Reconstruction
- Initial Semiannual Reports
- Semiannual Reports
- Percentage of Valves Leaking

pp. 50-53

Test Methods

- EPA Method 21
- EPA Method 25
- ASTM Methods
- Alternative methods

Portable Hydrocarbon Analyzers

- Types of VOC Analyzers
- Response Factors
- Method 21
- Factors in Selection and Use
- Safety Concerns

Ch 4

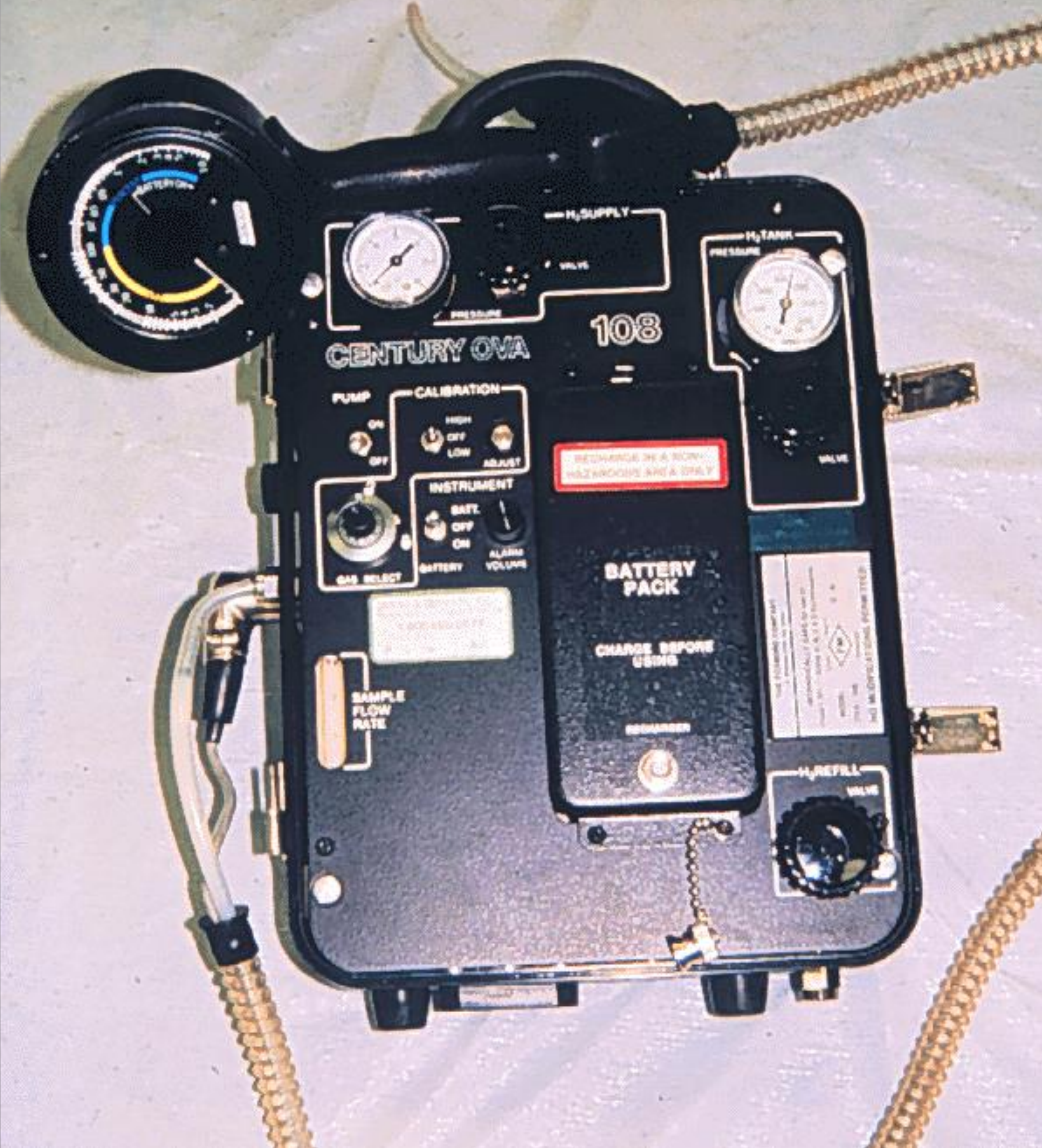
Types Analyzers Used for Fugitive Inspections

Flame Ionization Detector
(FID, OVA)

Catalytic Combustion Analyzer
(CCA, TLV)

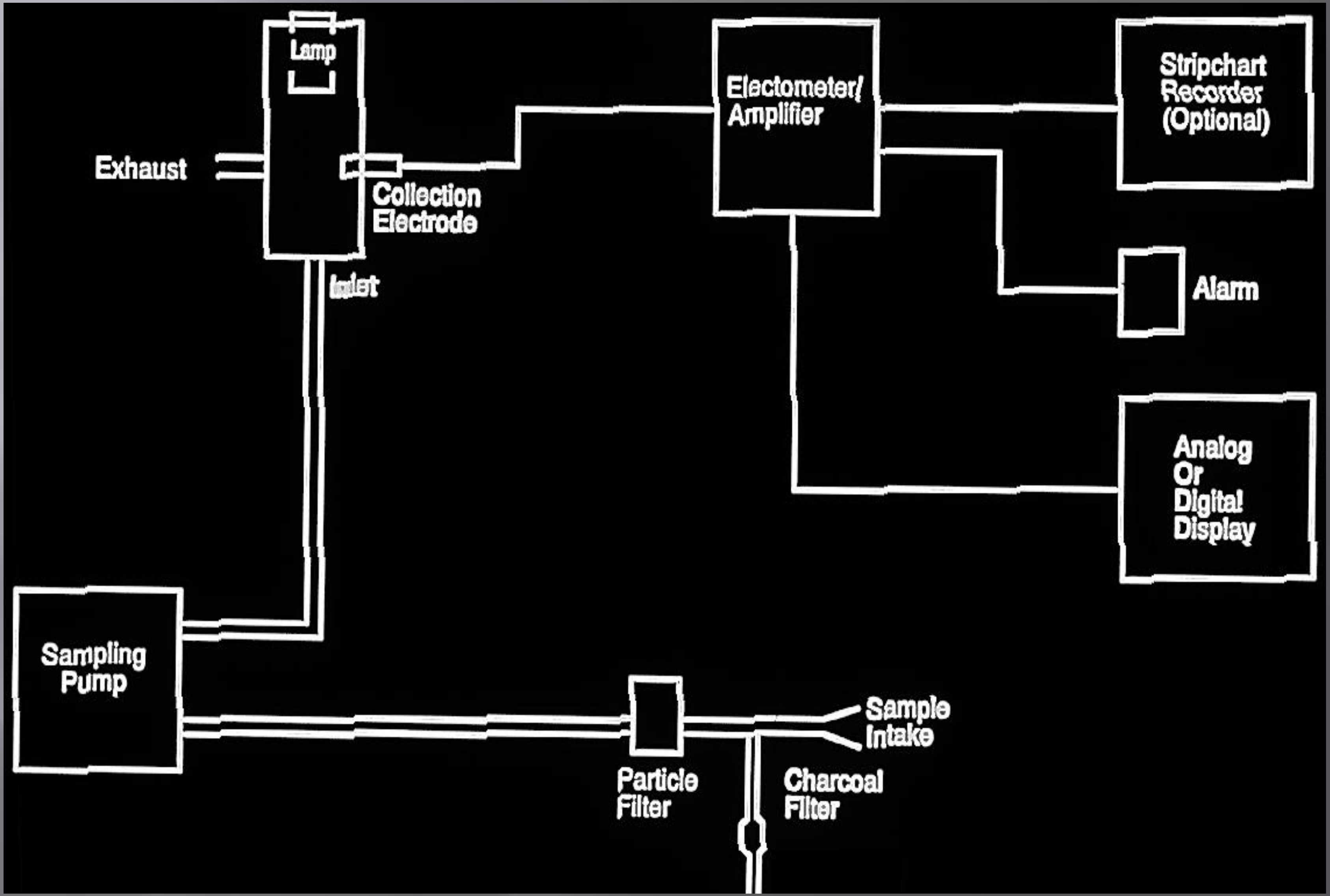
Photo Ionization Detector
(PID)

Century OVA 108



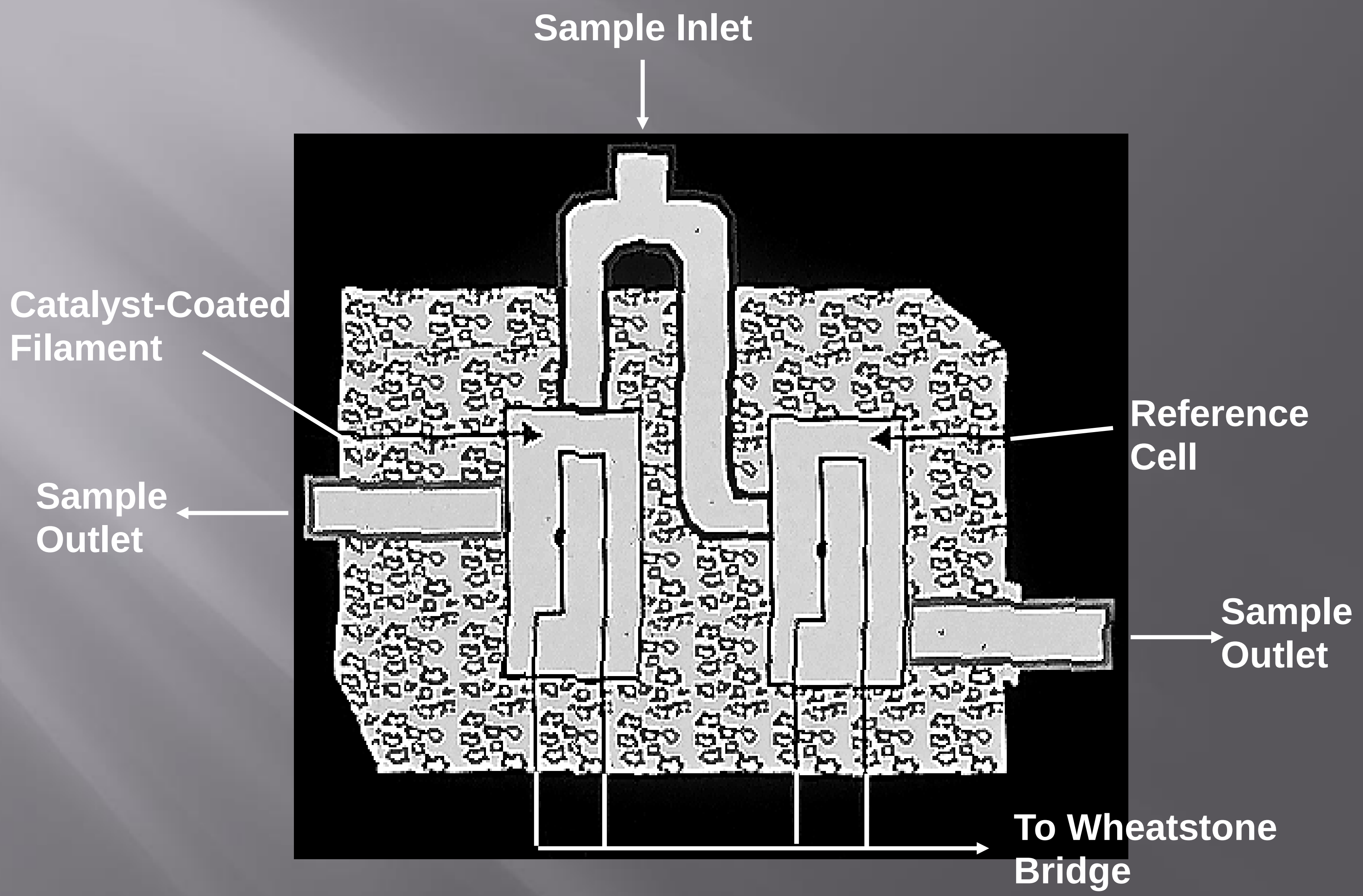
OVA 108 Readout

VOC Analyzer Using PID




FOXBORO
TVA-1000
CONTROL
1
2
3
4
5
6
7
8
9
OFF
0

Catalytic Combustion Analyzer (TLV)



USEPA Method 21
(40 CFR 60 Appendix A)

1. Applicability/Principle
2. Definitions
3. Instrument/Calibration Gases
4. Procedures

Performance Specifications
(Method 21 - 3.1.1)

- Must respond to organic compounds being processed
- Must be intrinsically safe for operation in explosive atmospheres
- Must measure concentration specified in the regulation
- Scale must be readable to +/- 2.5 percent of defined leak concentration
- Must have nominal flow rate of 0.1-3.0 liter/min
- Probe must be < ¼ inch OD with 1 opening

Specs continued

Criteria	Requirement	Time Interval
Response factor	Must be <10 unless correction curve is used	One time before detector is put in service
Response time	Must be <= 30 seconds	One time before detector is put in service If modification to sample pumping or flow conf is made a new test is req
Calibration precision	Must be <= 10 percent of calibration gas value	Before detector is put in service and 3-month intervals or next use, whichever is later

Response Factor

- The ratio of the known conc of a VOC to the observed meter reading when measured by the instrument with a reference compound

$$\text{Response Factor} = \frac{\text{Actual Concentration}}{\text{Instrument Indicated Concentration}}$$

Response Factor Examples

Actual Concentration	=	1,000 ppm
Instrument Gauge Reading	=	3,000 ppm
Response Factor	=	*??*

Actual Concentration	=	100,000 ppm
Instrument Gauge Reading	=	10,000 ppm
Response Factor	=	*??*

Response time

- The time interval from a step change in the VOC conc at the input on the sampling system to the time at which 90 percent of the value is reached on the readout meter

Calibration precision

- The degree of agreement between measurements of the same known value, expressed as the relative percentage of the ave diff between the meter readings and the known concentration

IR Camera Development

•Is there a better way?

•Hydrocarbons absorb and emit infrared energy at specific wavelengths within the IR spectrum

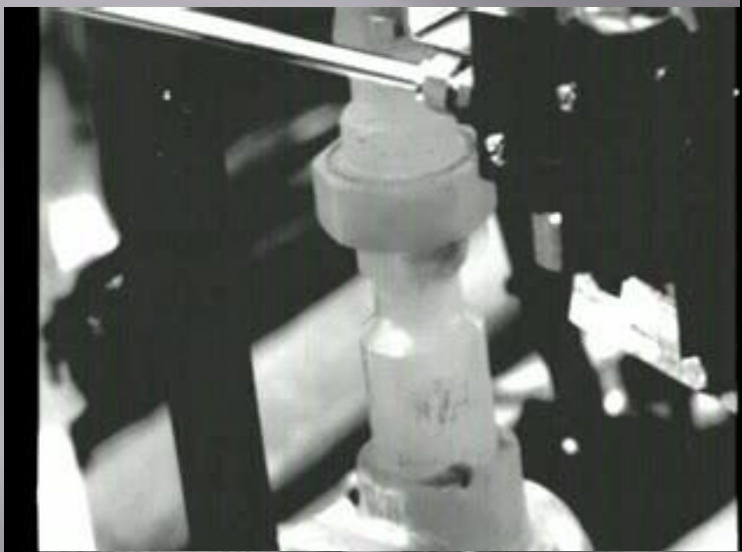
•Camera sees IR energy, but has a filter to allow only IR energy in the 3.3 – 3.5 µm wavelength band to be detected

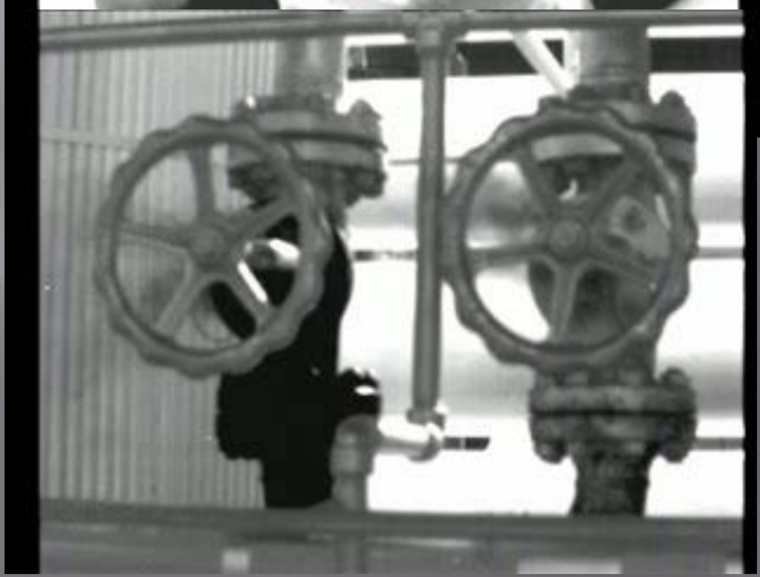
•Hydrocarbons that absorb IR energy in that range will be detected and imaged as a visible plume

Common chemicals detectable by the camera

- Benzene
- Butane
- Ethane
- Ethanol
- Ethylbenzene
- Heptane
- Hexane
- Methane
- Methanol
- Octane
- Pentane
- Propane
- Propylene
- Toluene
- Xylene

IR Camera Used for LDAR





New “alternative work practice” promulgated to allow the use of optical gas imaging as a replacement for method 21

40 CFR §63.11 (c), (d), and (e) and
40 CFR §60.18 (g), (h), and (i)

IR Camera Used for LDAR

- **<u>Expected Benefits</u>**
- *In theory* – ability to survey equipment faster

- Cheaper/less labor intensive

  Alternative work practice requires annual Method 21 monitoring

- **<u>Actual Implementation</u>**
- Camera is not as sensitive
- The image can be manipulated – leaks can disappear or be seen more easily with certain camera settings
- Image affected by background, environmental conditions
- Daily calibration and recordkeeping of everything monitored
- Camera is not intrinsically safe
- Camera is very expensive

Examples From Real Inspections

- Compressor distance piece oil sump at a natural gas compressor station
  - Distance piece is designed to prevent lubricating oil from leaking into the compressor cylinder.
  - Distance piece also acts as a process gas leakage control device
  - In this case, compressed gas was leaking passed the packing rings and carried over into the oil sump

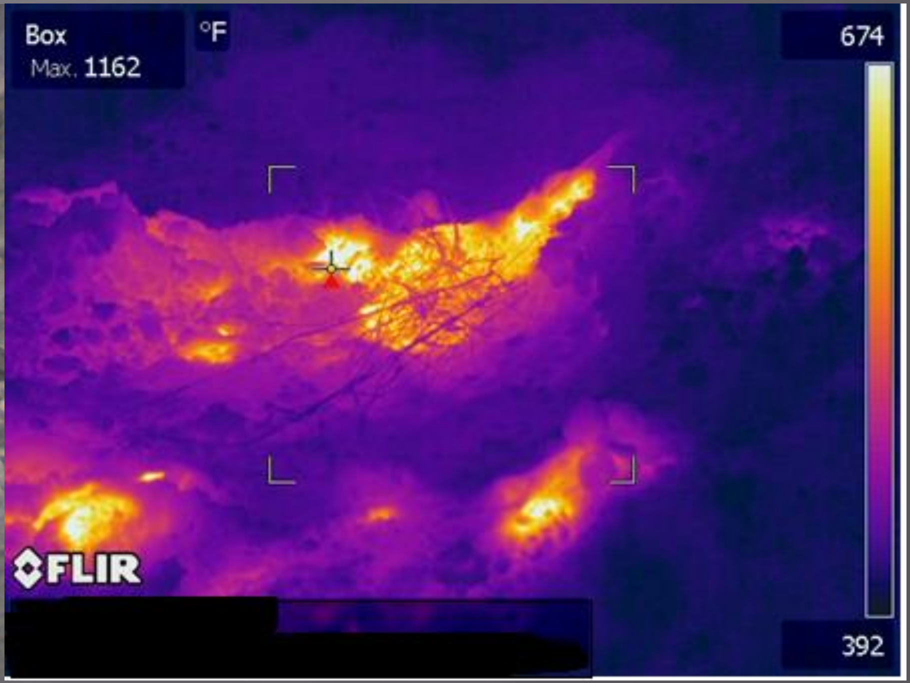
Examples From Real Inspections

Storage vessel bleeder vents must be closed at all times unless the tank roof is being landed or floated off the leg supports

Examples From Real Inspections

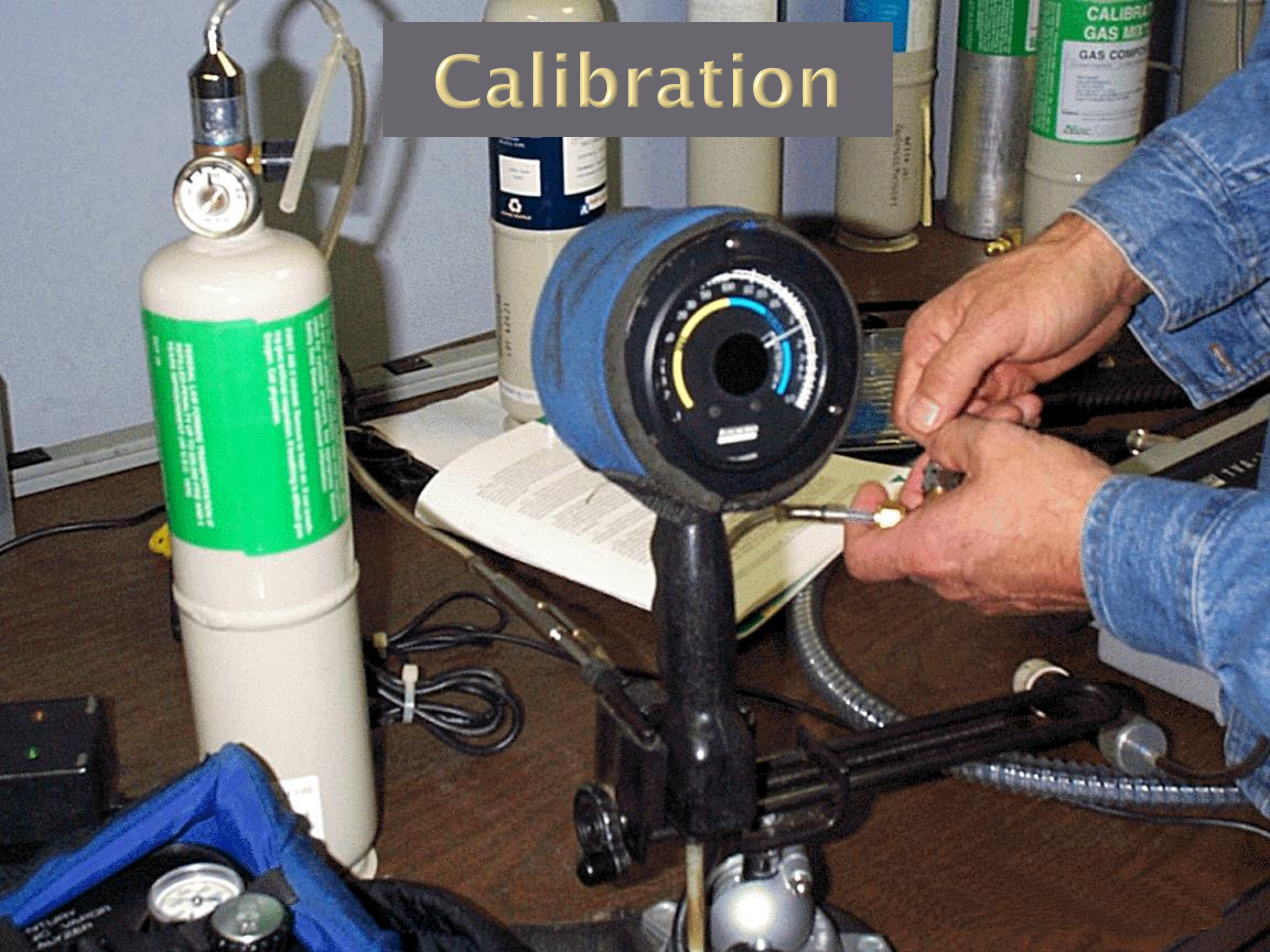
- Refinery Flare
  - Excess steam = incomplete combustion of hydrocarbons

Temperature Readings



- Fruit processing plant waste dumped in a pit
- Exposure to air and decomposition caused it to heat up
- IR camera used to see elevated temperatures

Calibration



Calibration Gases
(Method 21 - 3.2)

- Zero air (< 10 ppm VOC)
- Span gas
- Cylinder cal gas mixtures
  - certified to $\pm$ 2 % accuracy
  - shelf life specified
- Prepared gases
  - accurate to $\pm$ 2 %
  - replaced each day

Preparing PIDs for Field Use

1. Check battery status
2. Check probe condition
3. Check for obvious deposits on optical window
4. Confirm detector response
5. Measure sample gas flow rate at probe inlet
6. Calibrate

Performance Criteria
(Method 21 - 3.1.2)

- Response Factor less than 10
- Response time of 30 seconds or less
- Calibration precision less than or equal to 10% of calibration gas value

Determining Flow Rate

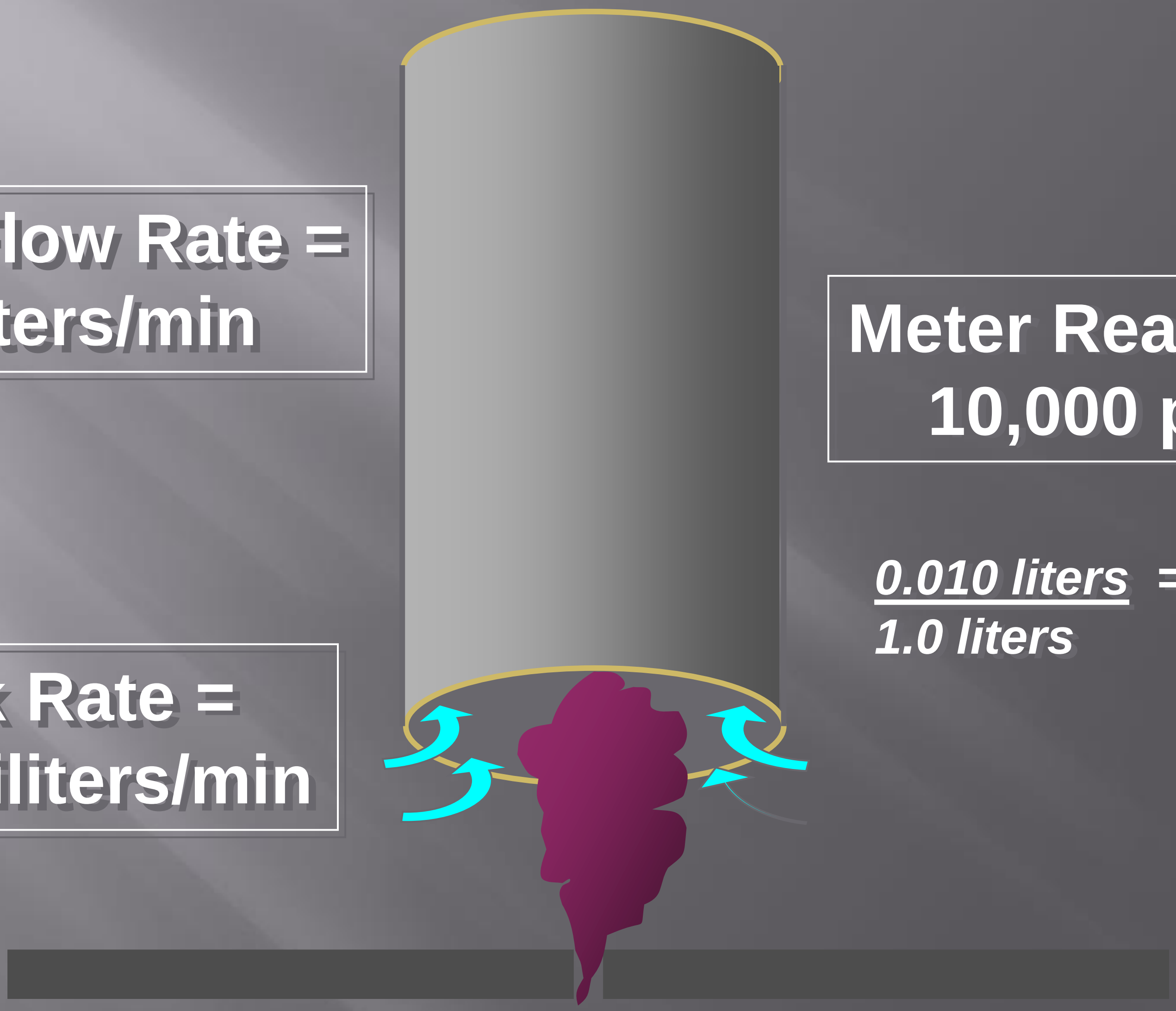
- Highly recommended
- No official protocol
- Flow rate may be affected by contamination, battery life, etc.

Effect of Flow Rate

Pump Flow Rate = 1.0 liters/min

Meter Reading = 10,000 ppm

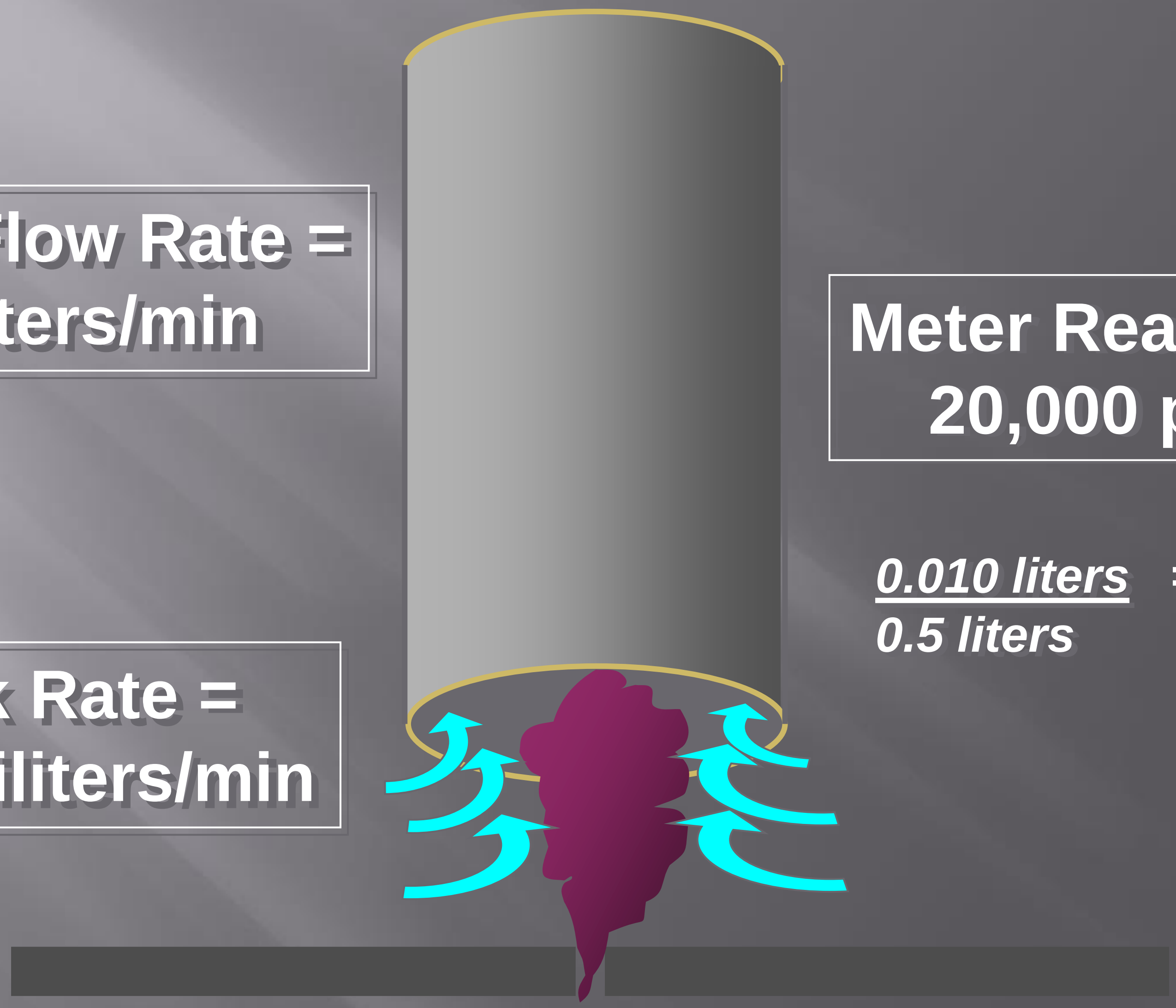
$$\frac{0.010\ \text{liters}}{1.0\ \text{liters}} = 0.010000$$



Leak Rate = 10 milliliters/min

Effect of Flow Rate

Pump Flow Rate =
0.5 liters/min



Meter Reading =
20,000 ppm

$$\frac{\textit{0.010 liters}}{\textit{0.5 liters}} = \textit{0.020000}$$

Leak Rate =
10 milliliters/min

CONDUCTING AN INSPECTION

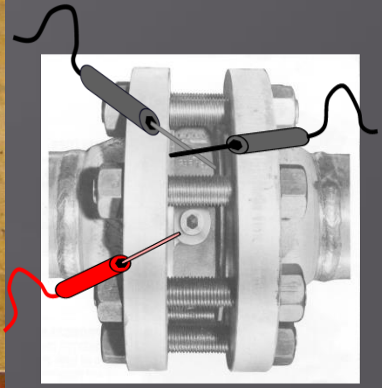
Leak Detection Monitoring

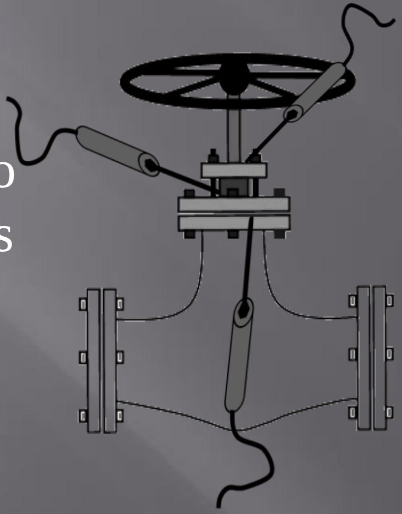
- 1000’s to 100s of 1000’s of valves and connections that must be monitored for leaks

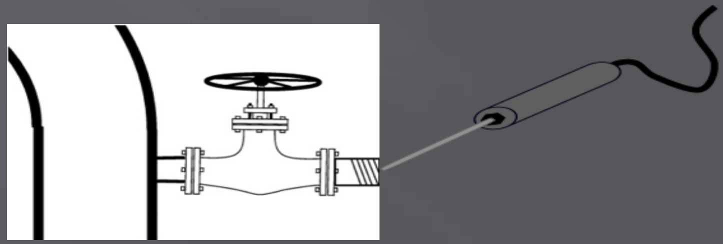
- 90 to 99% of valves and connections are not leaking

- Costly, monotonous, time consuming

- Work is contracted out to lowest bidder, technicians often uneducated and complacent







EPA list of common problems leading to enforcement

- Failure to Identify process units and components
- Failure to follow prescribed proceedures
- Incorrect or expired calibration gases
- Failure to repair and retest leakers on time
- Failure to submit quaterly records
- Failure to maintain calibration and monitoring records

Pre-Inspection

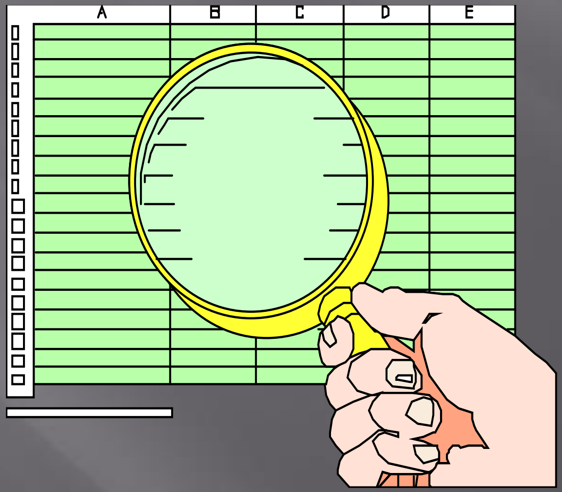
- Regulation Review
- File Review
- Permit Check
- Equipment Check

On-Site Inspection

- Initial Interview
- Records Review
- Plant LDAR Program Evaluation
- Component Screening Strategies
- Leak Monitoring

Records Review

- Are records complete per regulations?
- Verify unsafe and difficult-to-monitor determinations listed
- Check process unit determinations



Plant LDAR Program Evaluation

- Evaluate tracking system for scheduling monitoring and repairing
- Interview plant personnel
- Observe calibration of leak detection equipment
- Observe leak detection monitoring

Focusing the Inspection

Most important components for monitoring:

- *components/process units with history of high leak rates*
- *valves in gas and light-liquid service*
- *pumps in light liquid service*
- *compressors*

Review component identification system

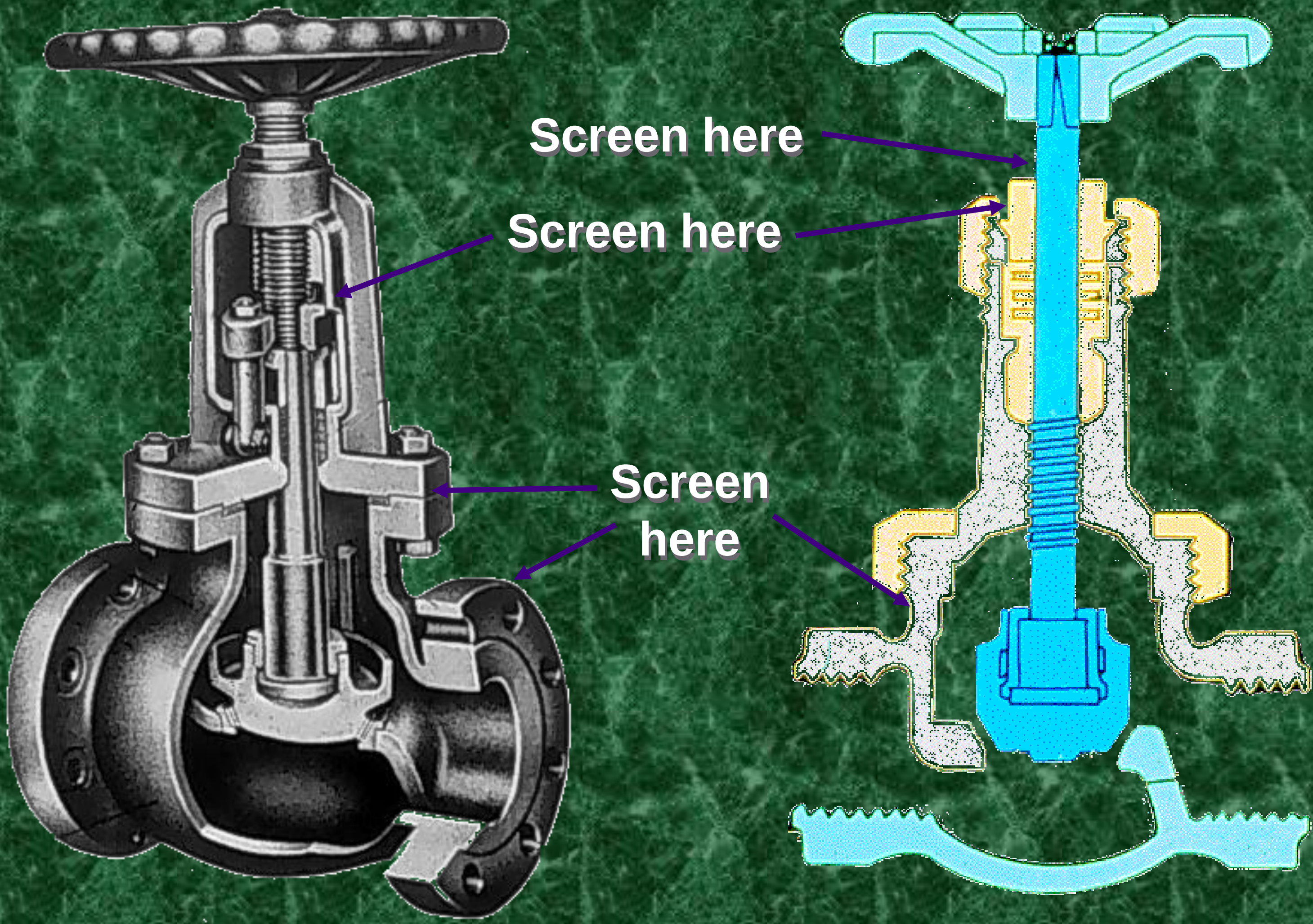
Locating Potential Leaks

- Individual Component Survey
  - visual, auditory, olfactory
  - soap solution screening
  - portable VOC analyzer
- Area Survey ("Walk-Through")
- Fixed Point Monitors
- Infrared imaging

Monitoring Individual Components (Method 21 - 4.3.1)

- Measure background levels
- Probe at surface of component
- Move along interface periphery while observing readout
- If increase occurs, sample until maximum reading; leave probe tip at this location for approx. 2 times response time
- Record results

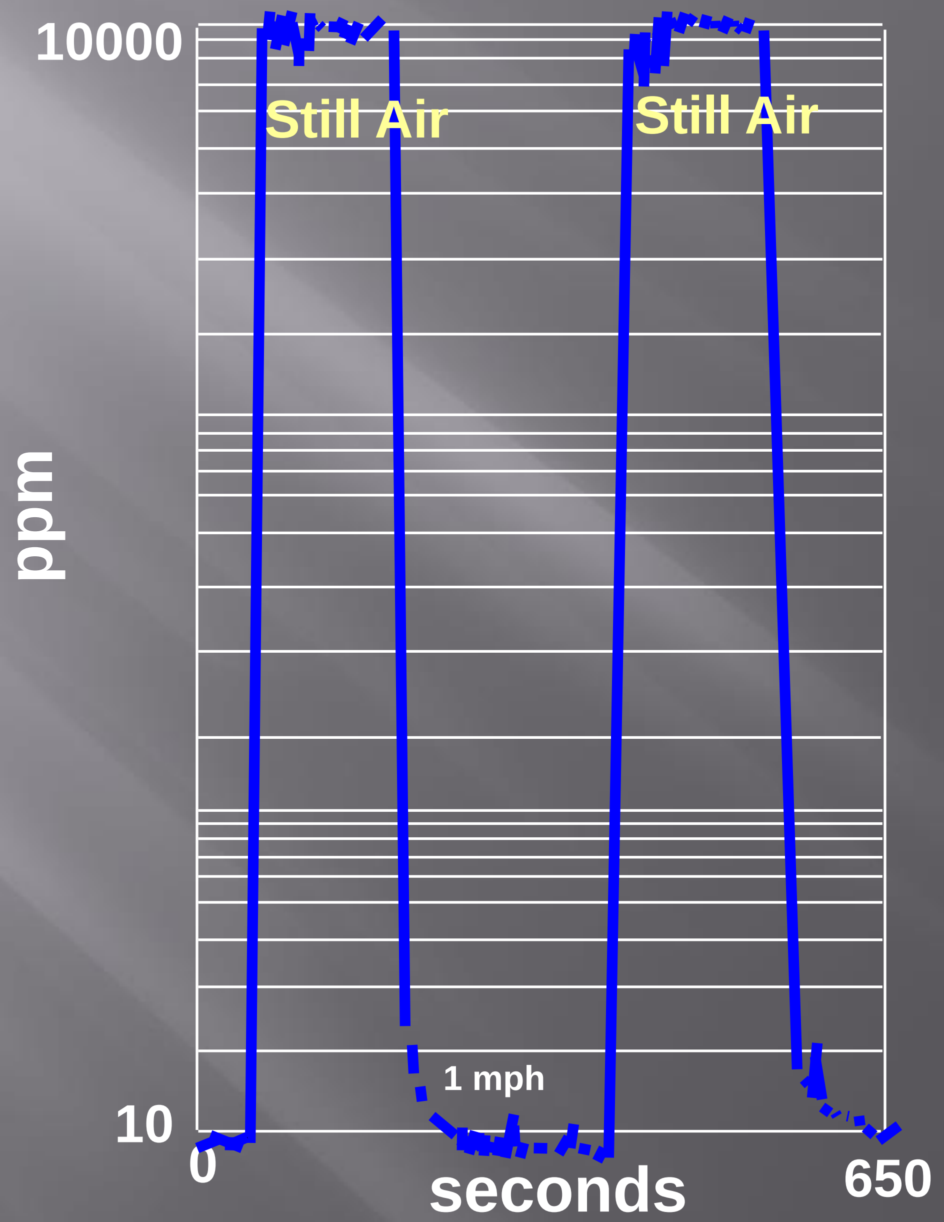
Screening Valves



Limitations and Problems Using Portable Instruments

- Poor capture capability & pinpoint nature of most leaks --> probe should be oriented directly into plume
- Negative pressure sampling --> limited capture distance
- Air drawn into probe from all directions --> dilution
- All instruments sensitive to gas flow rates
- Cross-wind reduces capture efficiency

Effect of Wind Velocity on PPM Reading
(probe tip 1/4" from leak source)



Effects of Excessive VOC Intake

Flame Ionization Detectors

- Flame-out at sample concentrations above 70,000 to 100,000 ppm
- Blinding of flame arrestor
- Sustained high observed readings due to condensation & revolatilization in sample lines

Photo Ionization Detectors

- Condensation of organic materials on the optical surface
- Condensation and revolatilization

Catalytic Combustion Analyzers

- Volatilization of catalyst on detector wire
- Condensation and revolatilization

Post-Inspection

- Compare field inspection observations with plant records
- Review findings with plant representative(s)
- List items to be checked during follow-up inspection(s)


Inspection
Safety

Pre-Field Safety

- Calibrate in well-ventilated space
- Make sure all intrinsically-safe features are intact
- Review possible on-site hazards
- Wear long-sleeved, fire protective clothing
- Be trained in use of specialized equipment

Field Safety

- Stay alert
- Move at a reasonable pace
- Be extremely cautious around hot (or cold) surfaces
- Be extremely cautious monitoring components with rotating shafts
- Stay upwind of components being screened
- Keep both hands free when climbing ladders
- Don’t make “heroic” physical efforts to reach components