Hot Mix Asphalt (HMA) Facilities

Overview

- Introduction
- Emissions and Effects
- Process
- Control
- Permit Requirements
- Inspection Procedures

Introduction

Industry Background

- **Over 125 Hot Mix Asphalt (HMA) facilities in CA**
  - ✓ **Stationary**
  - ✓ **Some transportable**
- **HMA is combination of**
  - ✓ **Hot aggregate,**
  - ✓ **Hot liquid asphalt binder**
  - ✓ **Filler**

- **Recycled Hot Mix (RHM) is HMA with**
  - ✓ **Crumb rubber (rubberized asphalt concrete)**
  - ✓ **Reclaimed asphalt**

Introduction

<u>Industry Background</u>

- Two basic processes
  - ✓Batch
  - ✓Continuous mix
- Batch change recipe based on customers order
- Continuous mix one recipe at a time stored for up to 7 days in insulated silo

Introduction

<u>Permit Process Requirements</u>

- District issues an
- "Authority to Construct"
- Inspection conducted
  - ✓Usually includes a source test
- All conditions met "Permit to Operate" is issued

Emissions and Effects

- HMA facilities emit pollutants such as PM, CO, NOx, SOx, VOCs and other toxic substances
- NOx and VOCs are Ozone (O_3) precursors each reacts with sunlight to form O_3

Emissions/Effects

Typical HMA Pollutants	Emissions (tons/yr)
PM (total for all size categories)	1500
PM10	700
PM2.5	400
CO	800
NOx	450
Total Organic Compounds	200
Reactive Organic Gas	200
SOx	100
VOCs	200

Emissions/Effects

AB 2588 Emission Inventory

- Requires HMA facilities to submit an emission inventory
- HMA emit 78 of the 730 listed "Toxic Substances"
- Emission Estimates
  - ✓US EPA, AP-42;
  - ✓District; or
  - ✓Source Test

Emissions/Effects

<u>Criteria and Precursor Pollutants</u>

- Created during production, storage, and transport of HMA
- PM from aggregate

Emissions/Effects

Criteria and Precursor Pollutants (cont.)

- **PM, CO, NOx, VOCs, and SOx from fuel combustion and storage of asphalt binder and HMA**
- **Blue Smoke (VOCs) from production and loading**

Process/Control

Hot Mix Facilities are Regulated Under Subpart OOO

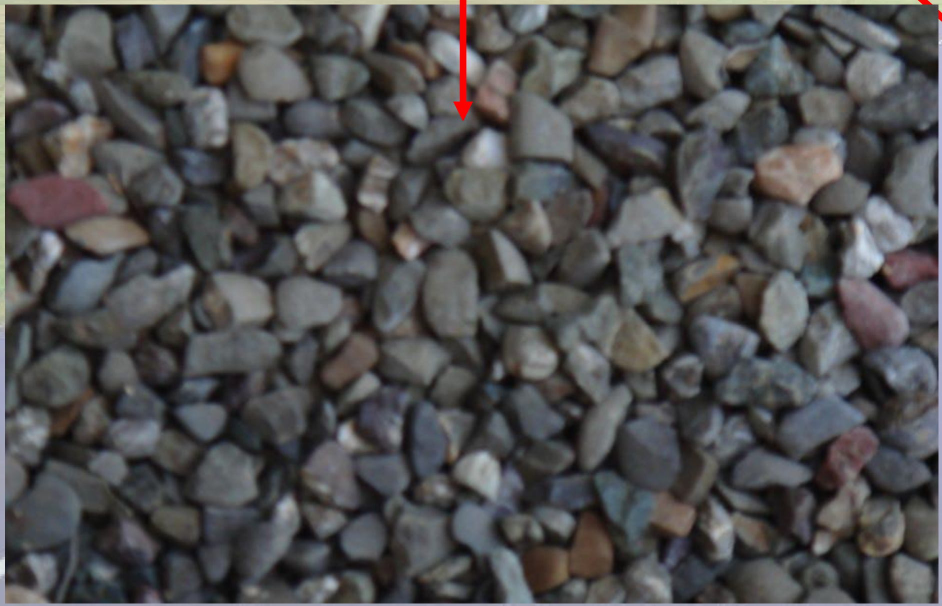
- ✓ How much aggregate is processed
- ✓ Moisture content of the processed material
- ✓ Control efficiency of the air pollution control equipment
- ✓ Opacity


The Process

Process

Composition of HMA

- Binder
- Filler
- Aggregate

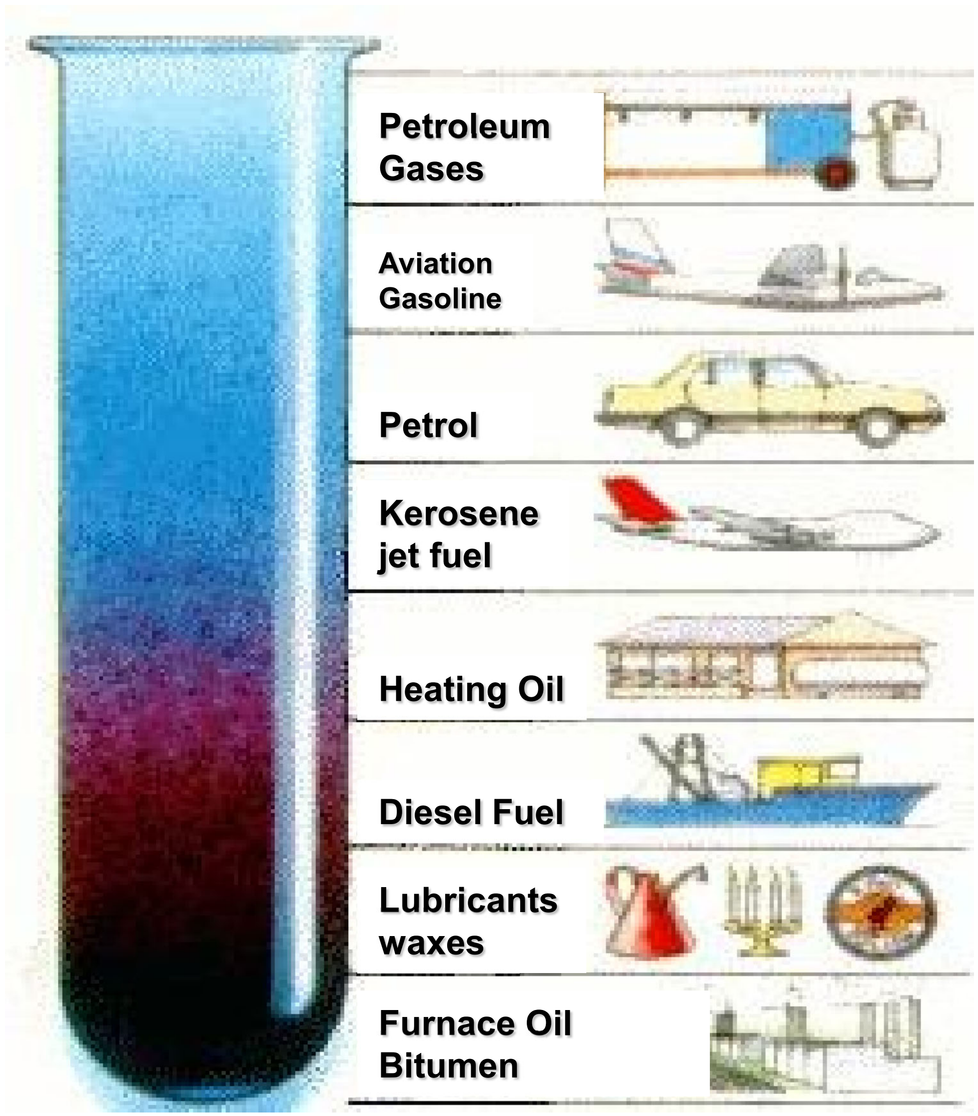


Process
Binder Composition

<u>Binder Terms</u>

- **Asphalt Binder**
  - ✓ **Includes asphalt cement and any material added to modify properties**
- **Bitumen**
  - ✓ **Class of dark colored (solid, semi solid, or viscous)**

Process
Binder Composition



Crude Petroleum Distillation Fractions

Process
Asphalt Grading

- Two grading methods
  - ✓ Viscosity Grading of Binder
  - ✓ Superpave Performance Grade (PG)

Process

<u>Viscosity Grading of Binder</u>

- Viscosity test developed during the early part of the 20th century.
  - ✓AC
    - Tests viscosity of binder to characterize viscosity as supplied (simulating condition before used)
  - ✓AR
    - Tests viscosity of binder aged in a rolling thin-film oven (simulating HMA production)

Process

Viscosity Grading of Binder (cond.)

- PG (Superpave Performance Grade)
  - ✓ Test developed in 1980-1990
  - ✓ Based on performance of binder in relation to climate
  - ✓ Temperature range is 115 to 180 F
  - ✓ Address rutting, fatigue cracking, and thermal cracking

Process

<u>Conventional HMA Binder</u>

- Solid at room temperature
- 250 and 325 F from point of origin to the final destination
- Softening binder adds VOCs by
  1. Adding softer grade asphalt
  2. Adding lighter petroleum oils

Process

Figure 2.16: RAP in Aggregate-Sized Chunks

Typical Alternative Asphalt Binder

- Reclaimed asphalt pavement (RAP)
- Used tires (crumb rubber)
- Proprietary polymers
- Anti-stripping agents (hydrated lime)
- Recycled baghouse dust

Process

Polymer Modified Binders

- proprietary blends added to bitumen
- Formula varies depending on desired result of end product

Process

Filler

- Dust added to asphalt binder and aggregate to improve adhesion

Process

RECIPE FOR HOT MIX ASPHALT

Process

Hydrated Lime

- Caltrans requires a lime-slurry-marination (LSM) where climate promotes stripping
- Requires that mixture be stockpiled for 24 hours before use "marinated"

Process

Hydrated Lime

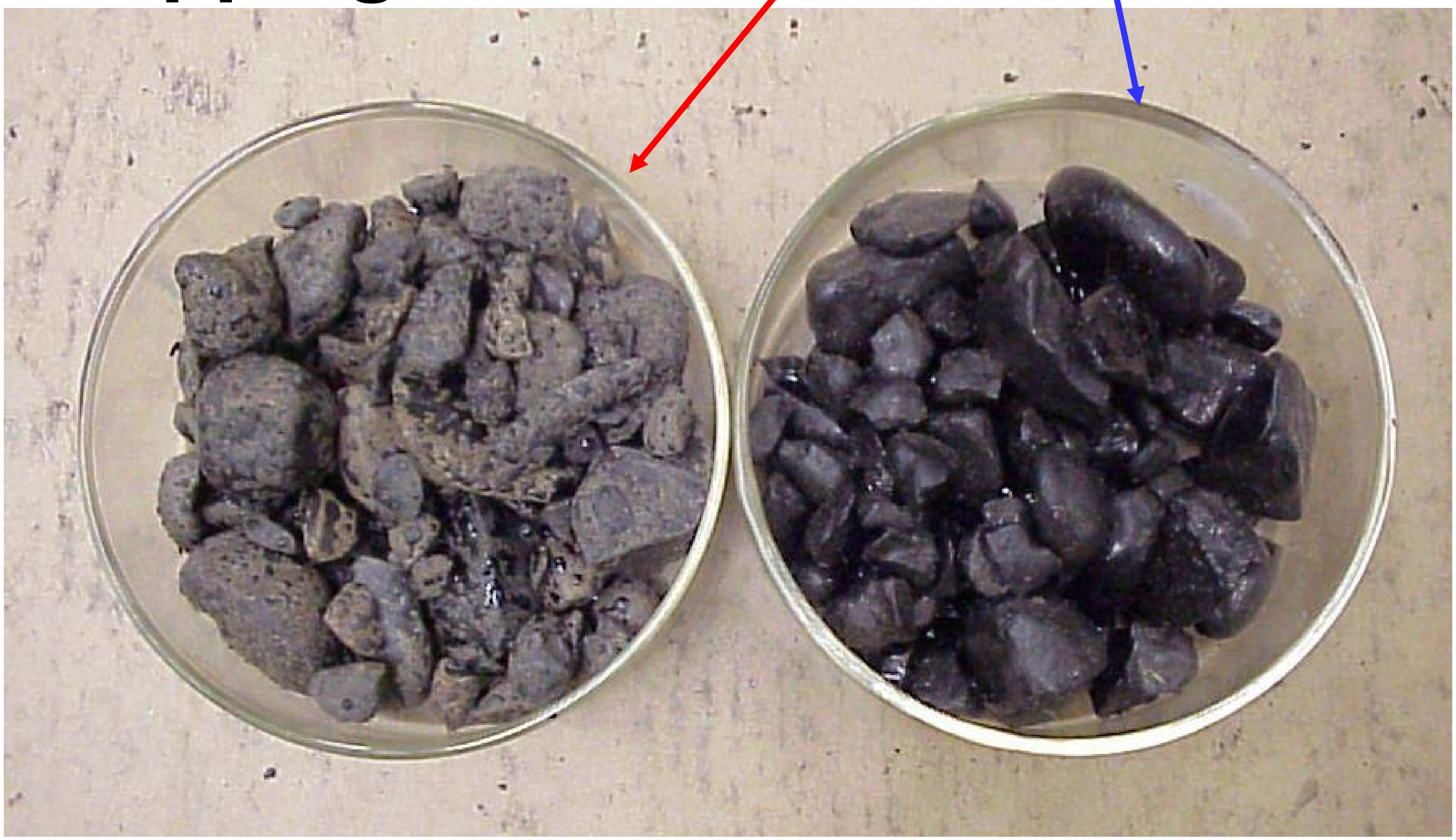
- Anti-stripping agent:

1. Added dry with binder
2. Added dry to wet or dry aggregate and “marinated” for several days
3. Added as lime slurry for immediate use or “marinated”

Process

Anit-stripping Agents

Illustration of binder with anti-stripping agent and without anti-stripping



Process

Alternative Binders

- Kept at temperatures higher than conventional binder
- Two types
  1. Polymer-modified asphalt cement
  2. Crumb rubber modified

Process

Crumb Rubber

- Added to binder to make crumb rubber modified (CRM)
- 75% scrap tire and 25% virgin rubber
- Non-hazardous hydrocarbon polymer
- Rubber-modified asphalt concrete (RAC)

Process

<u>Advantages of Crumb Rubber</u>

- Waste reduction
- Less water
- Quiet
- Lasts Longer
- BUT No regulatory relief from visible emission evaluation (VEE)

Process

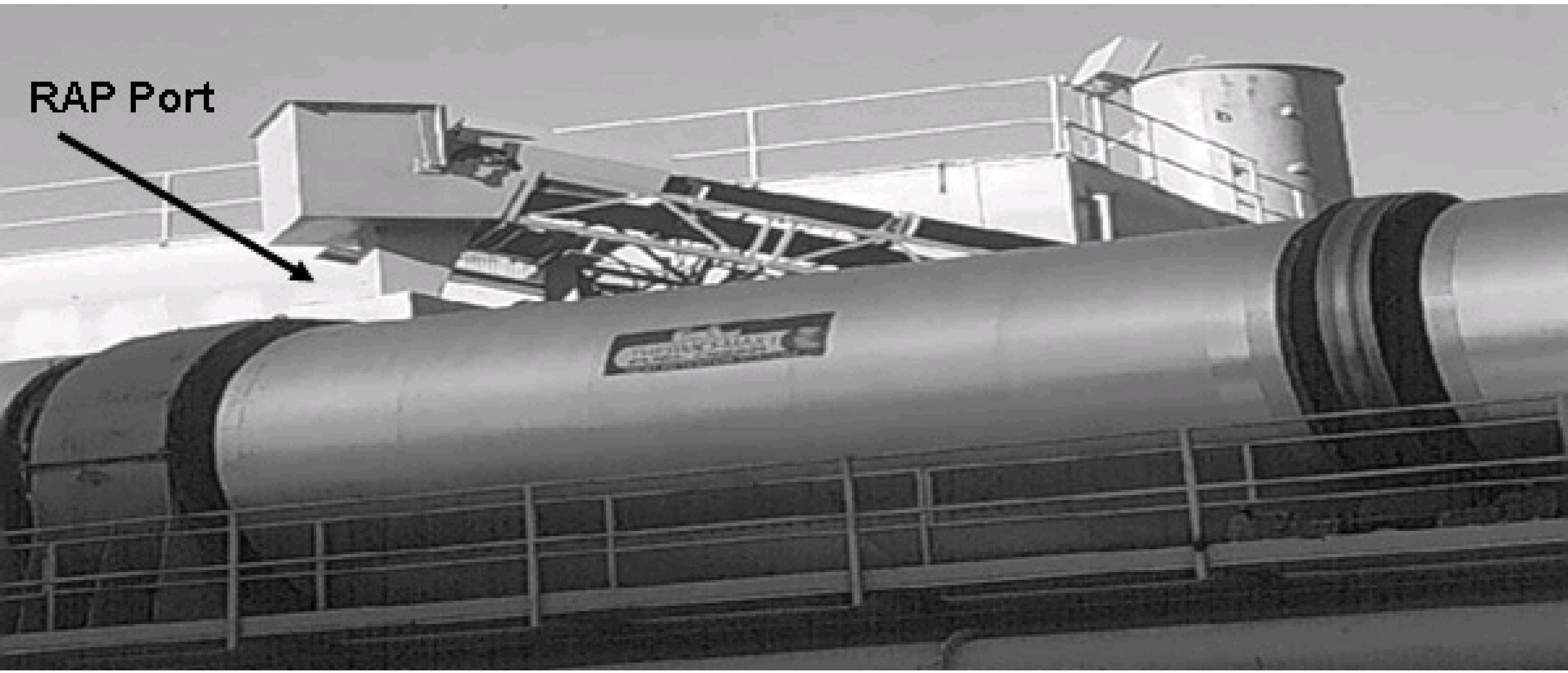
RECIPE FOR RAC

Process
Reclaimed Asphalt Pavement

- RAP is
  - ✓ Top layer of asphalt pavement removed
- Developed because of energy, economic, and environmental concerns
- RAP could be 30% of mix
- Increases asphalt lifetime
- May increase generation of Blue Smoke

Process
RAP

- Production temp of virgin aggregate is 500-800 F
- RAP is heated through conductive heat transfer
- RHM is 350 F

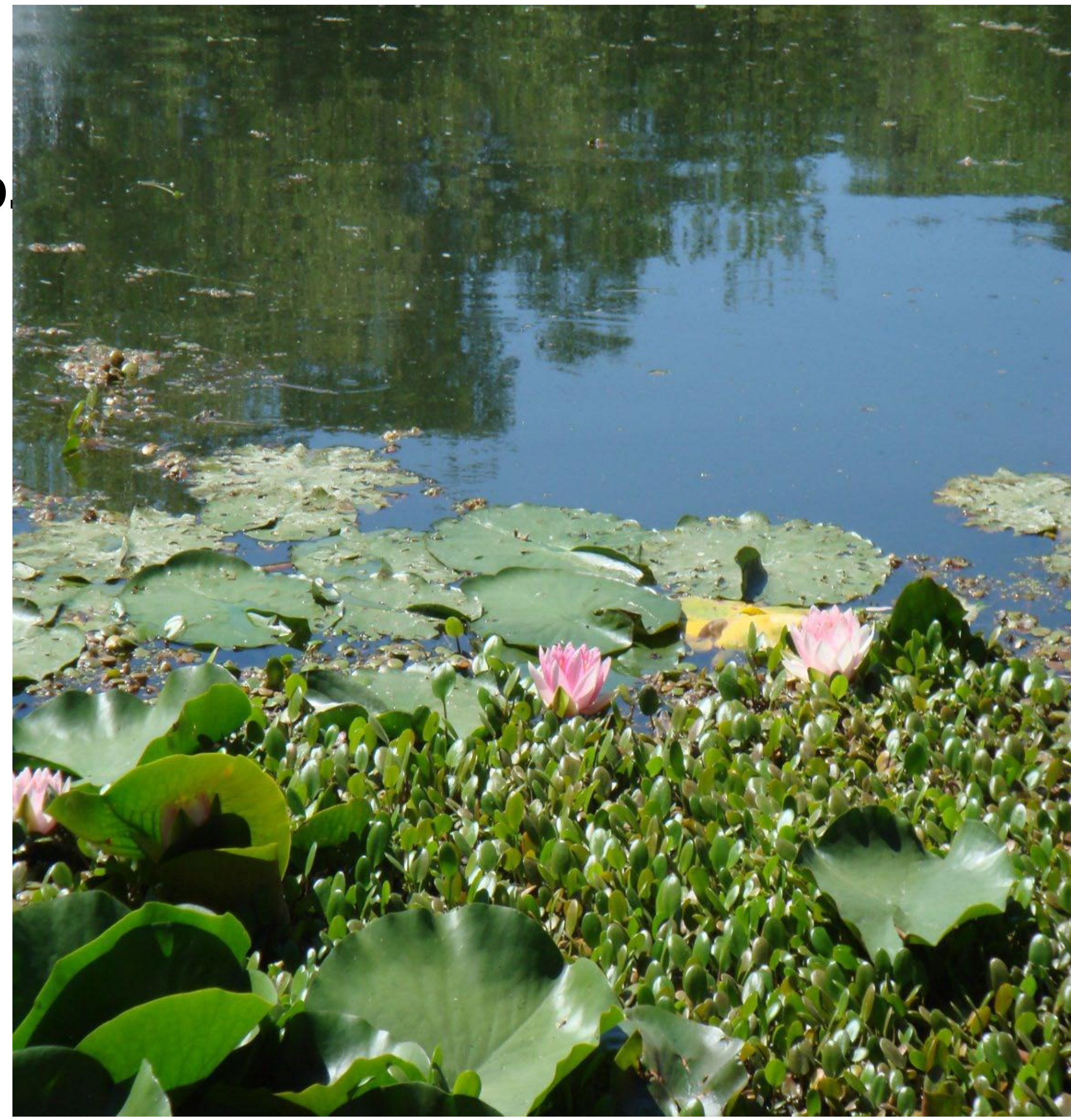


Process

RECIPE FOR RECYCLED HOT MIX

Process
In the News

- Watch for
  - ✓ Warm mix asphalt
- Advantages
  - ✓ Lower Production temp. 220 to 275 F
  - ✓ Less energy
  - ✓ Reduced cracking
- Disadvantages
  - ✓ Further testing to ensure QA/QC
  - ✓ Rutting
  - ✓ Workability
  - ✓ Longer setting=traffic delays

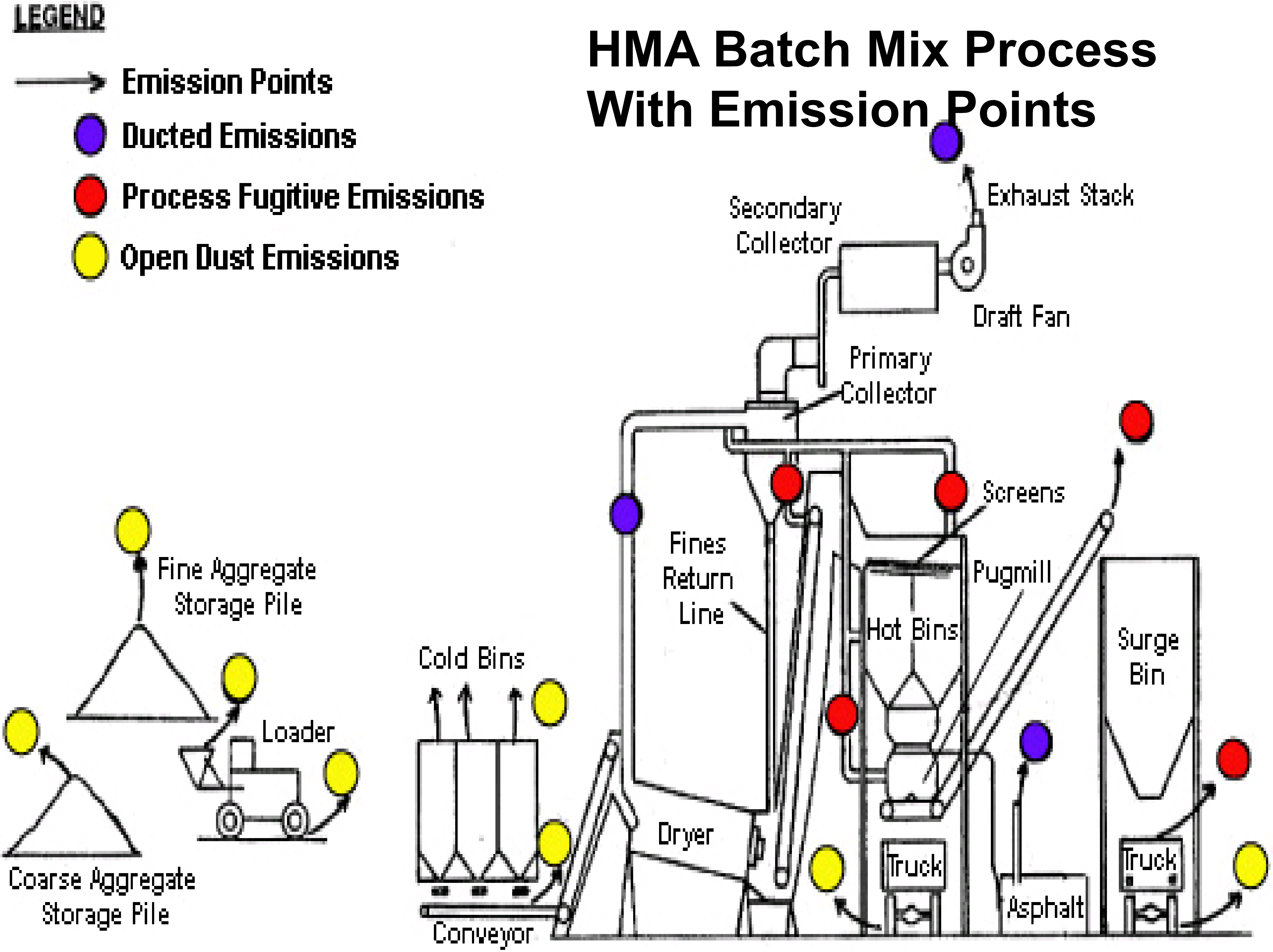


Process
HMA Facility Types

- Batch
- Continuous Mix

Process
Batch Mix

HMA Batch Mix Process With Emission Points



Process
Batch Facility

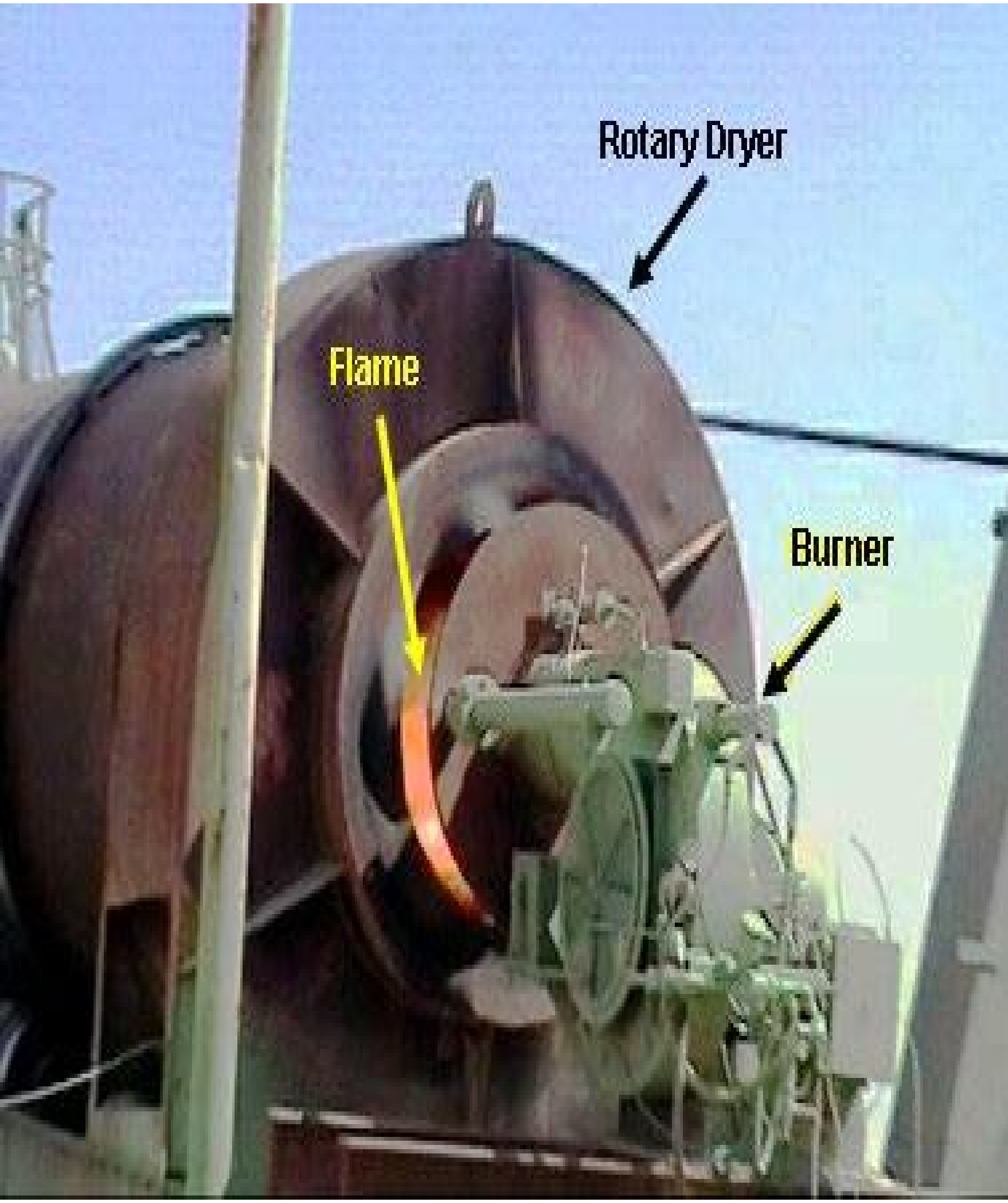
- Aggregate
  - ✓Stored in cold bins
  - ✓Moved by conveyor
  - ✓Sorted and weighted
  - ✓Dropped into dryer
  - ✓Elevated to top of batch tower and
  - ✓Separated

Process
Cold Bins
Aggregate Stockpiles

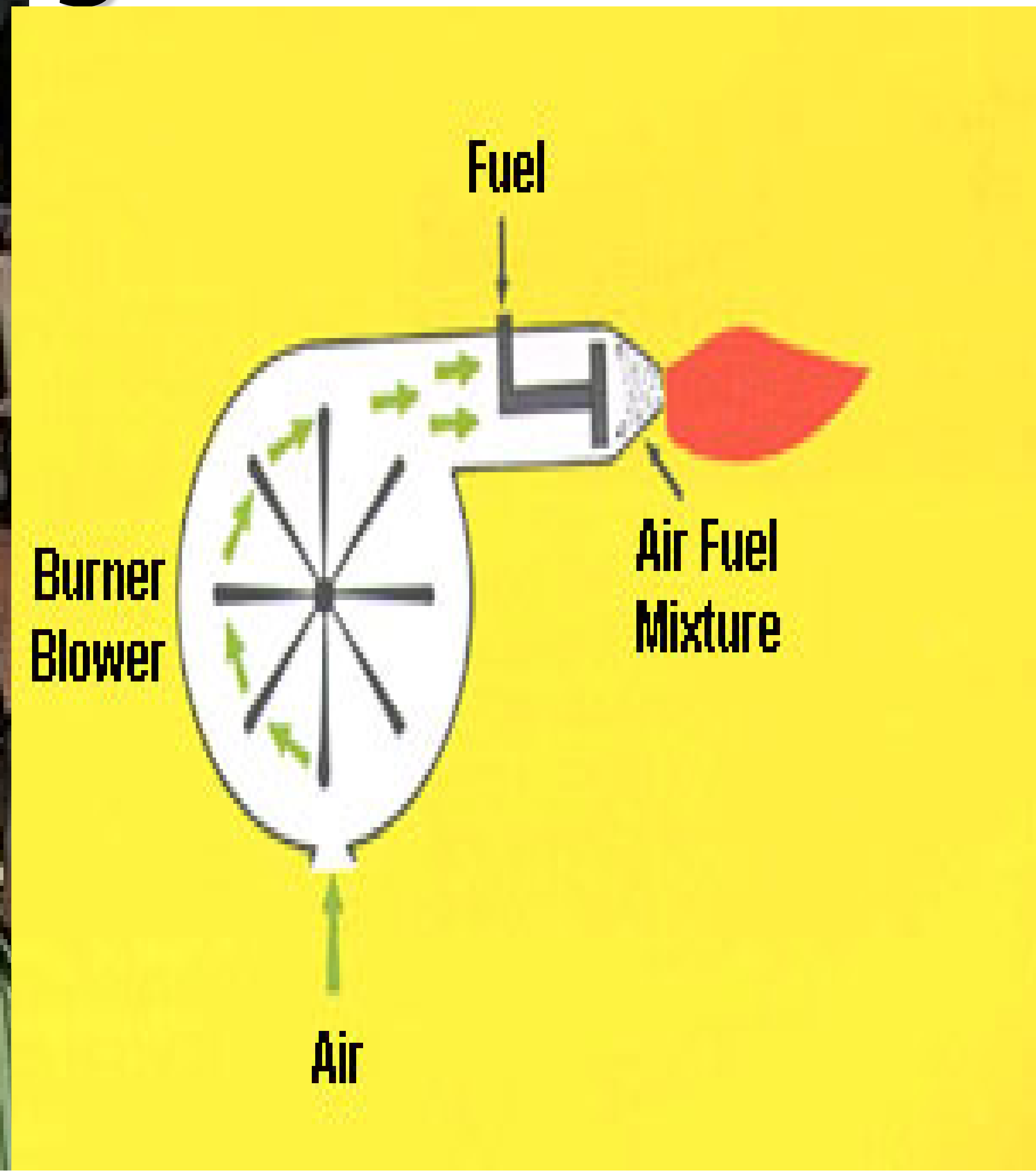
Process
Cold Bins and Conveyors

Batch Process
Aggregate Dryer

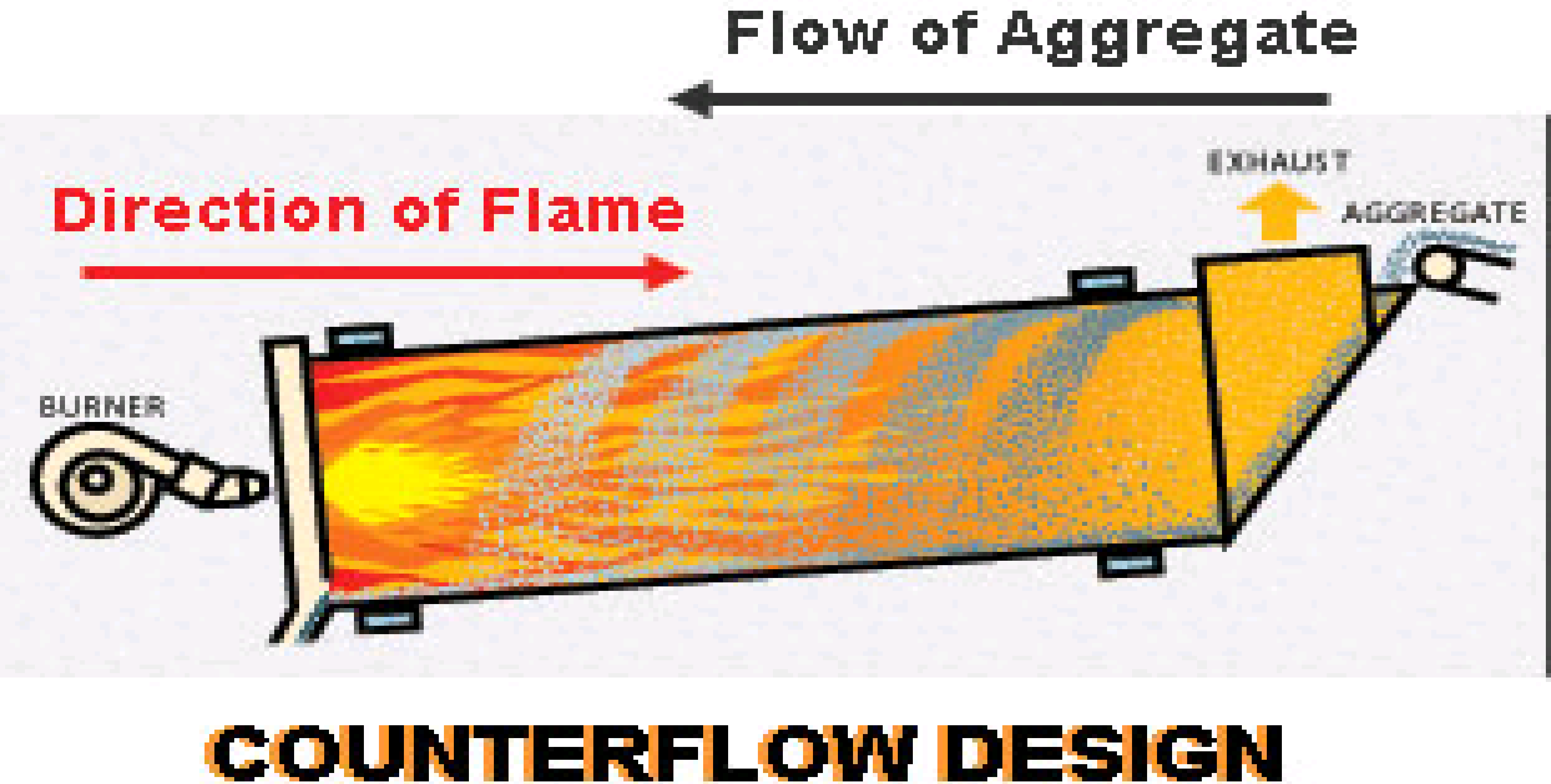
Batch Process Rotary Dryer



Process Combustion and Basic Burner Design



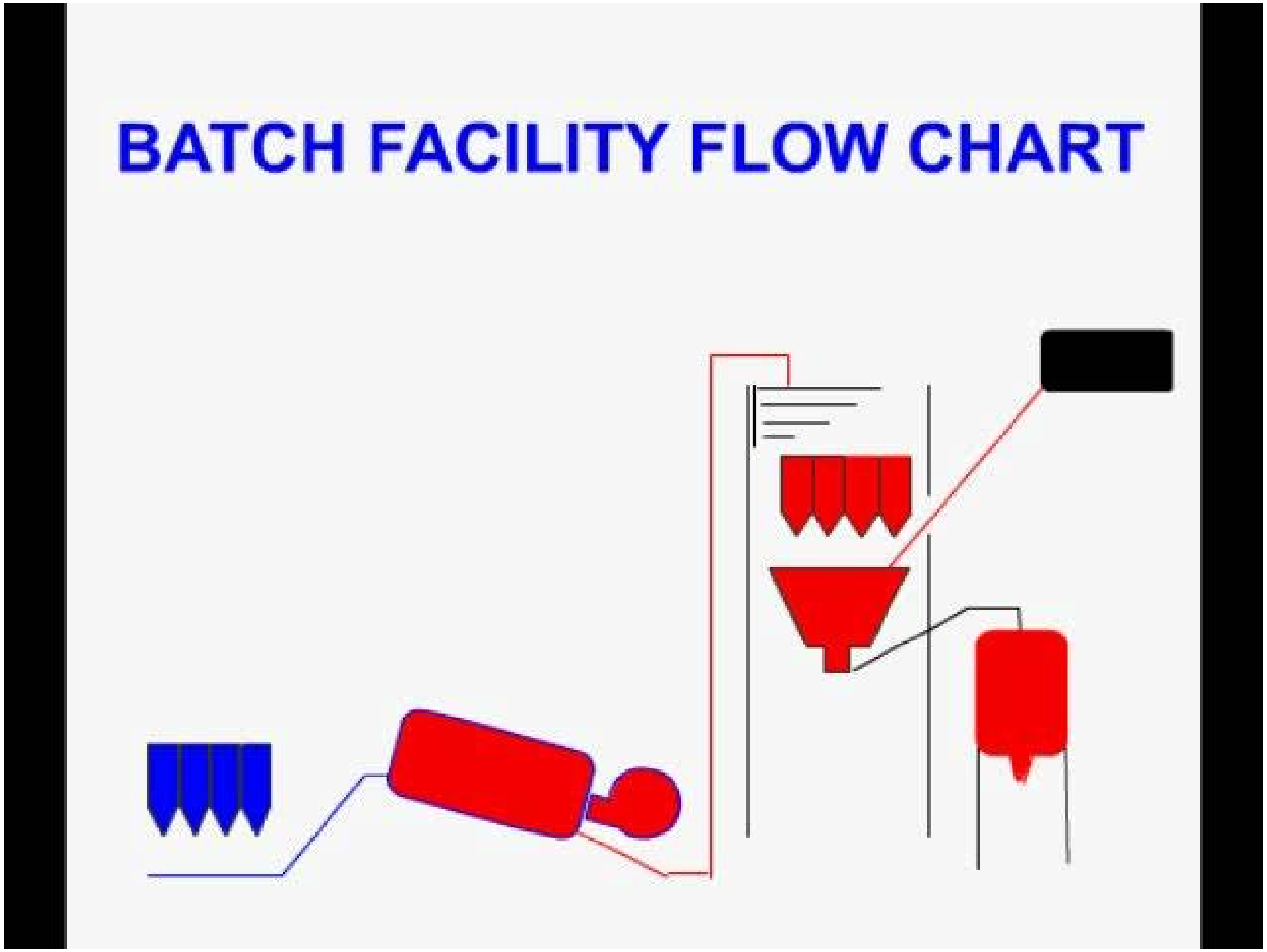
Batch Process Rotary Dryer Counterflow Design



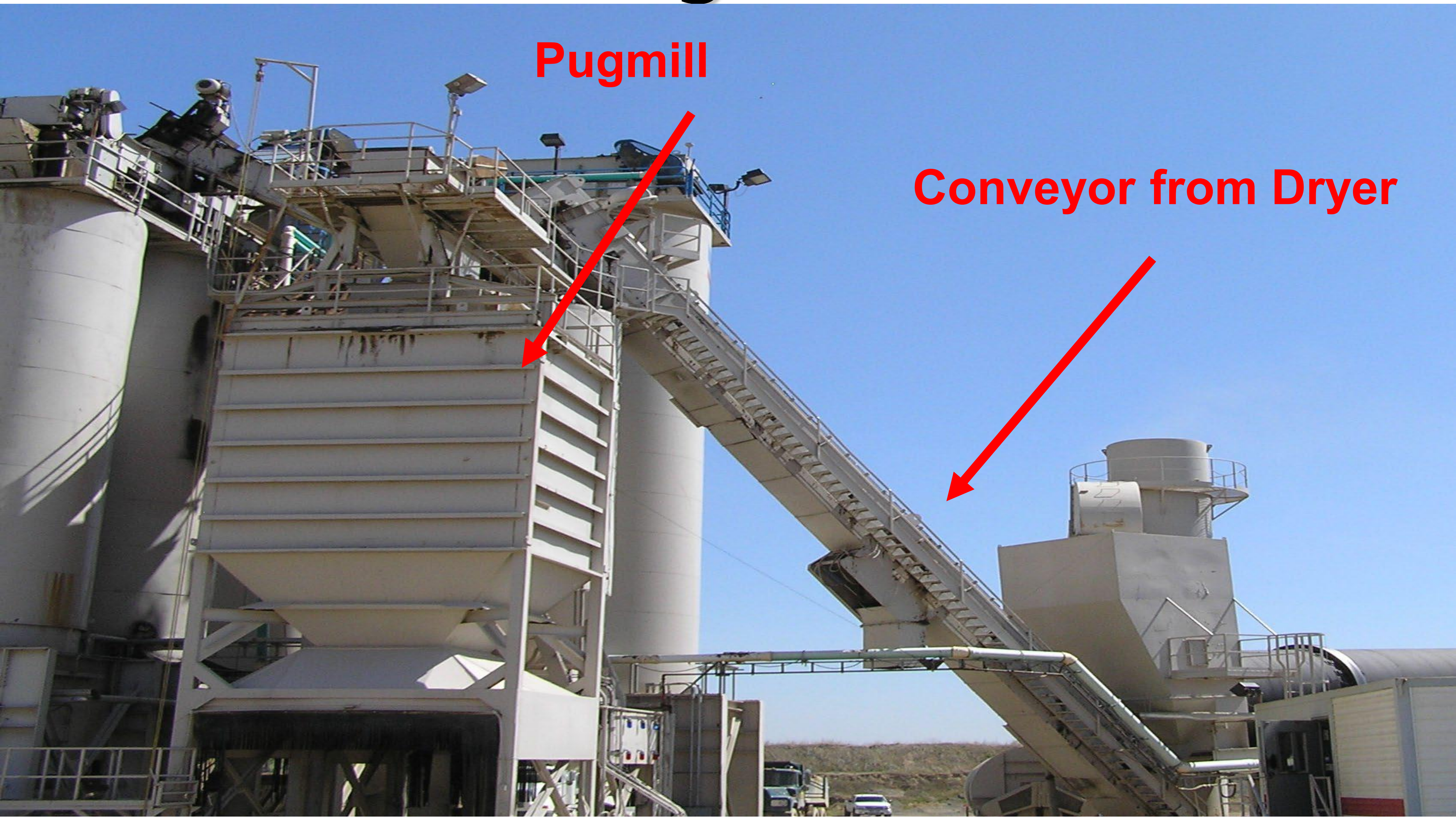
Batch Process
(continued)

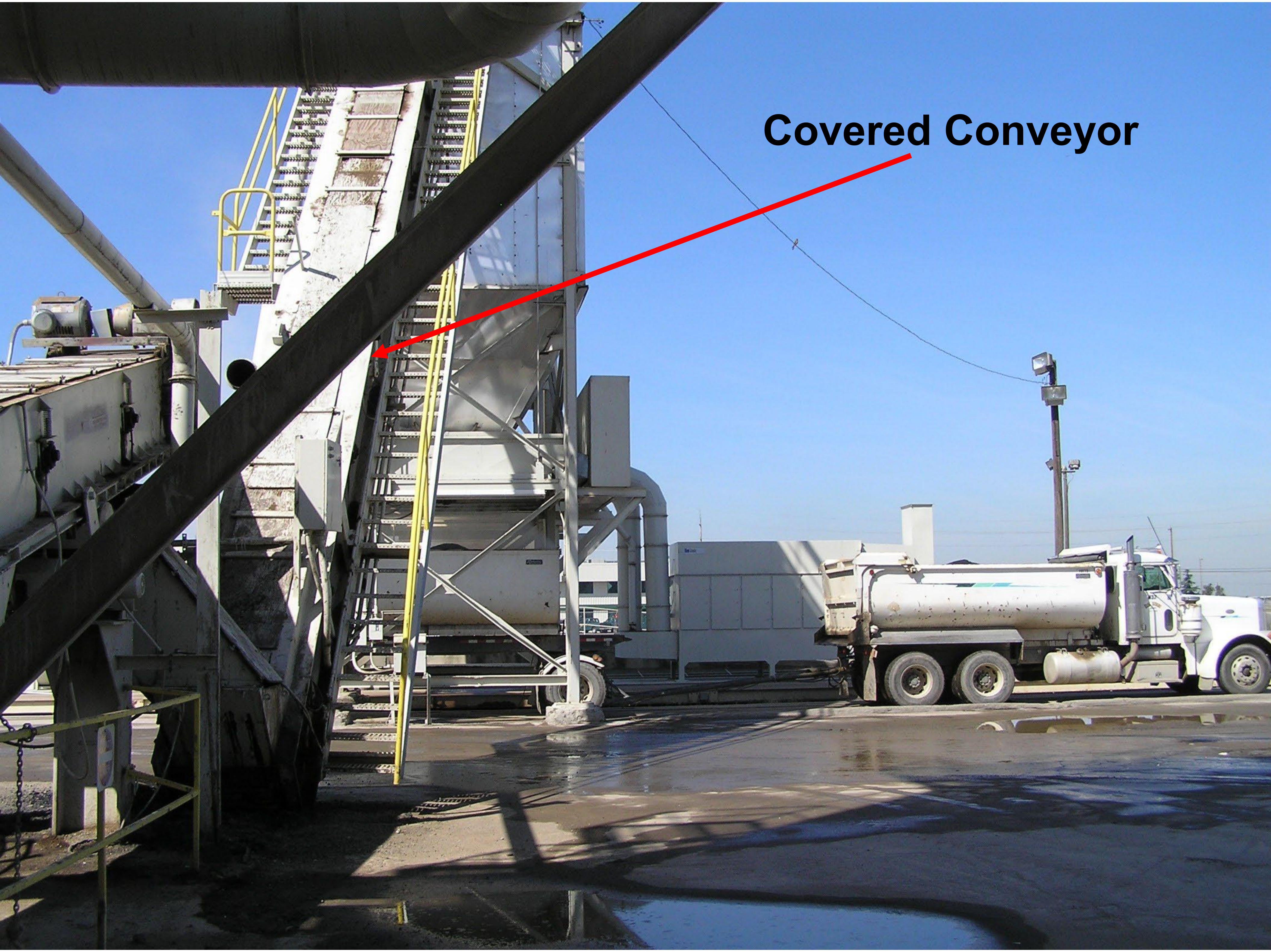
- Hot aggregate dropped from elevator to vibrating screens, sorted by size
- Weighed, and dropped into pugmill for mixing with
- Hot liquid asphalt binder and filler until coated
- Dropped into truck for delivery

Process



Batch Process Hot Aggregate Conveyor to Pugmill




Covered Conveyor

Batch Process
View of Pugmills


D.H. WINN


3
2
1
HOT PLANT
CB
CHANNEL 20
DRIVERS
DO NOT WEAR
OILY GLOVES
WHEN
CLIMBING LADDERS
TURNING VALVES
STARTING PUMPS

Batch Mix Process without Pugmill

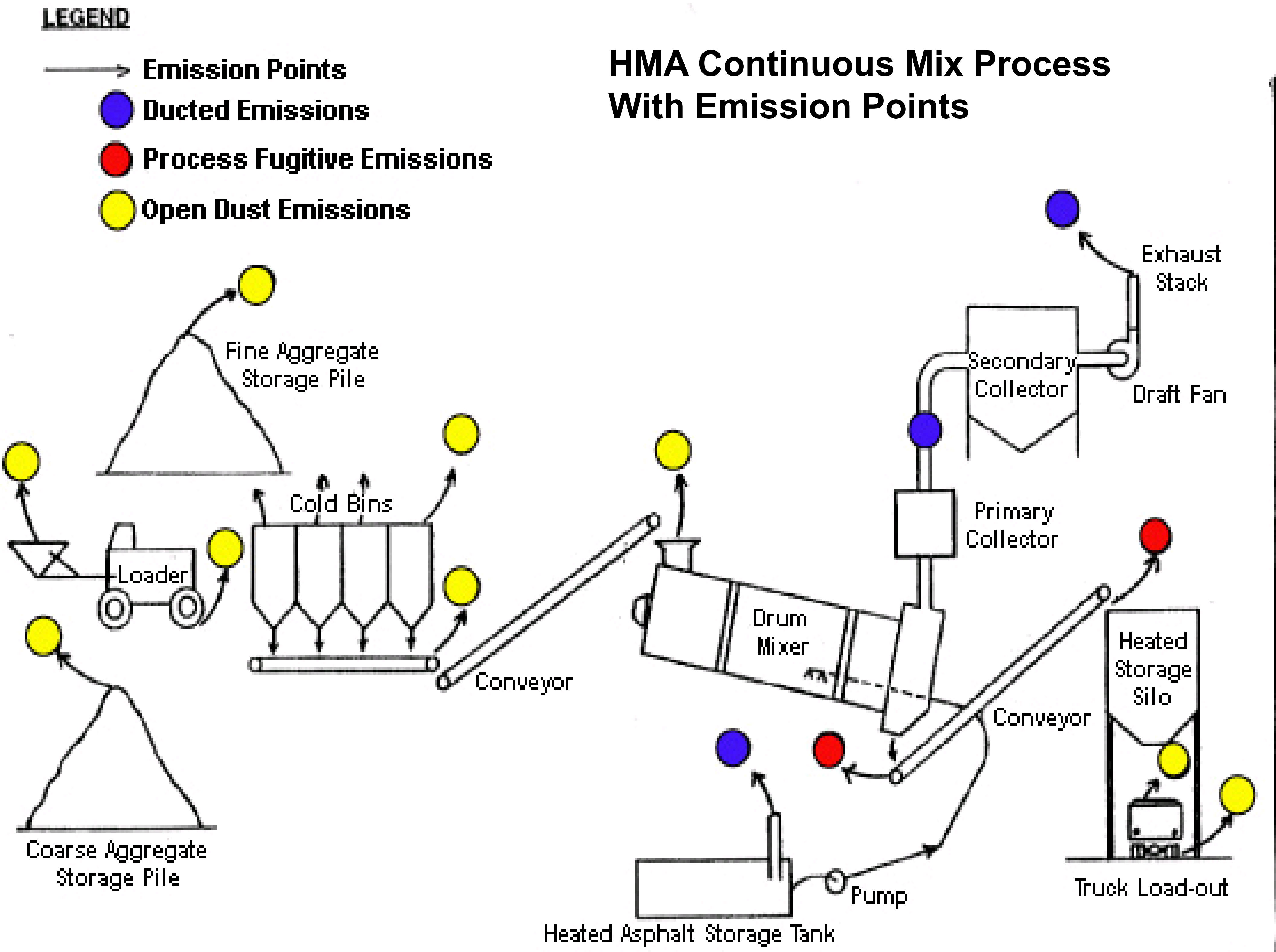
- Newer design
- All ingredients are mixed together in the drum and sent to silos
- Better controls

Batch Process Rotary Dryer/Mixer Combined

View of Batch Operated Double Drum Mixer Down for Maintenance

Inside View of Double Drum Mixer

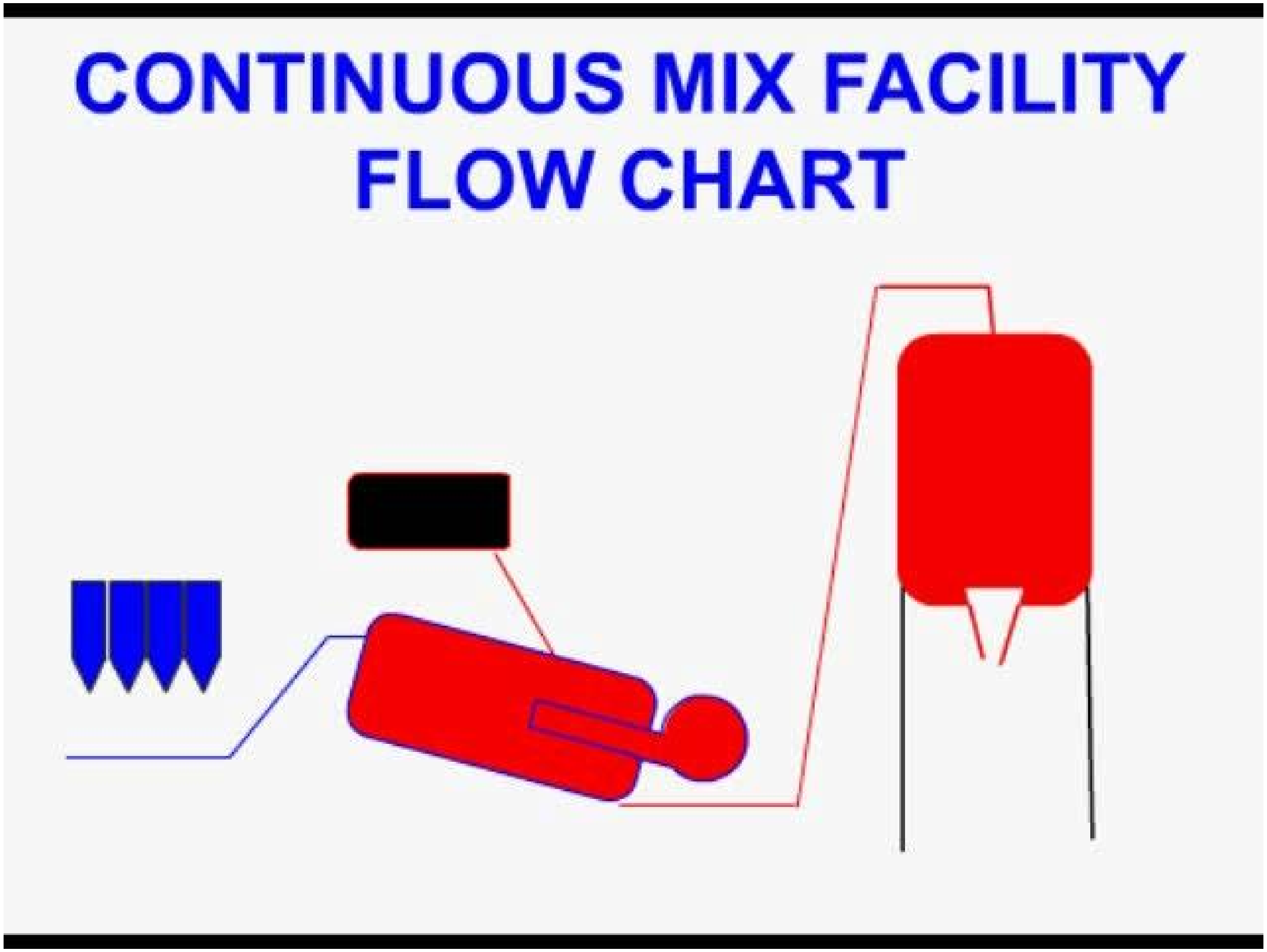
Continuous Mix Process


LEGEND
Emission Points
Ducted Emissions
Process Fugitive Emissions
Open Dust Emissions
HMA Continuous Mix Process
With Emission Points
Exhaust
Stack
Fine Aggregate
Storage Pile
Secondary
Collector
Draft Fan
Cold Bins
Primary
Collector
Loader
Drum
Mixer
Conveyor
Heated
Storage
Silo
Conveyor
Coarse Aggregate
Storage Pile
Pump
Truck Load-out
Heated Asphalt Storage Tank

Process
Continuous Mix Facility
Characteristics

1. HMA is continuously produced
2. No batch towers to segregate hot aggregate
3. Insulated heated storage silos are used instead of surge bins to store HMA
4. Production is horizontal verses vertical

Process

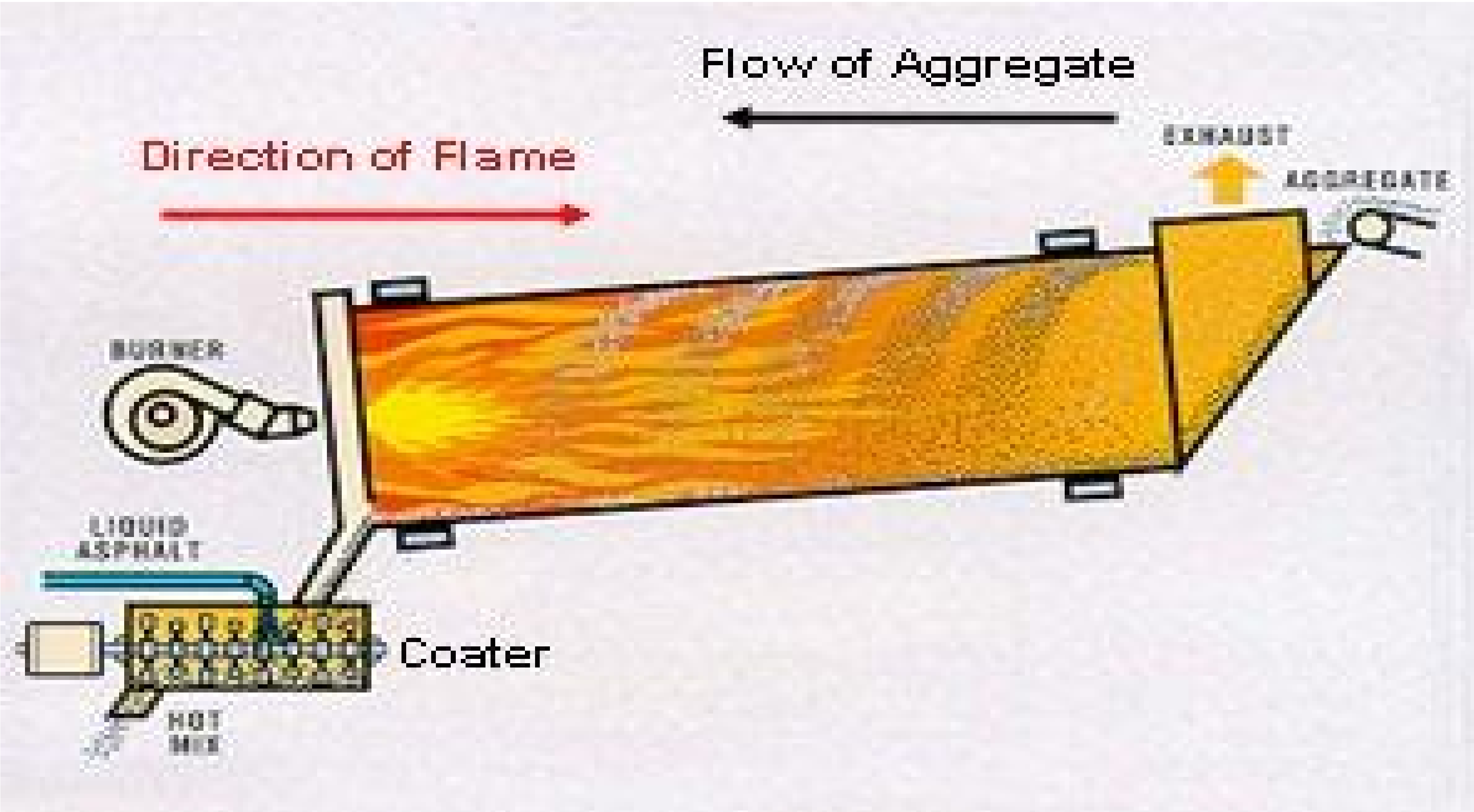


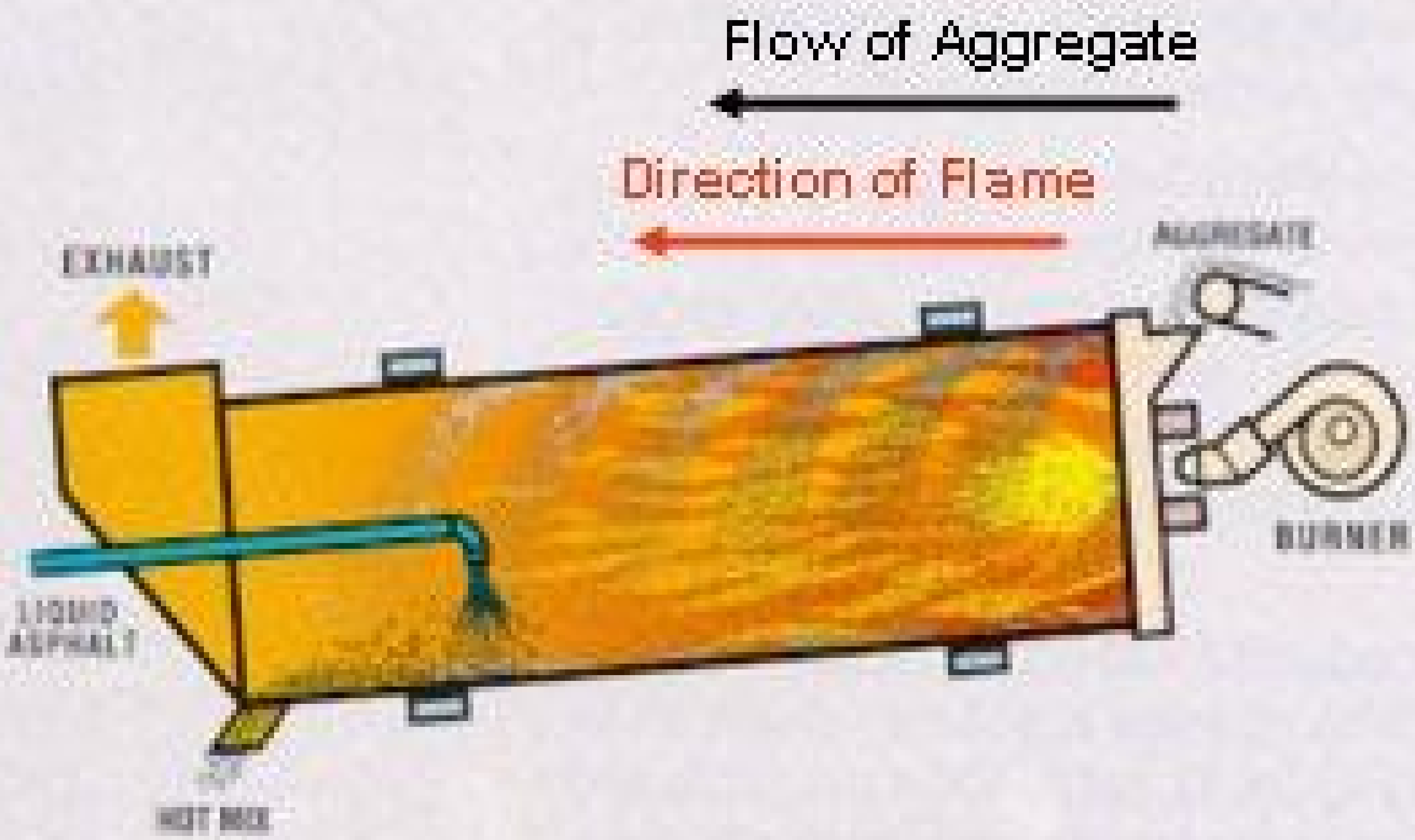
Process
HMA Drum Design

Process
Drum Design

- **4 general designs**
  - ✓ Counter Flow Dryer Coater
  - ✓ Parallel Flow Drum Mixer
  - ✓ Double Barrel Drum Mixer
  - ✓ Triple-Drum™ Mixer
- **Drum mixers two zones:**
  - ✓ primary for aggregate drying and heating
  - ✓ secondary for mixing heated aggregate with binder and filler

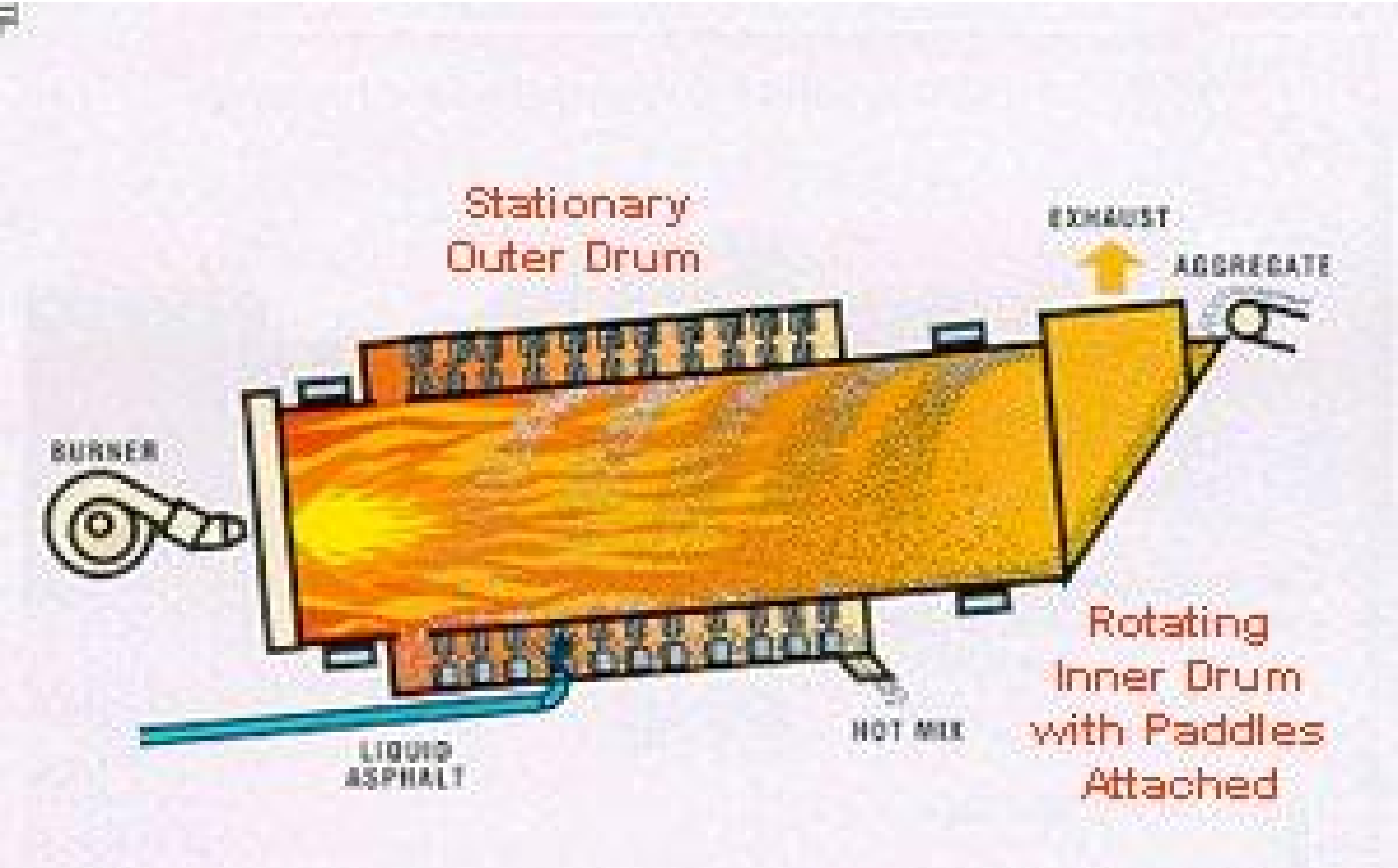
Counter Flow Dryer and Coater





PARALLEL FLOW DESIGN

Double Barrel Drum Mixer



TRIPLE-DRUM™
Hot Mix Asphalt Production and Recycling System
Dense material flow provides efficient drying of virgin aggregates.
Insulator flights hold heat and transfer aggregates to combustion zone.
Radiating combustion zone efficiently dries even high percentage, high moisture RAP mixes.
Adjustable mixing zone retains material flow for perfect blending.
Cold Aggregate In
Hot Mix Asphalt Out

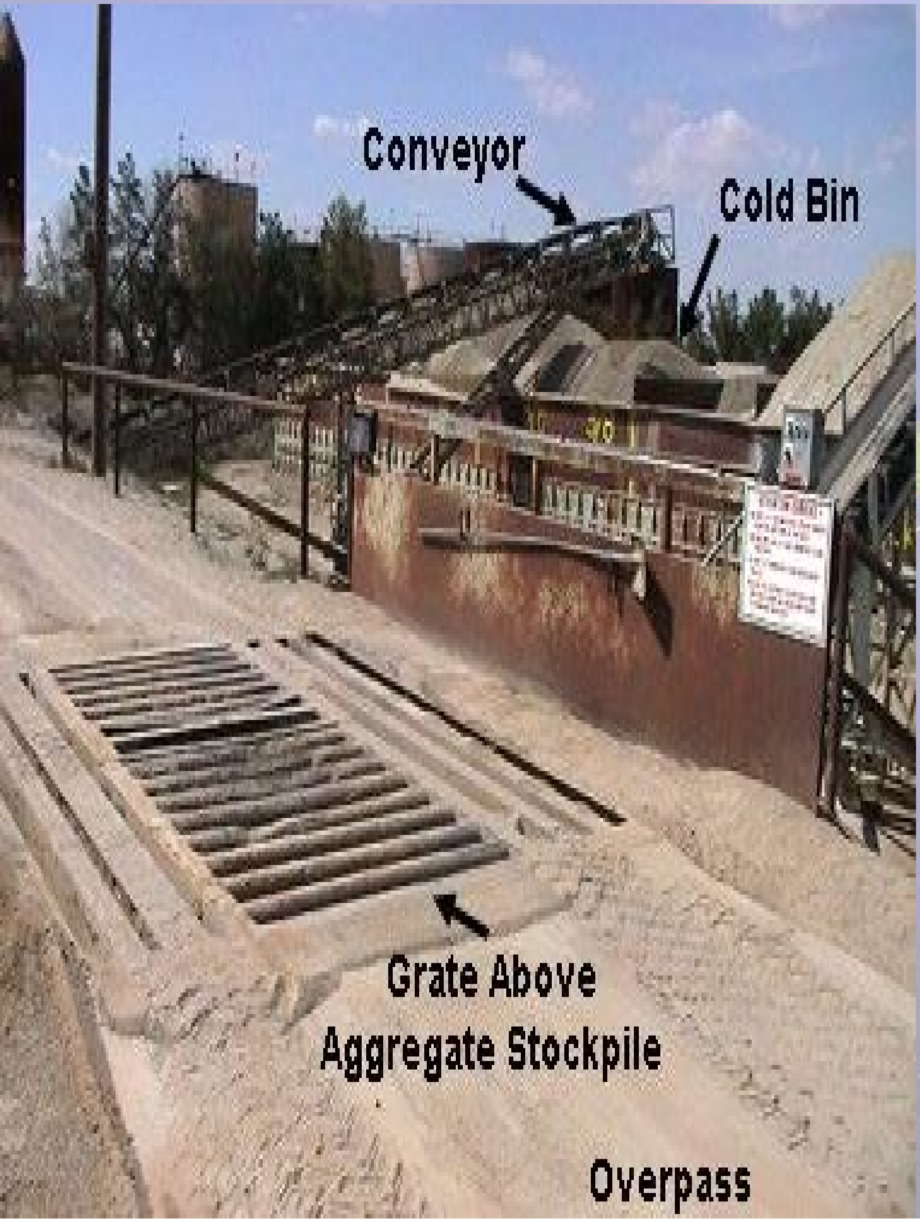
Triple-Drum

Process Asphalt Binder Storage

Underground Asphalt Storage Tanks

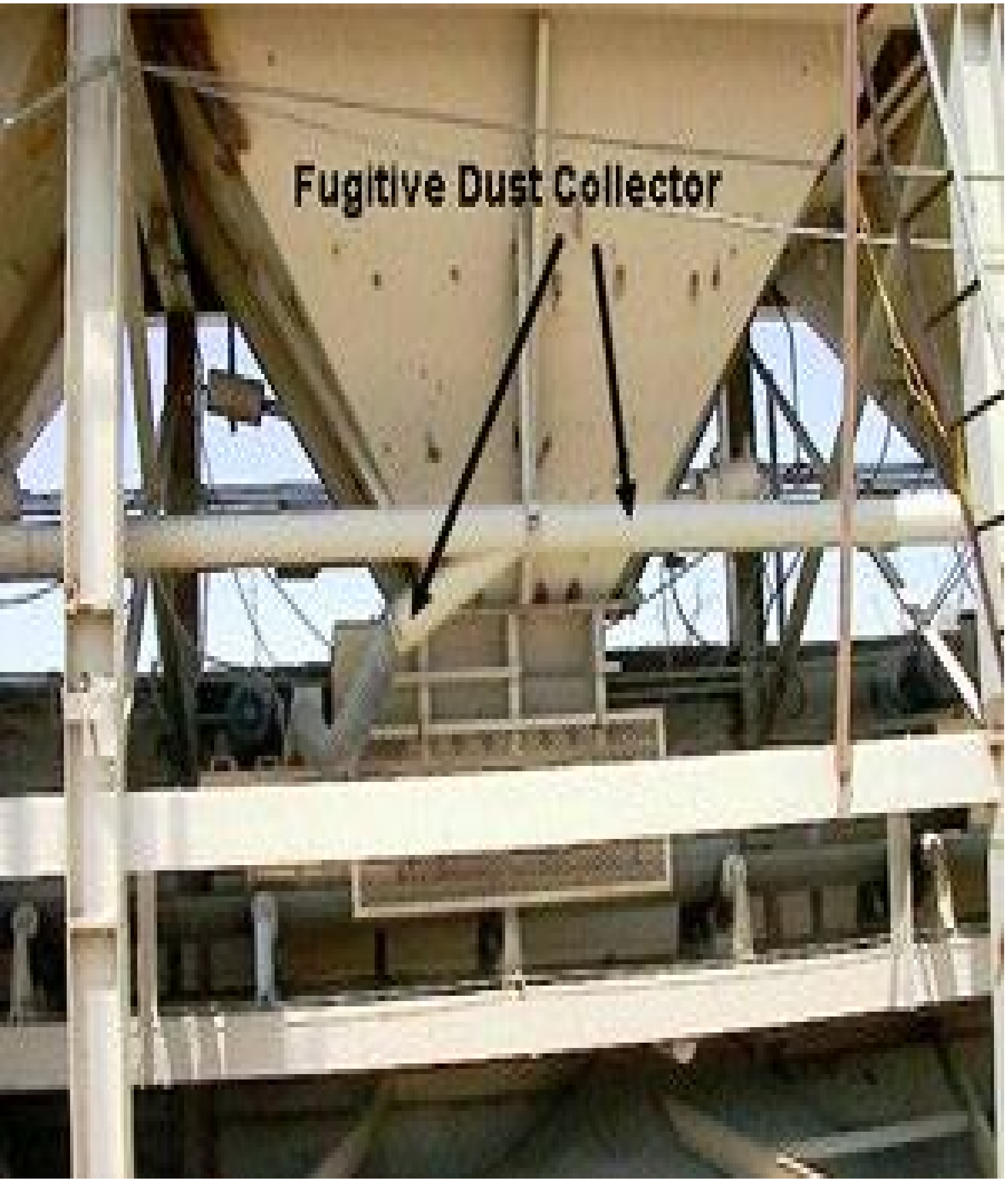
Emission Controls

Control Aggregate



- Wind-blown dust
- Fugitive dust
- Common Control methods

Process
Cold Bin Dust Collection System




DANGER
Keep hands clear
of moving
machinery

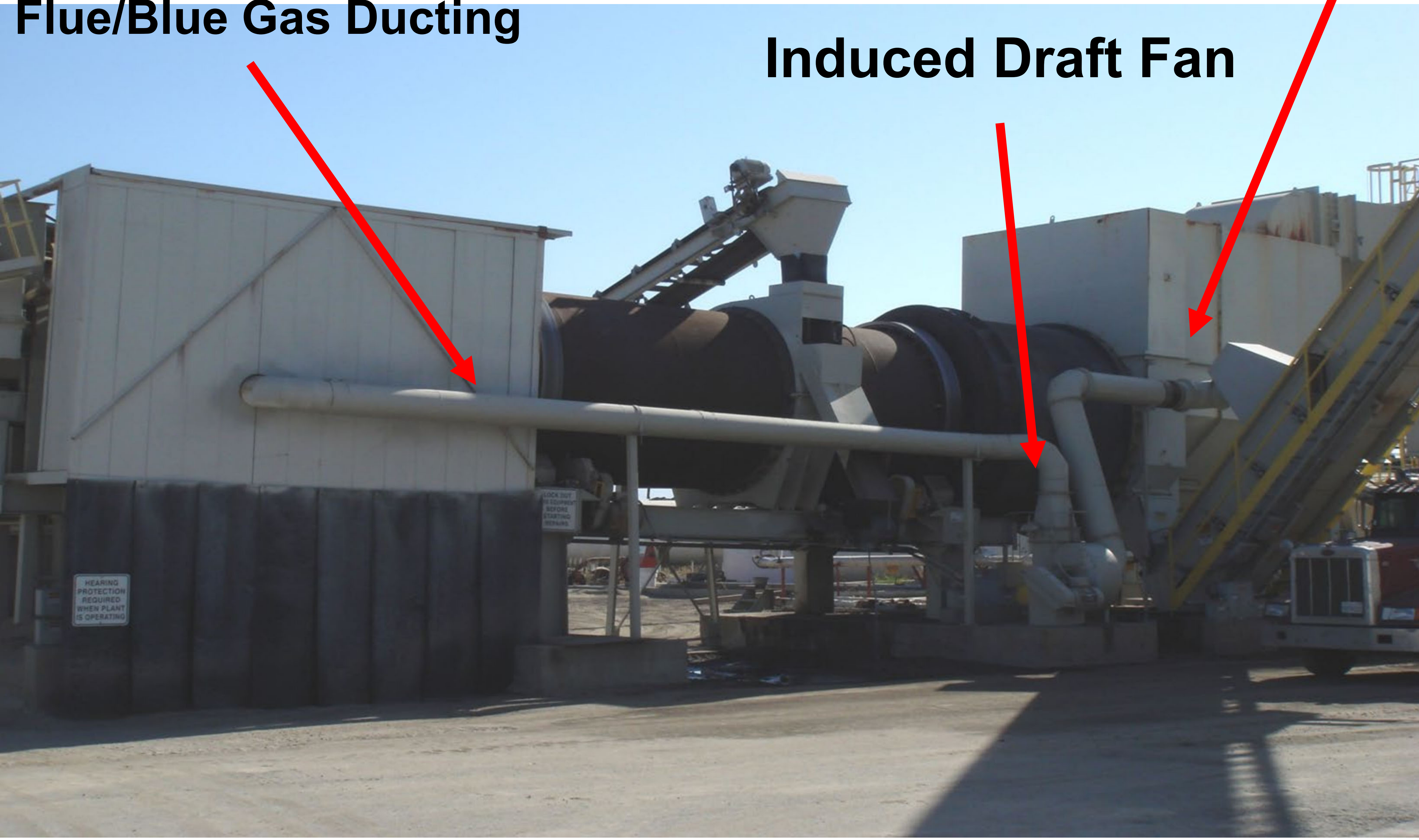

Keep hands clear
of moving
machinery
CAUTION
Louisville

Dust Suppression?

Emission Control
Hot Aggregate Handling

Emission Control
Hot Aggregate Handling

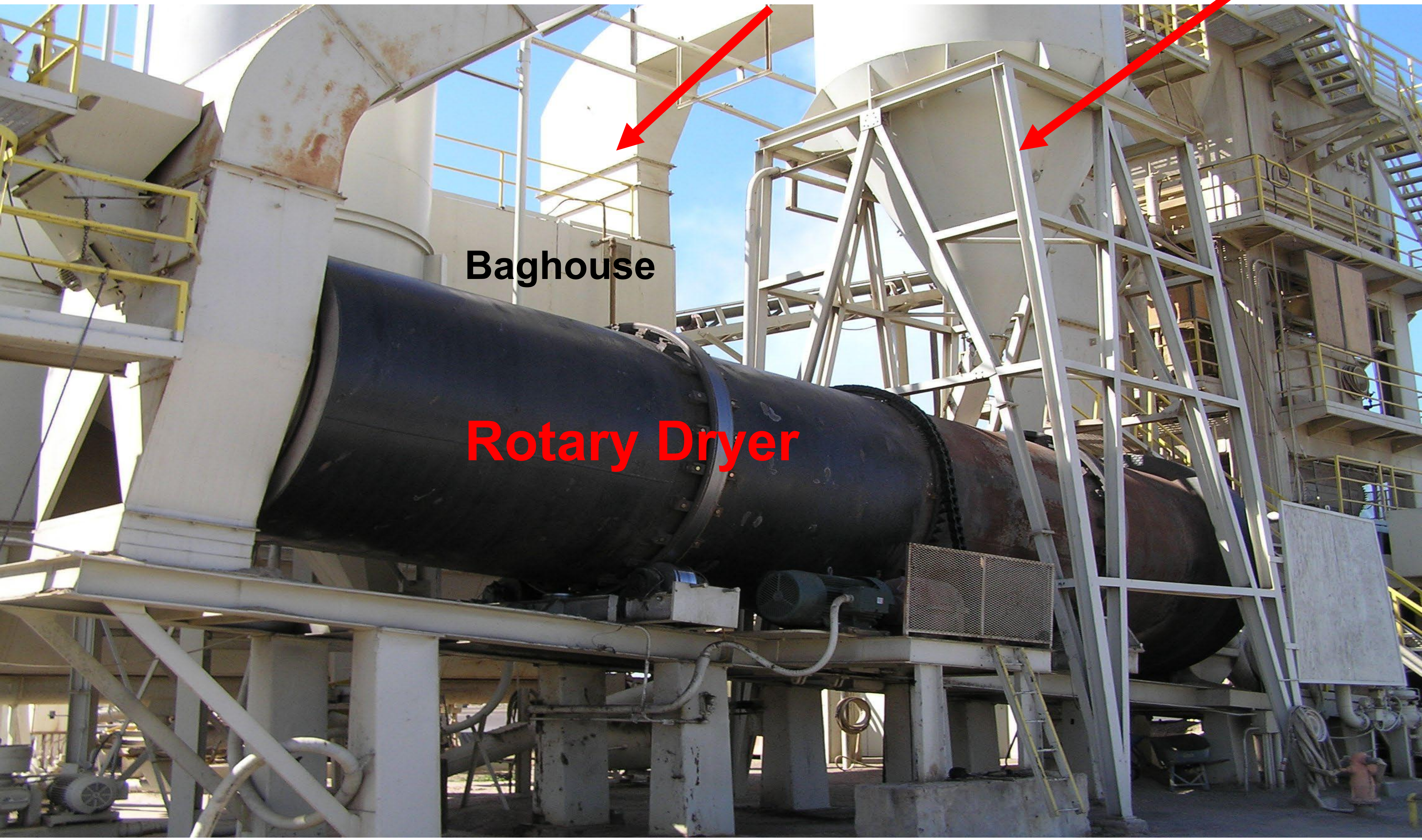
Emission Control Flue Gas Recirculation



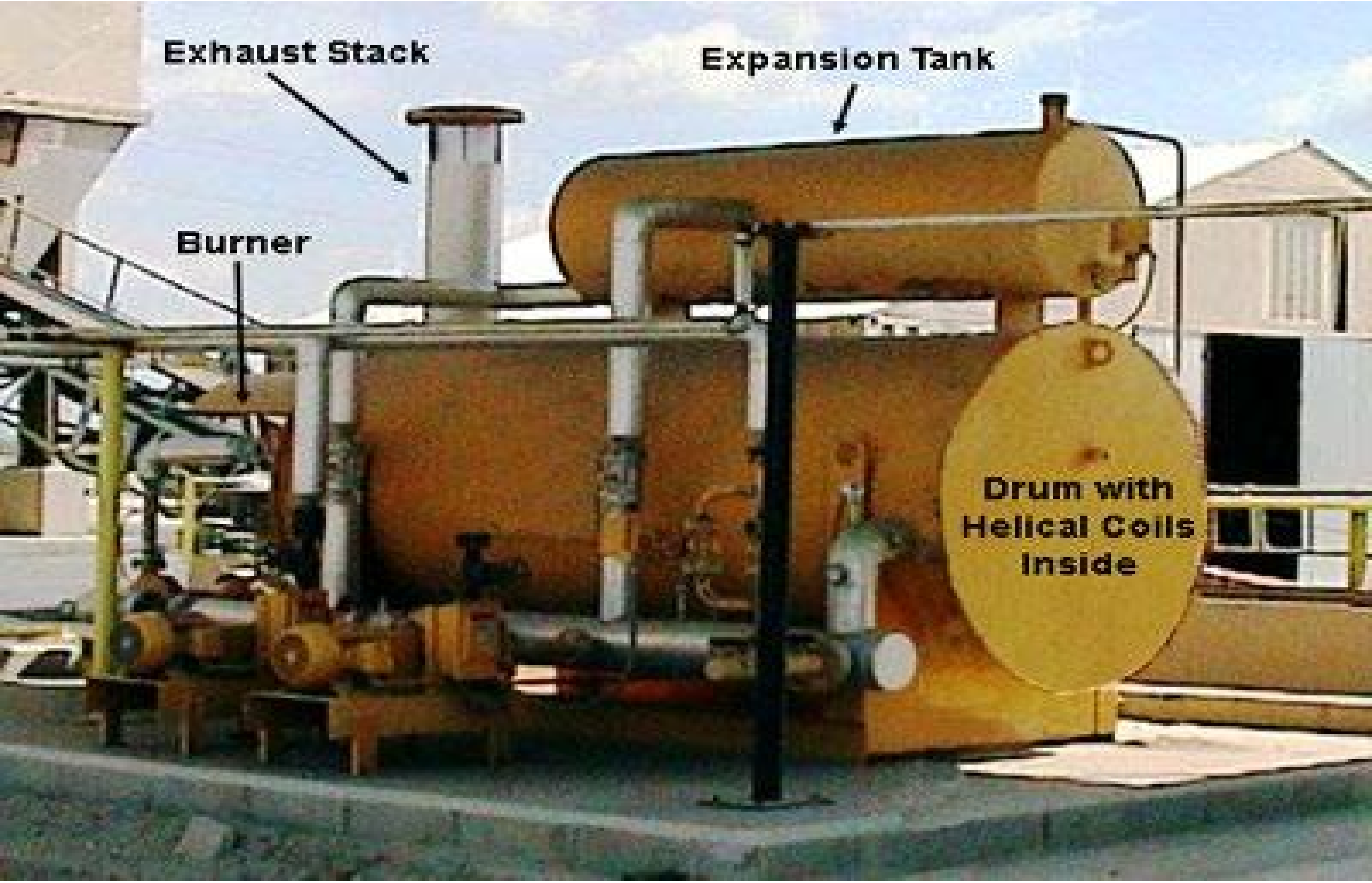
Emission Control

Cyclone

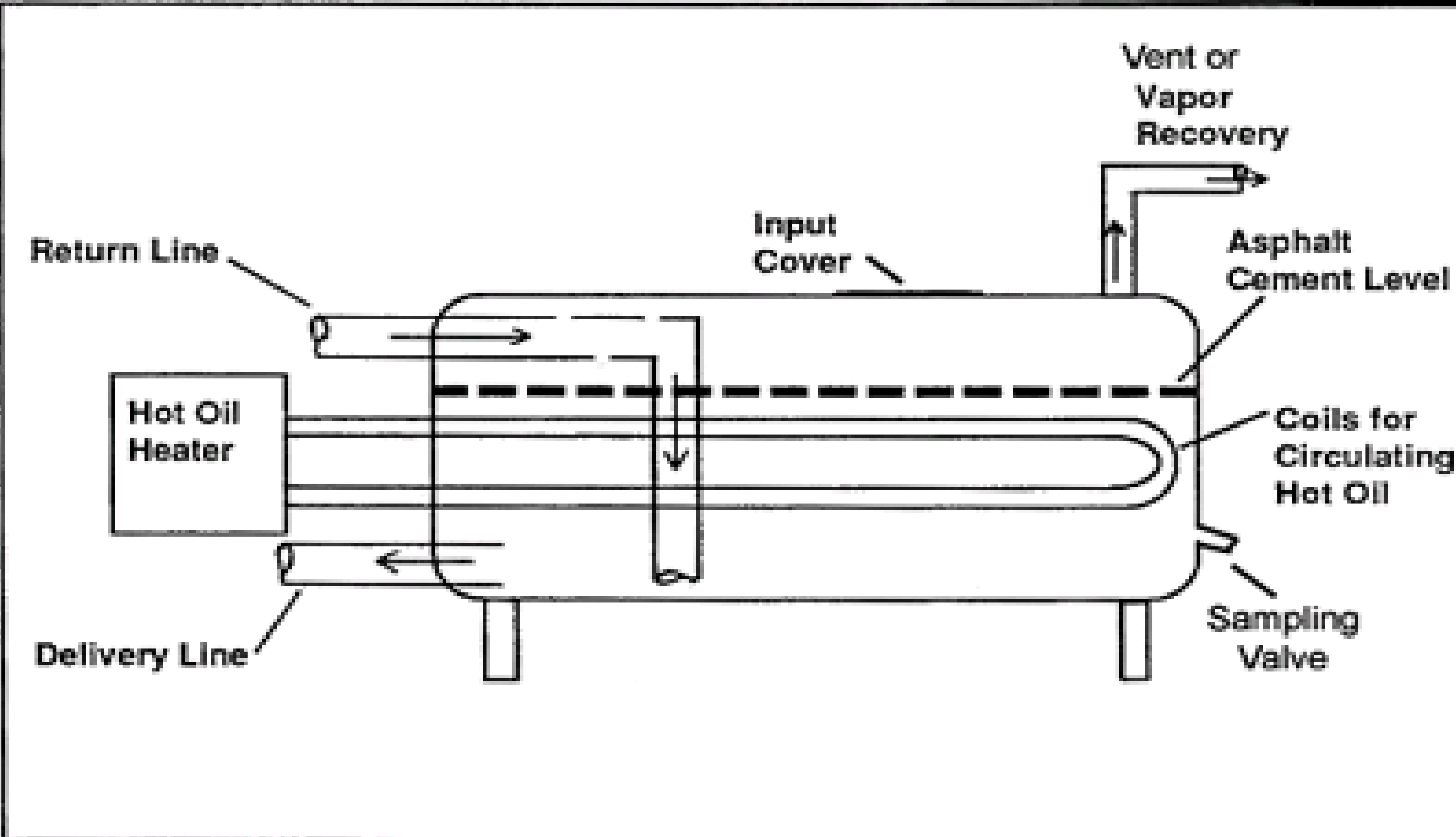
Ducting to Baghouse



Small Binder Storage Tank



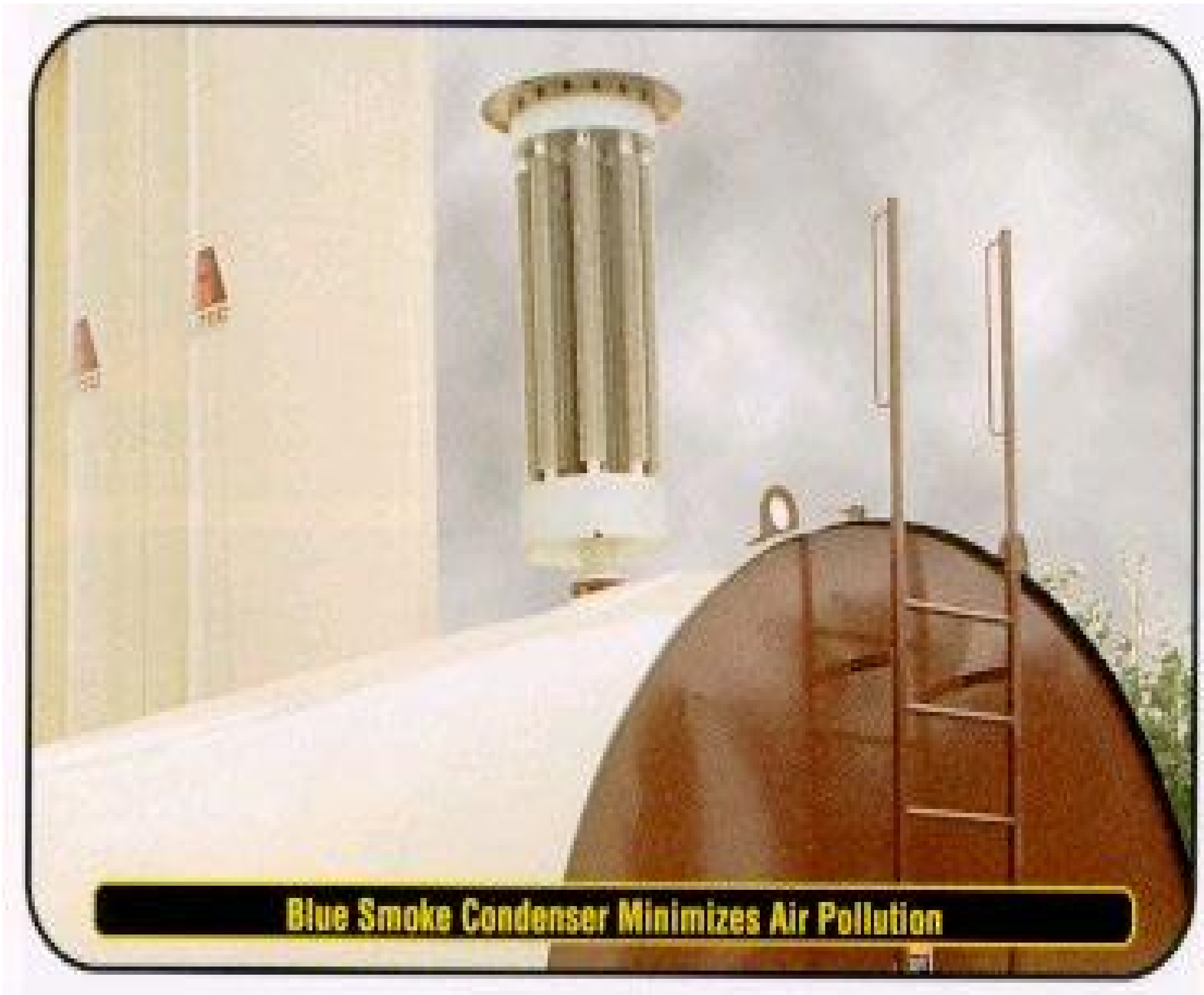
Hot Oil Heater Coils



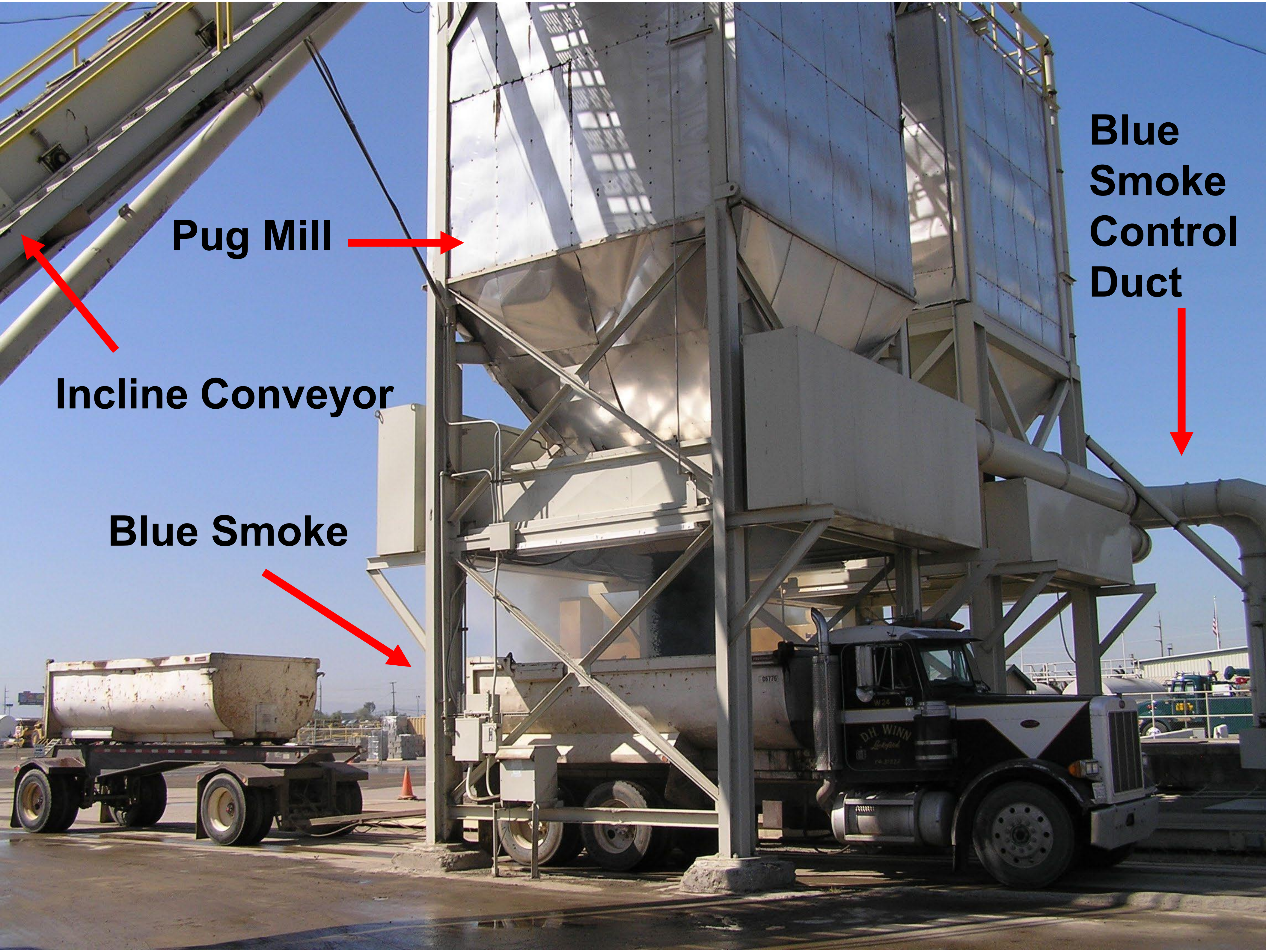
Process
Underground Storage Tanks


Uncontrolled RAC
Binder Storage Tank

Controlled Binder Storage Tank Vent Condenser



Dust Silo


Pug Mill
Incline Conveyor
Blue Smoke
Blue Smoke Control Duct
D.H. WINN

Control
Draft Air

Control
Draft Air

- Draft air passes through ducting due to pressure differential
- Draft air affects

1. Combustion efficiency
2. How a system develops leaks
3. Control effectiveness

Control
Types of Draft Air

- 4 Type

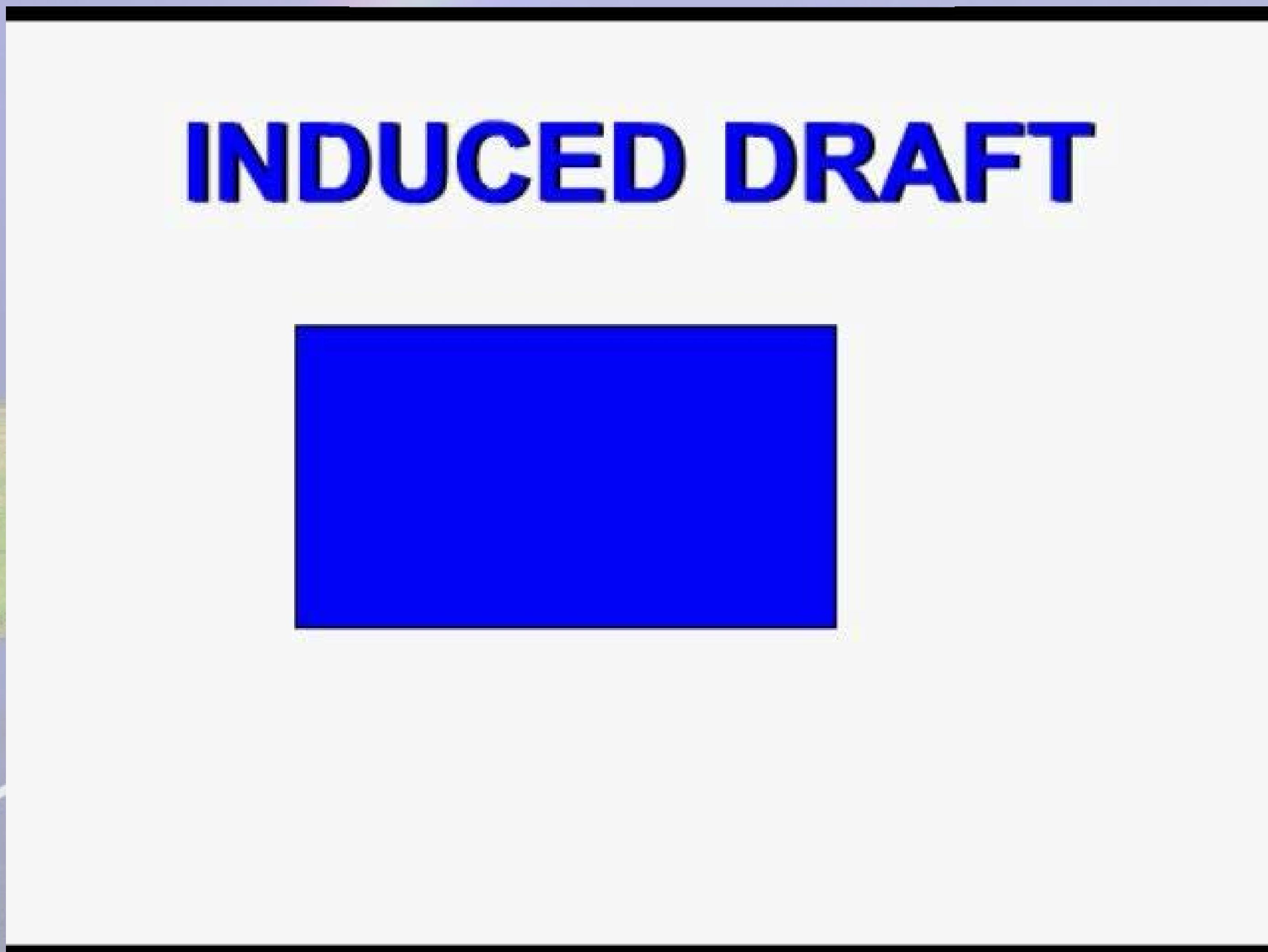
1. Forced Draft Air
   - ✓ Air that is pushed resulting in positive pressure
2. Induced Draft
   - ✓ Air is pulled by a fan resulting in negative pressure

Control
Draft Air Cont.

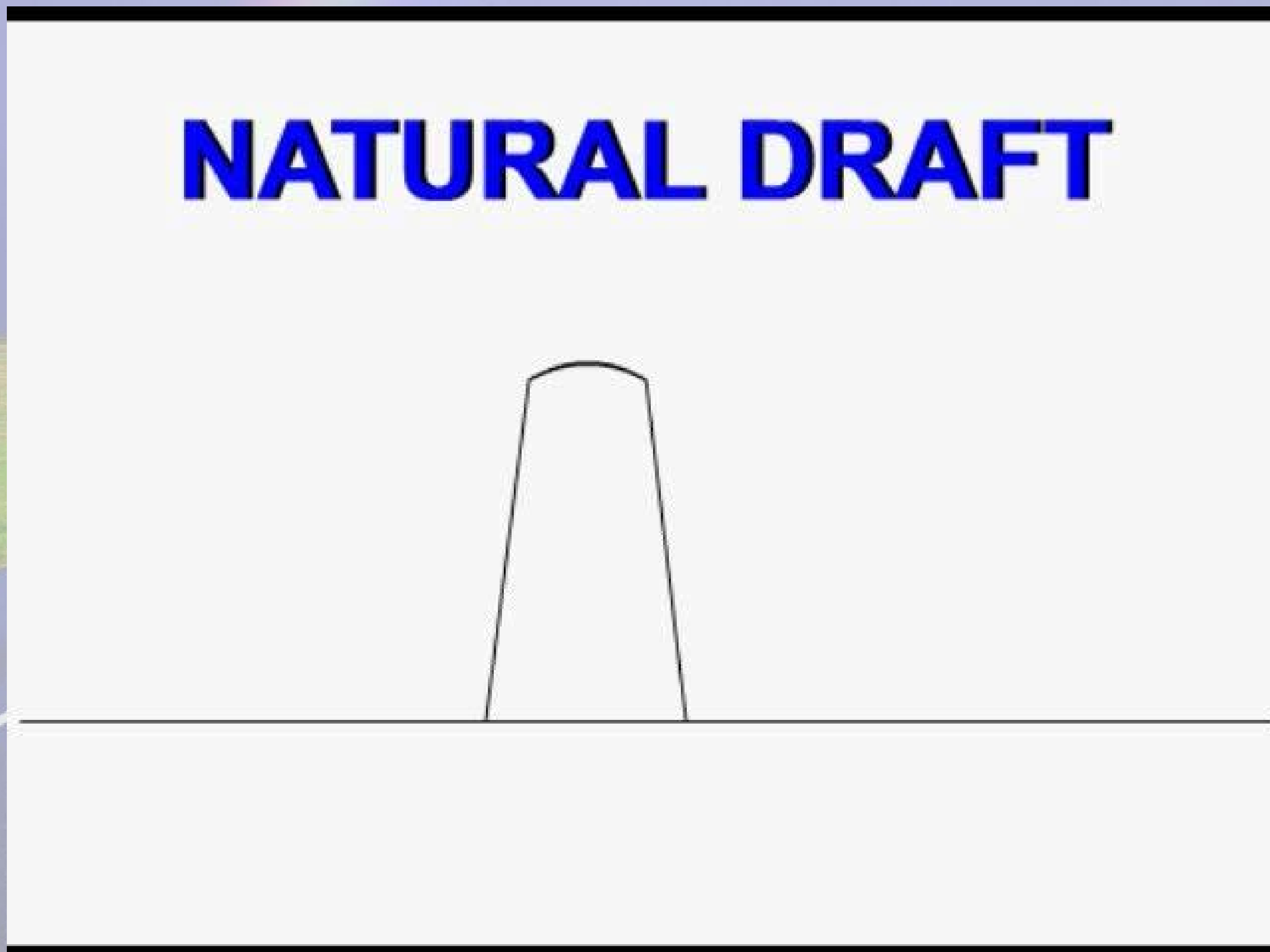
3. Natural Draft Air
    - ✓ Difference in temp between flue gases and the ambient air.
4. Balanced Draft
    - ✓ Forced draft fan pushes combustion air into combustion chamber.

Control

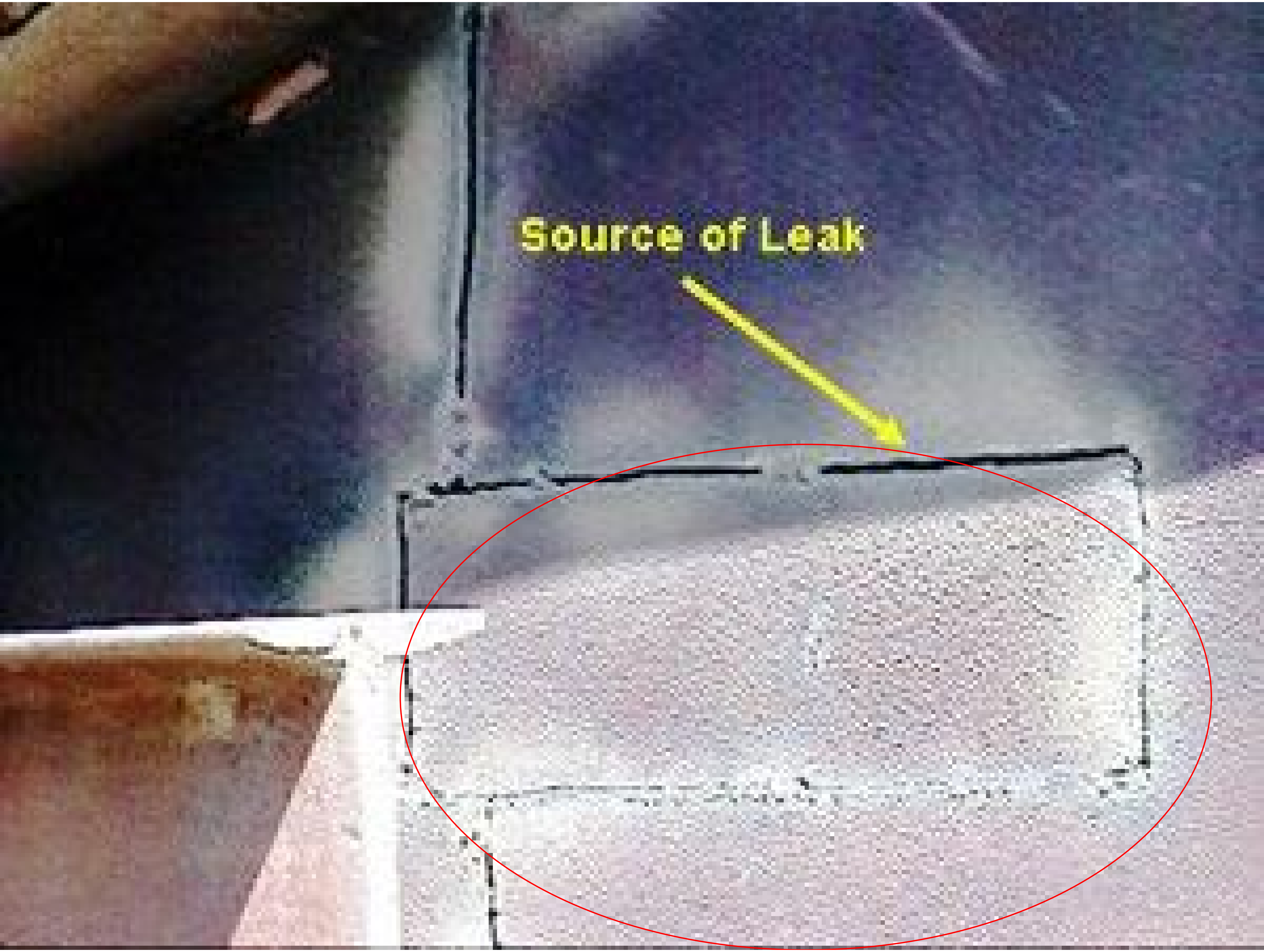
Control



Control



Leak in a Rotary Dryer

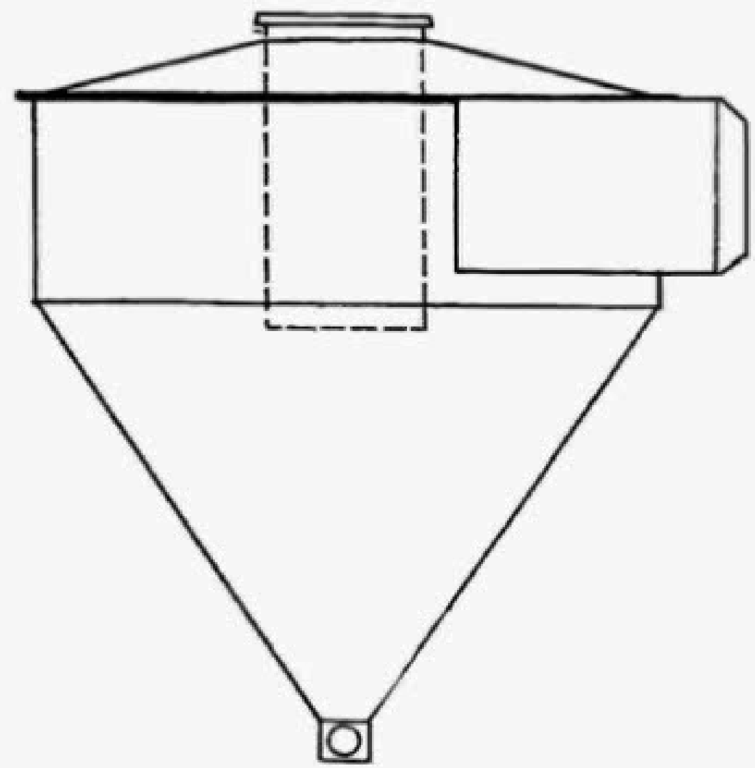

Source of Leak

Control
Drum/Dryer Emission

- Drum/Dryer produce large amounts of PM
- Two control devices
  - ✓Primary for large particles and
  - ✓Secondary for small particles
- Combined efficiency is 99% or greater
- Ask for manufacturer or facility guarantee

Primary Controls Cyclone

Primary Control Cyclone



Primary Control Wet Scrubber

Wet Scrubber?

Process/Control
Wet Scrubber

- Used to control stack emissions
  - ✓ Must meet the emission requirements specified in Subpart OOO
  - ✓ Continuous emissions pressure monitor
    - $\pm$ 250 pascals $\pm$ 1inch water gauge pressure
  - ✓ Continuous measurement of scrubbing liquid flow rate to scrubber

Control Techniques
Wet Scrubber

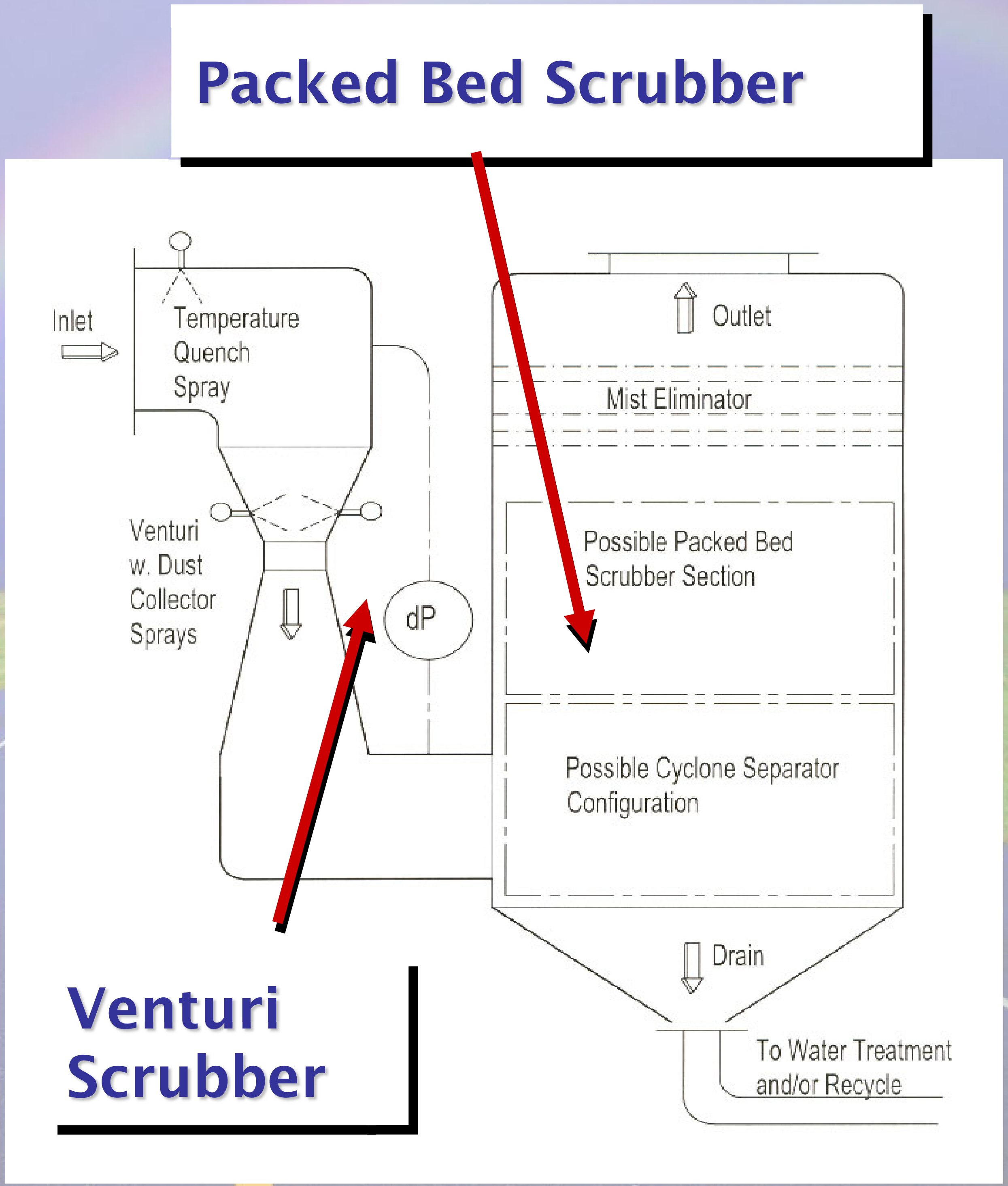
- General description
  - ✓ Particles get trapped in liquids
    - Inertial impaction and diffusion
  - ✓ Liquids must contact particles and dirty liquids must be removed from exhaust gas

Particulate Scrubbers

- Initial quench – use clean water
- Water drops and particles must contact (impact)
  - ✓Requires water flow and mixing energy
- Dirty water collection
- Water treatment & recirculation

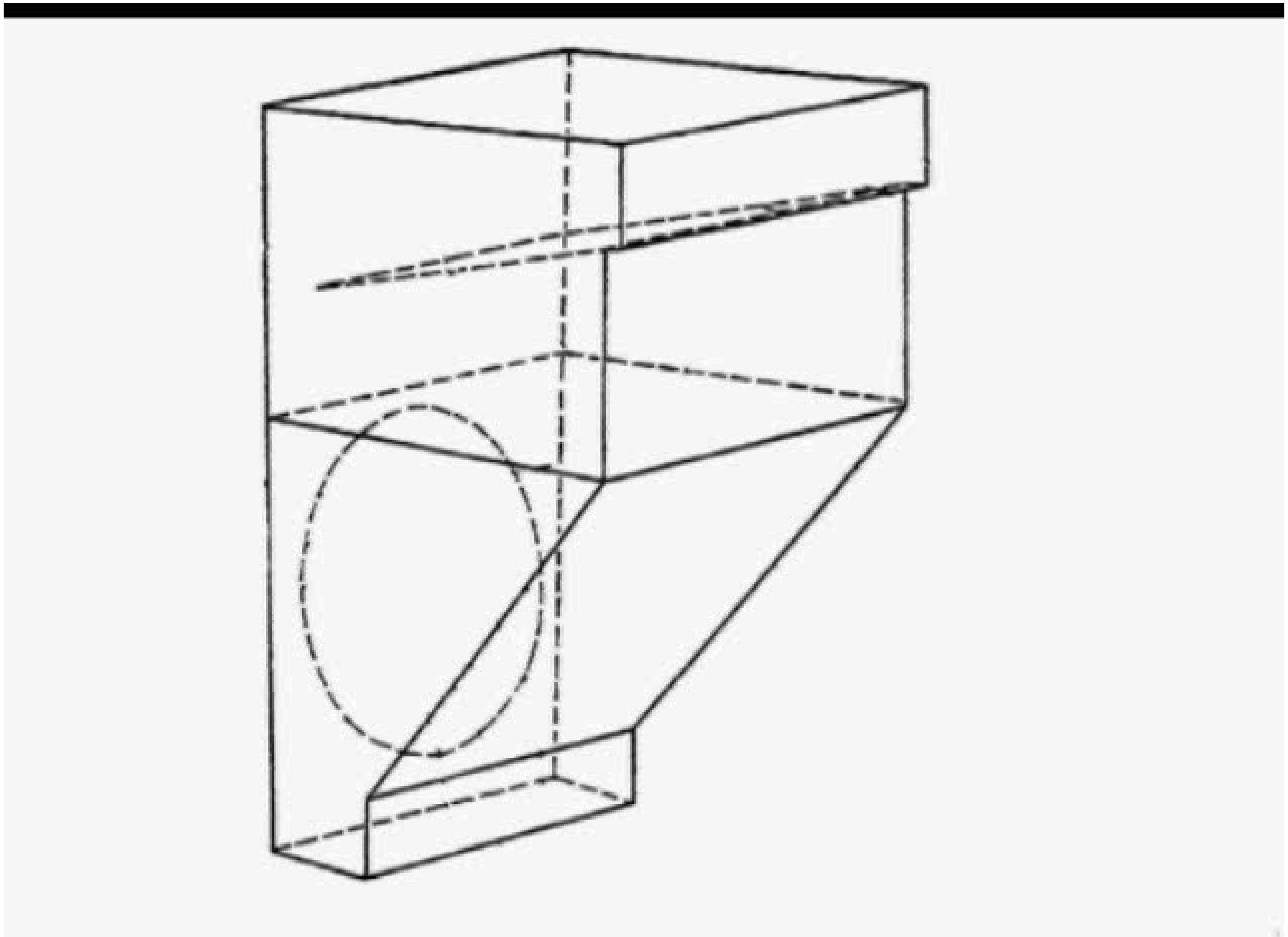
Wet Scrubber Operation

- Particles collected by impaction
- Gasses collected by diffusion & absorption



Scrubber Liquor

Primary Control
Knock Out Box



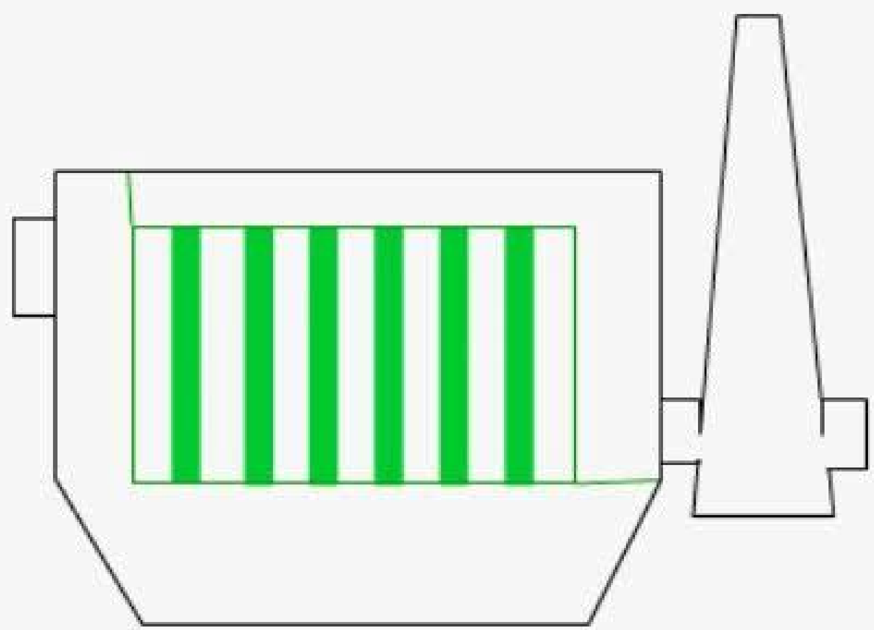
Primary Controls
Knock-out Box

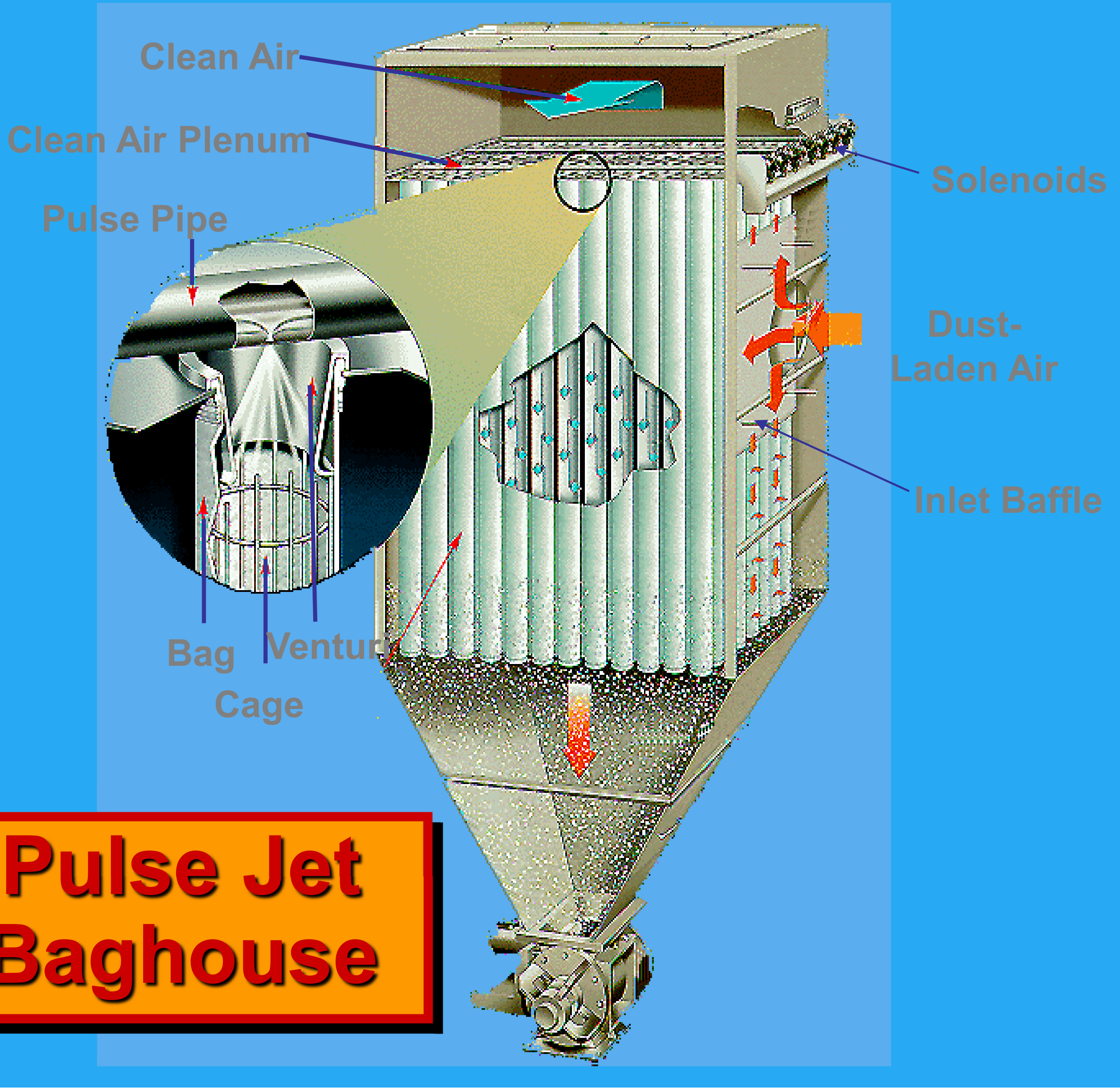

Secondary
Control
Baghouse

Secondary Control Baghouses

- General description
  - ✓ Particles trapped on filter media, then removed
  - ✓ Either interior or exterior filtration systems
  - ✓ Up to 99.9% efficiency
  - ✓ Fabric filters are big vacuum cleaners with a cleaning mechanism

Secondary Control
Baghouse





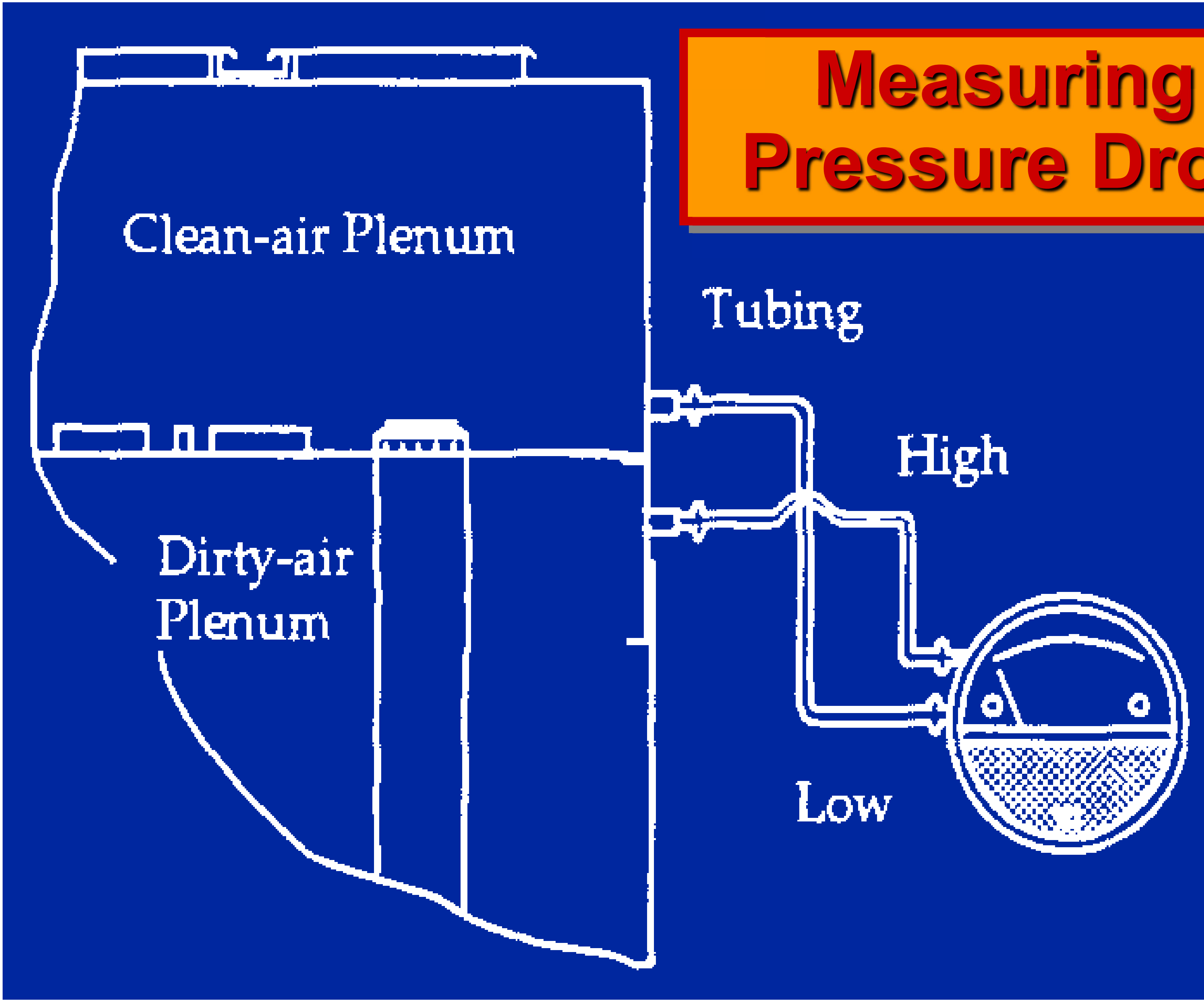
Pulse Jet Baghouse

Secondary Control
Pulse Jet Baghouse

Secondary Control
Inside a Pulse Jet Baghouse

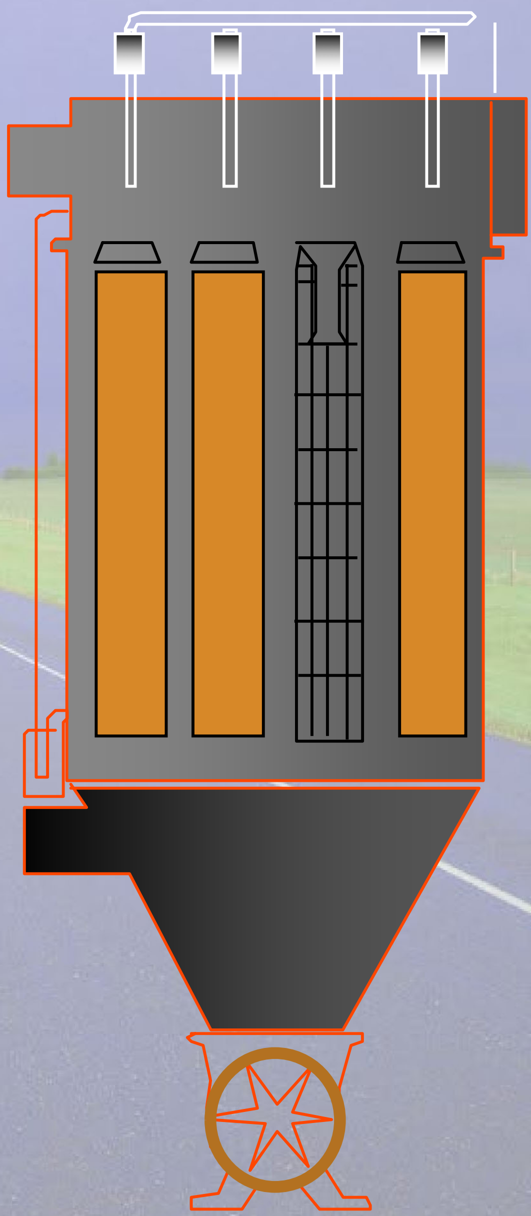

Pulse Jet Bag

Measuring Pressure Drop

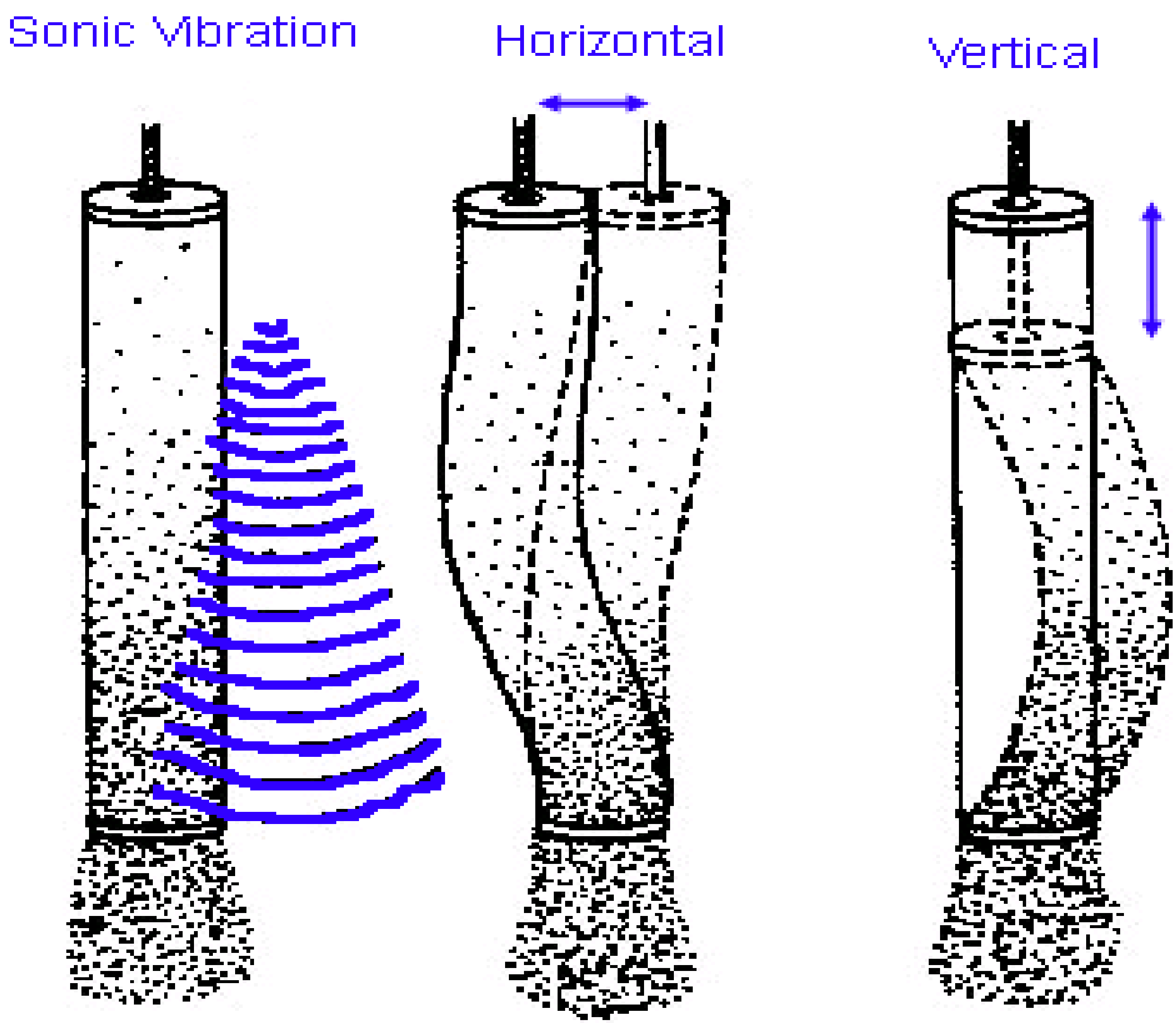


Baghouse Design Considerations

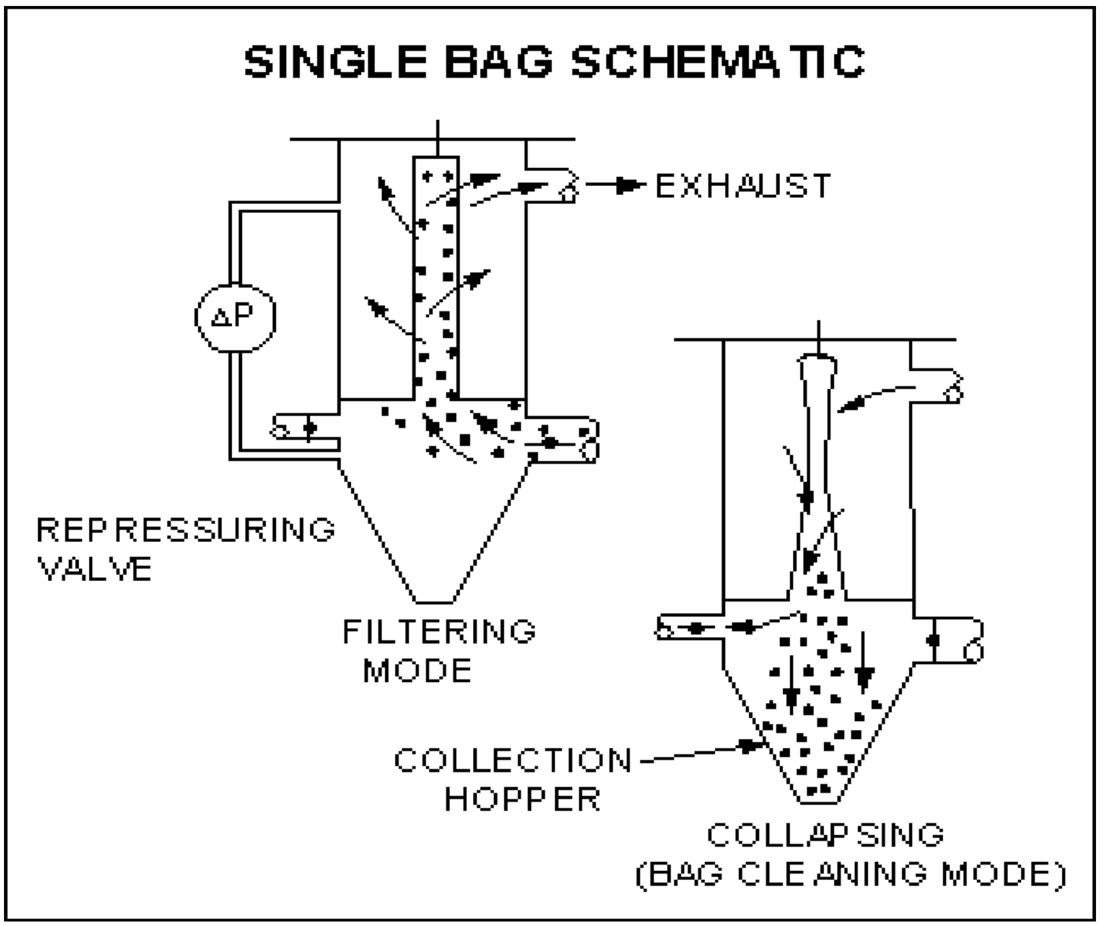
- Pressure Drop
- Air-To-Cloth Ratio
- Collection Efficiency
- Fabric Type
- Cleaning
- Temperature Control
- Bag Spacing
- Compartment Design
- Space and Cost

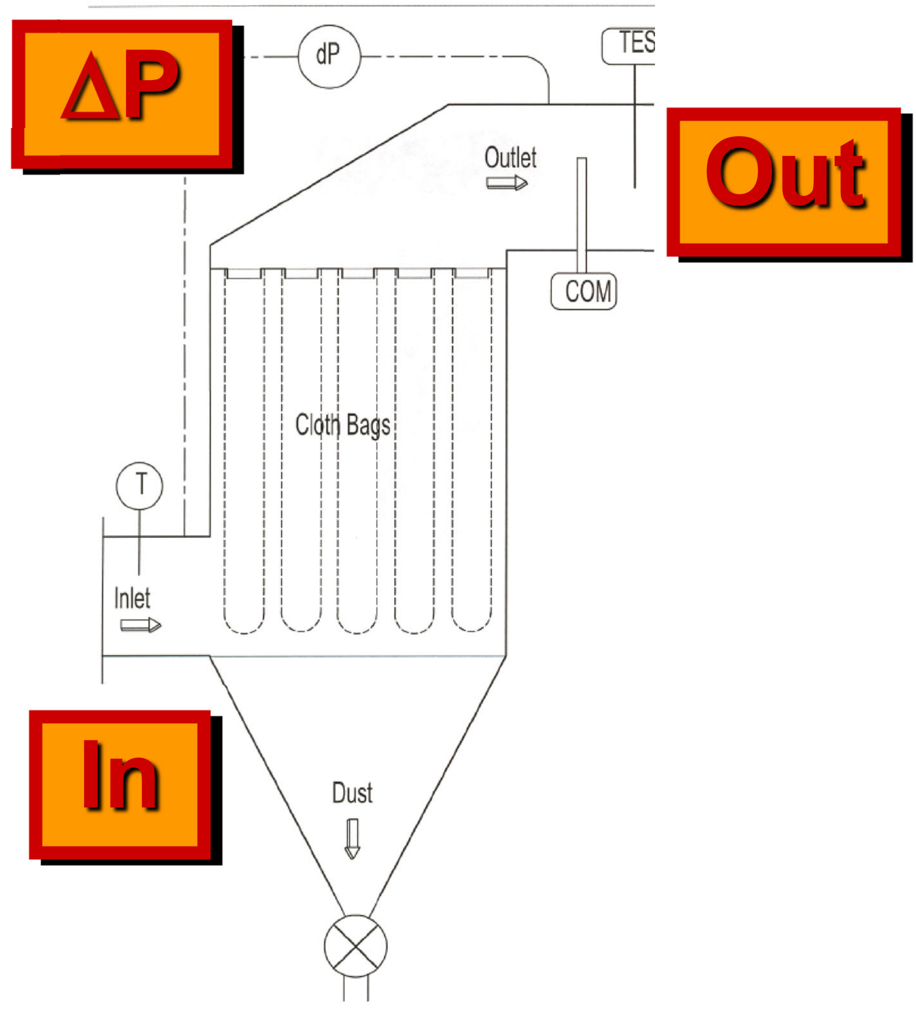


Secondary Control
Shaker Method



Secondary Control
PM Control Techniques – Fabric Filter





Secondary Control PM Control Techniques – Fabric Filter

- Factors affecting efficiency
  - ✓Filter media
    - Abrasion
    - High temperature
    - Chemical attack
  - ✓Gas flow
  - ✓Broken or worn bags

Secondary Control PM Control Techniques – Fabric Filter

- Factors affecting efficiency (continued)
  - ✓Cleaning system failure
  - ✓Leaks
  - ✓Re-entrainment
  - ✓Damper or discharge equipment malfunction
  - ✓Corrosion

Secondary Control PM Control Techniques – Fabric Filter

- Performance indicators
  - ✓Outlet PM concentration
  - ✓Bag leak detectors
  - ✓Outlet opacity
  - ✓Pressure differential
  - ✓Inlet temperature
  - ✓Temperature differential

Secondary Control PM Control Techniques – Fabric Filter

- Performance indicators (continued)
  - ✓Exhaust gas flow rate
  - ✓Cleaning mechanism operation
  - ✓Fan current
  - ✓Inspections and maintenance

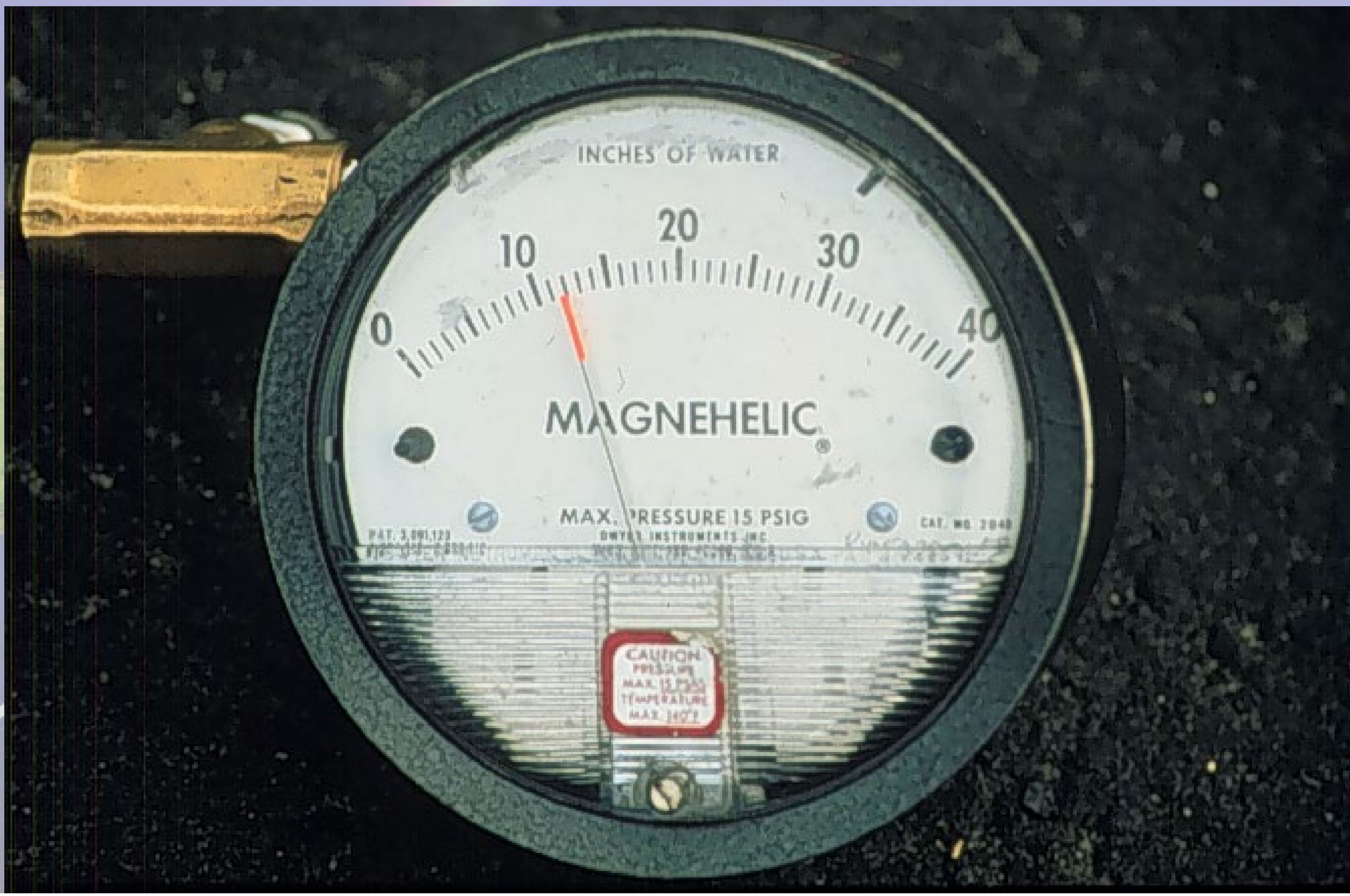
Secondary Control
Bag House Monitoring

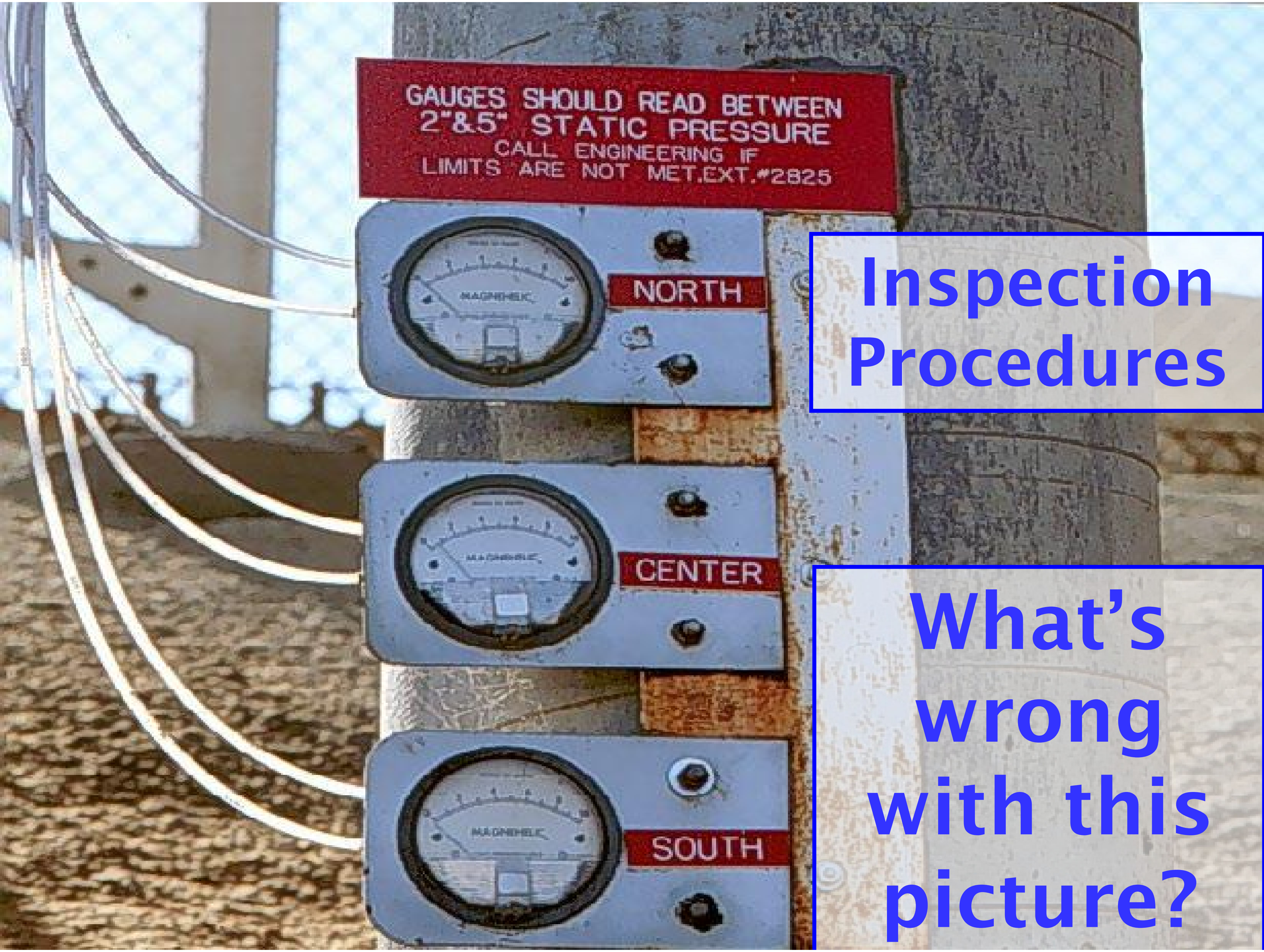
- Normal bag house emissions are very low.
  - ✓Opacity sensors (COM) aren't very good below 1-2%, so they don't detect initial problems.
  - ✓Opacity will show a major particulate emissions increase.
  - ✓COM or Method 9 may be OK for loose emission limits.

Inspection Procedures Instrumentation

- What types of instruments are being used to monitor for permit conditions?
  - ✓ Magnehelic Gauge
  - ✓ Triboelectric Monitor

Inspection Procedures
Magnehelic Gauge





Inspection Procedures

What's wrong with this picture?

Baghouse Monitoring Triboelectric Sensor

- TESs are a newer technology
  - ✓ Primary use cement, coal fired power plants, and food manufacturing
  - ✓ US EPA encouraging use of TESs as CAM (compliance assistance monitoring, 40 CFR 64) or
  - ✓ As a performance indicator in lieu of a source test
- Districts are adopting as BACT or compliance measurement tool

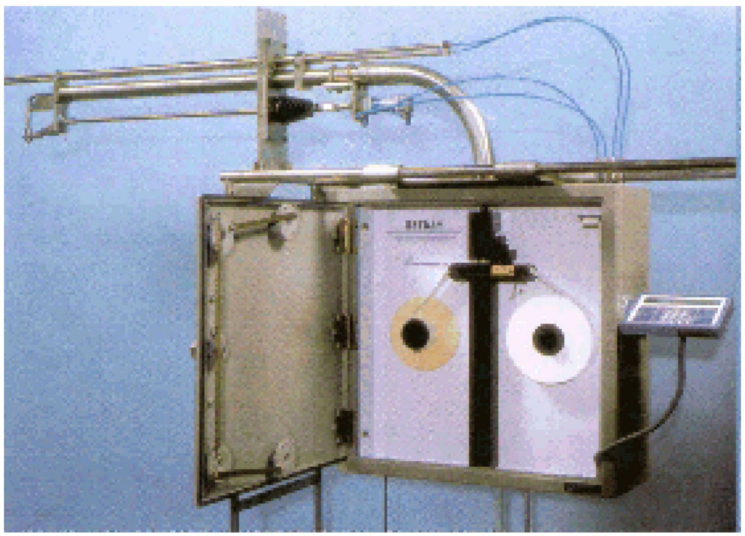
Baghouse Monitoring Triboelectric Sensor

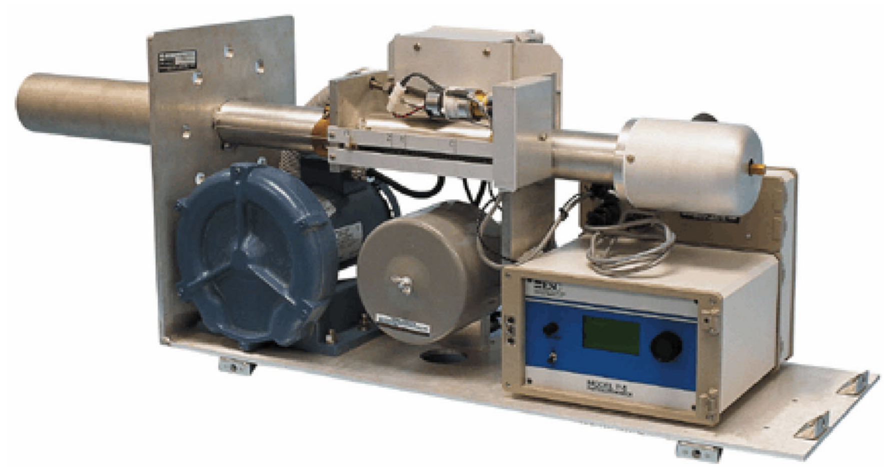
- Tribo electric sensors (TES) work well at very low particle concentrations (very sensitive).
- TES detects micro amp current from particles hitting a metal probe.
- TES is simple and inexpensive.
- TES is an effective monitor when a small to moderate increase in emissions is of concern.

Baghouse Monitoring Triboelectric Sensor

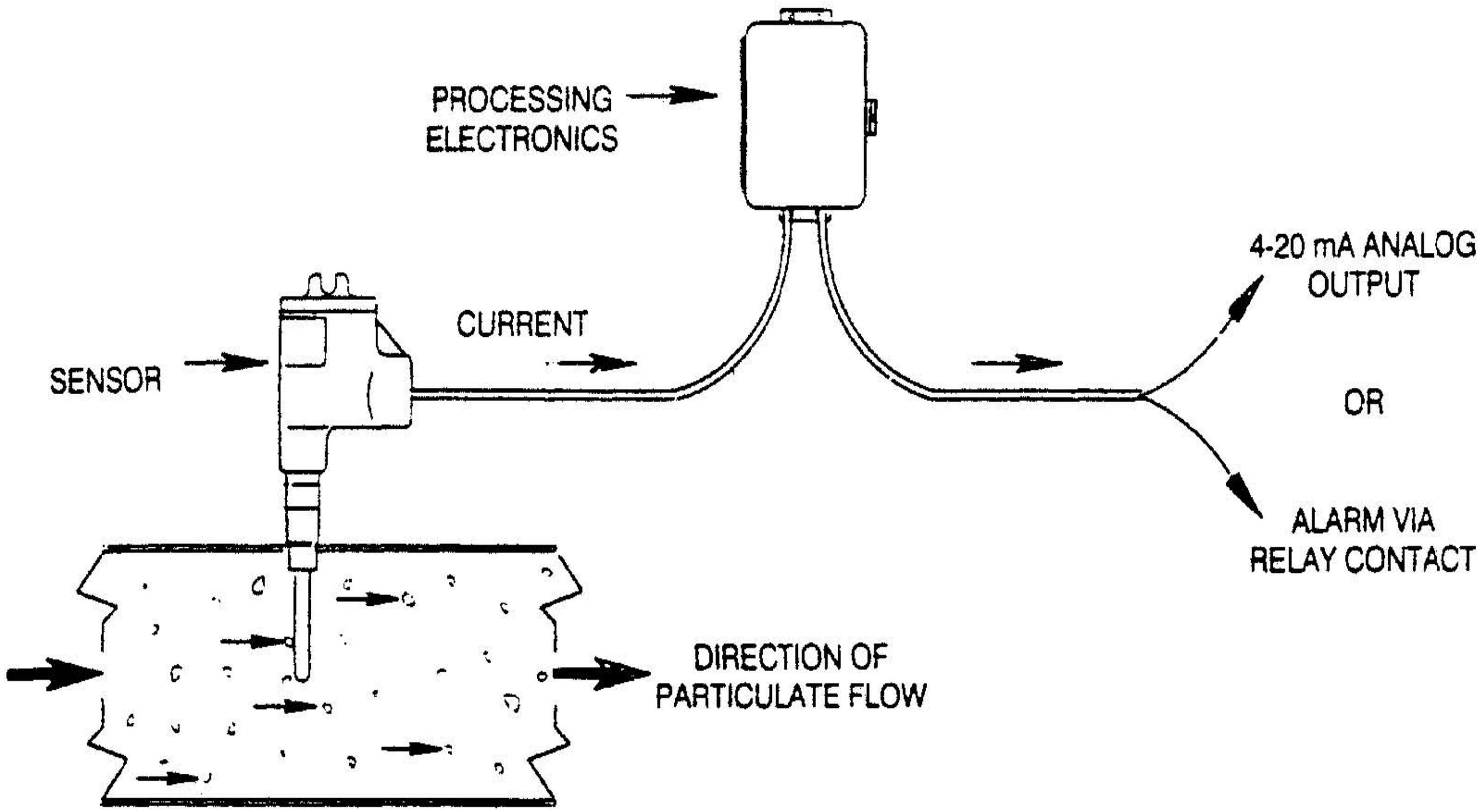
- Operates on the principle of electric conductivity
  - Triboelectric Principle: When 2 solids contact an electrical charge is transferred between the 2
  - Current generated is proportional to the particulate mass flow rate
  - Instrument tuned to produce continuous analog output and/or an alarm at a specific signal level

Control Devices
PM CEMS/TES Devices

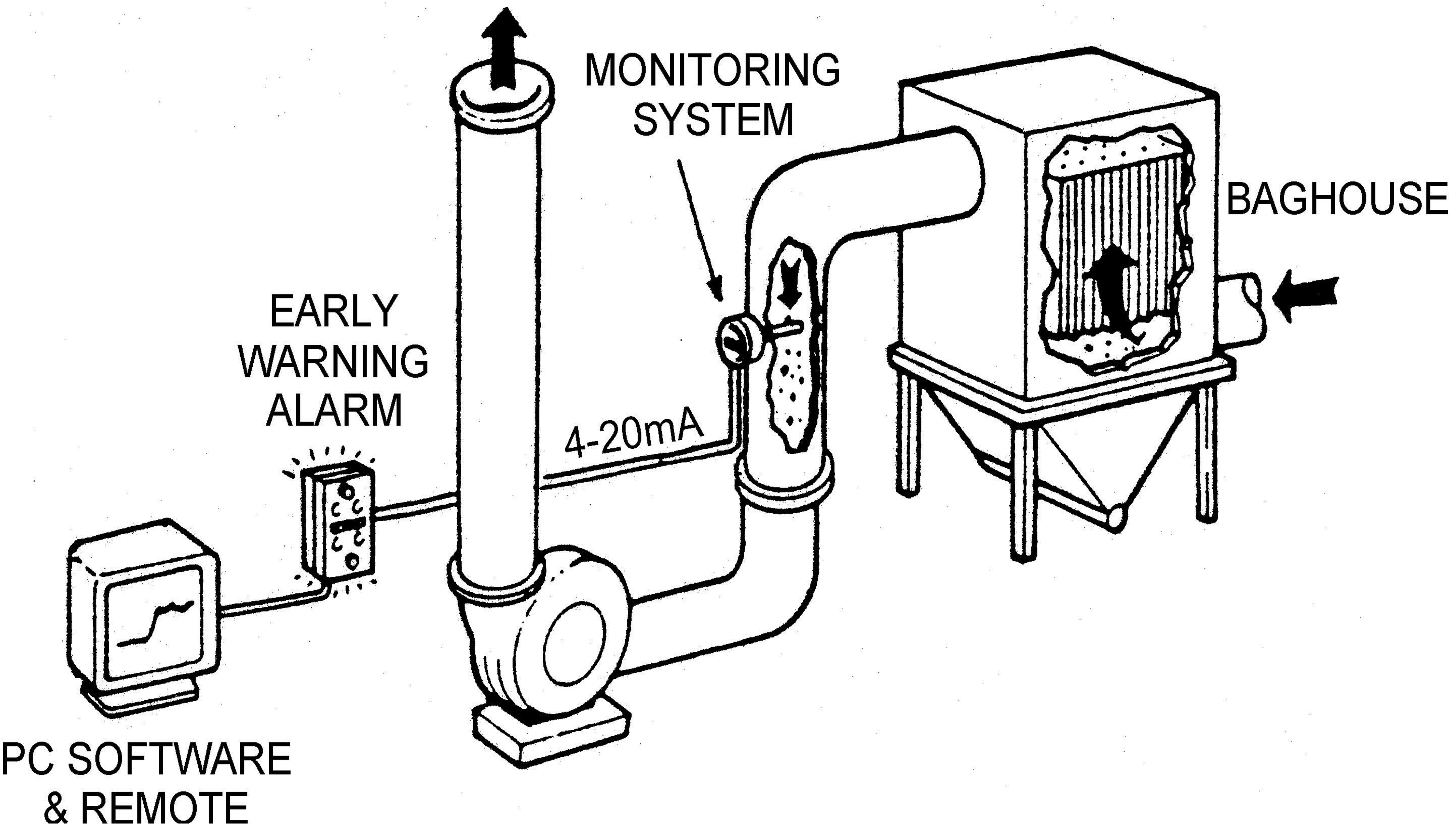




Control Device Triboelectric Sensor Schematic



Triboelectric Sensor Installation for a Negative Pressure Monitoring System



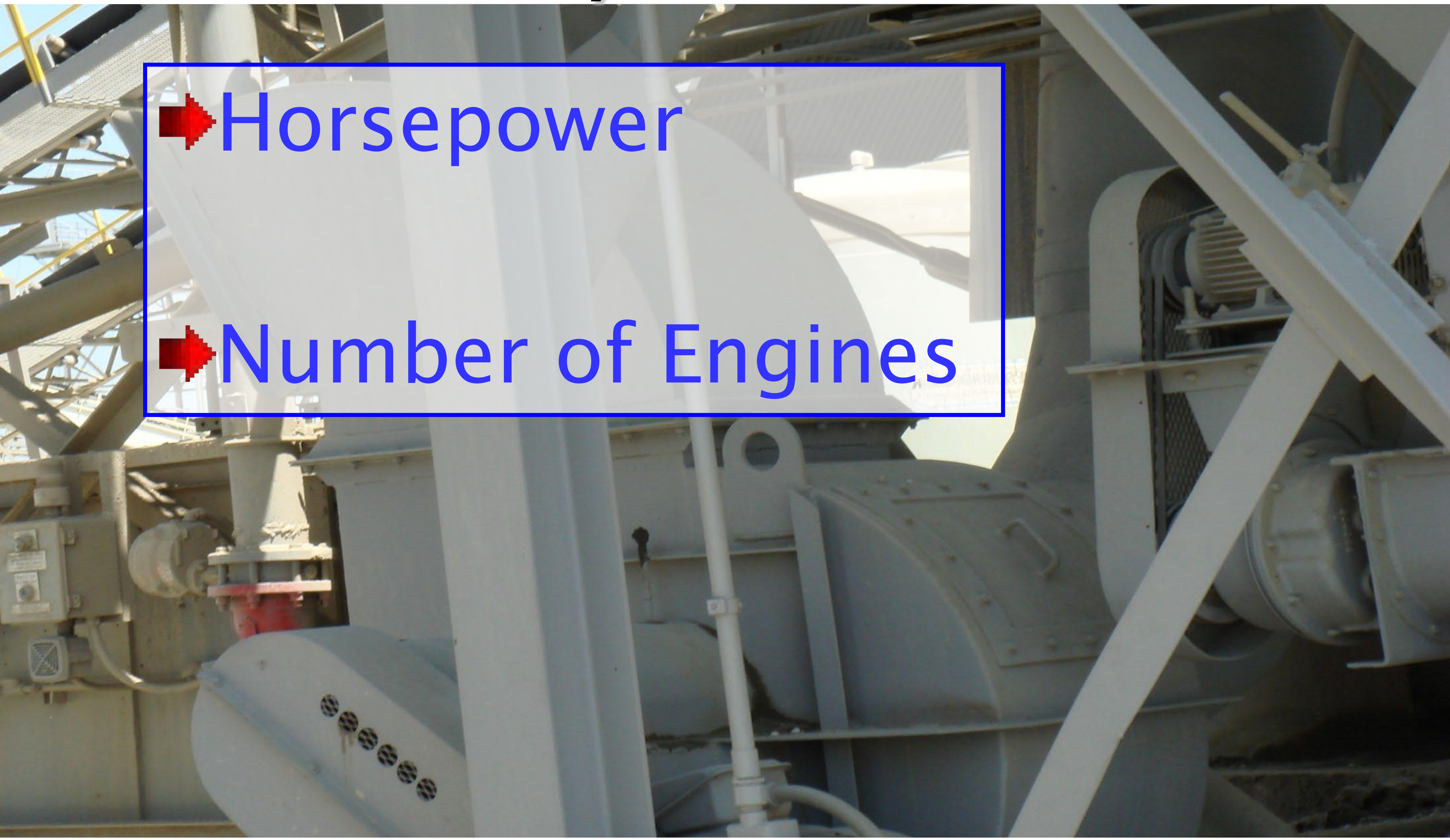
Monitoring Device
Triboelectric Sensor

- TES work well at low particulate concentrations
- Detects micro amp current from particles hitting a metal probe
- Simple and inexpensive
- Effective monitor when a small to moderate increase in emissions is of concern

Baghouse Monitoring Device Triboelectric Sensor

- Establish baseline
- Monitor detects gradual or instantaneous increases in the signal from baseline
- Baseline emissions can be as low as 0.1 mg/dscm (0.00005 gr/dscf)

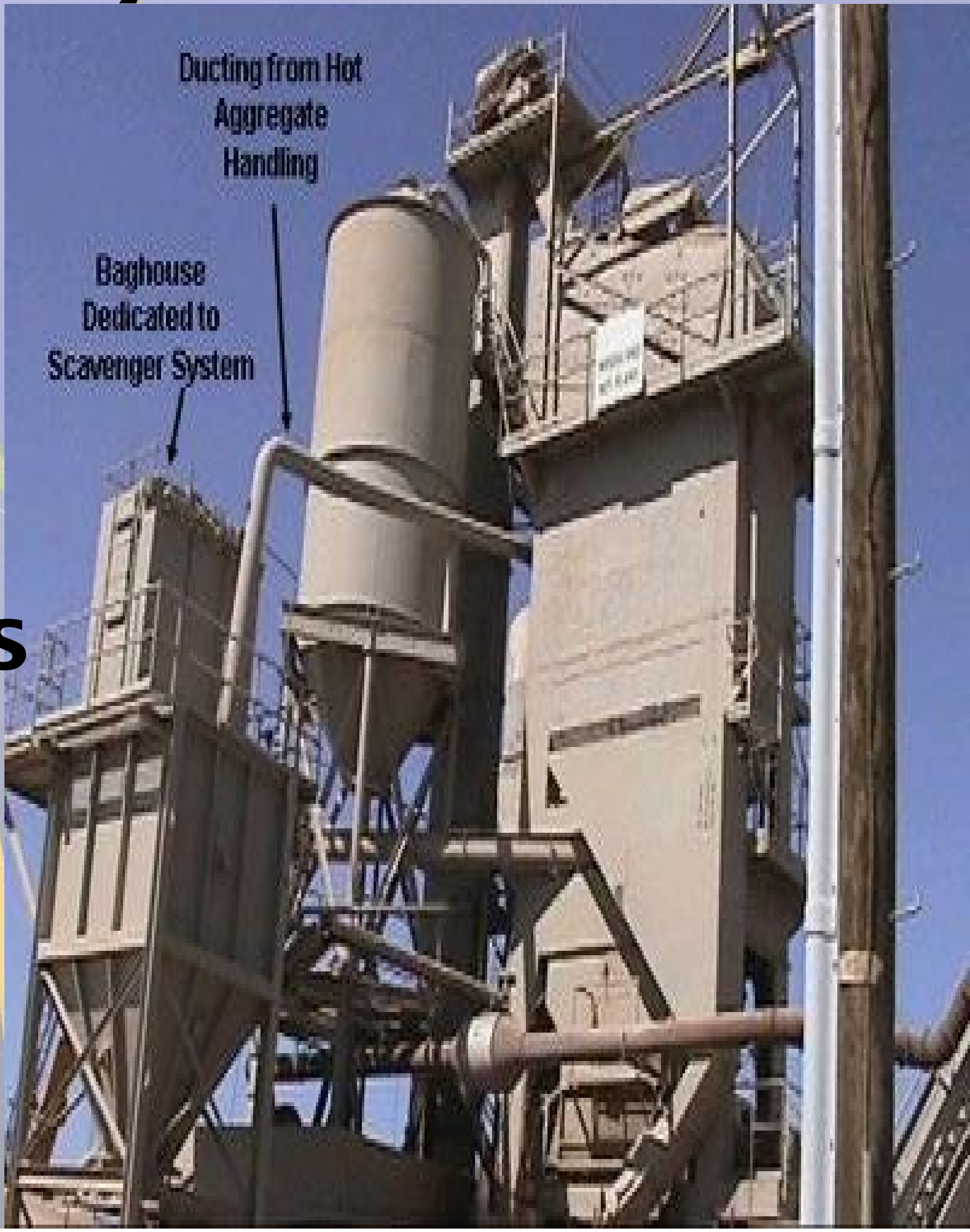
Inspection Procedures
Fans/Blowers



- Horsepower
- Number of Engines

Control
Scavenger System

- Collects fugitive emissions from:
  - ✓Hot aggregate elevator
  - ✓Vibrating screens
  - ✓Hot bins



Control
Asphalt Binder Storage

- May or may not be controlled
- Controls include
  - ✓ Condensers,
  - ✓ Vapor recovery system (similar to gas station)
    - Vapors returned to refinery for incineration
- Delivery truck lines are flushed with non-hazardous cleaners

Control
Asphalt Binder Storage

Control
Blue Smoke

Control
Blue Smoke

- An aerosol of condensed organic particles adsorbed to dust or water particles

Control
Blue Smoke

- Some organic compounds begin to

1. vaporize at 300 F
2. Condense in ambient air
3. Adsorb to dust and water particles

- To form visible emissions
- Visible emissions are formed until the air becomes saturated

Blue Smoke
Emission Points

Control
Blue Smoke Emissions Points

- Drop points of HMA from pugmill
- On top of surge bins/silos
- At the base of surge bins/silos
- Drag slat conveyors
- Truck loadout

- Challenge to capture and control
- Primary reason for complaints
- Perception !!

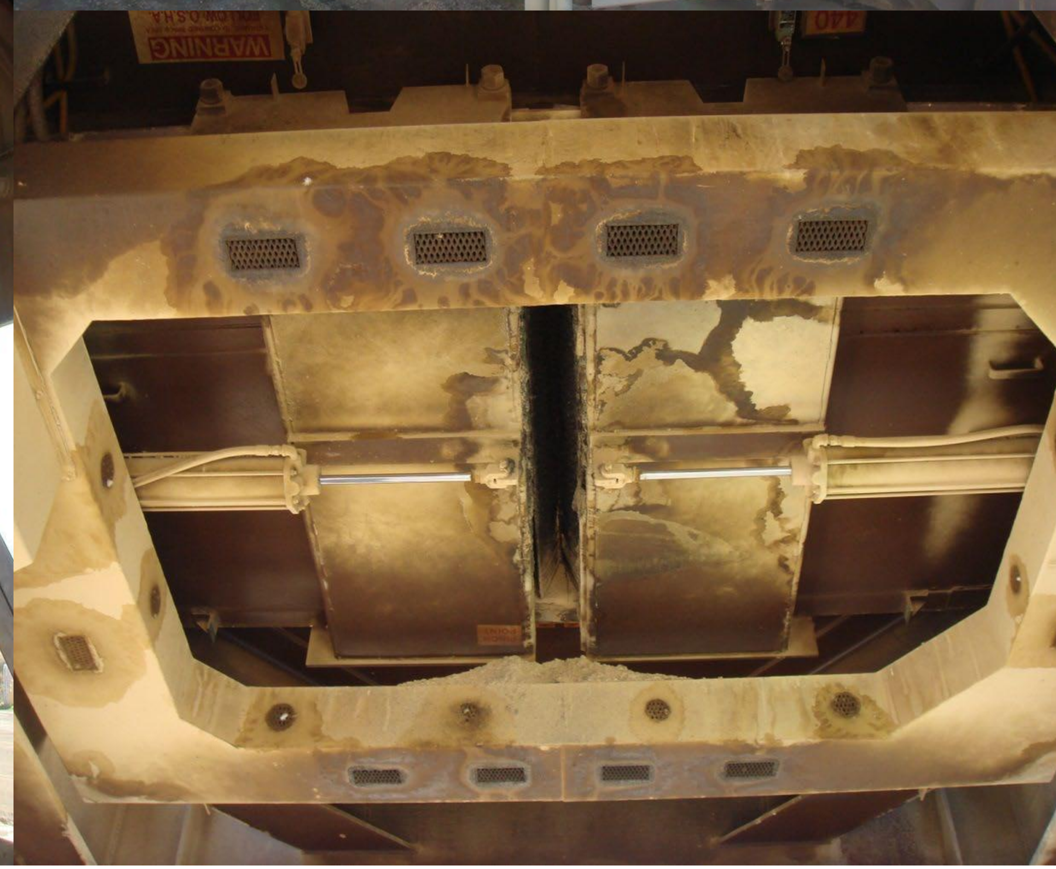

Blue Smoke Collection System


Blue
Smoke
Collection
System
to Dryer


Induction Fan of
Blue Smoke
Collection
System


Blue Smoke Control Device??


Blue Smoke
Controls



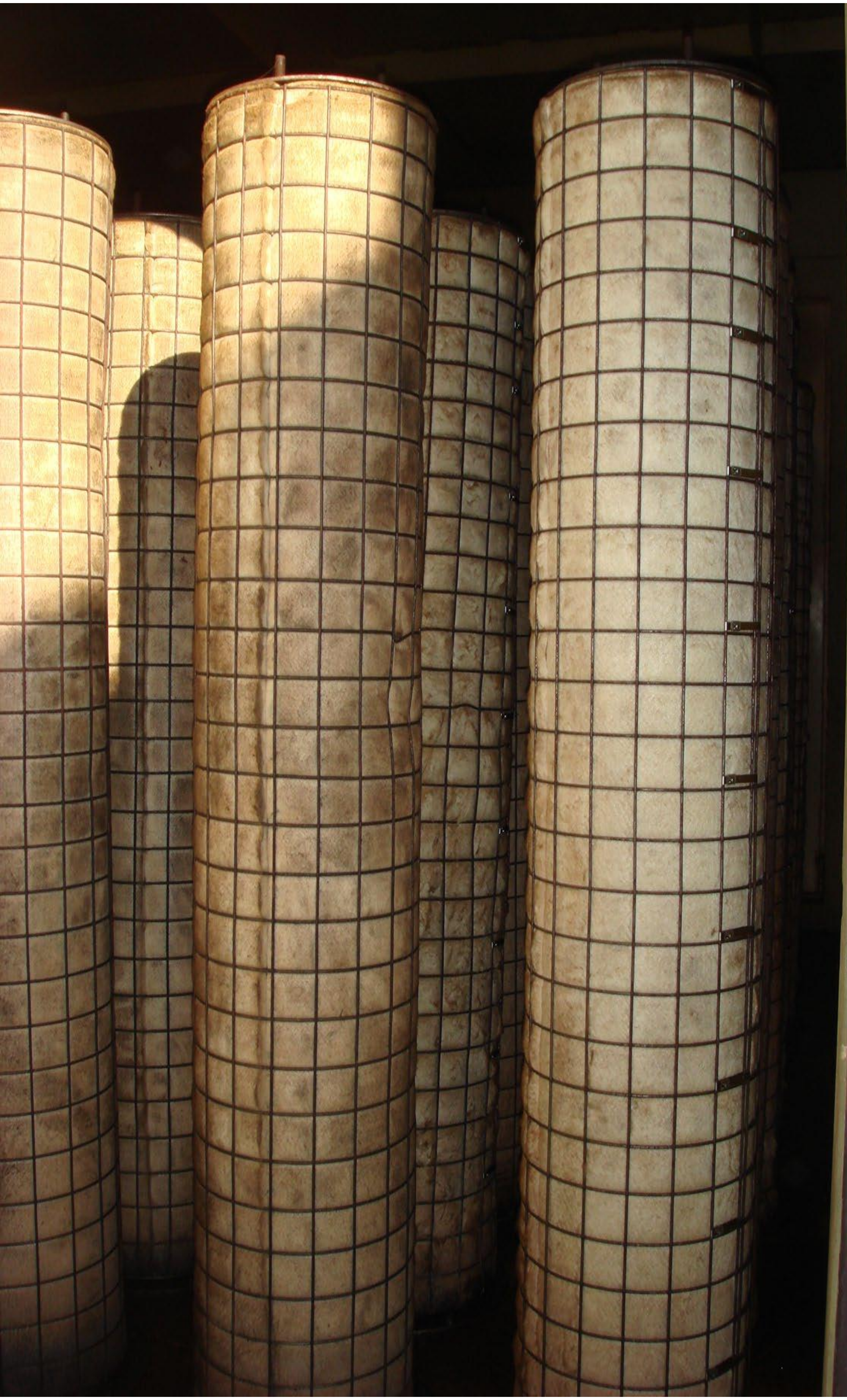
Truck Loadout & Blue Smoke Controls

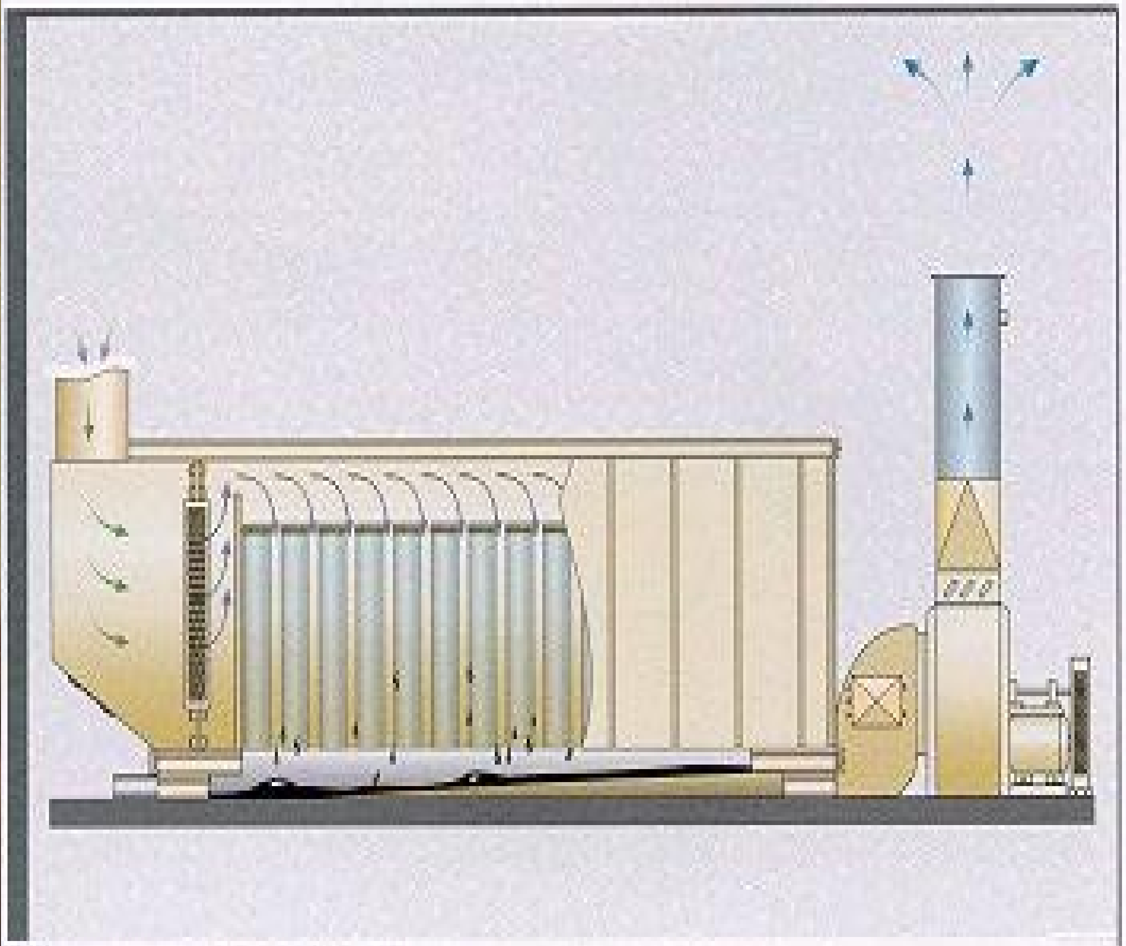
Silo/Truck Loadout & Blue Smoke Controls??

Blue Smoke Controls

Blue Smoke Control Device

Fiberbed Filtration





FIBERBED MIST COLLECTOR


ASTEC
ASTEC


Fiberbed Filtration

Control of Blue Smoke
Truck Entrance

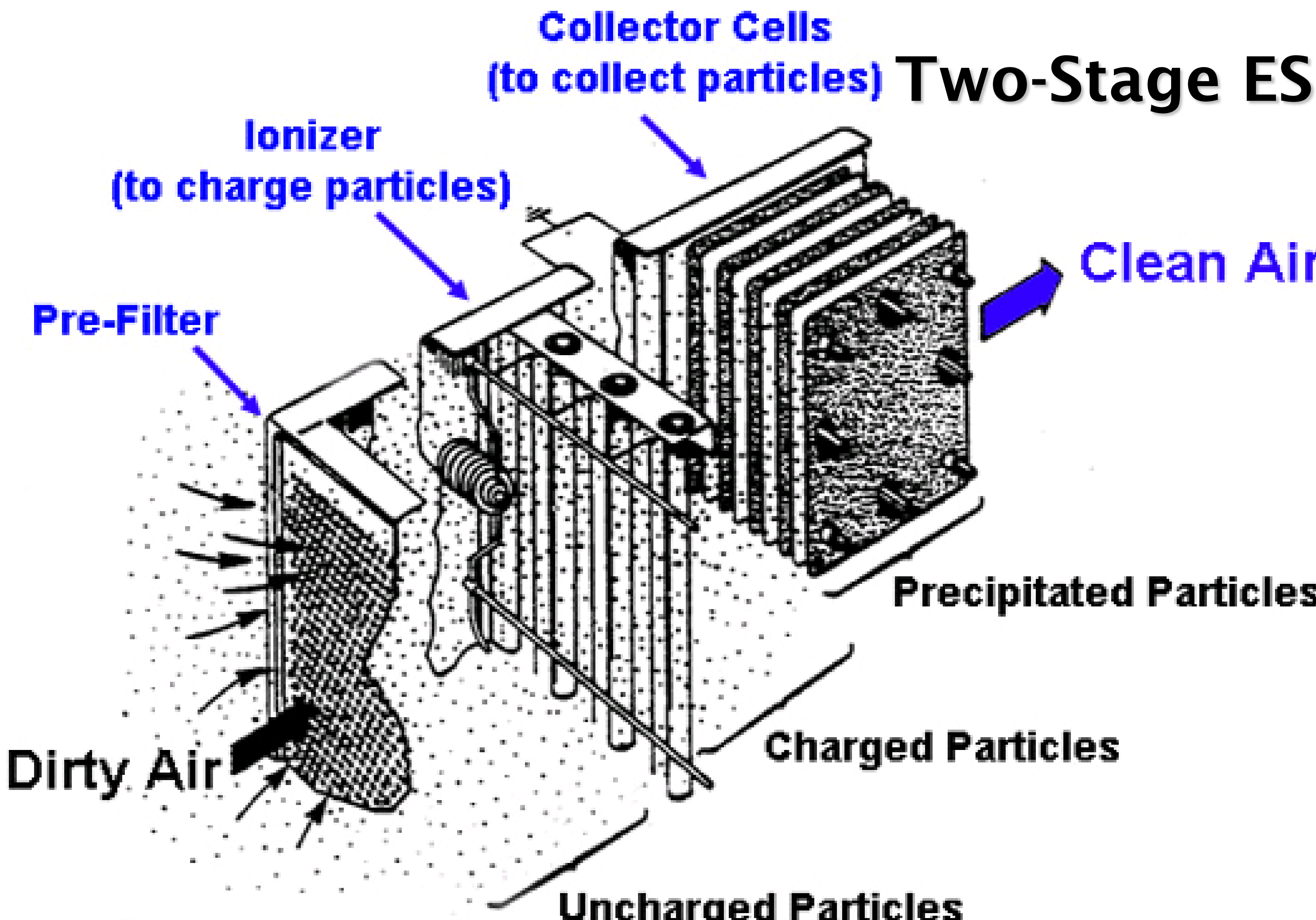
Control Blue Smoke
Enclosed Load Out

DUCTWORK TO ELECTROSTATIC PRECIPITATOR

Control
Side View of HMA Drop with ESP/Smog Hog for Blue Smoke

Control
Ducting to ESP/Smog Hog

Two-Stage ESP



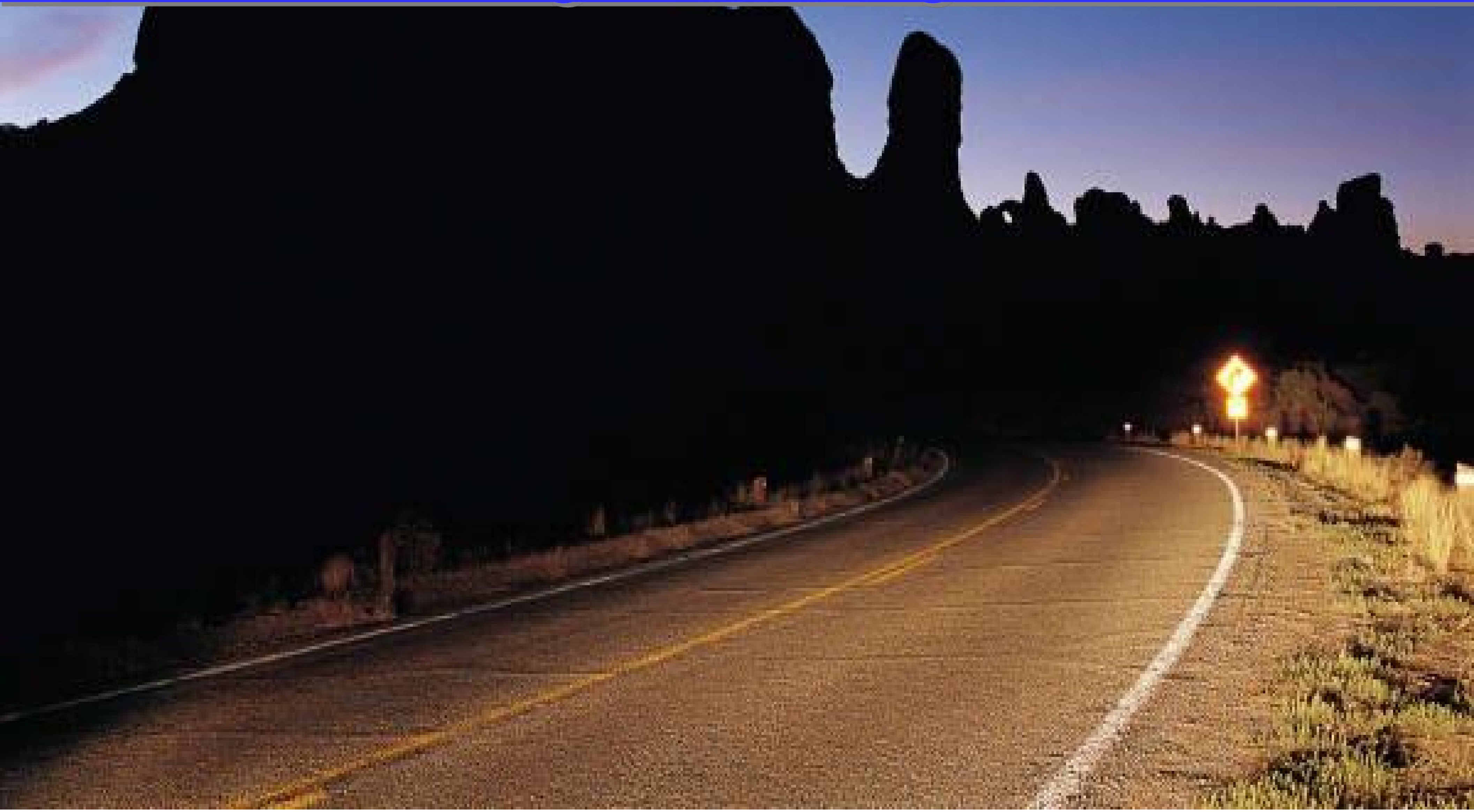
Controls
Innovations in HMA Production

- Four areas where the technology has improved
  - ✓burner design,
  - ✓fuels,
  - ✓dryer/drum design, and
  - ✓blue smoke controls

Controls
Triple-Drum Mixer

ASPHALT SEAL COAT AND PAVING

Reading a Moving Plume



Moving Source

Permit Conditions

- Emission Controls
  - ✓ Emission Limits
  - ✓ Process Limits
  - ✓ Emission Rate Limits
  - ✓ Requirements to Minimize Emissions
  - ✓ Source Test
  - ✓ CAM (gauges on baghouse)

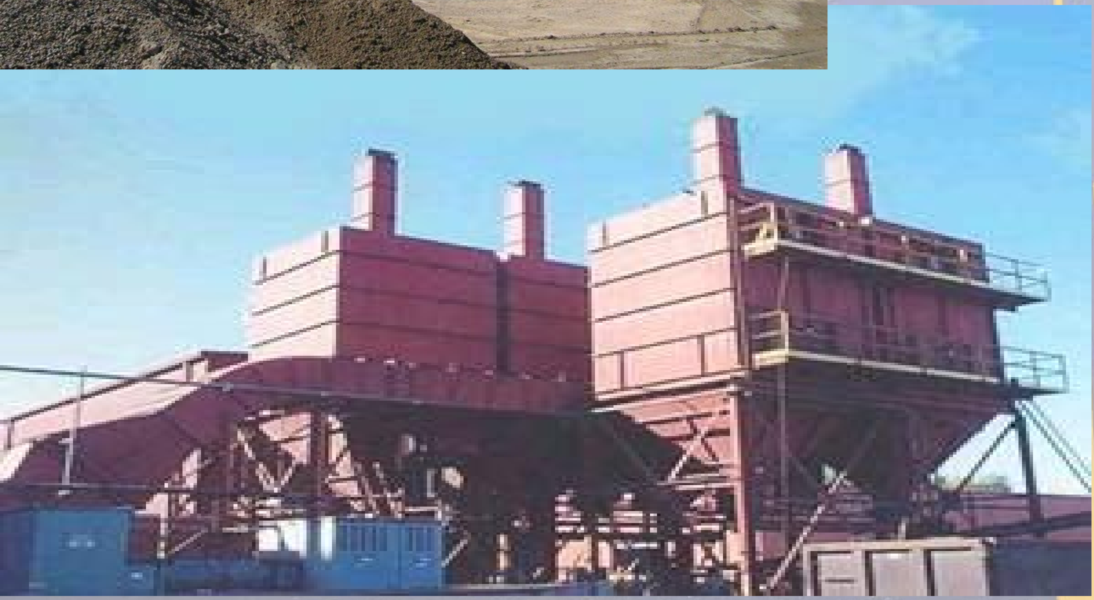
Permit Conditions cont.

- **Fuel Requirements**
  - ✓Type
  - ✓Nitrogen or Sulfur content
  - ✓Amount of fuel
  - ✓Type of backup fuel
  - ✓Method of measurement
  - ✓Recordkeeping of fuels purchased and used

Permit Conditions cont.

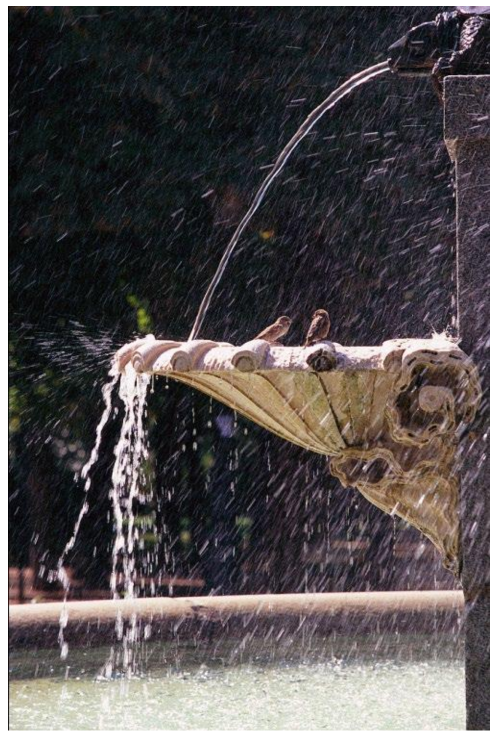
- Visible Emissions Limits
  - NSR lists are 20% or No. 1 on Ringleman
  - Sources permitted before NSR maybe 40% or No. 2 on Ringleman

Process/Control Dry Collection Systems

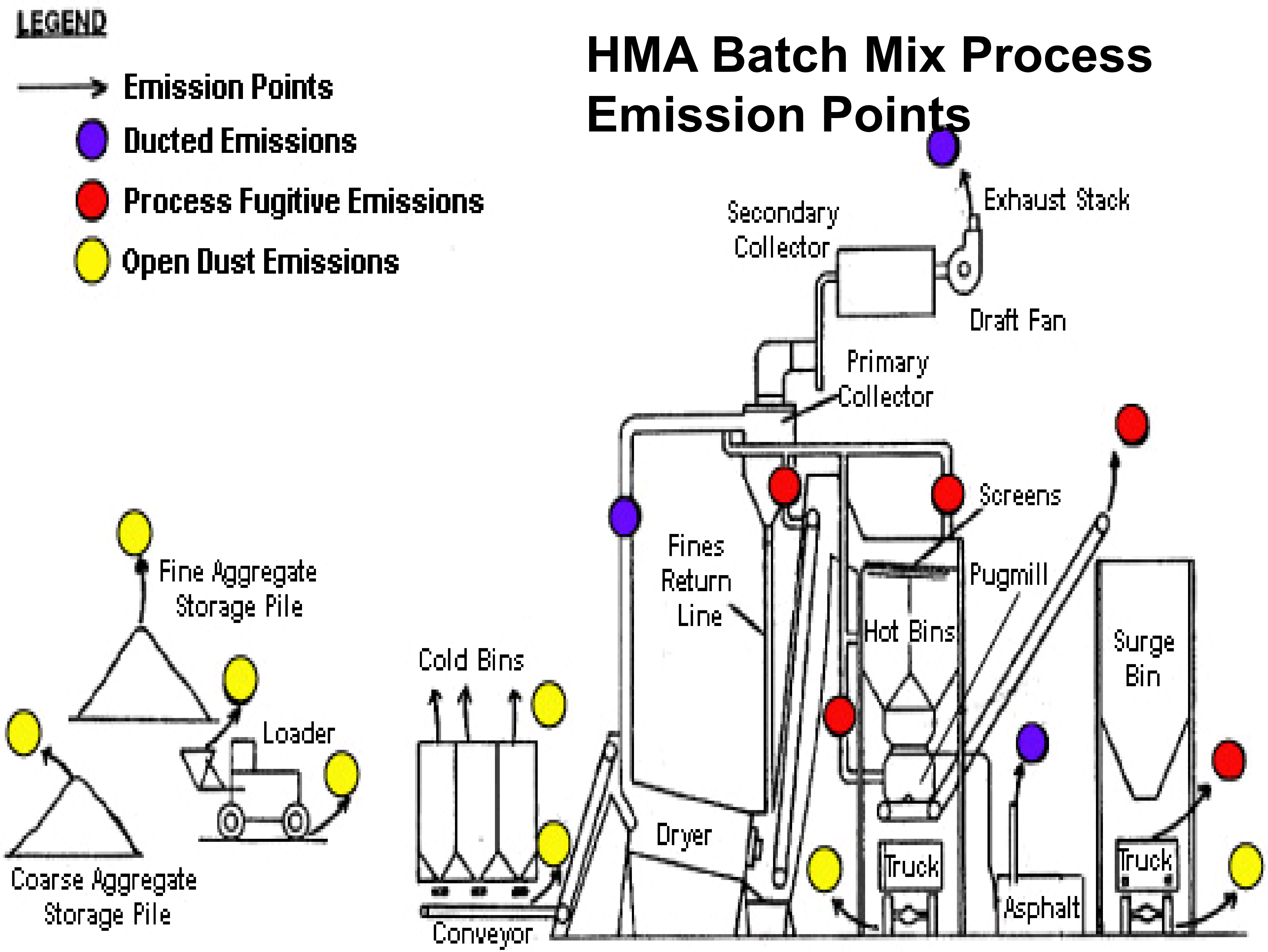


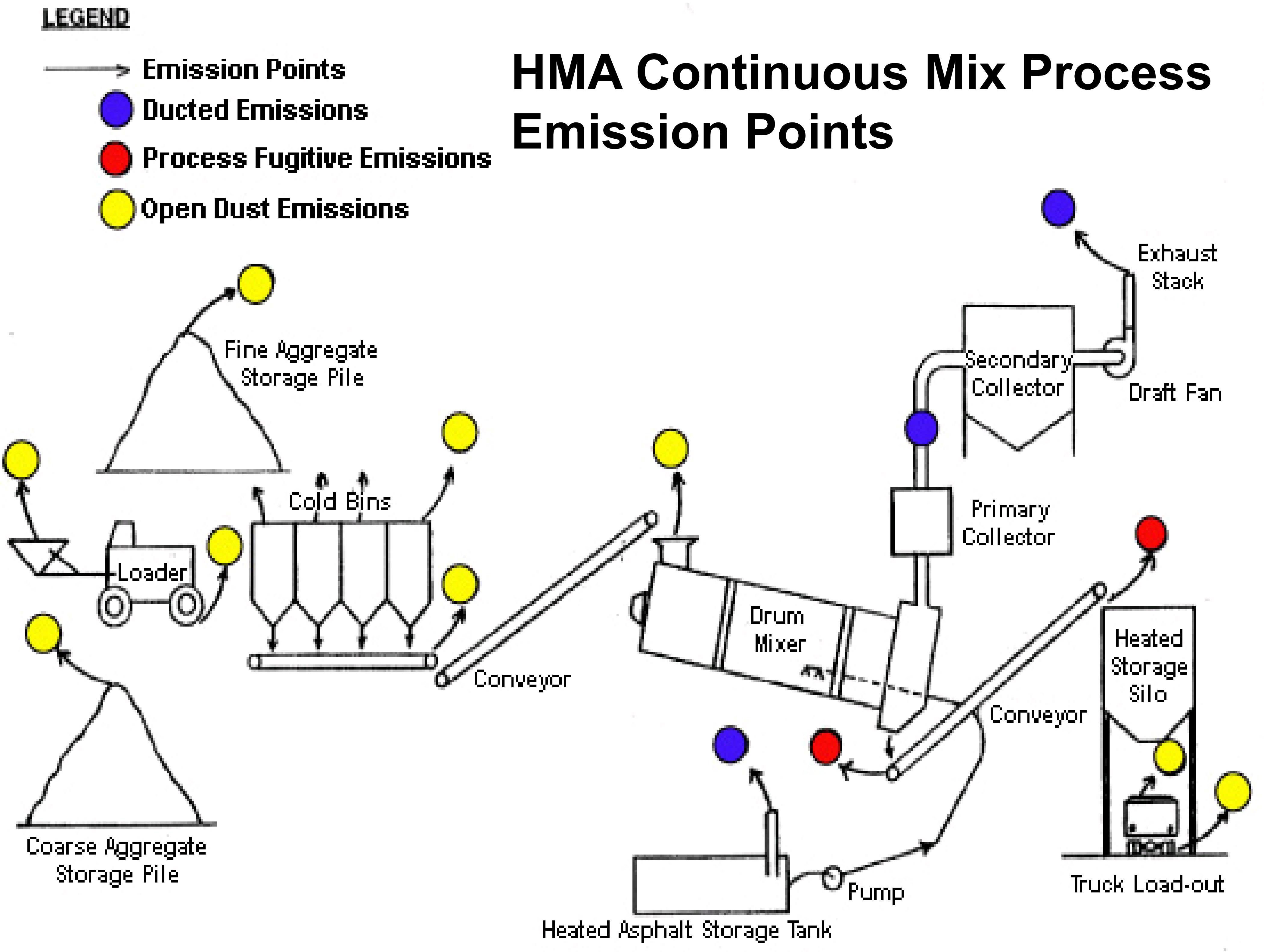
- **Baghouses are regulated in terms of**
  - ✓ **Source Test Requirements and Methods**
  - ✓ **Visual Test Method?**

Permitting/Inspection HMA Source Test

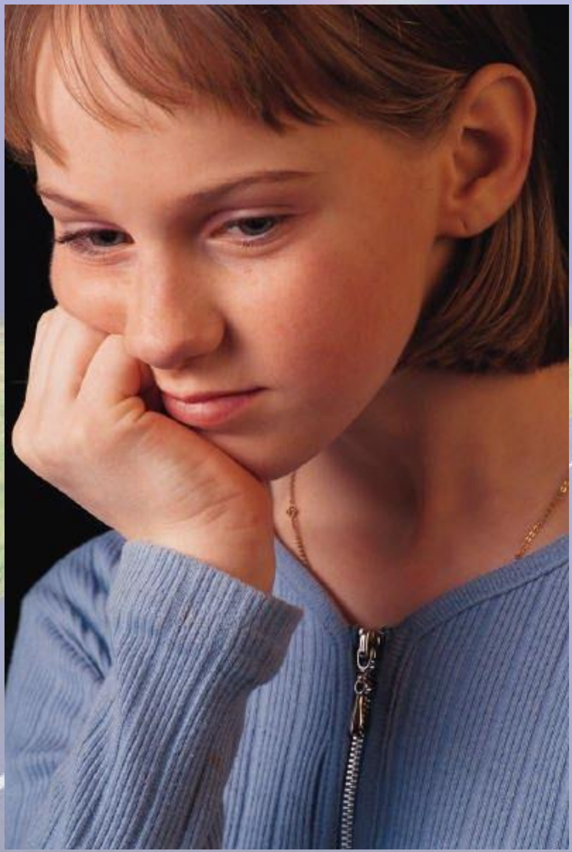


HMA Batch Mix Process Emission Points




HMA Continuous Mix Process
Emission Points
LEGEND
Emission Points
Ducted Emissions
Process Fugitive Emissions
Open Dust Emissions
Exhaust Stack
Secondary Collector
Draft Fan
Fine Aggregate Storage Pile
Cold Bins
Loader
Primary Collector
Drum Mixer
Conveyor
Conveyor
Heated Storage Silo
Coarse Aggregate Storage Pile
Pump
Truck Load-out
Heated Asphalt Storage Tank

Permit/Inspection Objectives



Determine compliance with District, Federal regulations & permit conditions

- Fugitive emissions
- Stack emissions
- Visible emission tests
- Oxides of nitrogen (for fuel burning equipment)